Newsletter No. 264
December 2020

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Copy date for the next Newsletter is Monday 1 February

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For enquiries about field and geoconservation meetings please contact the Field Secretary.
To submit items for the Newsletter please contact the Newsletter Editor.
For all other business and enquiries please contact the Honorary Secretary.
For further information see our website: bcgs.info, Twitter: @BCGeoSoc and Facebook.

Future Programme

Indoor meetings are normally held in the Abbey Room at the Dudley Archives, Tipton Road, Dudley, DY1 4SQ, 7.30 for 8.00 o'clock start unless stated otherwise. The same timing applies to the current programme of online 'Zoom' meetings.

Visitors are welcome to attend BCGS events.

Monday 14 December *(Christmas Zoom Meeting):* 'Algae, fish and climate change: the last 3.5 million years'. Speaker: Matt Sutton, DPhil student, Department of Earth Sciences, University of Oxford. Phytoplankton form the base of ocean ecosystems. They play a vital role in the climate system, the composition of the atmosphere and, ultimately, the health of humanity. Anthropogenic climate change is predicted to cause substantial changes in phytoplankton abundance over the coming centuries. Using the sedimentary record of the deep sea, Matt will be quantifying changes in the abundance of phytoplankton and fish microfossils across the Plio-Pleistocene, with an emphasis on episodes of rapid environmental change.

Monday 18 January *(Zoom Meeting):* 'Geology in Paradise'. Speaker: Graham Hickman. The islands of Trinidad and Tobago lie at the junction between the South American and Caribbean plates. The area has generated hydrocarbon accumulations which provide much of the economic revenue for this island nation. Graham Hickman, formerly with BP Exploration, describes the geology and adventure in the search for gas fields in the offshore Columbus basin, Trinidad.

Monday 15 February 2021 *(Zoom Meeting):* 'Atmospheric Cave Science'. Speaker: Professor Ian Fairchild, School of Geography, Earth and Environmental Sciences, University of Birmingham. Ian's talk will take us from caves and monitoring cave climates over time through the study of stalagmites, to the need for awareness about appropriate room ventilation i.e. CO_2 levels. Recently this issue has been covered in the press with respect to Covid-19, and ventilation on aeroplanes and trains, so it is timely and also of interest in relation to underground spaces in the Black Country.

Monday 15 March *(Zoom Meeting, 7.00 for 7.30 start):* AGM followed by 'Silurian Rocks of the Dingle Peninsula'. Speaker: Ken Higgs, Emeritus Professor of Geology, University College Cork. TBC.

Monday 19 April *(Zoom Meeting):* Speaker: Stephen Knipe in London, Ontario. TBC.

BCGS Committee - vacancy for Honorary Secretary

The Committee meets about 4 times a year to discuss all matters concerning the Society, but particularly to forge together our programme of events. The Society can only thrive with the efforts put in by the Committee behind the scenes, and we are always looking for new ideas.

Currently there is a vacancy for the post of Honorary Secretary, and we urgently need someone to fill this post. If you are interested, or would like more information about the work that this entails please don't be shy to put your name forward!

Please use the email address secretary@bcgs.info if you are interested.

Other Societies and Events

Covid-19 arrangements

Some societies have cancelled their meetings for the foreseeable future. Many are running virtual on-line meetings. Below is a list of the societies whose events we normally promote in this Newsletter. Please check websites for further information.

Warwickshire Geological Conservation Group

Wednesday 9 December: 'History and Hidden Gems of the Lapworth Museum of Geology'. Speaker: Aerona Moore, Learning and Engagement Officer at the Lapworth Museum of Geology.

Wednesday 17 February, 2021: 'Geological Time and the Anthropocene'. Speaker: Ian Fairchild Emeritus Professor, University of Birmingham and Chair, Herefordshire and Worcestershire Earth Heritage Trust.

WGCG Geology Free Talks: Wednesdays 7.30 via Zoom. For more details visit: http://www.wgcg.co.uk/ or email: warwickshiregcg@gmail.com.

Manchester Geological Association

Wednesday 13 January 2021: 'Plate tectonics explained'. Speaker: Professor Peter Burgess, University of Liverpool.

All Zoom meetings will start at 7.00 with a login time from 6.30. For further information about meetings: http://www.mangeolassoc.org.uk/ Visitors are always welcome.

Shropshire Geological Society

Wednesday 9 December: 'Carrying out marine geology at sea - the role of technology in discovery'. Speaker: Neil Mitchell, University of Manchester.

Wednesday 13 January 2021: 'Hydrogeology - water sources and plastic contamination'. Speaker: Stefan Krause, University of Birmingham.

Wednesday 10 February: 'Redrawing the Geological Map of South Wales'. Speaker: John Cope, National Museum of Wales.

Lectures are being held using Zoom and commence at 7.00 for 7.30. Further info: http://www.shropshiregeology.org.uk/SGS/SGSEvents.htm

The Geologists' Association

Geology from your Sofa

The Geologists' Association may not be able to invite you to attend lectures and field trips at the moment, but they are looking at ways for you still to enjoy geology, virtually through online courses, field trips and talks.

Virtual Festival of Geology, Saturday 7 November 2020 - catch-up

For those who missed the GA's virtual Festival of Geology, or would like to re-engage with the events, you have until **31 December** to catch up. There were 4 excellent talks, including 'The Day the Dinosaurs Died' by Prof. Philip Manning from Manchester University. Recordings of the **four talks** are now available on the VFOG website. These can be viewed here: https://festivalofgeology.org.uk/lectures-and-break-out-rooms/

Recordings of several **virtual walks** are available here: https://festivalofgeology.org.uk/tours/ These include a virtual walk around Martley, which will be familiar to some of our members from field trips.

Finally, don't miss the Saltwells Tour, guided by our very own Graham Worton, here: https://festivalofgeology.org.uk/saltwells/

See the website for further details: https://geologistsassociation.org.uk/sofageology/

Geological Society, West Midlands Regional Group

Tuesday 12 January 2021: 'X-ray analytical methods in Geology'. Speaker: Jonathan Wilkins, X-ray Mineral Services Ltd.

Tuesday 9 February: 'The assessment of landslide hazard and risk, using UK and Hong Kong examples'. Speaker: Steve Parry, Parry Engineering Geological Services.

Meetings are by Zoom Video Conference at 6.30. For further details please contact the Group Secretary at: geolsoc_wmrg@live.co.uk Click here for website.

Check websites for the following societies:

Mid Wales Geology Club: http://midwalesgeology.org.uk/
Teme Valley Geological Society: http://www.geo-village.eu/
Woolhope Naturalists' Field Club - Geology Section https://www.woolhopeclub.org.uk/meetings
East Midlands Geological Society: http://www.emgs.org.uk/
Lapworth Lectures: http://www.birmingham.ac.uk/facilities/lapworth-museum/events/lectures.aspx
Abberley & Malvern Hills Geopark: http://geopark.org.uk/
Herefordshire & Worcestershire Earth Heritage Trust: https://www.earthheritagetrust.org/
North Staffordshire Group of the Geologists' Association: https://nsgga.org/

Editorial

BCGS has now successfully presented three virtual meetings hosted by our Meetings Secretary Keith Elder, and managed by Ray Pratt, sharing access to 'Zoom Pro' with WGCG. At the last meeting we had a rolling slide show during the sign-in time, compiled largely from the BCGS photo archive by John Schroder. This will be extended for the next session, and as we all find our way gradually with this new technology, any suggestions from you will be welcome.

Below, our Chairman Graham Worton explains the origins and extols the wonders of Saltwells National Nature Reserve as we all celebrate its newly elevated status and applaud those who have worked tirelessly to make this happen. This follows from our recent well-attended virtual meeting with talks given by Alan Preece (Saltwells) and Ian Beech (Wren's Nest). This leads me on to another innovation for BCGS. Our social media representative, Pete Purewal has now set up a BCGS YouTube channel. The last talk was recorded and can now be viewed on YouTube (details in the box on p.17). For even more on Saltwells, Graham did a virtual tour for the GA's Festival of Geology. This is still available to view (details at the bottom of the Geologists' Association item on p.4). But finally on this subject, nothing beats a visit to explore this local gem for yourselves!

In the last issue, new member David Manning introduced himself, and since then we celebrate the enrolment of two more new members, Charles Hughes and Alison Delorie. Given the ongoing lack of face-to face contact, they both introduce themselves in this issue. We look forward to the time when we can all meet in person again, and Charles, Alison, and David can become more fully involved in our activities.

We have an up-date from our Poet in Residence, plus informative, entertaining and sometimes challenging items from Andy Harrison and Bob Bucki, and our regular column 'Mike's Musings'. We have a programme of virtual talks in place for the New Year, and will keep you posted about further activities as and when Covid-19 restrictions permit the resumption of our outdoor activities.

On a practical note - don't forget that subscriptions are due on 1 January (renewal form on p.21).

Finally, we look forward to our final talk of the year, (14 December) from student Matt Sutton whose roots are firmly planted in the Black Country. We hope that you will all be there with Christmas in mind. Please feel free to adorn yourselves with festive gear, and perhaps have to hand a glass of your favourite tipple and a mince pie so we can all say 'Happy Christmas'! ■

Julie Schroder

Saltwells National Nature Reserve

The Black Country gets its second geological National Nature Reserve

It's been a big year for Black Country geology and the Saltwells hasn't it! In October, the Saltwells Local Nature Reserve was upgraded to national status and became a National Nature Reserve on the basis of its very special Geology. So, it is now officially a geological National Treasure. Shortly after becoming a new NNR it was also awarded national Green Flag Status - so why did all this happen, and what does it mean for the future? *(N.B. Saltwells NNR contains three SSSI Geosites visited by BCGS for Geoconsrvation work: Doulton's Claypit, the tramway known as 'The Old Tub Line', and Brewin's Cutting. Ed.)*

Why Natural England upgraded the site to National Geological Importance

Everything about the Saltwells is so wonderfully grounded in the very ancient history of its geology. This gives the place its unique character, determines its biodiversity, and defines where people dug things up and placed pathways and structures. Even its name - 'Saltwells' - comes from the weak brine well that once supplied a medicinal bathhouse in the woods here. This place is so much more than a top scientific resource. While National Nature Reserve status was given to it this year for these exceptionally important geological features, the key interpreted features actually only occupy a small part of the 247 acres of the site.

Doulton's Claypit

That exposed geology, though, is particularly important for understanding the creation of the whole Midlands area. Within the context of what was an immense coal mining industry for England, where coal could be seen everywhere, it is now rare indeed in the national context. This is why Saltwells has become so very significant to the natural and cultural heritage of England, and why its status has moved upwards from Local Nature Reserve (LNR) to National Nature Reserve (NNR).

In terms of that rarity, Saltwells is now the only accessible place in which you can see a coal seam in-situ, in its genuine geological setting. Add onto that the surrounding landscape of mining features that are very well expressed here, along with their Industrial Revolution transport connections, and you have a site with a unique opportunity to explain a part of England's history like nowhere else.

Important Human Connections

Perhaps less well appreciated is the fact that Saltwells is also one of the earliest land-reclamation schemes on record. The Saltwells area was a very different landscape in the 1700s and 1800s, completely deforested and left in a chaotic state by intensive charcoal production, coal and clay mining and other small industries and transport routes crossing the area. Lady Dudley initiated a deliberate landscaping and tree planting scheme and for a long time this area was known by some as 'Lady Dudley's Plantation' or the 'Lady Wood' because of that pioneering environmental work. ►

Brewin's Cutting

I personally think that this particular National Nature Reserve has much greater importance than this and is a UK exemplar of good practice for managing and balancing a wide range of heritage interests, whilst celebrating and supporting people's interactions with that heritage through time - it has the context of past, present and future. Saltwells is also a hugely important asset in the treasure chest of the Black Country Geopark for all these things.

Saltwells becoming a NNR is pretty important for geological conservation and starts a new national programme for NNR's. It is the first geological NNR to be selected under Natural England's new National Nature Reserve Strategy (a partnership of Natural England and others that began in 2017). This is a new national strategy that focuses on conservation, people and science holistically.

There are now 223 National Nature Reserves in England and these are described by many as 'the crown jewels of England's natural heritage'. Saltwells moving into this category is no mean achievement. Of course, the reason that it has achieved this is because of the people behind it, who for decades have treasured it, championed it and worked out how to protect and nurture it against a continuously changing social landscape, That of course is an enduring partnership of specialists, site management teams and volunteers, including the BCGS as its primary community-based geological champion for the last 45 years.

The new designation announcement brought with it a range of lovely comments and press coverage such as these quotes that I picked up:

Tony Juniper, Chair of Natural England:

"England's National Nature Reserves embody our natural diversity of wildlife and geology. They are places where nature comes first, places for conservation, research, education and people..." "Achieving National Nature Reserve status is not easy and Dudley's wardening team, local volunteers, friends group and the Canal & Rivers Trust can be rightly proud of what they have achieved in managing this reserve to reach the standard it is today."

Dr Colin Prosser, Principal Geologist at Natural England:

"The geological features visible at Saltwells are nationally important and represent two periods of the Earth's history spanning more than 100 million years. This new National Nature Reserve provides visitors and local people alike with a window into deep time, connecting this ancient world of swamps and tropical seas with the history and people of Dudley and the Black Country; a further reminder as to why the Black Country was recently recognised as a UNESCO Global Geopark."

Another very important thing in all of this is that Dudley Council's teams, through their long track record of working so well with Natural England have themselves been given 'approved body' status for the management of National Nature Reserves and SSSI's, with Natural England recognising their work as national 'best practice' in terms of geoconservation and engagement of people in these urban settings. ►

Perhaps the most exciting thing happening now, as you read this item, is that we have had delivered, and are now working on the fitting out of the new wardens' base and teaching classroom at the reserve. It took a long time to plan and sort out funding, and has meant that for a number of years, the wardens had to operate daily from a remote site (Buffery Park in Dudley) to get their equipment and staff to and from the Saltwells site. When the new base opens in the early part of next year, we will finally have an operational site base which will be more welcoming and so much more efficient. I am working with teams on displays and interpretation to go into the classroom area at the moment so watch this space for future updates about this.

Saltwells Wardens' Base nears completion

Awards on top of awards – the Green Flag Award

In addition to the NNR declaration, in October the Saltwells received a 'Green Flag Award' under the National 'Keep Britain Tidy' campaign. This award recognises and rewards well-managed parks and green spaces, and again, is not an easy thing to achieve, particularly so in an urban area. Being one of the largest urban nature reserves in the UK with enormous footfall (particularly at the moment during the pandemic) Saltwells faces human pressures that perhaps more remote rural reserves suffer less. So there is a complex balancing act in its management, and a large effort from staff and community volunteers goes into keeping things safe, accessible and welcoming.

Saltwells NNR has a wide range of rare and sensitive natural features ranging from bare rock faces, mining features, canals and streams, heathland, woodland and wetlands, which provide all sorts of habitats and management challenges. To get all of these up to - and keep up - a high national standard sufficient to achieve a national Green Flag Award takes some doing, so huge respect is due for all those involved in taking care of this amazing place - and a particular shout out to our BCGS volunteers! Thank you all so much for your ongoing practical support in the well-being of the geology and natural heritage of this site.

Geosite notice at Doulton's Claypit

Isn't it great that despite the troubles and challenges of 2020 we have such good news to lead us into the festive season and the promise of some great things to add to this in the new year. The Saltwells NNR and Green Flag awards and the UNESCO Global Geopark declaration in July all recognise tremendous passion and hard work poured into them by individuals and true partnerships (both staff and volunteers of many organisations) that have made these things shining successes in a difficult year.

I think that 2021 is going to be a fantastic year for Saltwells as the newest geological National Nature reserve on the block!

Have a great festive season everyone. ■

Graham Worton

Hello from two new BCGS members

In the last issue, new member David Manning gave us a delightful introduction for us to get to know him in the absence of any opportunities to meet at the moment. I'm delighted that we have enrolled two more new members since then, and here they introduce themselves. We look forward to the day when we'll all be able to meet again in person – and not just as thumbnail images in a Zoom meeting!

Profile – Charles Hughes

Hi everyone! My name is Charles Hughes, and I am one of three environmental scientists for the Canal & River Trust (West Midlands, Heritage & Environment Team). I am an Essex lad now living in the Black Country. I studied Geology at A-Level during the Sixth Form and progressed on to studying Physical Geography at the University of Hertfordshire. I have always had a passion for all things environment and Earth related. I have been very impressed with the BCGS and am very much looking forward to getting more involved over the coming months/years.

My fondest geological memory was a field course to the Isle of Arran, Scotland. I was amazed at the sheer diversity of rocks and landforms that could be found on one single island! This certainly helped inspire me in choosing a career in the natural sciences. Pre-Lockdown I also got to visit both Wrens Nest and Saltwells NNRs and was incredibly impressed at these important geosites that are now very local to me. I am also keen to connect the Canal & River Trust and BCGS. Moving forward, if there are ways we can support each other (Brewins Cutting SSSI as an example), then please let me know any of your suggestions. I look forward to meeting you all, hopefully in person, in the not too distant future.

The Doon, Arran

Charles Hughes

Profile – Alison Delorie

Thank you for inviting me to let you know how I came to join the BCGS. As a child I was steeped in geology as my father was the Professor of Geology at Cardiff University. His name was J.G.C. Anderson and one or two of your older members may have read some of his books. My family was Scottish and every year my father used to take his students back to the Highlands, and I went too and learnt all the lingo about Inclines and Synclines! When I was older we went abroad and when my friends asked me if I had seen such and such Cathedral or Castle in a particular town, I knew nothing of them as the family had been dragged around interesting geological sites instead! ►

Once I got beyond my teenage years and left home, my interest in geology waned and disappeared altogether for decades. Then, on retirement, I discovered the Geological Society in London and attended a great many interesting lectures. I have a flat in North London and discovered the Finchley Geological Society and attended a few of their lectures when I happened to be in London. I also went on a geology course with the WEA. Due to my newly-discovered interest in geology, I booked Alan Clewlow's geology trip to Iceland, which is now delayed until next year. However, I did manage a trip to Cuba just before Lockdown and weighed down my suitcase with fossils. With the onset of Covid, my lectures and geology course stopped but I have kept up my interest through the Finchley Geology Society newsletter and numerous emails containing interesting snippets, Down to Earth magazine and other stuff. Also, during Lockdown, I designated Tuesdays to watching geology tapes and reading geology books.

Havana Cathedral

Coral reef limestone in Havana Cathedral façade

So, why am I now joining the Black Country Geological Society? My family live in Stourbridge and I visit them very regularly and through my daughter-in-law I became friends with an ex-BCGS member, Fiona Scott. She and I religiously talk every Tuesday geology day, and recently she took me to the Wrens Nest. I was delighted to find information on-line about your lecture on the Wrens Nest and Saltwells and was impressed by your willingness to let me join in without being a member. After the meeting, Keith, very correctly, pointed out that such organisations as the BCGS only exist through subscriptions, so I felt I should join! I think I have also persuaded your ex-member to join again! I am looking forward to future on-line events and, later on, to meeting you all. ■

Alison Delorie

BCGS Poet in Residence, an Update

I've been the poet in residence now for nearly six months, and had a great time exploring the Black Country Geosites. It's been a thrill to learn so much from the Society's work available online and in our newsletters, and this has been invaluable for my considerations of place-identity. I've written 30 pages of poetry, several blog posts and a couple of essays already. I'm really hoping this will, at least in a small way, bring a wider audience to the BCGS and the recent UNESCO success. Although I'm yet to meet many of you properly, I'd like to offer my gratitude to you all for sharing your ideas and giving me this opportunity.

My goals for the residency are to encourage more people to engage with this region's wonders, to help with the Geopark's aim of championing the marvels of the Geosites, and to offer people new ways to think about geology, poetry and place. ►

To this end, I've been involved in a series of workshops. In October, I gave a talk for the University of Wolverhampton's ArtsFest Online programme - discussing how your work, geology more generally and my poetics come together. I ran a similar event for the campus in Stafford in early November too. On 14 November it was 'Rich Soils: a geopoetic tour of Wren's Nest Nature Reserve' (my favourite Black Country place). With videos, sounds and images, I took people on a virtual tour of the geosite, pausing here and there to discuss my ideas and to run mini writing retreats. I'm particularly proud of this event. It was part of the Being Human Festival, a national festival of the Humanities. I was able to welcome people from all over the UK and share my passion for the region and my growing love for geology.

Geological attention and observation help show us the connections between ourselves and the earth. All events were well attended and I've received some great feedback from the participants; one lady said it helped her feel more grounded in these difficult times and had revitalised her in the same way two weeks at the seaside would. This is a sentiment I think we can all appreciate when we consider the power of uncovering the overlooked in the mineral and fossil rich grounds that gave rise to our social worlds. I get really awestruck by it! ■

Since the last Newsletter, there are new posts for October and November in Rob's 'Chain Coral Chorus' series. You can find them here: https://rmfrancis.weebly.com/chain-coral-chorus Ed.

R. M. Francis

The Clwydian Hills Area of Outstanding Natural Beauty (AONB)

With history dating back to prehistoric times, very varied biodiversity and geodiversity, and abundant walking routes, the Clwydian Range has a lot to offer. Straddling the north-east Wales Denbighshire and Flintshire border the Range's hills roll over approximately 35 kilometres (22 miles) from Prestatyn, in the north, to the Nant y Garth Pass, near Llandegla, in the south. The River Alyn (Afon Alun) and rolling hills fringe the range to the east before the landscape opens into the broad Dee Valley beyond. To the west, the Range drops dramatically into the broad Vale of Clwyd, through which flows the River Clwyd.

Covering approximately 160 km^2, the Range rises to a maximum 554m at its highest peak, Moel Famau. Numerous hills and low peaks make up the range, including from north to south: Moel y Parc (398m), Fron Haul (317m), Moel Plas-yw (419m), Moel Arthur (456m), Moel Llys-y-Coed (465m), Moel Dywyll (475m), Moel Famau (554m), Foel Fenlli (511m), Moel Eithinen (434m), Gyrn (384m), Moel Gyw (467m), Moel Llanfair (447m), Moel y Plas (440m), Moel y Gelli (361m), Moel y Waun (412m) and Moel yr Accre (405m).

Several 2,500 year old Iron Age hill forts: Penycloddiau Fort (440m), Moel Arthur Fort (456m), Foel Fenlli Fort (511m), Moel-y-Gaer (339m), and other structures including the Jubilee Tower on Moel Famau *(see front cover photo)*, dot numerous summits. Snaking its way from Prestatyn, the Offa's Dyke Path heads southwards through the Range before disappearing deeper into the Welsh borders. Numerous small trails provide easy access and short walks to the various summits. In 1985 the Range was declared an Area of Outstanding Natural Beauty (AONB), one of five in Wales. ►

Foel Fenlli, an Iron Age hill fort

Due to the poor quality upland soils, the hills are predominantly covered with moorland, rich in heather, bracken, and gorse. In places, patchy woodlands cover lower slopes where pine, ash, elm, hazel, and oak grow. Together these provide valuable habitats for black and red grouse, buzzards, hen harrier, ringed ouzel, whinchat, wheatear, and rabbits.

Three distinct stratigraphic belts define the Clwydian Range: the hills, the valley holding the River Alyn (to the east), and the Vale of Clywd. The oldest rocks underlie the Range itself and include Silurian mudstone, siltstone and some sandstone strata belonging to the Nantglyn Flags (oldest) and Elwy Formations.

The Nantglyn Flags Formation dates from around the Wenlock-Ludlow Epochs and fringes the Range's periphery. These beds generally comprise very thinly interbedded mudstones and laminated muddy siltstones with less frequent thin beds of calcareous siltstone.

Dominating the central Range is the younger (Ludlow Epoch) Elwy Formation. The British Geological Survey Lexicon (webapps.bgs.ac.uk/lexicon), describes these rocks as 'striped silty mudstones and subordinate sandstones with lateral facies changes'. Both the Nantglyn Flags and Elwy Formations show evidence of turbidite sedimentation and slump structures.

The Clwydian Range from the Bryn Alyn summit

Together, the Nantglyn Flags and Elwy Formations represent marine sediments deposited within a deep marine basin off a continental margin during the middle Silurian. The marine basin lay at the southern edge of the Iapetus Ocean off the north-west shelf margin of the Avalonia-Baltic continent. Compressional subduction forces to the north and the extensional forces associated with the opening Rheic Ocean to the south, were driving the Avalonia-Baltic continent northwards and closing the Iapetus Ocean.

Underlying the hills and River Alyn (Afon Alun) Valley to the east is a belt of various Carboniferous sequences that sit unconformably over the earlier Silurian strata. The oldest stratum represented in this sequence also forms a thin sliver down the Clwydian Range's western edge. The Carboniferous strata include: The Cefn Mawr Limestone Formation (oldest), Loggerheads Limestone Formation, Leete Limestone Formation, Llanarmon Limestone Formation and Minera Formation.

These strata belong to the Lower Carboniferous Dinantian Series (Holkerian to Brigantian stages). Together they form over 1,000m of dark grey and grey, thinly to thickly bedded wackestones, packstones and shelly and oolitic limestones. In places these formations also include interbedded calcretes, palaeosols, bentonites and calcareous sandstones that all together are arranged in shoaling upwards cycles. These formations were deposited on a shallow carbonate shelf known as the North Wales Platform that lay off the north coast of St George's Land. The individual layers within each formation represent cyclic marine transgression and regression episodes as the platform was periodically submerged and exposed. ►

Underlying the Vale of Clwyd, the youngest strata in the immediate area are early Triassic sandstones belonging to the Kinnerton Sandstone Formation. The BGS Lexicon generally describes this stratum as 'red-brown to yellow sandstone, generally pebble-free, fine- to medium-grained, cross-stratified'. The formation reportedly reaches 500m thickness and is aeolian in origin having been deposited against the Vale of Clwyd Fault. Like the early Triassic Bridgnorth Sandstone, in Shropshire, the Kinnerton Sandstone Formation belongs to what was formerly known as the Bunter or Lower Mottled Sandstone. This stratum formed under dry and arid conditions when the Midlands sat within the Pangaea supercontinent prior to the north Atlantic opening.

Moel Famau from the Offa's Dyke path

Throughout the Clwydian Range, patchy superficial till (or diamicton) and head deposits overlie the Silurian bedrock. Diamicton tends to comprise poorly sorted sediments with grain sizes ranging from clay size to boulders, having been deposited during glacial retreat at the end of the last (Devensian) Ice Age. Head deposits typically reflect the underlying bedrock and result from hillwash, soil creep and solifluction processes moving shallow soils downslope due to gravity, moisture content fluctuations, and freeze / thaw action. To the east and west, various glacial and alluvial deposits associated with local watercourses overlie the Carboniferous and Triassic bedrock associated with the River Alyn (Afon Alun) and the Vale of Clwyd.

Due to its geodiversity, the Clwydian Range and surrounding area has a historic mineral extraction legacy from quarrying limestone, sandstone, slate, sand and gravel, and mining for lead. Countless old quarries and workings litter the local landscape, and these also provide additional biodiversity to the area.

Unable to travel far this year due to the pandemic, we spent a week visiting the area during late September and stayed in Mold (Yr Wyddgrug). The town is situated on the western bank of the River Alyn (Avon Alun) and it provided a good base from which to explore the area. We used 'Walking in the Clwydian Range', by Carl Rogers as our guide for walks, which range from approximately four to seven miles and often include a good refreshment stop.

One walk was to Bryn Alyn (403m) and Moel Findeg (364m) located east of the Clwydian Range, and this started and finished at the main road approximately 1km south of Llanferres. The route followed paths and trails over open fields, grassland and through woods. Bryn Alyn itself is formed from Carboniferous Limestone layers belonging to the Loggerheads Limestone and Cefn Mawr Limestone Formations. Gently dipping strata, combined with glacial erosion of covering sediments and weathering, have resulted in exposed patches of limestone pavement on and around the hill. To the north, we could see a gaping hole, Burley Hill Quarry, which was testament to the limestone extraction that had once gone on here. Strata belonging to the Minera Formation underlie Moel Findeg, which is located just east of the village of Maeshafn. Together, Bryn Alyn and Moel Findeg provided good view west towards Moel Llys-y-Coed, Moel Famau, Fron Hen, Moel Eithinen, Moel Gyw and Moel Llanfair, forming the Clwydian Range ridge. ►

Limestone layers forming Bryn Alyn

Walks on the Range itself included Moel Famau and Foel Fenlli, starting and finishing from the Loggerheads Country Park situated on the Range's tree covered western slopes. The route was waymarked along well laid out gravel paths formed from the local Silurian shales. The summit was open and exposed with grass and scree covering it. Dominating the summit was a vast square shale structure. This was all that remains of the once impressive Jubilee Tower, constructed in 1810 to celebrate King George III's Golden Jubilee. A plaque on the hill summit indicates that over 3,000 people from the local area gathered in their best clothes to see the foundation stone being laid by Lord Kenyon on Thursday 25th October 1810. Although the tower only lasted for 50 years, the base still remains today and provides spectacular views north and south along the Clwydian Range, east towards the Dee Estuary and Cheshire, and west over the Vale of Clwyd and North Wales. From the tower, we followed the Offa's Dyke Path south to the next hill, Foel Fenlli, the summit of which has been shaped into terraces and boundary ditches belonging to an Iron Age Hill fort.

Another walk took in the hill fort belonging to Moel Arthur, which like Foel Fenlli, only exists today as heather and gorse covered terraces and ditches. In places, the vegetation and peat had been worn away to reveal the underlying Silurian shales. Both hills provided great views west into the Vale of Clwyd and Ruthin, to the Snowdonia peaks and south towards Cadair Idris.

This part of Wales certainly has a lot to offer and a week only provided a taster. ■

Further information about the Clwydian Range AONB can be found at:
www.clwydianrangeanddeevalleyaonb.org.uk

Andy Harrison

Collecting Mini Critters – Part 1

Many of us as geologists are usually collectors of rocks, fossils and minerals, mostly at hand specimen size. There comes a time however in most of our lives when we could sympathise with Sheriff Brodie in the movie 'Jaws', when he utters the unforgettable line 'we are going to need a bigger boat' but in our case it is a room or a garage where we house our collections. There is another way however, and that is to go small, collect micromount minerals or microfossils and storage becomes infinitely more user friendly.

There is a world of microfossils available for study, from organic walled acritarchs, dinoflagellates, spores and pollen grains, through to the inorganic walled coccoliths, forams, radiozoa, diatoms and ostracods. Some such as conodonts and scolecodonts usually only remain as fossilised mouthparts. These microfossils are now important for biostratigraphy and palaeoenvironmental studies and very much so within the oil industry. ►

Collecting some of the larger microfossils is much easier than you would anticipate, given that you have a small amount of the necessary specialist equipment. The most expensive item will be a microscope, ideally a binocular zoom version, followed by a number of sieves. Most micromounters already have the microscope and you need only purchase a small number of sieves targeted at the size of microfossils that take your interest (more of that later). The rest will come from your local brewing and hardware stores. Sieves can be obtained from Chris Darmon at his Geosupplies online shop (other suppliers are available).

Below is detailed a method for obtaining some of the larger microfossils from locally available rocks such as the Wenlock and Ludlow Series sediments. This method is ideal for Ostracods (Figs.1, 2 and 3), Conodonts and Scolecodonts, which are relatively simple to isolate due to their larger size.

Method

First you need a sample of some poorly indurated argillaceous sediment such as mud stone, shale, marlstone or even a 'soft' limestone, the more friable the better. A quantity of around 100gms will be more than enough. This is then treated using the solvent method (Armstrong and Brasier, 2005, p.274) that uses petroleum ether. Be aware at this point that this method is not suitable for very dark grey or black shales as their hydrocarbon content will be too high. They require a different approach.

Roughly crumble your sample, but don't be overly heavy as you don't want to damage the specimens. Then dry it in the oven to remove all, if possible, of the water content. Do this slowly and remember you are trying to dry it and not cook it! Don't do this on a Sunday morning or you may become unpopular very quickly in a hungry household.

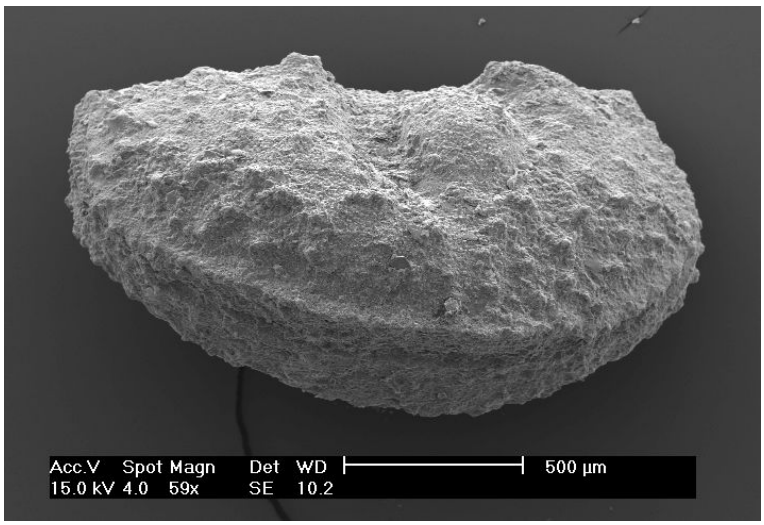

Fig.1: Beyrichia clausa. Tecnomorph, right valve, hinge length 1900 µm. SEM photograph of picked individual

The next step is to place the sample in a suitable container such as a glass beaker or jug and just cover the sample with petroleum ether, using a loose-fitting cover to prevent too much evaporation. I would recommend that if you don't have a fume cupboard (most, if not all of us), outdoors in the garden away from ignition sources is the best place for this, as ether is volatile and has a flammable vapour.

Leave the sample in for anywhere between 30 minutes and a few hours, agitating the container every now and again, before decanting all of the liquid into a container with a screw top. This will allow you to conserve the solvent for re-use, particularly if you pass it through a funnel with a filter paper in it. I would recommend 24 or 15cm filter papers from the local brew shop. We use them in the production of raspberry gin as a way of using excess allotment produce, but they will perform geological tasks equally well. This is known as the solvent method, but actually you dissolve nothing! The reason you do not put water on a chip pan fire is that it will flash boil and increase its volume explosively by about 1700 times the original. That forms the basis for the next step in the process. ►

Boil a kettle full of water and slowly pour it over the drained sample in the beaker/jug, (don't worry, it won't explode but just produce bubbles). Leave the lot to go cool, agitating it a couple of times during the cooling down process. The hot water causes the ether absorbed into pore spaces in the sample to convert to vapour causing it to fracture the rock, resulting in the production of a muddy soup.

The next step is to pour the contents into the top of the sieve stack and wash it through thoroughly with cold running tap water. Do not rush this part as you will over-fill the sieves and lose some of the contents through overflow out of the sides of the stack.

If you are going to do this on a regular basis, wash the sieves through into a large container rather than down the sink. Fine solids passing through will settle in your waste system and again, you will become unpopular with everyone except the local plumber. Washing into the container allows the solids to settle and they can be dug out and suitably disposed of when the container eventually silts up.

The next stage involves washing the contents captured in each sieve carefully out of the pan (an old squeezy bottle is good for this) and into a funnel (anchored securely), containing a filter paper, with the sieve size marked on the edge of the filter paper first. Leave each sieve fraction to drain through, then remove, unfold and lay it down flat on a tray. Repeat for all sieve samples then dry them carefully in a warm dry place such as an airing cupboard, and again, be patient. You cannot usually use your oven this time as fan ovens will turn your sample sets into kites and that will be the end of the story. That's it, job done!

Analysis

To examine the contents, brush each residue sample carefully into a small container using an artist's fine paintbrush, and one container for each sieve size. They will store here pretty well indefinitely. Don't forget to label each container, sediment identity and sieve fraction size. I use small glass sample bottles that are cheap and easy to get on the Internet.

For ostracods, I have found that the majority of the fossils are caught in the 125-, 250- and 500-micron sieves. The 1mm top sieve will exclude most of the unwanted rubbish. N.B. if you are looking for Conodonts or Scolecodonts you will need to include this fraction as they can be up to 200 microns in size, so you will need a catch sieve in excess of 2mm. If you use the smaller base sieve of 65 microns it usually only contains silt-sized quartz grains, so don't bother with that size initially. If you intend to gather organic walled microfossils you will need an additional specialist nylon sieve of 44 microns, but you will need to use further steps to concentrate your samples.

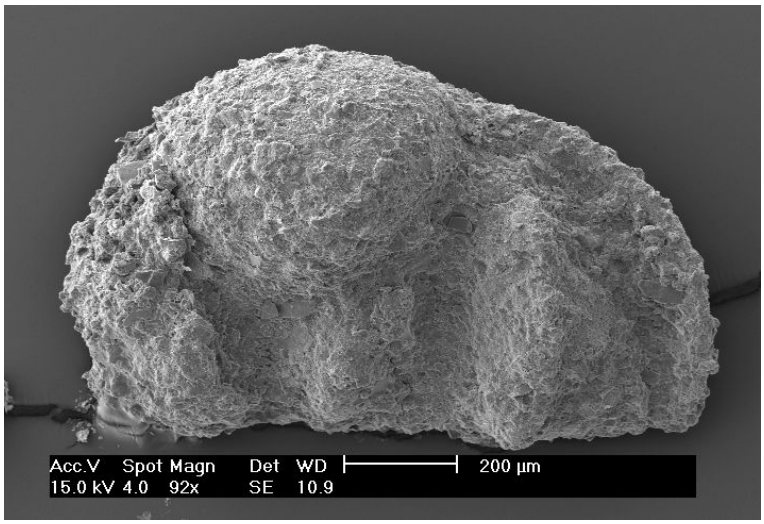

Fig.2: Ostracod Heteromorph, right valve, hinge length 1150 µm. SEM photograph of picked individual

Then away to the microscope for the fun part! ►

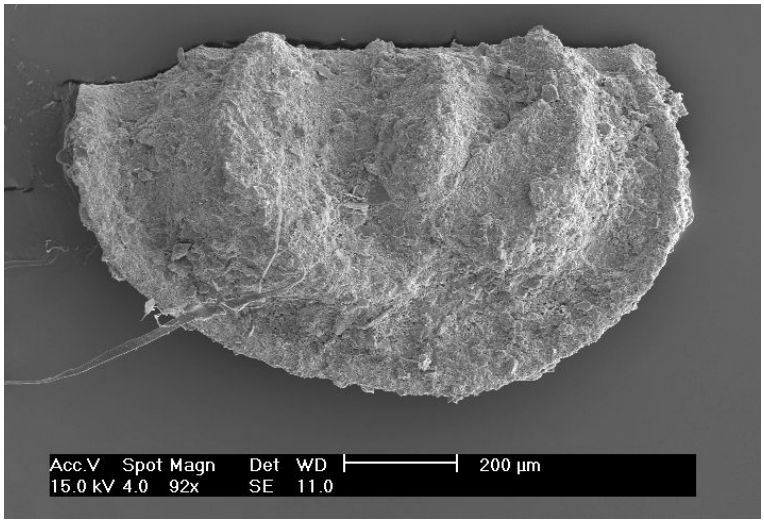

Fig.3: Sleia pauperata. Tecnomorph, right valve, hinge length 820 µm

You can get specialist microscope slides that have a metal body, a cardboard infill with a well in the centre, and the glass slide goes on top to trap the contents of the well. Place some of the residue on a matt black surface inside a small box or tray on the microscope table viewing at about 10x magnification, and use a very fine artist's paintbrush to 'pick' the microfossils out of the residue, placing them into the slide well for later viewing. The trick is to damp the end of a fine sable art brush in clean water then squeeze out the rest. You want it damp but not wet, and the fossils will then stick to the bristles and can be easily moved.

Once you have picked your fossils you may wish to identify them down to genus or even species level if you wish to use them as stratigraphical markers. For this you will need specialist literature.

In Mini Critters - Part 2 there will be a short case study that demonstrates how ostracod microfossils can be used to date and tell us more about palaeoenvironmental conditions when our local rocks were laid down. ■

Bob Bucki

References:

Armstrong, A.H., and Brasier M.D., Microfossils. Second Edition, Blackwell Publishing, 2006.

BCGS on YouTube

As you are aware, with the cancellation of our physical meetings programme this season we made the decision to broadcast our talks via Zoom. I don't think that I am alone in being pleasantly surprised by the number of registrations to join the broadcasts with many from members of other geological societies. To enable more members to view the talks (and others to see them again at leisure) we have set up a YouTube Channel where the talk videos will be uploaded (subject to permission from the speakers).

For those of you familiar with YouTube, search for the Black Country Geological Society under the 'Subscriptions' tab and then subscribe to receive the latest updates.

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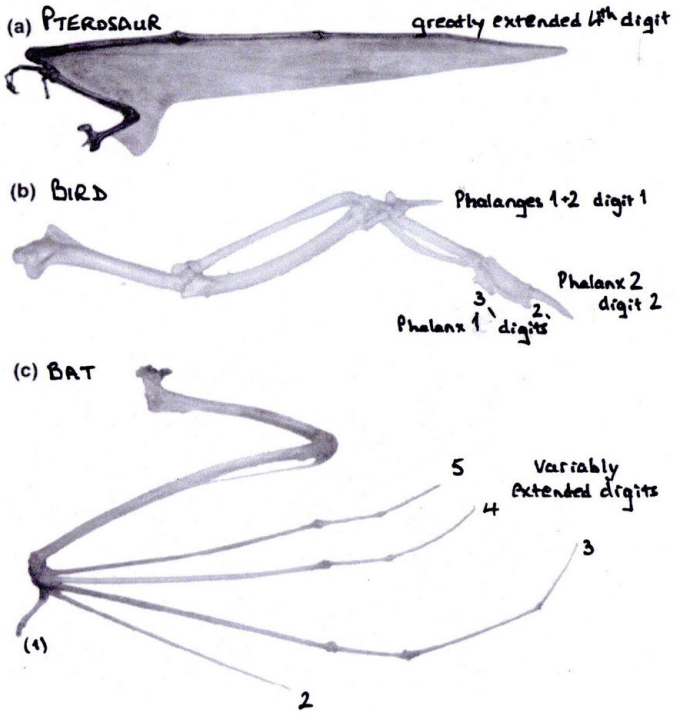
Peter Purewal

Mike's Musings No. 30: Flights of Fancy (part 2)

In the first part of this Musing (Newsletter 263, October 2020) we saw how insects and reptiles took to the air. Now we take a look at how the other two groups of 'fliers' added to the increased occupation of air space – long before man came along and also found ways to get off the ground.

Unlike the pterosaurs which succumbed to the end-Cretaceous mass extinction, the third major group of animals to take to the air are now firmly established as 'the dinosaurs that survived' this devastating event. In a sense, although they had been evolving alongside the pterosaurs, they had never really challenged for supremacy of the skies. But inherit the heavens they did, and they have certainly made the most of their opportunity.



COMPARISON OF ANATOMY OF PTEROSAUR, BIRD & BAT WINGS

Today, birds are the most varied and arguably the most successful of airborne animals, with over 10,000 species in modern skies, plus a few score that have either chosen to remain on, or have returned to, terra firma as a way of life. It has been estimated that this represents just 10% of all bird species that ever lived, so by any measure they have adapted well to their environment, from rudimentary beginnings exemplified by that most famous of all fossils, *Archaeopteryx.*

For over a century the early avian world was known from just a handful of specimens of this creature, from the late Jurassic 'Solenhofen Lithographic Limestone' of Bavaria. First discovered in 1860 as a single feather, this had an asymmetrical cross-section fundamental to avian flight. A more complete, long-tailed but headless specimen followed in 1861; and in 1876 a third specimen was discovered with a fine set of gnashers installed in well preserved jaws, distinctly non-bird-like. The story of *Archaeopteryx* discoveries and their chequered histories is an essay in itself: it turns out that the first specimen was actually unearthed in 1855, but not recognised until 1970. Others have been re-assigned (by some authorities) to new genera. The one thing they all have in common is their primitive nature: a mixture of reptilian (dinosaurian) and avian characteristics. But it is generally conceded that they were capable of powered flight, albeit clumsy and limited. Nor was the world blind to the significance of these early discoveries, coming as they did soon after Darwin's (and Alfred Russell Wallace's) pronouncements on the theory of 'evolution by natural selection'. 'Missing links' were all the rage, and *Archaeopteryx* played its timely part in this great debate.

Other discoveries have since demonstrated that dentition was not uncommon amongst Cretaceous birds, and 'pseudoteeth' (tooth-like projections along the margins of beaks) survived in a post K-Pg (or K-T, if you prefer) group of birds (the pelagornithes) until as recently as the Pliocene / Pleistocene boundary. Another group (the enantiornithes) evolved in a 'mirror-image' fashion: their digits ►

became fused in the opposite manner to modern birds, and the way in which their shoulder bones, the coracoid and scapula, articulated was also 'back-to-front'. But for reasons not entirely clear this group did not survive the K-Pg mass extinction.

Meanwhile, other skeletal innovations improved the avian stock, enabling them to perfect the range of flight styles we see today. Hollow bones (since also recognised in some of the dinosaurs) and air-sacs, lightweight beaks in lieu of teeth, and loss of long, heavy tails, all made for a lightweight frame facilitating flight. The development of a large breastbone (a keeled sternum) enabled firmer anchorage of larger, more powerful flight muscles. Although not directly related to flight, there is also much variation in the form of the digits, most notably with the so-called 'perching birds' which have both forward and backward pointing toes allowing them to grasp things (i.e. perch), which makes it possible for tree-dwellers to alight on the bough. In proportion to body-weight, many birds also evolved larger brains and better developed sensory organs to cope with more complex lifestyles associated with flight. All such variation led to specialisation amongst birds, allowing them to successfully occupy a wide range of ecological niches, whether it be on the wing itself, in trees, on the ground, in or on the water.

Archaeopteryx lithographica, specimen displayed at the Museum für Naturkunde in Berlin. Photo H. Raab, Wikimedia Commons

I alluded above to the first appearance of the **asymmetric** feather with *Archaeopteryx* (which still remains the oldest known, uncontroversial, fossil bird, although slightly older similar 'avialans' with bird-like credentials have come to light in China). This characteristic is deemed an essential requisite for flight, being the principle behind the aerofoil that helps to achieve 'lift'. Flapping a wing full of such feathers produces 'thrust' which propels a bird forward. So far, so good. But how exactly did those rudimentary birds first manage to 'take off'. Two basic theories are pretty well self-explanatory: 'ground-up' or 'cliff / tree-down'. With the pterosaurs, it seems more likely (or even certain) that they were exponents of the 'cliff-down' model. But even the clumsiest of early birds might have been sufficiently fleet of foot to have got off the ground from a running start. Some of the more ungainly birds today look quite unsuited to such a 'ground-up' model, and yet they achieve their ends by this method. Perhaps both models were called into action in different groups, depending on their actual lifestyle: ground or tree dwelling.

Almost as old as *Archaeopteryx* is the Chinese *Confuciusornis*, which also retained claws on its wings, but had already lost its reptilian teeth, so taking on a more modern appearance. Clearly, evolutionary trajectories amongst the birds were complicated during the Cretaceous period, with some birds looking more modern but living alongside more primitive forms. We shouldn't forget also that some 'feathered dinosaurs' transformed into part of the avian world without ever taking to the air at all, whilst other birds became secondarily flightless. Those most extraordinary of birds, the penguins, could even be said to 'fly' underwater, having many morphological adaptations to that end.

New discoveries in recent decades, especially coming out of China, continue to enrich our knowledge of the early avian world. Birds were clearly a significant part of the living world by mid-Cretaceous times, and who knows, more discoveries might push this rich diversity still further back and closer to the first appearance of all bird-life. ►

So we come to the fourth and final group of animals that have learnt the art of flight, the mammals, and more specifically, bats. The earliest known fossil bats date back to around the Palaeocene – Eocene boundary (? coincident with a 'thermal maximum', ever since which time our planet has been generally getting cooler, notwithstanding the current dread of global warming!). Since that time they have become the second most abundant (to rodents), order of mammals. They range in size from tiny, (wingspan 15cm) to quite large, (wingspan 1.7m), although the largest still only weigh a few pounds.

Bats are traditionally divided into two main subgroups; some 85% are echo-locating micro-bats which generally feed on insects, but also include the vampire bats, whilst only 15% are the mainly fruit-feeding mega-bats (or 'flying foxes'). This division has been modified recently, and there is some debate over whether they all shared a common ancestor or evolved as two separate groups. Either way, there is little difference between the wing morphology of the early bats and their modern counterparts, which points to a rapid and successful evolutionary transition from their non-flying ancestors, which may well have been tree-dwelling and squirrel-like as it seems more likely that they evolved as 'cliff / tree -down' exponents. Their closest living relatives are thought to be the colugos, or 'flying lemurs', part of the small group of arboreal dermopterans ('skin-wings'), which glide between trees thanks to folds of skin between their front and hind limbs.

Microraptor gui from Liaoning Province, China. It lived 120 million years ago and had long feathers on arms and legs, so it had 4 wings and could fly

It is easy to see that bats are more akin to the pterosaurs than birds, in that they developed outstretched membranes supported on long extensions of the 'fingers' (in their case, the 2nd, 3rd, 4th and 5th digits are variably elongated), but this is as far as the analogy can be taken. Unlike all other mammals, their 'finger-bones' are more flexible due to a flattened cross-section and lower calcium content near the tips. Moreover, having a membrane with several supports produces a more rigid wing when outstretched, and probably one that is less susceptible to injury (though the multitude of feathers on birds is a better solution still in this respect).

Despite their shared clumsy appearance with pterosaurs when not in the air, bats in flight demonstrate great manoeuvrability and can achieve amazing turns and bursts of speed of up to 100mph, especially when aided by that most sophisticated of all navigational aids, echolocation. I still wonder how swarms of any flying animal (or shoals of fish likewise) don't get in each other's way. Compare this with a crowd of us humans jostling together even at slow speeds – an image I shall use to draw things to a close!

This, then, is a brief appraisal of four unrelated, yet equally successful cases of animals taking to the air. Three of them are still very much with us today, and have no doubt provided the inspiration for our own kind to find surrogate means of doing likewise. ■

Mike Allen

Wishing you all a very Happy Christmas

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