Newsletter No. 259
February 2020

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To find out more about this photo - read on!

Copy date for the next Newsletter is Wednesday 1 April

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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 will be 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.

Visitors are welcome to attend BCGS events but there will be a charge of £1.00.

Please let Andy Harrison know in advance if you intend to go to any of the field or geoconservation meetings. If transport is a problem for you or if you intend to drive and are willing to offer lifts, please contact Andy with at least 48 hours notice.

Saturday 8 February *(Geoconservation Day):* Saltwells Local Nature Reserve. Meet at the Nature Reserve car park (Grid ref: SJ 934 868) on Saltwells Lane at 10.30. Wear old work clothes, waterproofs and stout footwear or wellies. Please bring gloves and garden tools (hand brushes, trowels, loppers, secateurs, forks and spades if you have them). We will be concentrating on the dolerite exposures close to Brewins Cutting. Either bring packed lunch or hot food can be acquired from the Saltwells Inn adjacent to the car park. Finish at 2.30.

Monday 17 February *(Indoor Meeting):* 'The Impacts of Future Climate Change on Industrial Landscapes: recent work in The Derwent Valley Mills WHS and its relevance to the Black Country'. Speaker: Dr Andy J. Howard ('Landscape Research & Management', and Honorary Fellow, Dept. of Archaeology, University of Durham). The availability of coal, limestone and metal ores together with water for power, were critical to the development of the heavy industries that kindled the Industrial Revolution. Paradoxically, many of these advantageous characteristics also create environments where geomorphological processes are most sensitive to future climatic and environmental change. This talk by Dr Andy Howard describes a 'landscape' approach developed to manage the built and other historic assets of the Derwent Valley Mills World Heritage Site, along the river between Matlock Bath and Derby. As we move forward into the Anthropocene, the applicability of this study to other industrial landscapes such as that of the Black Country is considered.

Saturday 7 March *(Geoconservation Day):* Barrow Hill. Directed by the reserve warden. Meet on Vicarage Lane off High Street, Pensnett (A4101), at the top end near to the nature reserve and the church (St. Marks), for a 10.30 start. The day will involve vegetation clearance in the East Quarry. Wear old clothing and stout boots or wellies. Please bring gloves and tools; i.e. brushes, trowels, loppers, saws, rakes etc. Safety glasses and hard hats will be provided where necessary. Bring a packed lunch and hot drink. We will aim to finish around 2.30.

Monday 16 March *(Indoor Meeting, 7.00 for 7.30 start):* AGM followed by three short talks by young geologists:

1. 'Disentangling geological and human biases of the non-avian theropod dinosaur fossil record'. Speaker: Daniel Cashmore (Doctoral researcher, University of Birmingham). Non-avian theropods were a highly successful group of bipedal, predominantly carnivorous, dinosaurs, popularly known by species such as *Tyrannosaurus rex* and *Velociraptor mongoliensis*. Key to our understanding of their evolutionary history are interpretations of their changing diversity through geological time. However, spatial and temporal changes in fossil specimen completeness, diagnostic quality, and sampling availability can bias our understanding of a group's fossil record. In this talk I outline the research I undertook as part of my PhD thesis, quantifying the skeletal completeness and the diagnostic quality of theropod fossil specimens, in order to critically assess any potential geological and human biases acting upon their fossil record. Results suggest the theropod record is heavily spatially and environmentally biased, and shows signs of taphonomic and taxonomic identification bias towards particular subgroups.

2. 'Phytoplankton and the response of ocean ecosystems to ancient and future climate change'. Speaker: Matt Sutton (Postgraduate research student, Oxford University). 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, I 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. By disentangling the relationship between climate and marine ecosystems in the geological past, we will begin to build a picture of the future ocean.'

3. 'Geology before, during and after university'. Speaker: Connor King (BSc graduate from Plymouth University). Connor will talk a little bit about his motivations for studying geology, followed by his time at university, and finishing with what he's doing now and some of the less-discussed parts of postgraduate life, such as applying for further study and finding work.

Monday 20 April *(Indoor Meeting):* 'Silurian Rocks of the Dingle Peninsula'. Speaker: Ken Higgs, Emeritus Professor of Geology, University College, Cork. Dudley and the Dingle Peninsula in Eire have much in common, sharing a common Silurian geology. Professor Ken Higgs was not only born in Dudley but has also undertaken an extensive study of the geology of the Dingle Peninsula recently published as a field guide: 'Geology of the Dingle Peninsula', by the Geological Survey of Ireland. His illustrated talk will describe the Dingle Peninsula's dramatic 485 million year history of environmental and climate change.

Saturday 25 April *(Field Visit):* Visit to Wren's Nest and the Dudley Museum and Archives. Led by Ian Beech (Wren's Nest Warden) and Graham Worton (BCGS and Dudley MBC). Meet at the wardens' base off Wren's Nest Hill adjacent to the Caves Bar and Grill for 10.30. We will have a walk round Wren's Nest led by Ian Beech (Head Warden) before going to the archive and Dudley Museum for the afternoon. Bring a packed lunch. Finish around 4.00.

Friday 8 May to Monday 11 May *(Warwickshire Geological Conservation Group, Residential Field Trip):* North Lincolnshire. Members of BCGS are invited to apply to join this residential field weekend. Places are limited, and allocated on a first come first served basis. For details and booking information please contact our Field Secretary, Andy Harrison (contact details top of p.2).

Saturday 16 May *(Field Visit):* North-west Herefordshire. Led by John Moseley (Gloucestershire Geology Trust). Meet for 10.00 at Aardvark Books, Brampton Bryan, SY7 0DH (NGR: E336950, N: 272410). We will visit Brampton Bryan Park to see Longmyndian sandstones and conglomerates and scenery / topography from structural / geomorphological aspects; Eltonian shales; Upper Pedwardine and the Llandovery / Tremadocian unconformity; Lingen area – disused quarry with good exposures of boulder bed and channelling at Eltonian / Leintwardinian contact. If time allows, we will also look at the Eltonian sedimentation section. Bring a packed lunch or purchase lunch from the Aardvark Bookshop at Brampton Bryan. Finishing around 4.00.

Saturday 6 June *(Field Visit):* Northcot Brick and Blockley, North Cotswolds. Led by Jon Radley (WCGC). Details TBC.

Procedures for Field Meetings

Insurance

The Society provides public liability insurance for field meetings but personal accident cover is the responsibility of the participant. Details can be obtained from the Secretary, and further helpful information can be found in the Code for Geological Field Work published by the GA and available on our website. Schools and other bodies should arrange their own insurance as a matter of course.

Health and Safety

If you are unsure about the risks involved or your ability to participate safely, you should contact the Field Secretary. Please take note of any risk assessments or safety briefing, and make sure that you have any safety equipment specified. The Society does not provide hard hats for use of members or visitors. It is your responsibility to provide your own safety equipment (eg. hard hats, hi-viz jackets, safety boots and goggles/glasses) and to use these when you feel it is necessary or when a site owner makes it a condition of entry. Hammering is not permitted unless specific permission has been sought and granted. Leaders provide their services on a purely voluntary basis and may not be professionally qualified.

Other Societies and Events

BCGS members are normally welcome to attend meetings of other societies, but should always check first with the relevant representative. Summarised information for approximately **two months** is given in our Newsletter. Further information can be found on individual society websites.

Woolhope Naturalists' Field Club - Geology Section

Friday 27 March: 'What makes an Oilfield'. Speaker: Dr. Pete Jeanes.

Meetings are held in the Woolhope Room, in the central library, Hereford. 6.30 for 7.00 until 9.00. Non-members of the Club pay £2. Visit: https://www.woolhopeclub.org.uk/meetings or contact Sue Olver on 01432 761693, email: susanolver@hotmail.com

Shropshire Geological Society

Wednesday 12 February: 'Earthquake Risk'. Guest speaker: Martin Degg, Chester University.

Wednesday 11 March: 'Subduction-related Volcanics'. Guest speaker: Sebastian Watts.

Lecture meetings are being be held in room 019 at the University Centre, Guildhall, Frankwell Quay, Shrewsbury, SY3 8HQ and commence at 7.00 for 7.30. A nominal charge is levied for attendance by non-Members. Further info: www.shropshiregeology.org.uk/

Geological Society, West Midlands Regional Group

Tuesday 11 February: 'Provenance, the search for a source' - using microfossils to track the origins of various items from paintings to murderers. Speaker: Haydon Bailey (University of Birmingham).

Tuesday 10 March: 'The role geology plays in sustainable management of mine tailings'. Speaker: Nick Watson (Wardell Armstrong).

Venue: Deritend Room, St Martin in the Bullring, Birmingham, B5 5BB. Meetings are at 6.00 for 6.30. For further details please contact the Group Secretary at: geolsoc_wmrg@live.co.uk
Click here for website.

Lapworth Lectures

Monday 10 February: 'Crowdsourcing bird evolution'. Speaker: Jen Bright, University of Hull.
Birds are one of the most successful groups of animals ever, boasting over 10,000 living species. Much of their success has been attributed to the shape variation shown in the beak, and its relationship to diet. In 2015, a crowdsourcing project, Mark My Bird, was launched to investigate the processes driving beak shape evolution. Members of the public were engaged to help measure beak shape changes through time. The data generated has helped us to understand how birds became so diverse following the extinction of their dinosaur cousins, and why they continue to thrive today.

Monday 24 February: 'Dangerous Neighbours: Learning to live with volcanic activity'. Speaker: Jenny Barclay, University of East Anglia.
Volcanic eruptions are as varied as they are fascinating. But this variability creates real challenges for the scientists and the populations who live within their reach. This lecture explores volcanic variability and the uncertainties it creates, and some of ways we can rise to these challenges.

Monday 9 March: 'How to look inside a volcano'. Speaker: Chris Jackson, Imperial College.
Volcanoes are big, hot, loud, and scary; because of this, we know little of their internal structure or underlying 'plumbing system', despite them representing a global natural hazard. In this talk, Chris will show how new 3D seismic imaging techniques can be used to illuminate the structure of volcanoes and the evolution of their underlying 'hot rocks'.

Lectures are at 5.00 - 6.00. Venue: All Lectures are in G33 – Engineering, which is building Y3 on the campus map. There is no admission charge and all are welcome to attend. For more information: http://www.birmingham.ac.uk/facilities/lapworth-museum/events/lectures.aspx

Manchester Geological Association

Wednesday 12 February at 7.00 AGM, followed by Presidential Address: 'Living in a greenhouse world: what the Cretaceous can tell us about global warming'. Speaker: Professor Cathy Hollis, MGA President.

Tuesday 3 March at 6.30 - Joint Meeting with Manchester Geographical Association: 'The 2018 Sulawesi Earthquake and the Hazard Management in Indonesia'. Speaker: Professor David Petley, Sheffield University. Venue: Manchester Metropolitan University, Brooks Building, 53 Bonsall St, Manchester, M15 6GX.

Meetings are held in the Lecture Theatre in the Williamson Building, University of Manchester, 176 Oxford Road, Manchester, M13 9QQ, unless otherwise stated. For further information about meetings: http://www.mangeolassoc.org.uk/ Visitors are always welcome.

Mid Wales Geology Club

Wednesday 19 February: 'Fluvial Geomorphology Forms & Processes, examples from Welsh Rivers'. Guest Speaker - Dewi Roberts:

Wednesday 18 March: 'Geothermal Energy in the UK'. Guest speaker - Prof. Ian Stimpson.

Further information: Tony Thorp tel. 01686 624820 and 622517 tonydolfor@gmail.com
Web: http://midwalesgeology.org.uk Talks at 7.30 at Plas Dolerw, Milford Road, Newtown.

Warwickshire Geological Conservation Group

Wednesday 19 February: 'Geology & Wine in Southern France'. Speaker: Roger Suthren, Derby University. Includes a chance to taste some examples!

Wednesday 18 March: 'The Anthropocene – Man's impact on our planet'. Speaker: Ian Fairchild.

Venue for talks: St Francis Church Hall. There is a charge of £2.00 for non-members. For more details visit: http://www.wgcg.co.uk/ or email: WarwickshireGCG@gmail.com. Meetings start at 7.30 with tea/ coffee and biscuits available beforehand from 7.00.

Teme Valley Geological Society

Monday 16 March: 'The Japanese Island Arc: Perspectives on the Malvern Complex and Warren House Formation'. Speaker: Richard Edwards.

Talks are held at 7.30 in the Martley Memorial Hall, on the B4197 by the Sports Ground, Martley. For field trip details and further information contact John Nicklin on 01886 888318 or visit: http://www.geo-village.eu/ Non-members £3.

East Midlands Geological Society

Saturday 8 February: 'Ignimbrites and associated rocks from the Palaeocene, Isle of Skye, NW Scotland and the Ordovician Upper Borrowdale Volcanic Group, English Lake District'. Presidential Address: Dr. Simon Drake.

Meetings will be held at 6.00 in the Geography Department of Nottingham University, which is in the Sir Clive Granger Building. Non-members are welcome and should register with the secretary. Further info: www.emgs.org.uk or email: secretary@emgs.org.uk

North Staffordshire Group of the Geologists' Association

Thursday 13 February: 'The Evolution of Phytoplankton'. Speaker: Dr Jim Riding (BGS).

Thursday 12 March at 7.00 AGM, and 7.30 Chair's Address: 'The post-Carboniferous geological evolution of the Peak District: some insights from temporary exposures'. Speaker: Dr Peter Jones (Derby University & Chair NSGGA).

Meetings are held at 7.30 in the William Smith Building, Keele University unless otherwise stated. For enquiries: Steve Alcock, Longfields, Park Lane, Cheddleton, Leek, Staffs, ST13 7JS. Tel: 01538 360431 or 07711 501028. Email: steves261@aol.com More info: www.esci.keele.ac.uk/nsgga/

Open University Geological Society, West Midlands

Practical Mineralogy & Petrology Day Courses, and Field Skills Day.

Whilst these practical geology workshops and the field skills day are primarily intended for OU geology students, the leader (BCGS member Alan Richardson) is willing to include others who wish to gain some practical experience. The programme has been designed for those who are new to earth science, but has proved popular with more experienced geology students looking for a refresher. All events will be led by Alan.

Saturday 8 February: Metamorphic Petrology Workshop
Saturday 29 February: Thin Section Microscopy
Saturday 28 March: Field Skills Day (in the Bridgnorth area)

To book a place contact Alan on: alanrichardson.geo@gmail.com With the exception of the Field Skills course, all the above take place from 10.30 to 4.00 at the Lickey Hills Visitor Centre, Warren Lane, Lickey, Birmingham B45 8ER. For more detailed information go to: https://ougs.org/westmidlands/

BCGS Committee -Vacancy

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. If you think you could help please don't be shy to put your name forward!

If you would like to put your name forward please contact the Secretary at: secretary@bcgs.info

Editorial

We have a varied programme with the usual mix of field trips, geoconservation days and indoor meetings to look forward to. Please note that the AGM will be held on Monday 16 March, and there is a vacancy for a new member of the Committee (see box above).

In this issue you will see that our Field Secretary, Andy Harrison has been busy with his usual detailed reports of our field trips. We had a very successful programme last year, crowned by the weekend visit to Dorset, but we would still like to see more of you attending these trips and enjoying the expertise of the leaders. Remember, you can contact Andy if the main problem is transport.

Mike Allen concludes his fascinating trilogy 'The Eyes Have It', in his 25th consecutive 'Musing' and I'd like to thank Mike for informing - and often amusing - us with this column, which has become a very welcome regular feature in our Newsletter.

Finally, please write to let me know your thoughts on the extraordinary 'snake in coal' item below! ■

Julie Schroder

'Snake or Adder found in a Block of Coal' Tipton 'Pieces' Colliery, 1817

This extraordinary item appeared in the Hereford Journal, 9 April 1817. A copy was given to our Chairman, Graham Worton by George Price who has been a coal mining volunteer at the Black Country Living Museum since it was established in the 1970's. Your comments please! Ed.

We lately gave a communication on the singular circumstance of two lizards having been discovered in a chalk-bed in Suffolk, sixty feet below the surface. The publication of this fact has given rise to the following affidavit of a similar discovery by two pitmen in the county of Stafford. "We, William Mills and John Fisher, both of the parish of Tipton, in the county of Stafford, do hereby certify and declare, that a few years ago in working in a certain coal-pit belonging to the Rt. Hon. Viscount Dudley and Ward, at what is called the Pieces, in the parish of Tipton aforesaid, and on cleaving or breaking the stratum of coal called the stone coal, which is about four feet thick, and in that situation lies about fifty yards from the earth's surface - we discovered a living reptile of the snake or adder kind, lying coiled up, imbedded in a small hollow cell within the said solid coal, which might be about twenty tons in weight. The reptile when discovered visibly moved, and soon afterwards crept out of the hole; but did not live longer than ten minutes on being exposed to the air, when it naturally died, not having been at all hurt by the cleaving of the coal, whose thickness and solidity must have kept it before from all air. The hollow in which it lay was split or cloven in two by means of an iron wedge, and was rather moist at the bottom, but had no visible water. It was nearly the size of a common tea-saucer; and the reptile was about nine inches long, of a darkish ashy colour, and a little speckled. After it was dead it was thrown aside; and the large coal in which it lay, being broken to pieces, was drawn up out of the pit, and disposed of the usual way. In testimony of these facts we have certified the same upon oath, before the Rev. Dr. Booker, a magistrate, this fifth day of March, 1817. Witness our hands,

(Signed) WILLIAM MILLS.
The X mark of JOHN Fisher.
"In the presence of WILLIAM SUMMERS." ■

Field Meeting Reports

Friday 13 to Monday 16 September 2019: BCGS Field Excursion to Dorset - part 3. Led by Alan Holliday, Richard Edmonds and John Scott (Dorset Geologists Association Group, DGAG, and Steve Etches (Etches Collection Museum of Jurassic Marine Life, Kimmeridge).

Monday 16 September 2019: The Etches Collection, led by Steve Etches.

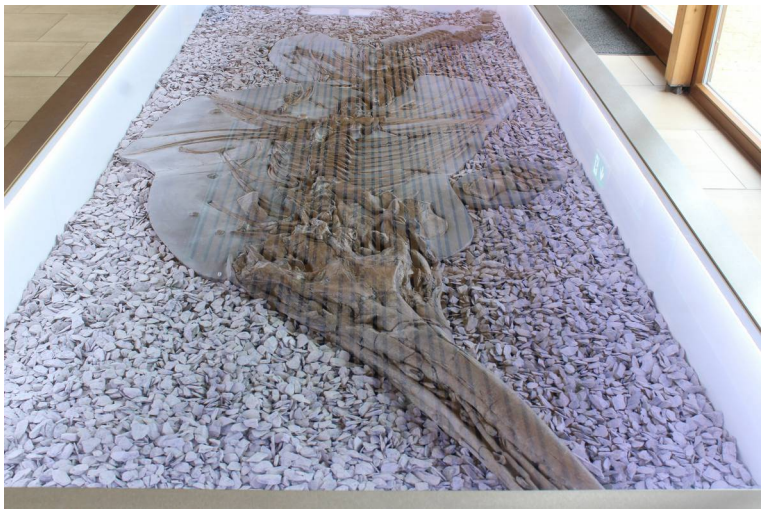
The Museum

The final (third) day of our Dorset excursion involved a visit to Kimmeridge and the Etches Collection, which is housed in its own museum and was recommended by John Scott. After detouring round local firing ranges between Weymouth and Kimmeridge, we congregated at the museum car park for 10.00 under grey clouds. Here we met the collection and museum founder, Steve Etches, who is a self-proclaimed champion for the Kimmeridge Clay and the secrets it holds.

Kimmeridge is situated just over 20 miles east of Weymouth in rolling green countryside. After Weymouth, the Kimmeridge Clay disappears at Lulworth and Durdle Door around the Cretaceous deformations, before reappearing further east in Kimmeridge Bay. The town itself is situated approximately one mile inland from the Bay, with the Etches Collection Museum located on its northern outskirts.

The Etches Collection

Steve led us to a second-floor landing where we gathered around an impressive Ichthyosaur skeleton in a glass topped case before entering the main gallery. Here he gave an introduction to the museum, the local area and its geology. Steve has been collecting Kimmeridge fossils for over 35 years, is self-taught and has collected well over 2000 specimens which used to be housed in his converted garage. The museum was a dream of Steve's for over 20 years and finally opened in 2016 with help from the Heritage Lottery and much privately raised funding.



Ichthyosaur skeleton in a glass topped case

The museum itself is a long gallery lined with glass panelled show cases, and glass topped cases down the centre. *(See front cover photo.)* On the ceiling CGI imagery seen from below the sea surface portrays animated ammonites, fish, sharks and marine reptiles. At the far end of the gallery a glass wall provides a view into the area where all received fossils are prepared and stored. ►

In the past, the Kimmeridge Clay was rather overlooked and taken as uninteresting when compared with other Jurassic clay strata like the Lias or Oxford Clay. Steve's intention in opening the museum was to change this view. He wanted to create a collection and keep it local to the area where it came from and not be dispersed to larger museums around the country. The museum focuses on how to best preserve and present the specimens to unlock the secrets of individual fossils, and extrapolate how these animals lived and died, what happened to their remains after death, and make comparisons with modern deep marine environments. The museum also pays homage to important women who have played a big role in palaeontology. These include Mary Anning and her ichthyosaur, plesiosaur and pterosaur discoveries at Lyme Regis, and Marjorie Courtney Latimer, who discovered living coelacanths off the Comoro Islands in the 1930s.

Only 10% of Steve's collection is on display and over time he will move this round in order to show the diversity it represents. Many specimens in the collection are new to science with around 30 new species collected already. To aid with their preservation, all specimens are stored under a regulated humidity of 40% to 45%. Many specimens are preserved in pyrite, which rapidly degrades if not stored correctly.

The Kimmeridge Clay deposits and fossil fauna

According to Steve, Kimmeridge Bay holds the best exposures of Kimmeridge rocks in the world. The Kimmeridge Clay also outcrops in Russia, India, Portugal, Switzerland, Spain and Germany. Approximately 4.5 miles of Kimmeridge Clay is exposed in Kimmeridge Bay with the layers dipping towards the east. Therefore, each layer is easy to reach. Rock ledges below the high tide mark form the best places to collect fossils. This combined with shear cliffs, the Bay's remoteness and rapidly turning tides make it a hazardous place to be for the unwary. Fortunately, it means that not many people visit the site to do serious fossil hunting.

Kimmeridge Bay

The Kimmeridge Clay dates roughly between 157 and 152 Ma in the Late Jurassic when the area was situated close to where North Morocco is located today. It includes extremely weak black shale layers and stronger grey coccolith limestone bands. These rocks are notoriously hydrocarbon rich and the source for North Sea Oil, hence over the years they have attracted much interest from geologists in the oil industry.

The environment under which the Kimmeridge Clay formed has been interpreted as deep tropical marine conditions with water depths in the order of 50m to 150m, where storms, a strong wave base and currents influenced the upper water column. At depth, calmer and fluctuating anoxic conditions influenced the seabed, which comprised a thick muddy ooze. The fossil record shows that conditions allowed great biodiversity and were ideal for preserving fossils, particularly their soft tissues.

Under less anoxic conditions many animals lived on and in the seabed. A diverse bivalve assemblage has been recorded that includes *Trigonia* and razor shells. The latter lived at 90° to the sediment surface with feathery arms that swept up passing plankton, similar to those seen today. Echinoids, lobsters, crayfish, trace fossils (burrows and tracks) and fish coprolites are also abundant in the muddy substrate. The coprolites reveal what the fish were eating as they contain barnacle platelets and fish scales. ►

Fossil ray

Abundant remains of other animals preserved within the Kimmeridge Clay fossil record indicate how diverse life was in the overlying water column. The most abundant free-swimming (nektonic) animals recorded include cephalopods (ammonites, squid and cuttlefish), sharks, rays and fish. Ammonites were amongst the most abundant nektonic fauna in Jurassic seas with over 8,500 different species having been identified throughout the period. Generally, an ammonite is a squid in a coiled shell. A main body chamber houses the soft parts at the front and a series of gas filled chambers (camerae) make up the remainder of the shell. Males and females show sexual dimorphism in terms of size (female ammonites tending to be larger than males), external rib patterns, and males growing a horn (or lappet) on the shell aperture. The museum collection reveals many interesting and new discoveries relating to ammonites.

Specimens showing both male (horns) and female traits (rib patterns) are on display indicating that at certain times during growth, ammonites may have been hermaphrodites. Also on display is the first evidence of ammonite eggs within the female body cavity. At first Steve was unsure at what he had discovered. However, after much research and collaboration with specialists in the cephalopod field it was agreed that Steve had found evidence for ammonite eggs and he produced a paper on it. This has yet to be disputed.

Many ammonite specimens show missing chunks in the same place at the rear of the body cavity. This has been interpreted as predation by another intelligent predator such as squid. The absence of shell fragments on the sea floor suggests that predation took place in the water column. Ammonite shells have also been found with lobster carapaces within them. This has been interpreted as growing and moulting lobsters living inside empty ammonite shells that settled on the seabed. Such shells also show evidence of encrusting serpulid worm tubes.

The collection includes 74 cuttlefish specimens complete with soft body preservation and internal organs. Once dead, cuttlefish today break down into an organic mess in no time. The preservation seen in these specimens is believed to be from rapid pyrite precipitation under anoxic conditions.

Fossil cuttlefish

Various fish, shark and ray species including *coelacanth, caturids, thrissops, gyrodus*, and something akin to a deep-sea angler fish are represented in the collection. The jaws and mouthparts of these all reveal information about how they fed and what they ate with many specimens equivalent to species ►

existing today. The preserved scales belonging to *thrissops* display a yellowish and black pattern. Such a feature is not seen in modern sea-going fish, which tend to be silvery or dark on top and light beneath to avoid being seen. The teeth and dorsal fin spines of sharks in life position provide evidence that the seabed was deep enough not to be disturbed by currents.

The largest marine predators from the time were ichthyosaurs, plesiosaurs, pliosaurs and marine crocodiles (Metriorhynchids). The museum holds three complete ichthyosaur skeletons including the one outside the entrance. They come in various sizes and skeletal differences hint at lifestyle variations. The skeleton at the entrance had relatively small dorsal fins and eyes. Yet another specimen had longer dorsal ribs, large eyes and small sharp teeth. These features may have allowed this ichthyosaur species to breathe and see in oxygen poor and dark conditions enabling them to dive to great depths after squid. Fish and squid remains have been found in ichthyosaur guts. The similarity of the ichthyosaur body plan to that of modern dolphins is an example of convergent evolution.

Ichthyosaur

Plesiosaurs and pliosaurs both had big barrel-like bodies and four flippers. However, where plesiosaurs had long necks and short heads the pliosaurs had short necks and large heads. These animals were at the top of the food chain feeding on fish and squid. The teeth and gut evidence indicate what they ate. Many specimens are marked with burrowing activity from *Osedax*, (zombie worms), which thrive in deep marine environments today. Once a dead carcass has dropped to the seabed and all covering tissues have been stripped away, these worms will bore into the bones after the bacteria feeding within.

Various ichthyosaur, plesiosaur and pliosaur limb bones show bite marks from ridged teeth, detached limbs and crushed bones. This indicates that during Kimmeridgian times predation was rife. Whilst pliosaurs represented one top marine predator, they were not the only ones. Another large carnivorous mega-predator was a smooth-skinned crocodile with short front flippers called Metriorhynchus. This monster of the deep would not go ashore and preyed on other marine reptiles or hoovered up remains off the seabed.

Many specimens within the collection represent oddities brought in from elsewhere. Bones belonging to sauropod dinosaurs and pterosaurs are occasionally found in the Kimmeridge Clay. The sauropod carcasses recorded were most likely washed out to sea during monsoonal floods with bits dropping to the seafloor as the carcass broke down. Pterosaurs were lightweight and strong, but fossils showing broken limbs indicate an inability to fly, leading to the animal drowning before ending up on the seafloor.

Steve has also found a dragonfly wing but has no explanation for how it got there. Fossilised goose barnacles are an interesting oddity. Charles Darwin first described living goose barnacles off Japan and theorised that they must have evolved from an ancestor during Jurassic times. Known as Darwin's missing barnacles none had been recorded in the fossil record. However, Steve has discovered numerous examples that are in his collection. These molluscs are likely to have attached themselves to drifting detritus before sinking to the seabed. ►

We finished our tour shortly after midday. Afterwards members took time to have a better look round the museum, went for some lunch and a walk down to Kimmeridge Bay before starting the long trip home.

More information about the Etches Collection and visiting the museum can be found on their website - https://www.theetchescollection.org/ or within the museum guide book:

'Stories from deep time, Bringing a Singular Passion to Life, The Etches Collection'.

I would like to thank Steve and the museum staff for a very enlightening and fantastic visit and I look forward to hearing about new discoveries in the future.

Saturday 16 November: BCGS Field Visit: A Guided Walk Around Castle Hill, Dudley. Led by Ian Beech (Head Warden at Wren's Nest National Nature Reserve).

The BCGS November visit to Castle Hill was a change from our usual BCGS activity with Ian Beech, geoconservation works at Wren's Nest. Compared with its famous neighbour, Castle Hill gets rather overlooked in respect of its geology and historical importance. However, as part of an ongoing project to link and improve Dudley's green spaces, things may be about to change. There is a proposal to construct a new light railway through Dudley linking Birmingham, Tipton and the Halesowen area using a former disused railway, which passes along Castle Hill's eastern edge. This could potentially lead to generating Lottery funding for investment in the area. Castle Hill and Wren's Nest Hill together with Sedgley Beacon and Hurst Hill, form a chain of four limestone hills, all linked by an existing walking trail - The Limestone Way. In the future they could become the Four Limestone Hills Nature Reserve linking geology and biodiversity for all four hills. The new light railway would mean easy access for people from Birmingham and it would be tied into the Black Country Geopark. On the back of this potential future project, Ian had the idea for our guided walk around Castle Hill looking at its interesting features, which are similar to those of Wren's Nest.

Castle Hill is situated south-east of Wren's Nest Hill and is probably best known for Dudley Castle and the zoo. The hill rises to around 225m above sea level at its southern end, where the castle is situated, is tear-dropped in plan and oriented north-south. North of the castle, the ground slopes downwards to approximately 160m above sea level and is generally covered with rough vegetation and woodland of ash, sycamore and beech. To the north is the Priory Estate, which continues southwards to bound the western edge of Castle Hill, north-west of which is Wren's Nest Hill. To the east is open ground and various commercial and light industrial units that include the Black Country living Museum, Dudley Canal Trust, and The Dudley Archives Building / Dudley Museum and Art Gallery. To the south and south-west is Dudley Town Centre.

Like Wren's Nest Hill, Castle Hill is a single fold, or pericline, formed from Silurian Wenlock Series rocks - the Much Wenlock Limestone Formation (Lower Quarried Limestone Member, Nodular Member and Upper Quarried Limestone Member). Historically, Castle Hill was important not only for its castle, but also its geological and industrial heritage. ►

For our Castle Hill walk, we met Ian at 10.00 at the wardens' base off Wren's Nest Hill Road on a cold and grey morning. We headed along Wren's Nest Hill Road turning right past the NCC Cutting and followed tracks and minor roads to Priory Road. Crossing Priory Road, we continued along Castle Mill Road and past the Priory Estate to the northern entrance of the Castle Hill woodland. A leafy autumnal carpet of yellow, orange and reddish browns and shades of green covered the woodland floor along our route. Heading southwards our route undulated along ridges that dropped off sharply into deep hollows, representing the remains of quarries and collapses that are a testament to Castle Hill's industrial past.

Like Wren's Nest, Castle Hill was worked for the pure Lower and Upper Quarried Limestone Member beds from the 18th century as part of the estate of Lord Ward, the Earl of Dudley. By the late 19th century the hill was riddled with tunnels and caverns. In 1778 Lord Ward had an underground waterway constructed to link his deep mines under Castle Hill with the Birmingham Canal. The canal ended in a cavern beneath the old Castle Mill, the roof of which was later removed whilst linking the mines to the Stourbridge Canal, resulting in the creation of Castle Mill Basin. Four tunnels start from Castle Mill Basin. The first, Lord Ward's Tunnel, leads eastwards to the Black Country Living Museum to connect with the Birmingham Canal. A second tunnel heads west towards Wren's Nest and the base of the Severn Sisters Caverns and a third leads southwards towards Parkhead Locks and the Stourbridge Canal. In 1984 a fourth canal tunnel was constructed to link Castle Mill Basin with Singing Cavern under the eastern side of Castle Hill, which is currently used for canal boat trips by the Dudley Canal Trust.

Our first stop was Kettle Hill, now just a clearing in the woods with steps leading away from it. This was once the location for a large steam engine that was used to power machinery for extracting limestone from the quarries. Continuing southwards we passed the surface expression of Castle Mill Basin, which today is enclosed with metal hoarding for health and safety reasons. This was not always the case. Photographs taken by Peter Parkes during the first BCGS field trip in 1975, show members venturing into the Castle Mill Basin from the surface. *(Link to photos on BCGS website.)*

Continuing south we passed Little Tess, and an inaccessible depression that ended in a vertical face of the Nodular Member, containing a set of metal doors. Voices including a booming monologue explaining the history of the caverns could be heard from behind the doors, which form an emergency exit for the canal tunnel leading to and from the Singing Cavern. The largely untouched Nodular Member layers contain good examples of fossils and ripple beds like those seen at Wren's Nest.

Lime pies at Castle Hill

Continuing southwards we passed some large rounded mounds that represented the earliest methods for producing slaked lime from limestone. Larger than those on Wren's Nest, these 'lime pies' comprise crumbly built up layers of fused limestone and charcoal with a distinct red colouration. These early methods of lime production involved heaping up successive layers of limestone and initially charcoal, but later coal, burying it and setting it alight. The slaked (quick) lime could then be extracted for use. Like Wren's Nest the limestone originally extracted on Castle Hill was used as a building stone for the likes of the Castle and Dudley Priory. The quicklime was used for either 'sweetening' heavy clay soils associated with the surrounding coal measures strata or as a flux during iron smelting. With increasing demand for quicklime the method of production eventually changed from lime pies to the box lime kilns seen at Wren's Nest. ►

Big Ben Cavern

From the lime pies we continued south towards the back of Dudley Zoo and Big Ben Cavern, which lies beneath the zoo and the south end of the hill. Walking through a long, narrow and steep sided cutting along the axis of the hill we eventually came to a cavern entrance, similar to the Severn Sisters, with Nodular Member layers dipping towards the west. Here we stopped for lunch and a bit of fossil hunting, to the calls of big cats and other wild animals emanating from the zoo.

After lunch and looping back northwards we eventually reached a very overgrown cavern entrance that was partially fenced off. Unfortunately, Ian informed us that it was not safe to venture down, but what we were looking at was the entrance to the famous Dark Cavern. After studying the rocks and fossils of Wren's Nest and Castle Hill, it was here that Sir Roderick Murchison launched his work on the 'Silurian System', in 1839 before 200 philosophers and natural scientists from the Royal Society of London. Ten years later Murchison returned to Dark Cavern to give a speech about his work. Reportedly during the visit 15,000 locals turned up to listen to him speak and afterwards he was lifted aloft on the shoulders of miners and crowned the 'King of Siluria'. For the occasion, gas lights and a stand were installed outside the cavern and according to Ian they are still there.

From Dark Cavern we retraced our steps back through the woodland to the northern entrance and back up to the wardens' base. Through the day Ian hinted at the amount of exposure and untouched potential there was at Castle Hill, particularly for fossil hunting. Currently, local residents generally use it as a rubbish dump, but with some clearance, better access, interpretation, security and TLC it could become as big a visitor attraction as Wren's Nest.

I would like to thank Ian for his time and a very interesting walk. Hopefully Castle Hill will form a future conservation project. ■

Andy Harrison

Mike's Musings No. 25, The Eyes Have It - Part 3

*In 'The Eyes Have It - Part 2' (Musing No. 24, Newsletter 258) I discussed a variety of sophisticated developments in the design of the **camera eye** arising from the primitive **simple eye** introduced in the first part. Improved vision was made possible with the ability to vary the shape of the lens, the size of the aperture (pupil) and by the introduction of a mirror into some overall designs. Different types of retinal cell (rods and cones), enabling colour perception, were also referred to.*

In Part 1, I remarked that *direction-sensitive photocells* could be arranged on either ***concave*** or ***convex*** curved surfaces. The **camera** / **pinhole** / **simple** and **mirror eye** designs have all been concerned with ***concave*** surfaces. They have all produced images that are both *inverted* and *left-right reversed*, which it requires the brain ('neural-processing') to correct.

It is now time to go down the ***convex path***. The immediate advantage of turning the ***concave*** surface inside-out is that it corrects these defects – the image will be 'true'. This takes us into the very different realm of the **compound eye**, of which the simplest is the **apposition compound eye**. Such eyes consist of separate tubes containing photoreceptors pointing 'outwards' in different directions, only ►

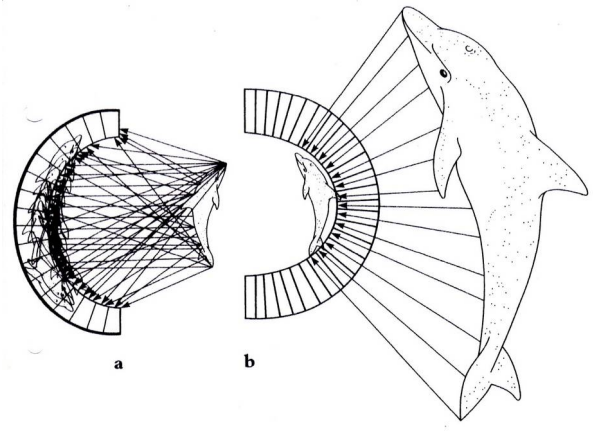


Figure 5.20 (a) reproduction of Figure 5.6; (b) the cup turned inside out. Principle of the apposition compound eye.

seeing a narrow part of the horizon (similar to that trick employed by our friend the jumping spider in the last instalment). This avoids the chaos of multiple images seen by the *'open cup' camera eye,* **(Fig. 5.20 a)** and obviates the need for a *pinhole* to restrict the number of light rays entering the eye. In effect, each tube (or *ommatidium*), with its own lens and retinal cells, acts independently, producing an upside-down image just like the **camera-eye**. But the overall effect of all *ommatidia* functioning together produces a 'total image' that is 'true' or upright. **(Fig. 5.20 b).**

Compound eyes are good at picking up movement. To produce a sharp single image equivalent to a **camera eye** requires equal numbers of *ommatidia* as our eyes have retinal cells. **Compound eyes** are the preserve of invertebrates (in particular the arthropods, but also some types of worm and a few bivalves), **camera eyes** mainly that of vertebrates. *Ommatidia* can only be so small before the same problem of diffraction that places a limit on the 'tininess' of a pinhole comes into play. A **compound eye** able to see as much detail as a **camera eye** would need to be very much larger than a 'standard eyeball', measured in metres not centimetres. This would be quite impractical even for a large vertebrate, such as you or I, **(Fig. 5.22)** let alone an invertebrate, not many of which rise to the size of a giant squid!

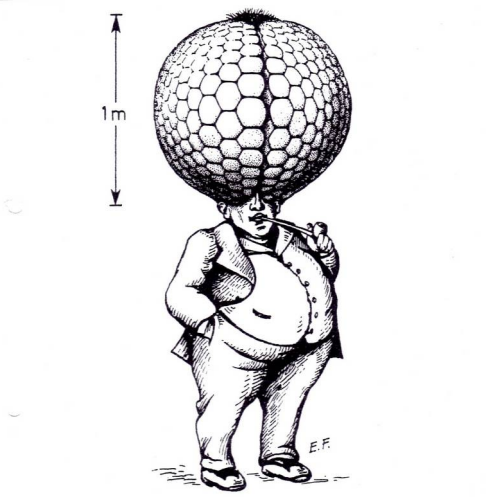
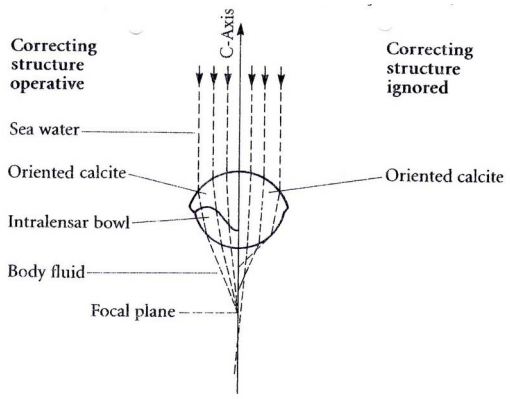


Figure 5.22 Kuno Kirschfeld's picture of how a man with compound eyes would look if he wanted to see as well as a normal human.

Compound eyes have been described by some as a basically disastrous design, though they seem to serve their bearers sufficiently well for them not to seek any alternative way of seeing the world. This seems to have been particularly true for a much loved group of extinct creatures the geological fraternity is familiar with. Trilobites were most successful in a world with fewer 'problems' (i.e. inhabited by fewer predators!). Whilst many managed without eyes at all, some reached a level of sophistication that can only be marvelled at. Their lenses were constructed from single calcite crystals, which invited the potential problem of double refraction (and hence double vision) characteristic of this mineral. This was specifically overcome by aligning the lens with the optic C-axis of the crystal, the only direction of single refraction. *(See image on the left from 'Trilobite!' by Richard Fortey, p.103.)* Moreover, their lenses were constructed in such a way as to also overcome spherical aberration in a similar way to the scallop's **mirror eye**. **(Fig. 5.18 d/e** *see Newsletter 258 p18.*) The fact that many insects have done very well for millions of years with just compound eyes suggests this design was not instrumental in the demise of the trilobite. ►



The drawing made by Euan Clarkson and Riccardo Levi-Setti to illustrate how the more highly refractive bowl inside the lens of *Phacops* helps to bring rays more closely to focus.

Some deep water crustaceans carry simple *ommatidia*, lacking any lens or tube-like construction on their outer surfaces somewhat akin to the simple *ocelli* of the '**pre-camera-eye-world**'. The crustacean *Ampelisca* has a **camera eye** that clearly betrays its descent from a **compound eye** by retaining a retina composed of a remnant cluster of *ommatidia*, which suggests a possible evolutionary pathway between the two distinct types of eye design. **(Fig. 5.23)**

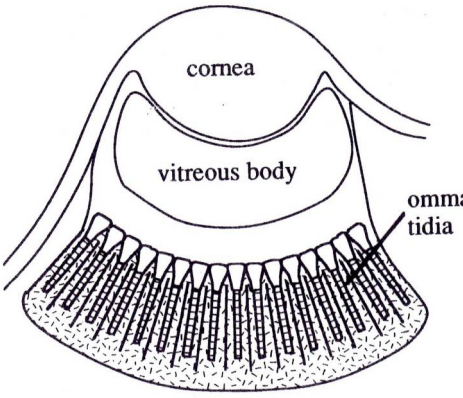


Figure 5.23 A camera eye with a compound eye in its ancestral history. The remarkable eye of *Ampelisca*.

There are further examples in the modern world that hint at how the **compound eye** might have evolved. Some worms have 'eyes' which are little more than a loose cluster of photoreceptors, whilst others have them in more organised, geometric groups – in effect a **compound eye** with just a few *ommatidia.* **(Fig. 5.24)**

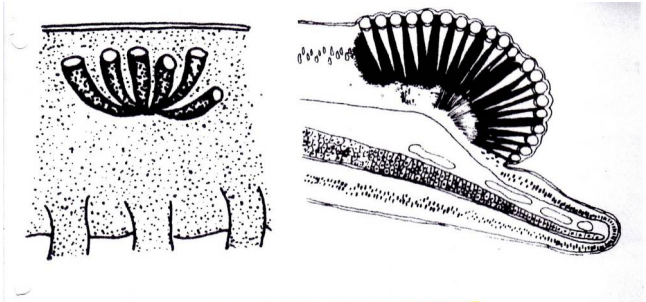


Figure 5.24 Possibly primitive compound eyes from two kinds of worms.

Ommatidia acting independently depend on each having a sheath of opaque pigment to isolate them from each other. This is inconvenient for those marine creatures that rely on transparency for their defensive camouflage. They need to dispense with dark pigments altogether and overcome this need by designing each *ommatidium* along the same ingenious lines that humans have employed in the manufacture of optic fibres. This involves the use of a lens of varying refractive index so as to 'trap' the path of a single incoming light ray, dispersing all others, such that just a single image is produced at the base of the *ommatidium*.

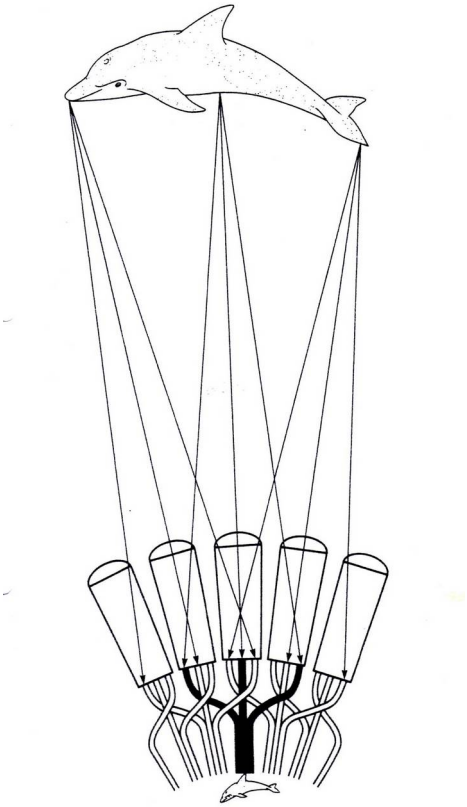


Figure 5.27 The ingenious principle of the 'wired-up superposition' compound eye.

The **superposition compound eye** has evolved, probably from an **apposition** ancestor, so as to overcome the problem of multiple images in other, more subtle ways. In this kind of **compound eye** the rays of light that pass through the lens of a particular *ommatidium* are received by the photoreceptors of neighbouring *ommatidia*, but produce a single, and upright, image on a shared retina. Remarkably, evolution has achieved this in several ways analogous to the clever tricks employed by different designs of the **camera eye**: with composite lenses in several groups of insects and crustaceans; with the addition of mirrors in other groups of crustacea; and by fancy 'neural wiring' in true flies and some other insects. **(Fig. 5.27)** The detail is getting out of hand, so I won't dwell further on this matter, but refer you to pages 171-174 of Dawkins' book 'Climbing Mount Improbable' (or, indeed, read his whole chapter, which explains things far more eloquently than my rather abbreviated version!). ►

I began with the title of Dawkins' book 'Climbing Mount Improbable'. In fact, all this variation within the world of eyes shows that the 'Mount' is more like a range of hills, with many subsidiary summits to which different pathways in the design of the eye have risen. **(Fig. 5.30)** All seem to serve their varied bearers perfectly well.

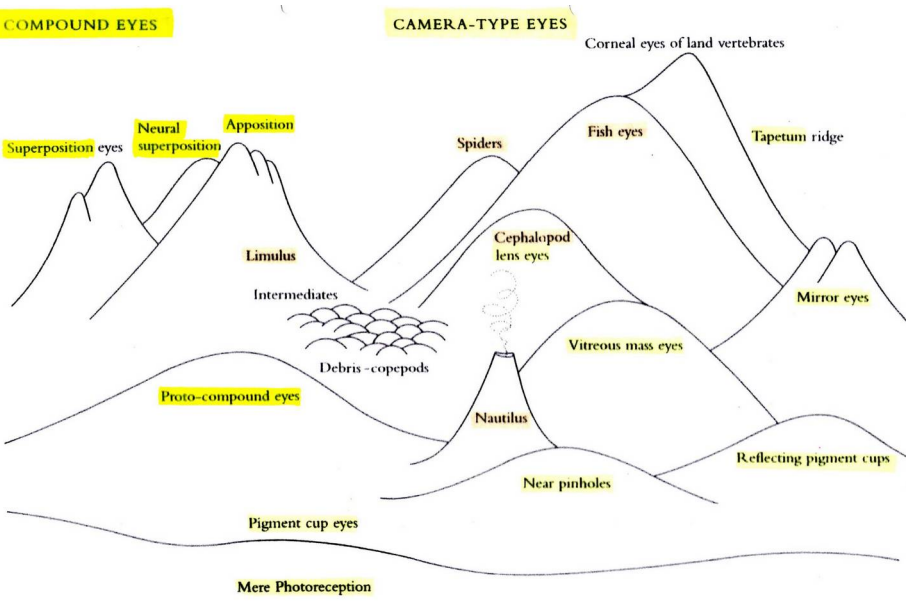


Figure 5.30 The eye region of the Mount Improbable range: Michael Land's landscape of eye evolution.

The important message to take away from all this is the plain fact that the evolution of the eye has occurred along many different independent routes, in all kinds of animals. Nor is the human eye the pinnacle of such evolution (eagles have greater visual acuity, mantis shrimps can see in the ultra violet and infra red ranges), just as humans are not at the top of the evolutionary tree. Even more importantly, natural selection provides a perfectly sound mechanism for evolving such a highly intricate organ as the eye, and moreover, from the perspective of geological time, these have all been achieved in the mere 'blink of an eye'. ■

Mike Allen

Reference: *Figures from Chapter 5, 'Climbing Mount Improbable' by Richard Dawkins. Penguin Popular Science: ISBN-13: 978-0-14-102617-6.*

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