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- providing information and advice on all matters relating to geology in museums
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Cover: Geological Curator, Anne Pennington George of Doncaster Museum in 1976. See paper by Bowden *et al.* inside.

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PRESERVING CARBONATITE LAVAS

by Lu Allington-Jones

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Geological material is the most chemically diverse of all types of natural history collections. Each mineral assemblage will require a specific set of environmental parameters to ensure stability. Unfortunately these are not yet fully understood and it is widely recognised that there is no environmental condition which will be suitable for all. Within a mixed collection microclimates are the simplest solution. At the Natural History Museum, London (UK), the carbonatite lava collection is currently being re-housed in dry microenvironments in an attempt to halt deterioration by hydration.

Allington-Jones, L., The Conservation Centre, Department of Science Facilities, The Natural History Museum, London SW7 5BD, UK. email: lua@nhm.ac.uk. *Received 24th April 2014. Accepted 29th May 2014.*

Introduction

The collection of natrocarbonatite lava samples (from the active Ol Doinyo Lengai volcano, Tanzania) in the Department of Earth Sciences, The Natural History Museum, London (UK) have undergone significant changes in external appearance since collection, due to inappropriate environmental conditions. These aesthetic changes represent alteration to different mineral constituents and have serious connotations for their value in future analysis. The problem varies between specimens, from the formation of crusts to conversion into powder. Blackwill believes that complete recrystallisation of a specimen makes it "no longer valid" because it becomes a different mineral (1990, 65). The specimens have been stored in polythene enclosures with silica gel sachets to control relative humidity. These measures have proved insufficient, the specimens have continued to develop white crusts (Figure 1).

Carbonatites can occur as both intrusive and extrusive rocks. Only one carbonatite volcano is known to have erupted in historical time (producing the natrocarbonatite lavas of this paper), but intrusive forms have been identified throughout the world: from Kodvor, Russia, to Phalaborwa, South Africa, and Mountain Pass, California. High-alkali carbonate lavas, such as natrocarbonatite, were once thought to be rare, but it is now believed that most extruded, and exposed intrusive, carbonatites have suffered alteration in reaction to atmospheric and meteoric water (Dawson *et al.* 2001; Hay 1983). This means that many more outcrops and museum specimens are in fact natrocarbonatites than was previously believed. Natrocarbonatites can be identified as carbonatites, and both may be confused with marble.

Natrocarbonatite lavas

Carbonatites are igneous rocks consisting of over 50% carbonate minerals. Natrocarbonatites are composed of the anhydrous sodium and potassium carbonate minerals nyerereite $Na_2Ca(CO_3)_2$ and gregoryite $(Na_2K_2Ca)CO_3$. When the lava erupts it is black or dark brown, but becomes coated with white

Figure 1. The current storage style. A sachet of old silica gel can be seen on the left.

efflorescence - thermonatrite, trona, sylvite, halite and nahcolite, with accessory kalicinite and villiaumite - after a couple of hours when it has reacted with meteoric water (Zaitsev and Keller 2006). Within a couple of days the whole flow turns pale grey and after a few weeks becomes brown and friable (Keller and Zaitsez 2006). Gaylussite and aphthitalite have also been identified as secondary minerals (Keller and Kraft 1990; Genge *et al.* 2001). After 2.5 months reaction crusts can reach 5mm in thickness and consist of trona, pirssonite, gaylussite, nahcolite and kogarkoite (Zaitsev and Keller (2006). After a year at temperatures between 8 and 43°C, Zaitsev and Keller (2006) record that 30% volume of the natrocarbonatite had transformed into a sand consisting of fluorite, shortite, gaylussite and calcite. The mineralogical changes also destroy much of the original texture of the lavas, although replacement phenocrysts have been noted in some cases (Hay 1983).

Dawson *et al.* (2001) report the replacement of nyrereite by pirssonite, with loss of K, Rb, SO_3, Cl and P_2O_5. Intersitial fluorite had been created when fluorine was released by the alteration and combined with calcium. Dawson *et al.* (2001) believe that this reaction requires the addition of calcium, but other researchers disagree. Reactions with meteoric water are complex, depending on the presence of contamination and dissolved minerals from other formations, lava and fumerole gases. Depletion of Na, K, S and Cl by meteoric water creates further permutations (Zaitsev and Keller 2006). The conversion of nyrereite to pirssonite, and then to gaylussite, however, only requires the addition of pure water, and does not require any change in bulk composition (Keller and Zaitsev 2006). The replacement of pirssonite frees up calcium for further reactions to form calcite whilst the transformation of gaylussite to calcite depends on the temperature and activity of sodium ions in solution (Keller and Zaitsev 2006). Zaitsev *et al.* (2008) propose that nyerereite - pirssonite - calcite relationships depend on variations in $P(H_2O)$ and $P(CO_2)$ during crystallization.

Recommended Relative Humidity for Mineral Collections

Museums tend to aim to control relative humidity in general collection areas according to local climate. The bounding parameters are, however, an upper limit of 65% to avoid mould growth, and the lower limit of 45% to prevent failure of organic materials (Erhardt and Mecklenberg 1994, 32; Thomson 1997, 268). Authors recommend different ranges for mixed museum collections: 55% RH (Staniforth 1994, 237); 60-70% RH (Pye 1994, 400); 40-55% RH (Stolow 1987, 252).

The general recommendations for mineral storage are <60% RH (Munday and Dinsmore 1990, 42) and 30-40% RH (Bradley 2005, 163). Blackwill (1990, 64), however, warns that dehydration can occur below 40% RH. Price (1992, 8) recommends 50% RH for all minerals. Stable relative humidity is generally accepted as the ideal. Values recommended for specific material types are "often mentioned without justification or...any research" (Erhardt and Mecklenberg 1994, 32).

Mineral hydrates require a specific range of relative humidity. Waller (1984, 13.8) estimates that approximately 10% of minerals undergo phase transitions when exposed to inappropriate RH levels. Erhardt and Mecklenberg (1994, 34) recommend the use of microenvironments and that, in the event of a lack of research, relative humidity should be maintained as low as practicable. Waller (1980, 120) recognises that no one humidity level is suitable for all mineral species. Lacquering is a technique which has been historically used, but lacquers do not form sufficient vapour barriers (Waller 1984, 13.8). Whilst storage at mineral<->solution equilibrium (the exact point at which the minerals will go into solution) risks morphological changes since the mobility of ions is permitted and the mineral may become subject to oxidation and hydrolysis whilst in solution (Waller 1984, 13.8). Storage at hydrate equilibrium conditions requires hermetic sealing because the humidity level must be precise. This is therefore only practicable within glass ampoules for specimens of less than 1cm diameter. Waller (1983, 103) recommends storage of larger specimens at an enforced RH within the stability limits of the mineral, although these limits must be accurately known and maintained.

Microenvironments

Waller (1992, 42) recommends the use of silica gel to control microclimates as opposed to saturated salt solutions, electrolyte solutions and salt hydrate pairs, due to the risk of contamination from the latter. Saturated salts can, however be used to condition silica gel if the silica gel is weighed every 2-3 days until a constant weight is reached (Waller 1992, 43).[1]

[1] At 20°C Lithium bromide - 6.6%RH; Lithium chloride 11.3; Potassium acetate 23.1; Magnesium chloride 33.1.

RH can also be controlled using oxygen scavengers (Mitsubishi Gas Chemical's RP System™ type K for the retention of ambient RH or type A for 0% RH) or inert gas, such as nitrogen. Chemical oxygen scavangers are more economical than active purging over long periods of time (Gilberg and Grattan 1994, 177). Ageless Z is suitable for a large range of relative humidities, but its action is slower at lower values (Gilberg and Grattan 1994, 177). Ageless E absorbs carbon dioxide as well as oxygen (Gilberg and Grattan 1994, 177). Ageless creates a temperature increase and moisture loss from the sachet immediately after implementation, so a buffer such as cotton wadding must be incorporated to absorb the excess moisture generated (Gilberg and Grattan 1994, 179). A similar effect has been observed using RP systems (pers. comm. D. Ault, August 2012).

Decomposition can occur during deliquescence so the original mineral species may not be regained on dehydration (Waller 1992, 35). Repeated dehydration/hydration cycles will result in decrepitation of specimens (Waller 1992, 38). If the specimens are removed for study then an allowable duration of time must be established - these limits have as yet not been established. An alternative form of damage limitation may comprise storage in a stable enclosure at ambient relative humidity.

King (1985) recommended G-PAK polypropylene and polyester welded pouches of 4.5mm thickness due to the high moisture migration rates from polypropylene boxes. Escal™ is also formed of several layers and may serve as a more advanced alternative barrier film. The outer layer is polypropylene, the inner layer is polyethylene. The barrier layer is a vacuum-deposited ceramic on a PVA substrate. Oxygen permeability is 0.05cc/m^2/24hrs, water vapour transmission is 0.01gm/m^2/24hrs.

Recommended Temperature for Mineral Collections

Price (1992, 8) recommends 15-20ºC storage for all minerals. A mineral species will become metastable outside of its stability field, which equates to the conditions of its formation (Waller 1992, 25). With added energy a metastable mineral will alter to a more stable product (Price 1992, 3). Therefore the reduction of temperature and light energy is desirable in mineral storage. Temperature controls the stability fields and solubility of minerals in water (Königsberger *et al*. 1999) and also has a direct effect on RH, high temperatures will speed reaction rates (a 10ºC increase will approximately double reaction rates), and at certain temperatures, hydrates will dissolve in their own water of crystallisation (Blackwill 1990, 65). For example, Parsons (1922) noted that laumontite only deteriorated outside the temperature range 0.6-12.8ºC. He recommended this range for the storage of all minerals that suffer damage from water loss but Waller (1983) maintains that refrigeration only slows reaction rates, so it must be used in conjunction with other methods, but in general, Waller (1992, 27) states that the rate of volatilization will be reduced at lower temperatures. If the gas involved is water or carbon dioxide, volatilization should be eliminated at 0ºC and -10ºC respectively. Marion (2001) proved that temperature had a significant effect on carbonate mineral solubility. King (1985) found that refrigeration of the G-PAK pouches was the most effective method to prevent deliquescence or hydration of a range of minerals. Mineral storage areas, however, must also be a suitable environment for museum staff and visitors.

Carbonatite Storage

Some carbonatite minerals are stable in ambient RH e.g. fluorite, barite, magnetite, apatite, sodalite, natrolite and ancylite. However, the stability fields of other carbonatite minerals are very complex depending on pressure, temperature and relative humidity. At <5%RH Natrite (Na_2CO_3) is the most stable form but at higher relative humidity (at atmospheric temperature and pressure) Trona ($Na_3(CO_3)(HCO_3).2H_2$) is most stable (Waller 1992, 26-27). Waller (1992, 26) recommends Nahcolite ($NaHCO_3$) storage at -10ºC at 50% RH. At atmospheric pressure Gregoryite crystallises at 630ºC and Nyerereite at 595ºC (Mattsson and Caricchi 2009) so their stability at ambient room temperature is difficult to equate.

In early literature Waller cites the carbonatite mineral buetschliite ($K_2Ca(CO_3)_2$) as an example of a deliquescent mineral. "When exposed to moist air K_2CO_3 is leached from this mineral leaving a powdery pseudomorph of $CaCO_3$" (Waller 1980, 118). He recommends specific parameters of relative humidity for only 3 carbonatite minerals: 75%RH upper limit for hanksite ($KNa_{22}(SO_4)_9(CO_3)_2Cl$; 76-87%RH for natron ($Na_2CO_3.10H_2O$); and 24%RH as a lower limit for thermonatrite ($Na_2CO_3.H_2O$), with efflorescence or deliquescence resulting from inappropriate levels (Waller 1980, Table 1, 121-123).

Parsons (1922) notes that pirssonite is damaged by water loss, but not that nyerereite and gregoryite suffer by water gain. King (1985) does not list nyerereite or gregoryite in his extensive list of minerals affected by humidity but does mention that natron, pirssonite, gaylussite and trona will effloresce. King *et al.* (2007) note the formation of pirssonite evapourites at 82.1-84.9% RH and calcite evaporites at above 38.9% RH. This would imply that stability of nyerereite and gregoryite will fall below 38.9% RH.

With fluctuating relative humidity carbonate within calcareous specimens reacts with atmospheric moisture to form weak carbonic acid which can dissolve specimens and cause the creation of calclacite crystals (Blackwill 1990, 65). Nassan (1992, 20-21) does not list carbonatites amongst the photo-sensitive minerals, but warns that the temperature increase caused by light can cause efflorescence.

Carbonate minerals are susceptible to acids (Nassan 1992, 21; Price 1992, 4) so they should be stored in acid-free packaging materials within metal cabinets. If wooden cabinets have to be used then these must either be well-ventilated or the specimens must be protected within stable polyolefin enclosures. Waller (1992, 32) recommends the use of buffering materials within such enclosures, to counteract the effect of temperature change on relative humidity. Croucher and Woolley (1982) also recommend buffered enclosures for deliquescent minerals, but do not suggest suitable parameters. Zaitsev and Keller (2006) recommend a sealed (and presumably dry) argon environment for carbonatite field samples. The anhydrous nature of nyerereite and gregoryite certainly imply that a dry environment would be ideal.

The Current Solution

The temperature of the collections storage area is controlled by the HVAC system to 19+/-2ºC and 45+/-5 %RH. The existing collection of natrocarbonatite lava is now being housed in acid-free cardboard trays with Plastazote® foam (by Polyformes) nests and heat-sealed Escal™ barrier film enclosures. RP System type A oxygen scavengers, by Mitsubishi Gas Chemicals, were used to ensure 0% RH (Figures 2 and 3), since cheaper silica gel systems had failed to halt deterioration in the past. This gift-bag style (as seen in Figure 2) is commonly used within the Conservation Centre for pyritic fossil material, usually accompanied by an oxygen-level indicator and RP System type K sachets, which do not affect relative humidity. The folding and sealing of the bag has been found not to compromise the barrier film. Enclosures created 6 years ago have been found to retain their oxygen barrier properties (and therefore also a barrier to the larger water molecule). Cobalt chloride indicator cards (Süd-Chemie Performance Packaging) were incorporated to allow quick visual checks of bag integrity. Trays, to hold the specimen within the enclosure, were constructed from fluted acid-free card board (supplied by Conservation by Design) and held-together using cotton thread or nickel-plated rivets, rather than adhesives. Tray heights were dictated to fall below the level of the existing drawers, but above the height of the specimen. This was to prevent the barrier film touching the specimen, since a slight vacuum is created by the scavenger. The bags were made much taller than the trays to allow easy access and re-use by cutting and re-sealing. All of the excess air was manually squeezed out before sealing so that the specimens could be returned to their original drawers. The humidity indicator strips will be monitored annually to check enclosure integrity. Each new enclosure cost £6 to £35 depending on its size. By far the most expensive component was the scavenging sachet.

Figure 2. A specimen stored in the new packaging style.

Figure 3. Some of the specimens returned to their collection drawer. The enclosure design was chosen specifically to fit below the height of the drawer, without increasing footprint size.

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RECOGNISING COMPOSITE SPECIMENS OF JURASSIC ICHTHYOSAURS IN HISTORICAL COLLECTIONS

by Judy A. Massare and Dean R. Lomax

Massare, J.A. and Lomax, D.R. 2014. Recognising composite specimens of Jurassic ichthyosaurs in historical collections. *The Geological Curator* 10 (1): 9 - 15.

Composite specimens have been a problem in palaeontology since its beginning. Numerous composite specimens exist in museum collections assembled in the 19th century in the UK. Features of the ichthyosaurian vertebral column are often overlooked, but centrum morphology can be used to evaluate the authenticity of a specimen. In particular, two landmarks are useful for assessing authenticity in many derived Jurassic ichthyosaurs: (1) the transition from two articular processes to one on the centrum, which often occurs in the pelvic region, and (2) the presence of wedge-shaped centra at the tail bend. We apply these criteria to a specimen of *Ichthyosaurus* to show that more than half of the seemingly articulated vertebral column was added using centra from perhaps five other individuals.

Judy A. Massare, Department of the Earth Sciences, SUNY College at Brockport, Brockport, NY 14420, USA Email: jmassare@brockport.edu; and Dean R. Lomax, Doncaster Museum & Art Gallery, Chequer Rd, Doncaster DN1 2AE, UK; School of Earth, Atmospheric and Environmental Sciences, The University of Manchester, Oxford Rd, Manchester, M13 9PL, UK. Email: dean.lomax@manchester.ac.uk
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Introduction

The first half of the 19th century saw a huge interest in ichthyosaurs, and many major collections were amassed in the UK during that time. Throughout the early and middle 19th century, exposures along the west Dorset coast near Lyme Regis and Charmouth, numerous stone quarries near Street, Somerset, and brick pits in the Peterborough area, Cambridgeshire, were some of the sites that yielded specimens. These were acquired by private collectors, who later donated or sold entire collections to major museums or individual specimens to local museums. Our work on *Ichthyosaurus* has focused our attention on many of the historical collections of Lower Jurassic specimens from Dorset and Somerset, UK.

The question of composite specimens goes back to the early 1800's, with Mary Anning (1799-1847) herself being unjustly suspected of modifying a plesiosaur specimen (Torrens 1995). Thomas Hawkins (1810-1889), a renowned fossil collector, was infamous for enhancing specimens from Somerset (Taylor 1989; McGowan 1990). Thus early in the development of palaeontology as a science, composite specimens were of concern. Whether composites were constructed to make a more aesthetically pleasing specimen for display or to misrepresent a specimen to command a higher sale price, the problem of composites is not a new one. Unfortunately, even today specimens are modified during preparation to increase their commercial value and then unlawfully sold as genuine (Mateus *et al.* 2008). More reputable sources, however, keep good records of preparation and restoration of specimens (see Deeming *et al.* 1993. pg. 426; Lomax and Massare in press).

Often large, complete skeletons are excavated in several blocks, so the question always arises as to whether the blocks assembled for a display mount represent a single individual (e.g., Lomax and Massare 2012). McGowan (1990) questioned the authenticity of several historical specimens of the Lower Jurassic ichthyosaur *Leptonectes* from Street, Somerset. Of particular concern were specimens in which the matrix had been covered by a uniform plaster veneer, often with patterns of chisel-like marks on the surface. This might mask differences in colour, hardness or texture of the matrix that would suggest a composite (McGowan 1990). Some composites are easy to spot, however, as when the skull or forefin of one taxon is added to the skeleton of another or when added limbs or limb elements are incorrectly oriented (McGowan 1990). When an historical specimen is conserved, it provides an excellent opportunity to verify its authenticity. One such specimen, donated to the NMW in 1886, was recently found to be a composite, with both a partial mandible and partial forefin added to the specimen

(Buttler and Howe 2002). However, disassembling a specimen, especially one on display, is usually not possible, so having other means to assess authenticity is important.

The purpose of this paper is to describe how the morphology of the vertebral column can be used to recognize composite specimens of derived ichthyosaurs, particularly those from the Lower Jurassic of the UK. Many historical collections include fairly complete skeletons from localities that are no longer accessible. They often display informative morphological or taxonomic features, but it is important to verify that the information is from a single individual. This is especially necessary when relative sizes or ratios of skeletal elements are used in descriptions or diagnoses of taxa. Moreover, specimens from the Hawkins collection have been widely dispersed, and a critical assessment of any historical specimen from Somerset is warranted (McGowan 1990). Obviously, if a specimen is a patchwork of several individuals, it probably has little, if any, scientific value. However, if a specimen has only a few "enhancements", it can still provide useful data.

Abbreviations: **ANSP**, Academy of Natural Sciences, Philadelphia, USA; **CAMSM**, The Sedgwick Museum, Cambridge, England and **NMW**, National Museum of Wales, Cardiff, Wales.

Vertebral morphology

During our survey of ichthyosaurs from the Lower Jurassic of the UK, we have come across several composite specimens that could be recognized by examining the morphology of the vertebral column. Many of these are very well done, with the preservation, size, and sometimes even the shape of centra matching almost exactly. Two examples from historical collections are held in the CAMSM, in which the addition of vertebrae gave the appearance of more complete specimens (Lomax and Massare 2012; Massare and Lomax 2014). In both instances, however, it is possible that a member of the museum staff, rather than the donor or collector, modified the specimens to make a more aesthetically pleasing display.

Derived ichthyosaurs (most thunnosaurians and some parvipelvians) have double-headed ribs in the cervical and dorsal region but single-headed ribs in the caudal region. So if the centra are preserved in lateral view, their general position in the vertebral column can be determined by the number of articular processes on each side of the centrum. For Lower Jurassic ichthyosaurs, the number of precaudal centra ranges from 43-50, although the Upper Jurassic *Ophthalmosaurus* has 35-39 (Table 1). Thus fewer than 35 or more than 50 precaudal centra suggests a closer examination of the specimen is necessary. Precaudal counts, however, are imprecise because the pelvis is not connected to the sacrum, and no distinctly different sacral vertebra are present (McGowan and Motani 2003). The precaudal count has been estimated in different ways: using the position of pelvic bones (especially the ilium), the position of the hindfin, or the anterior-most position of single-headed ribs (e.g., McGowan 1993; Buchholtz 2001; Massare *et al.* 2006). Of course the amount of displacement of the hindfin, and to a lesser extent the pelvis, can be too great to be of any use. The transition from trunk to tail stock is also characterized by a marked decrease in rib length (Buchholtz 2001) and this can serve as a check on the estimate.

In CAMSM J 35279, a *Leptonectes* from the Thomas Hawkins collection, the transition from double-headed ribs to single-headed ribs appeared to start after the 19th centrum and the processes had merged into a single, elongate articulation on the 21st centrum. Even allowing for the possibility of two or three missing cervical centra, the specimen had fewer than 25 precaudal centra (Lomax and Massare 2012). Closer examination revealed that a series of eleven centra, although articulated in the correct order and lined up exactly with the ribs that were preserved on the slab, were upside down relative to the anterior centra, with the ventral surface facing dorsally. Furthermore, there was a distinct crack and plaster filling under the questionable centra. We determined that the centra (No. 18-28) did not belong to this individual or came from a more posterior section of its vertebral column. Thus, as pointed out by McGowan (1990), the precaudal centrum count might not always confirm that a specimen is complete, but an unusually small count can indicate a composite.

The preflexural centrum count can also be useful (McGowan 1990), although the caudal series is often incomplete, even on otherwise well preserved skeletons. Among Lower Jurassic ichthyosaurs, the preflexural count ranges from 76-80 in *Ichthyosaurus* to 98 in *Excalibosaurus*, although again the Upper Jurassic *Ophthalmosaurus* has fewer (69-73; Table 1). So, less than about 70 centra anterior to the tail bend may also indicate a composite, as the example below (NMW G1597) will illustrate.

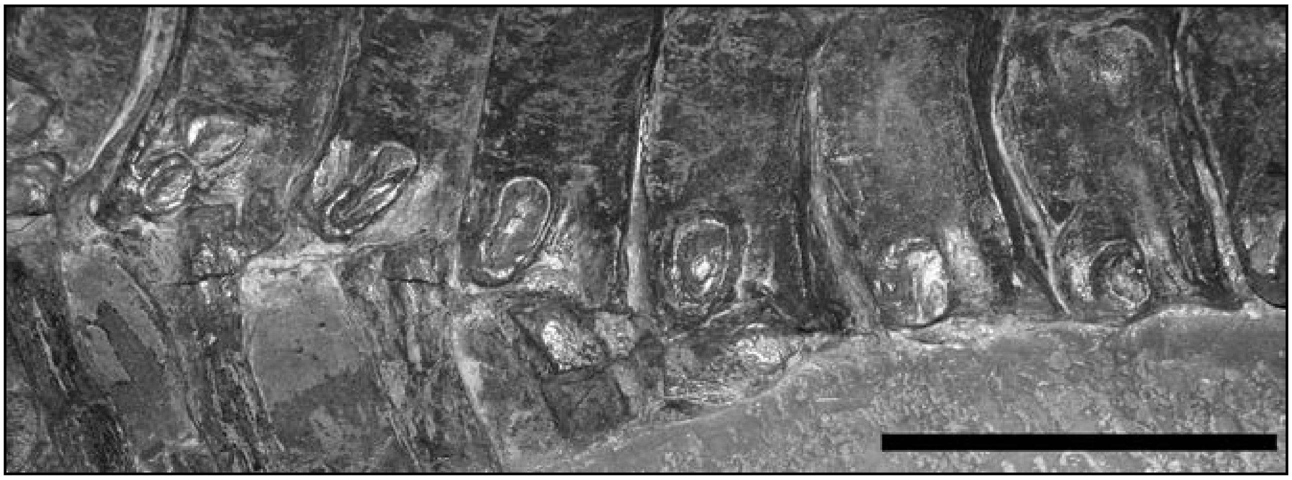

Figure 1: ANSP 15766,* Ichthyosaurus communis*, vertebral column showing the transition from two articular processes to a single elongated process on the centrum. Anterior to the left. Scale bar = 5 cm.

We have also used the progression of morphological change in the vertebral column, which can be seen in lateral view, to recognize segments of vertebral columns that are "out of place". Centra increase in size from the cervical to the anterior caudal region and then decrease in size to the tail bend (Buchholtz 2001; Massare *et al.* 2006). The size change tends to be gradual, although a lot of fluctuation occurs because of preservation or preparation differences. Especially on slab mounts, some of the centra are better exposed and so the measurements are more reliable. Centra can also be rotated along the column, so that the dimension (often the height) cannot be measured accurately. Nevertheless, abrupt changes in size or shape are always suspicious. This was the case with CAMSM X50187, an *Ichthyosaurus* in which the anterior caudal centra were much higher and narrower than the immediately adjacent posterior dorsals (Massare and Lomax 2014). Closer examination revealed that the caudal centra were upside down relative to the anterior skeleton and surrounded by plaster, and so were most likely from another individual.

Two landmarks on the vertebral column are reliable indicators of position for many derived ichthyosaurs. The first is a transition from double-headed to single-headed ribs, which occurs in the pelvic region. The two processes for rib articulation on each side of the centrum (diapophysis and parapophysis) merge to a single one. Anterior to the merge, the two processes become progressively closer together until they touch (Figure 1). On the next centrum posteriorly, they merge into a single, dorsoventrally elongated articulation, which sometimes forms a 'figure eight' shape. The elongated process may persist on two or more centra, before shortening to a circular process low on the centrum that is typical of caudal centra.

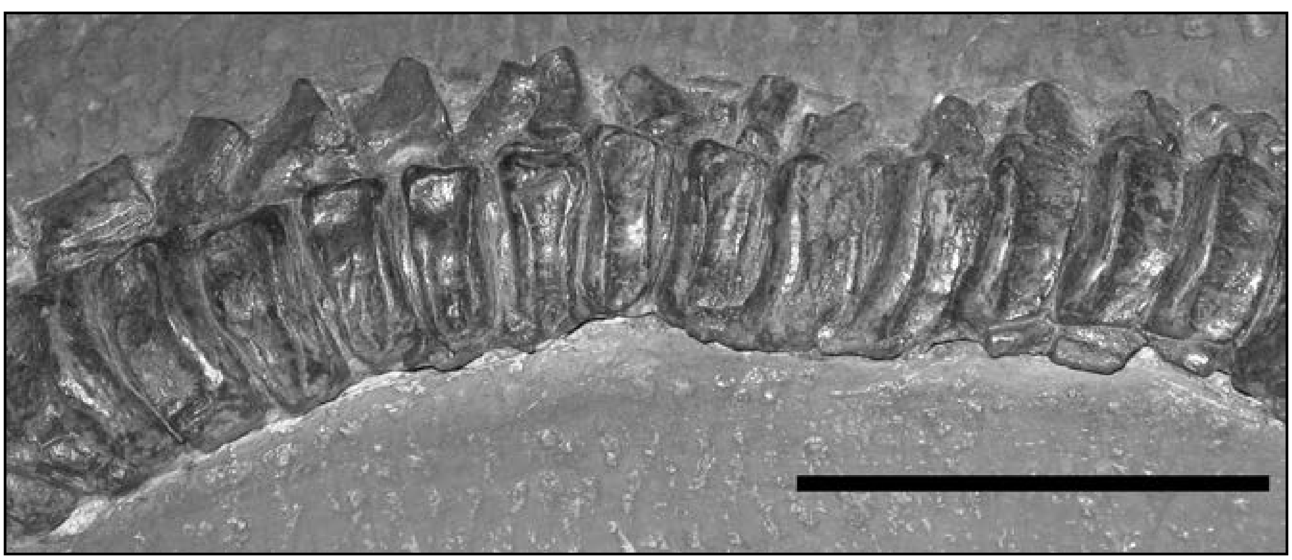

Figure 2: ANSP 15766,* Ichthyosaurus communis *vertebral column showing the wedge-shaped centra of the tail bend. Note that the fluke centra to the right have a more rectangular shape in lateral view. Anterior to the left. Scale bar = 5 cm.

We have used this landmark in evaluating specimens of *Ichthyosaurus* and *Leptonectes*, but it can be used for other derived ichthyosaurs, especially thunnosaurians. The transition from two processes identifies the boundary between the posterior dorsal and anterior caudal regions of the vertebral column in many species (e.g., Massare *et al.* 2006; Lomax and Massare 2014). The transition also indicates the direction of anterior and posterior in any species with double-headed ribs, regardless of whether the transition is in the pelvic region or anterior to it. The second landmark occurs at the tail bend, where one to several wedge-shaped centra occur, hereafter referred to as 'apical centra'. Their dorsal lengths are noticeably greater than the ventral lengths (McGowan 1989). In addition, the anterior and posterior edges of the centra (in lateral view) are more rounded and poorly defined in comparison to the adjacent centra (Figure 2). The rounded edges allowed a greater range of movement between adjacent centra at the base of the fluke (Massare *et al.* 2006).

An example: NMW G1597

A specimen at the National Museum of Wales (NMW G1597) provides an interesting example of how using the landmarks described above can identify a composite specimen that otherwise looks intact. The specimen is from the old Cardiff collection, and so was acquired very early on in the history of the museum (C. Howells, pers. comm. 2013). The colour of the bone suggests that the specimen is likely from the Dorset coast. It is an *Ichthyosaurus* based on the humerus shape and the anterior digital bifurcation in the forefin, traits that are diagnostic for the genus (Motani 1999, McGowan and Motani 2003). See Lomax and Massare (in press) for more details on the taxonomy. The specimen is preserved lying on its left side, and includes a partial skull and mandible with teeth, right forefin and partial pectoral girdle, and a vertebral column lacking any ribs (Figure 3). At first glance, there do not seem to be any abrupt changes in the size of the centra and they all look fairly well articulated. The preservation looks similar along the entire vertebral column and there are no obvious cracks in the slab that would suggest that pieces have been added.

The vertebral column begins at centrum No. 2 (axis) and the next 30 centra (to No. 32) certainly belong to the specimen. The diapophysis and parapophysis are well separated on all of the first 32 centra. Beyond that, the centra have been added to the specimen. The next two (No. 33 and No. 34; Figure 4, region A) are offset slightly, and seem like they might belong, but they are 10% taller and more than 15% longer than the two nearest anterior centra (Table 2). This is a fairly large change in size for consecutive centra, so these are most probably from another individual. The next 9 centra (No. 35-43; Figure 4, region B) include posterior dorsals and anterior caudals, but the sequence is reversed: the caudals are anterior to the dorsals. Centra No. 35-39 (caudals) have a single, elongated articular process whereas centra No. 40-43 (dorsals) have two distinct articular processes. Had the series been oriented in the opposite, anatomically correct way, it would have been difficult to recognize that they did not belong to this individual. The next five centra (No. 44-48; Figure 4, region C) are also oriented backwards and again show the transition from two articulations to one. The anterior three centra are caudals, with a single articulation; the posterior two are dorsals, with two articulations. The centra are slightly smaller than those in the previous series, but this region of *Ichthyosaurus* typically has the largest centra of the vertebral column, so they should be larger. The next 14 centra (Figure 4, region D) are caudals, and the sequence ends with an

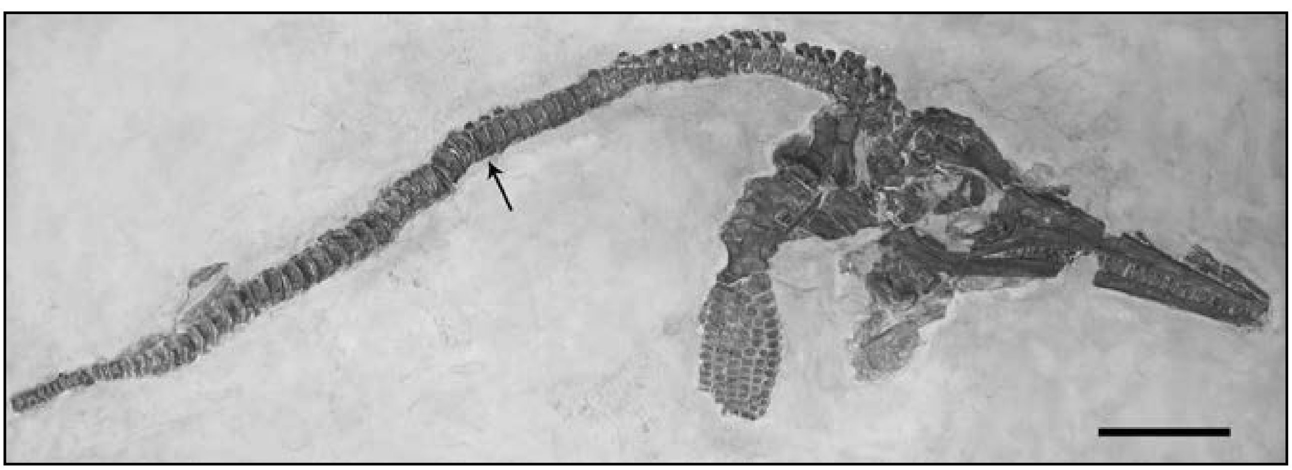

Figure 3: NMW G1597,* Ichthyosaurus *sp. The arrow points to centrum No. 32, the last authentic one. All posterior centra have been added to the specimen. Scale bar = 10 cm.

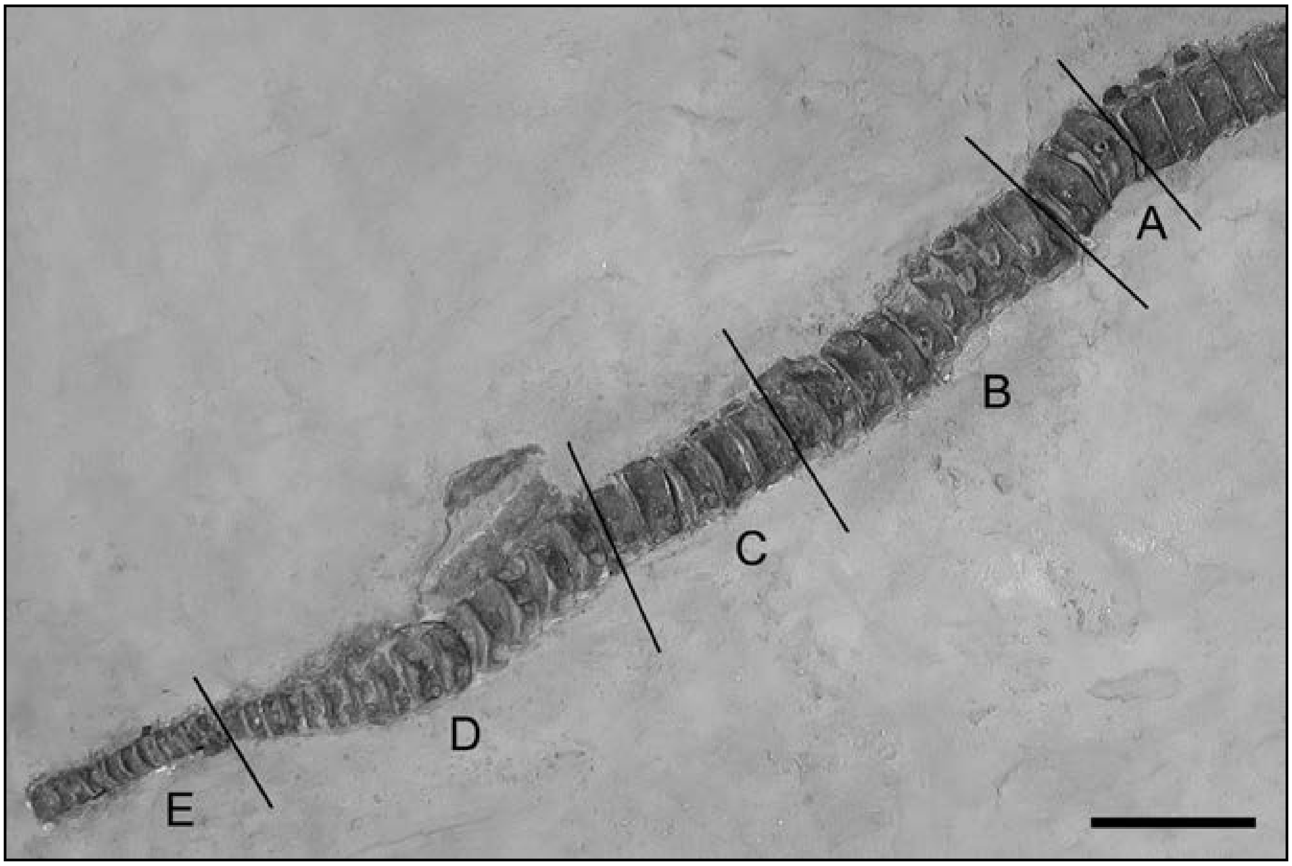

Figure 4: NMW G1597,* Ichthyosaurus *sp. A closer view of the posterior half of the vertebral column. Oblique lines divide the vertebral column into regions A-E, where articulated sequences of centra have been added to the specimen. See text for a more detailed discussion. Scale bar = 5 cm.

apical centrum, however the decrease in centrum size is quite rapid so these 14 might not be a continuous sequence or from a single individual. The apical centrum is No. 62, which would be an unusually low number of preflexural centra (Table 1). The next centrum is broken (No. 63), but the remaining sequence of eleven (Figure 4, region E) include six fluke centra (No. 64-70), then at least another three apical centra (No. 71-73), plus two more centra at the end of the column that are probably also fluke centra. In addition to fluke centra being anterior to apical centra, the apical centra are oriented upside down such that the tail bend would be upward (dorsal) rather than downward (ventral).

Overall, the composite is fairly convincing (at least if the vertebral column is not examined closely), and may have been prepared specifically for display, though this is difficult to determine given the lack of information. The change in size of the centra from anterior to posterior seems reasonable, and the lack of a distinct bend in the vertebral column would suggest that the caudal portion was incomplete, which is not unusual. The discrepancies described above would not have been noticed by someone standing a few feet away from the specimen. Other features that may have suggested that this specimen is a composite include the lack of any ribs, and the matrix, which has been painted, probably several times. A painted matrix is not only associated with composite specimens, but McGowan (1990) suggested that it justifies a careful assessment of authenticity.

Conclusion

The vertebral column in ichthyosaurs is often overlooked, especially on fairly complete skeletons where features of the skull, limb girdles, and forefins provide diagnostic taxonomic information. Examination of NMW G1597 has shown that the vertebral column can yield important information regarding the authenticity of a specimen. The dimensions and shapes of adjacent centra, the precaudal and preflexural centrum count, and the location of two landmarks (transition from double to single articulation, apical centra) are useful in evaluating whether an articulated vertebral column of a derived ichthyosaur is a composite. In addition, articulated vertebral columns can provide palaeoecological information and, in some cases, taxonomic information as well (Buchholtz 2001; Massare *et al.* 2006).

Species	Precaudal	Preflexural	Reference
Leptonectes solei	47-53		McGowan 1993 (n=2)
Leptonectes tenuirostris	44-48	83-87	McGowan 1993 (n=9)
Suevoleviathan disinteger	44	89	Buchholtz 2001 (n=1)
Excalibosaurus costini	48	98	McGowan 2003 (n=1)
Eurhinosaurus longirostris	45-50	91-95	McGowan 2003 (n=7)
Temnodontosaurus platyodon	46-47		McGowan 1993 (n=3)
Temnodontosaurus trigonodon	44	95	Buchholtz 2001 (n=1)
Ichthyosaurus communis	43	76-80	Buchholtz 2001 (n=1)
Ichthyosaurus breviceps	45-46		Massare & Lomax 2014 (n=1)
Stenopterygius quadriscissus	47	81	Buchholtz 2001 (n=1)
Ophthalmosaurus natans	35	69	Massare *et al*. 2006 (n=1)
Ophthalmosaurus icenicus	39	73	Massare *et al.* 2006 (n=1)

Table 1: Precaudal and preflexural centrum counts for some parvipelvian ichthyosaurs. All species are from the Lower Jurassic except for the* Ophthalmosaurus *species, which are from the Middle- Upper Jurassic. The number in parentheses in the 'Reference' column indicates the number of specimens that provided information.

Centrum No.	Height (cm)	Length (cm)
23	1.99	1.16
24	2.19	1.20
25	2.06	1.19
26	1.97	1.07
27	2.12	1.11
28	2.15	1.12
29	2.08	1.03
30	2.06	1.04
31	2.25	1.13
32	2.20	1.11
33	2.46	1.31
34	2.45	1.32

Table 2: Centrum measurements (in cm) of a portion of the vertebral column of NMW G1597. Note that the last two centra (No. 33-34) are much higher and longer than the ten anterior to it, and probably do not belong to this individual. Centra posterior to No. 34 had been added to the specimen.

Acknowledgements

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A TALE OF TWO HOLOTYPES: REDISCOVERY OF THE TYPE SPECIMEN OF *EDESTUS MINOR*

by Wayne M. Itano

Itano, Wayne, M. 2014. A tale of two holotypes: Rediscovery of the type specimen of *Edestus minor*. *The Geological Curator* 10 (1): 17 - 26.

Edestus is a Carboniferous chondrichthyan genus known mainly from its triangular, serrated teeth. A maximum of around ten teeth are joined at their bases to form tooth whorls. *Edestus minor* Newberry, 1866, was described on the basis of a single, isolated tooth. A tooth whorl containing seven teeth, described and figured by Hitchcock in 1856, but not named by him, was later referred to *E. minor* by Newberry, who came to regard it as the holotype. However, the isolated tooth remains the holotype, since it is the sole specimen upon which the original description was based. The distinction is not trivial, because the crown of the holotype of *E. minor* differs from those present in Hitchcock's specimen. *Edestus mirus* Hay, 1912, was designated as a new species, based on differences from the Hitchcock specimen, although the crowns are not distinguishable from those of the holotype of *E. minor*. Thus, *E. mirus* is almost certainly a junior synonym of *E. minor*, while the Hitchcock specimen may require a new name. If so, it should probably be referred to *Edestus minusculus* Hay, 1910. Recently, the holotype of *E. minor* was located at the American Museum of Natural History, where it had not been recognized as a type specimen. Published documents as well as nineteenth-century museum labels provide some insight into this tangled nomenclatural history.

Museum of Natural History, University of Colorado, Boulder, Colorado 80309, USA Email: wayne.itano@aya.yale.edu. Tel: +1 (303) 499-4248. Fax: +1 (866) 356-2016. *Received 7th May 2014. Accepted 26th June 2014.*

Introduction

Holotypes of fossil species are often poorly preserved and incomplete. There is a natural temptation to substitute a better-preserved or more complete specimen thought to be of the same species. Not only would this be in violation of Article 73, Paragraph 73.1.2, of the ICZN (International Code of Zoological Nomenclature) (ICZN 1999), but the two specimens might subsequently prove not to belong to the same species at all. Problems with the use of referred specimens as proxy 'holotypes' have been discussed by Parker (2013).

Edestus Leidy, 1856b, is a genus of chondrichthyan fishes having a wide geographic (North America, Russia, and Britain) but rather narrow stratigraphic (Early to Middle Pennsylvanian) range (Itano *et al.* 2012). The genus is in need of revision, as most of the approximately 14 species were based on single, isolated teeth or on single tooth whorls (files of teeth joined at the bases), without taking into account possible variation due to ontogeny or position (upper or lower jaw). Thus, it is likely that many of the nominal species are synonymous with one another. In this article I attempt to trace the nomenclatural history of one species, *Edestus minor* Newberry, 1866, and its two 'holotypes'.

Institutional abbreviations

ACM, Beneski Museum of Natural History, Amherst College, Amherst, Massachusetts, USA; AMNH, American Museum of Natural History, New York, NY, USA; ANSP, Academy of Natural Science of Drexel University (formerly Academy of Natural Sciences of Philadelphia), Philadelphia, Pennsylvania, USA; MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; PIN, Palaeontological Institute of the Russian Academy of Sciences, Moscow, Russia; TsNIGR, Tchernyshev Central Scientific Research Geological Museum, St. Petersburg, Russia; USNM, National Museum of Natural History, Washington, DC, USA.

Edestus vorax Leidy, the first species of *Edestus* to be described

The type species of *Edestus* is *Edestus vorax* Leidy, 1856b. The original description was given by Leidy (1856b) and presented by him at a meeting of the Academy of Natural Sciences of Philadelphia on October 30, 1855. A more complete description with a figure appeared later (Leidy 1856a). The locality is poorly known:

The specimen is most probably from the Carboniferous series, and it was obtained by William S. Vaux, Esq., from an itinerant showman, who found it at Frozen Rock, Arkansas River, 20 miles below Fort Gibson, in the Indian Territory. (Leidy 1856b)

The specimen, which will be referred to in this article as the Leidy specimen, is shown in Figure 1 from Leidy (1856a, pl. 15). It is a poorly-preserved partial tooth whorl including parts of four teeth. The orientation, with crowns pointing down, probably reflects Leidy's original opinion that the fossil was a superior maxilla (upper jaw bone) of an osteichthyan fish. The Leidy specimen is located at the ANSP (N. Gilmore, pers. comm.). Photographs have been published by Branson (1963, figs. 2, 3) and Ginter *et al.* (2010, fig. 125B). Several labels are preserved with the specimen. The one which appears to be the oldest is shown in Figure 2. It confirms the locality information given by Leidy (1856b).

The locality on the Arkansas River in the Indian Territory has often been misinterpreted as being in the state of Arkansas (Newberry and Worthen 1870, p. 353; Newberry 1889, p. 218; von Zittel 1890, fig. 131; Hay 1902, p. 337; Jillson 1949, p. 8; Zangerl 1981, p. 89; Ginter *et al.* 2010, fig. 125B). In fact, Frozen Rock in what was then Indian Territory is near the present-day city of Muskogee, Oklahoma (Branson 1963). Branson (1964) questioned the Oklahoma provenance of the Leidy specimen and suggested that it was instead from a coal mine near Decatur, Macon County, Illinois. This opinion seems to have been based on circular reasoning: no other *Edestus* fossils were then known from Oklahoma and at least one *Edestus* specimen resembling the Leidy specimen (the holotype of *Edestus giganteus* Newberry, 1889) was known from the Illinois locality. Several other *Edestus* teeth are now known from Oklahoma (Branson 1964; Mapes and Chaffin 2003, fig. 10A; Itano, *et al.* 2012; J. Maisey, pers. comm. quoted in Itano, 2014).

Throughout the rest of the nineteenth century and into the first part of the twentieth, opinions varied as to the position on the body of the *Edestus* fossils, now known to be tooth whorls. They were thought by some to be teeth, located in the region of the mouth, and by others to be defensive spines positioned on the dorsal, pectoral, or caudal fins. For summaries of the early discussions, see Newberry (1888), Eastman (1903), Hay (1910), and Karpinsky (1912).

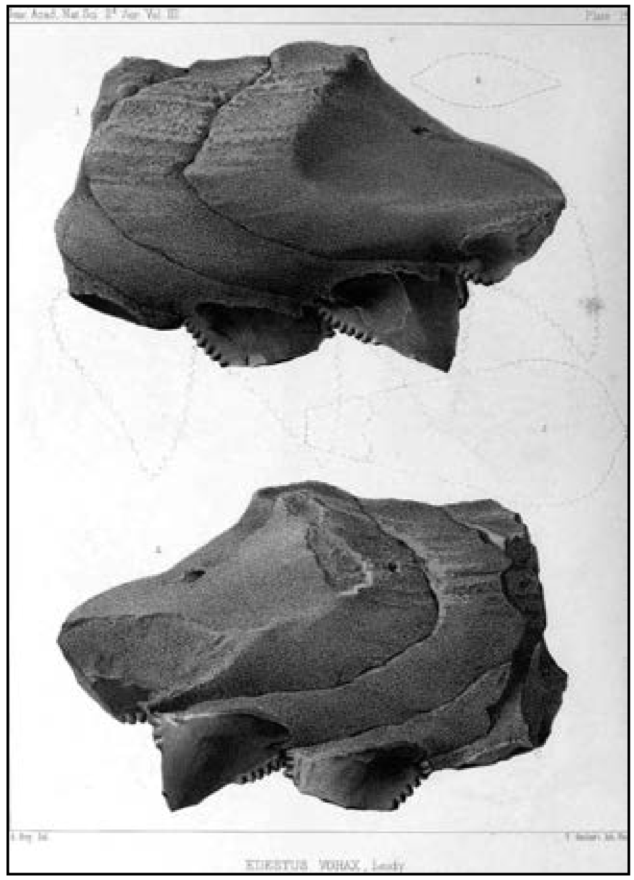
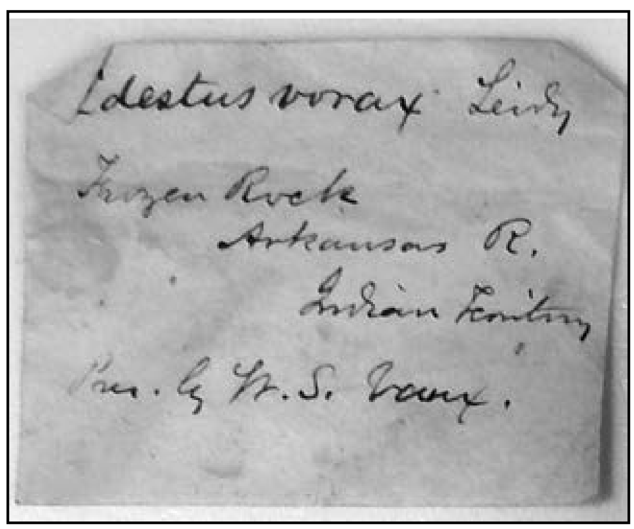


Figure 1. Two views of ANSP 9899, the holotype of* Edestus vorax *Leidy. Length 15 cm.



Edestus vorax Leidy
Frozen Rock
Arkansas R.
Indian Territory
Pres. by W. S. Vaux.

Figure 2. Label associated with holotype of* Edestus vorax *Leidy.

The *Edestus* specimen described but not named by Hitchcock

In August 1855, Professor Edward Hitchcock of Amherst College presented a specimen of *Edestus* at the Providence, Rhode Island, meeting of the American Association for the Advancement of Science (Hitchcock 1856). Figure 3 is Hitchcock's published drawing of the specimen. It shows that the

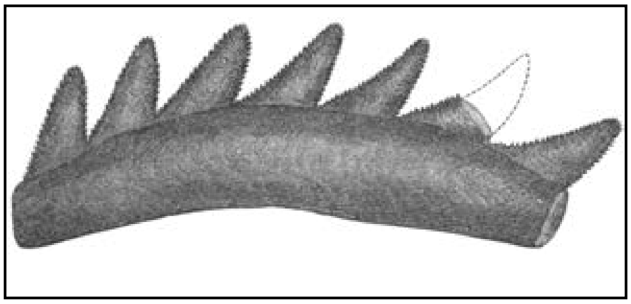


Figure 3. Figure of ACM 85, an* Edestus *tooth whorl (Hitchcock 1856).

second tooth from the right side is missing the tip, which is not obvious from later drawings or photographs. The missing portion of that tooth must have been reconstructed later to improve the appearance. The specimen is now at the ACM, with catalogue number ACM 85 (K. Wellspring, pers. comm.). It will be referred to in this article as the Hitchcock specimen.

The specimen was sent to Hitchcock by the Rev. John Hawks of Montezuma, Indiana, who obtained it from Dr. S. B. Bushnell, also of Montezuma. It was said to have been found in a layer of slate above a coal bank in Park [sic] County, Indiana. (The correct spelling is Parke County.) The 'slate' was probably carbonaceous black shale. Professor L. Agassiz of Harvard University, who was at the meeting, expressed the opinion that the object projected from the head of a shark, similarly to the spiked rostrum of the extant sawfish *Pristis*, and that there was another one symmetrically on the other side of the head. The specimen was to be loaned to Agassiz to be described by him (Hitchcock 1856), but I have been unable to find any evidence that this was ever done.

The specimen was loaned to Richard Owen of the British Museum (Natural History), who stated, "I am indebted to Professor Hitchcock, of Amherst College, U.S., for the opportunity of examining this most rare and singular fossil" Owen (1861, p. 124). Owen referred the fossil to Leidy's genus *Edestus*, but spelled it '*Edestes*'. Figure 4 is his drawing of the Hitchcock specimen (Owen 1861, fig. 38). The figure is odd in three respects: 1) it is oriented vertically, unlike most other depictions of *Edestus* tooth whorls; 2) only about half of it is shown; 3) the base tapers vertically, which is not an accurate depiction. It seems that Owen was willing to distort the evidence, particularly with regard to the inaccurate tapering, in order to support his opinion that the *Edestus* fossil was a dorsal finspine. Hitchcock died in 1864. His specimen was not referred to a particular species of *Edestus* during his lifetime.

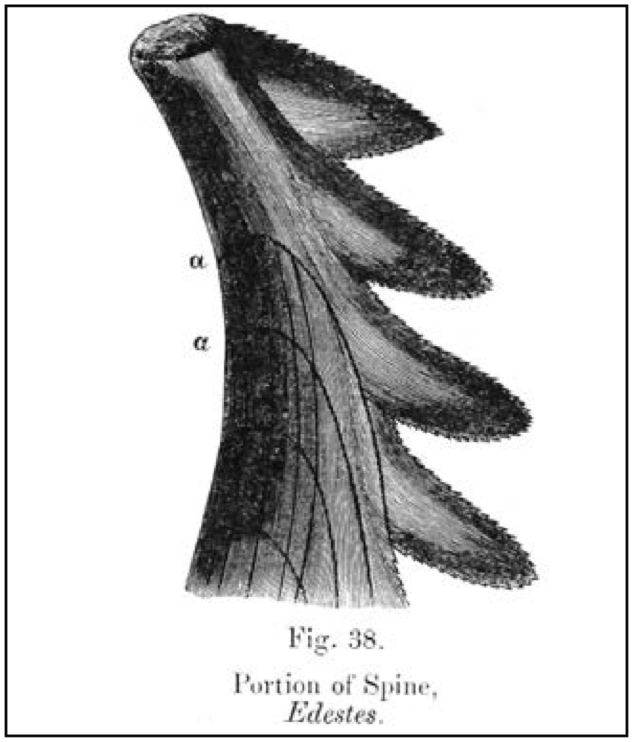


Figure 4. The Hitchcock specimen of* Edestes *[sic] as figured by Owen (1861, fig. 38). Letters "a" denote the points where the borders of the individual tooth bases intersect the margin of the tooth whorl.

The holotype of *Edestus minor*

A few years after Leidy described *Edestus vorax* and after Hitchcock described and figured, but did not name, another specimen of *Edestus*, Newberry described *Edestus minor* Newberry, 1866, based on a single tooth from Posey County, Indiana. In his description of the tooth, he noted that it differed from *E. vorax* in its smaller size and in the margins being 'coarsely doubly crenulated'. It is hard to understand why size would be used as a criterion for distinguishing species when only single specimens were known, without knowledge of the ontogenetic development, but this seems to have been done routinely at that time. The double crenulation may refer to the fact that the serrations are subdivided in some cases. Figure 5 is Newberry's drawing of the specimen (Newberry and Worthen 1866, pl. 4, fig. 24). Since it is the sole specimen upon which the description was based, it is the holotype. Newberry stated that he could not compare his specimen to the Hitchcock specimen because he did not have a detailed description of it. It is worth noting that the species name is *E. minor* Newberry, not *E. minor* Newberry and Worthen, even though the description was contained in Newberry and Worthen (1866). On page 84 of that reference, the description of *E. minor* is headed by the line "EDESTUS MINOR, Newb.", in contrast to, for example, "CHOMATODUS COSTATUS, N.

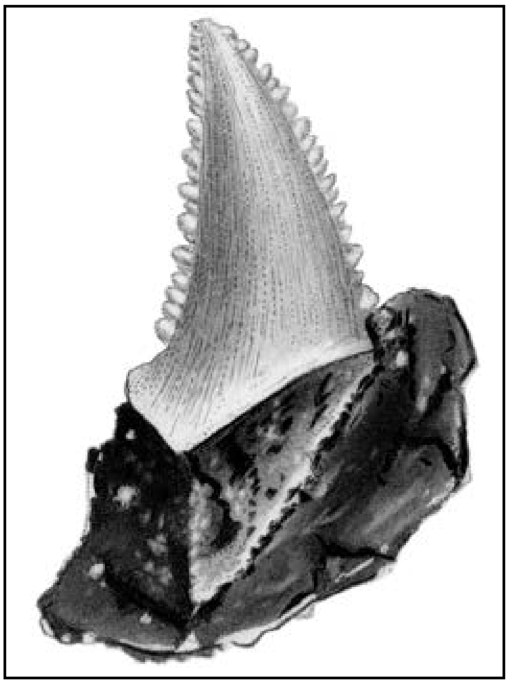


Figure 5. Figure of the holotype of **Edestus minor** *Newberry (Newberry and Worthen 1866, pl. 4, fig. 24).*

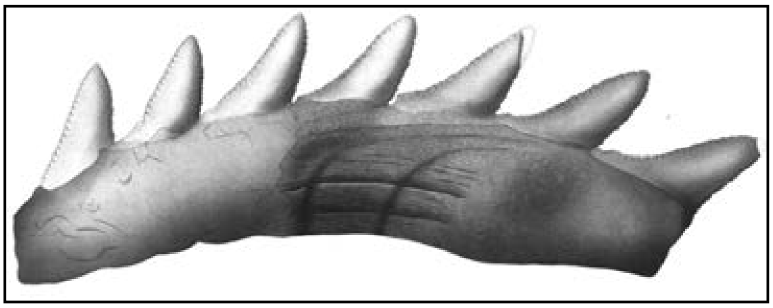


Figure 6. Figure of Hitchcock specimen (Newberry and Worthen 1870, pl. 1, fig. 2), mistakenly labelled as* Edestus vorax *Leidy. Length along base 18 cm.

and W." on the next page. This indicates that Newberry alone was responsible for the description of the former species, while the latter species was described by Newberry and Worthen jointly.

Later history of the Hitchcock specimen

At some time after the writing of Newberry and Worthen (1866) and before that of Newberry and Worthen (1870), Newberry had the opportunity to examine the Hitchcock specimen. Figure 6 (Newberry and Worthen 1870, pl. 1, fig. 2) depicts that specimen, although it was not identified as such. The caption identifies it as *Edestus vorax* Leidy. The reason for the mistaken species identification is not clear, given that the Leidy and Hitchcock specimens differ in morphology, particularly in the shapes of the crowns. The figure is not discussed in the text.

The holotype of *Edestus heinrichi* Newberry and Worthen, 1870, appears on the same plate (Newberry and Worthen 1870, pl. 1, fig. 1). [The species was originally designated as *Edestus heinrichsii*, but, since it was named for a Mr. Heinrich, *Edestus heinrichi* is the correct spelling (Zangerl and Jeremiah 2004, p. 9).] H. Woodward (1886, p. 3) questioned the identification of the specimen depicted in Newberry and Worthen (1870, pl. 1, fig. 2) as *E. vorax*. Noting the similarity between the Leidy specimen and the specimen labelled as *E. heinrichsii* (Newberry and Worthen 1870, pl. 1, fig. 1) and the differences between the Leidy specimen and the specimen labelled as *E. vorax* (Newberry and Worthen 1870, pl. 1, fig. 2), H. Woodward considered that the labels had perhaps been reversed. In fact, only the *E. vorax* label was incorrect, while the *E. heinrichi* label was correct. This confusion led him to label Owen's figure of the Hitchcock specimen (Figure 4) as *Edestus* sp? (*E. Heinrichsii*?) (H. Woodward 1886, fig. 1).

Newberry and Worthen's mistake in labelling the Hitchcock specimen as *E. vorax* was later acknowledged (Newberry, 1879, p. 347; 1889, p. 218), but not before it had caused some confusion. An interesting example is given by an illustration from a textbook by von Zittel (1890), reproduced here as Figure 7. Von Zittel's illustration (Figure 7) is a mirror-reversed copy of the depiction of the Hitchcock specimen by Newberry and Worthen (1870, pl. 1, fig. 2), which is reproduced here as Figure 6. Von Zittel's illustration is not an unreversed representation of the other side of the specimen; this is clear from comparison with the photographs of both sides published by Eastman (1903, pl. 21, figs. 2 and 3). Von Zittel's figure caption, reproduced here in Figure 7, propagates two errors and commits a third one in just one line of text: 1) the species name is incorrectly given as *Edestus vorax*; 2) the locality given is that of the Leidy specimen, not that of the Hitchcock specimen; 3) the locality of the Leidy specimen is given as Arkansas, not the Arkansas River in Indian Territory.

A figure of the Hitchcock specimen appears in Newberry (1889, fig. 39, fig. 1), this time labelled as *Edestus minor*, but not as a type specimen. The effect of this change in identification can be seen in the published record. For example, the same *Edestus* specimen, from near Bend, Texas, was identified first as *Edestus* vorax (Cummins 1890, p. 149) and later as *Edestus minor* (Cummins 1891, p. 392). Apparently, the former identification was based on Newberry and Worthen (1870, pl. 1, fig. 2), while the latter was based on Newberry (1889, fig. 39, fig. 1).

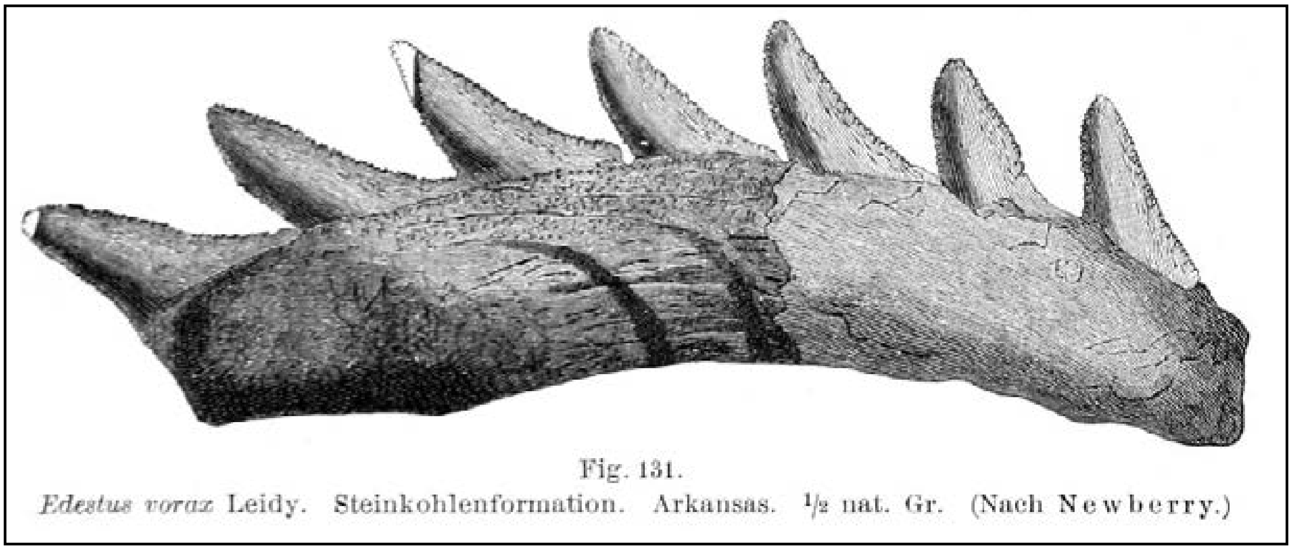


Figure 7. Figure of Hitchcock specimen misidentified as the Leidy specimen (von Zittel 1890, fig. 131).

At some point, Newberry decided to designate the Hitchcock specimen as the holotype of *E. minor*, which does not stand under the ICZN rules. Figures 8A and 8B show two undated labels associated with the Hitchcock specimen, both of which identify the Hitchcock specimen as the type of *E. minor*. Figure 8A is said to be in Newberry's own handwriting. I have been unable to determine whether Newberry ever made the designation in a publication. Hussakof, who curated Newberry's fossil fish collection after it was deposited at the AMNH, noted that Newberry was rather casual in his treatment of type specimens:

> A number of minor difficulties were encountered in the identification of some type specimens, particularly in the case of the Newberry Collection. Professor Newberry, it appears, did not always designate his type specimen at the time of description, but like some of his contemporaries, sometimes selected a more perfect specimen obtained later and designated it as the type. (Hussakof 1908, p. 4)

The Hitchcock specimen has, on occasion, been referred to by others as the type specimen of *Edestus* minor, for example by Eastman (1902, p. 66). However, it is not entirely clear that the holotype of *E. minor* (Figure 5) and the Hitchcock specimen (Figures 3 and 6) represent the same species. The outlines of the crowns are similar, but in *E. minor*, one of the serrated edges is convex while the other is concave (right and left edges, respectively, of Figure 5). In the Hitchcock specimen, one edge is convex (right edges of crowns in Figure 6) while the other is sigmoid (left edges of crowns in Figure 6), being concave near the base and convex near the apex.

The Hitchcock specimen, usually identified as *Edestus minor*, has been figured many times. In addition to the depictions already noted, there are, for example, Dean (1895, fig. 35) (as *Edestus heinrichsii*), Dean (1897, fig. 4), Eastman (1903, pl. 21, figs. 2 and 3) (photographs of both sides), Karpinsky (1899, text-figs. 2,3), Lesley (1889, p. 214) (as *Edestes* [sic] *vorax*), Miller (1889, fig. 1129)

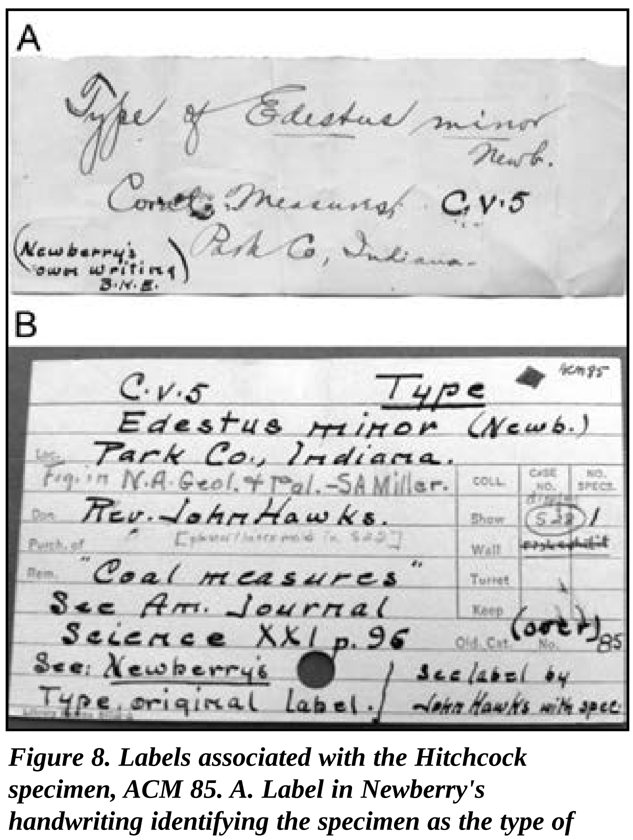


Figure 8. Labels associated with the Hitchcock specimen, ACM 85. A. Label in Newberry's handwriting identifying the specimen as the type of **Edestus minor.** ***C.V.5 is an old catalogue number. B.K.E. is Benjamin Kendall Emerson (1843-1932), a geology professor at Amherst College (K. Wellspring, pers. comm.). B. Specimen card identifying ACM 85 as a type specimen.***

(as *E. vorax*), Newton (1904, fig. 1), Obruchev (1953, fig. 1), Obruchev (1964, fig. 38) (as *Edestodus minor*) and A. S. Woodward (1891, fig. 12). *Edestodus* is a genus erected by Obruchev (1953) to include species similar to *Edestus minor*. It is regarded by Ginter *et al.* (2010) as a junior synonym of *Edestus*. Dean's error in labelling a figure of the Hitchcock specimen as *Edestus heinrichsii* probably stems from the confusion previously noted in the label of H. Woodward (1886, fig. 1). H. Woodward (1888, fig. 12) reproduced Owen's figure of the Hitchcock specimen (Figure 4), calling it "Portion of spine of *Edestes* [sic] *vorax*". He may not have realized that Owen's drawing was based on the Hitchcock specimen, which is depicted elsewhere in the same book (H. Woodward 1888, fig. 11h).

Neglect and rediscovery of the true holotype of *Edestus minor*

After Newberry's referral of the Hitchcock specimen to *E. minor*, the true holotype of *E. minor* was neglected. I have been unable to find any figure of it published after the original description and prior to Itano (2013, fig. 3D). Newberry's fossil fish collection was transferred to the AMNH in 1903. However, the holotype of *E. minor* was not listed in Hussakof's catalogue of type and figured specimens of the AMNH (Hussakof 1908). The catalogue does include others of Newberry's type specimens, such as AMNH FF225, the holotype of *Edestus giganteus* Newberry, 1889. In 2013 I determined that the holotype of *E. minor* was not at the MCZ or at the USNM, which are known to hold fossil fish specimens described by Worthen, Newberry's sometime collaborator. Neither was it listed in catalogues of type or figured specimens from various other institutions. I was, however, able to locate specimen AMNH FF477 (Figures 9 and 10), with help from A. Gishlick. This appears be the missing holotype. It is now lacking part of the crown, but the external mould preserves the shape of the missing portion. The height given by Newberry was 10 lines = 2.1 cm (12 lines = 1 inch), in good correspondence with this specimen, if the height is measured along the right edge of the crown in the figures. The shape of the broken base and matrix also resembles that of Newberry's figure. Figure 9 is oriented so as to correspond to Newberry's drawing (Figure 5). Figure 10 is oriented and illuminated so as to better display

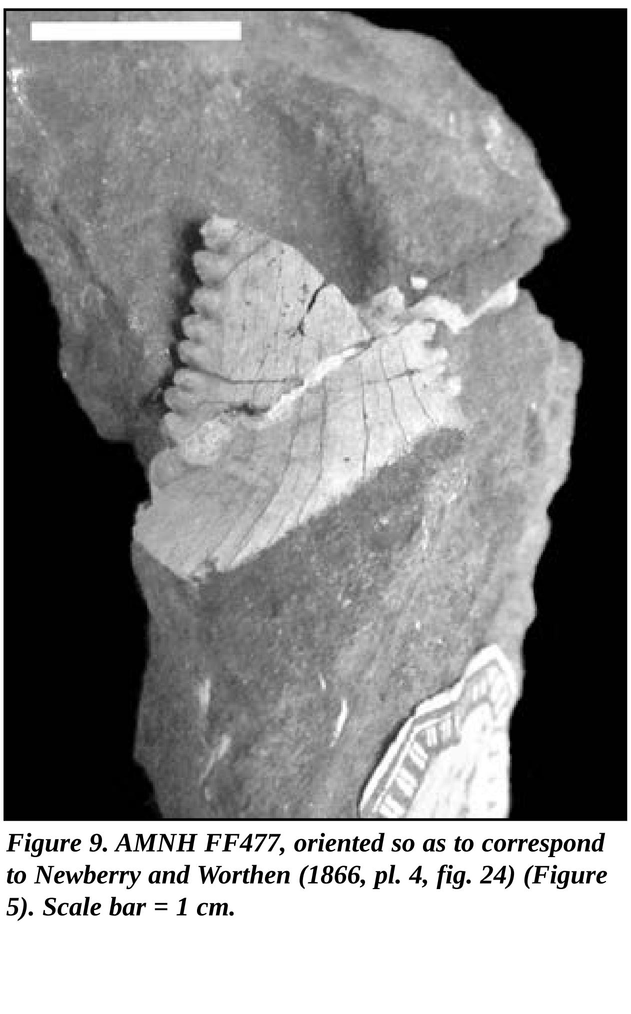


Figure 9. AMNH FF477, oriented so as to correspond to Newberry and Worthen (1866, pl. 4, fig. 24) (Figure 5). Scale bar = 1 cm.

Figure 10. AMNH FF477, illuminated so as to better display the external mould of the missing part of the crown. Scale bar = 1 cm.

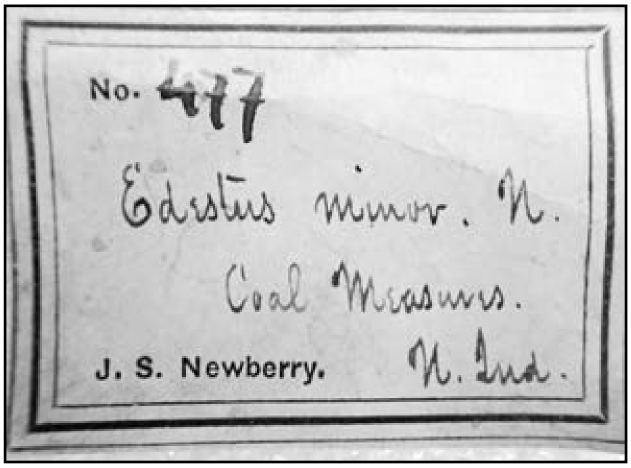


Figure 11. Label associated with AMNH FF477, giving the locality as northern Indiana (or, possibly, as northern Indian Territory).

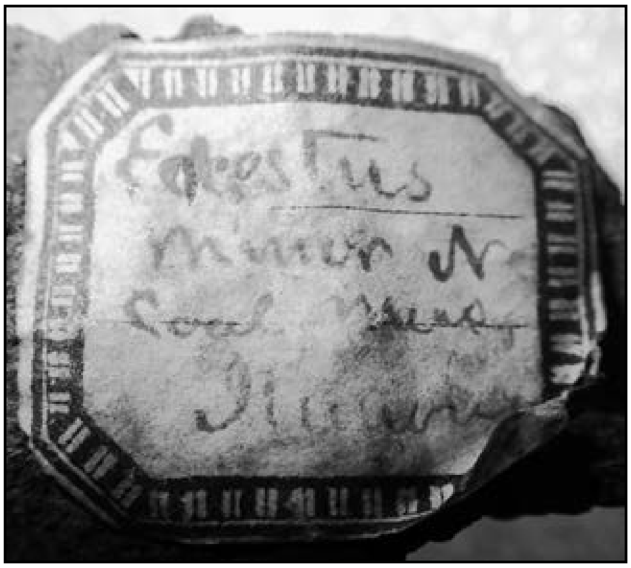


Figure 12. Label affixed to the matrix of AMNH FF477, giving the locality as Illinois.

the external mould of the apical portion of the crown. Given the size and physical appearance of AMNH FF477 and other evidence from the associated labels, there would seem to be little doubt that it is the holotype of *E. minor*.

The labels associated with AMNH FF477 confirm that the specimen was referred to *E. minor* and that it was part of the Newberry collection, but display some inconsistencies with regard to the locality. The location in the label shown in Figure 11 is northern Indiana (or, possibly, northern Indian Territory), while that given by Newberry and Worthen (1866) is Posey County, which is in southwestern Indiana. The label which is affixed to the matrix of AMNH FF477 (Figure 12) gives the locality as Illinois. The inconsistencies probably reflect the lack of attention paid to the holotype of *E. minor* after the Hitchcock specimen was referred to that species. It is very likely

Figure 13. Holotype of* Edestus mirus *Hay. USNM V7255. Image copyrighted, Smithsonian Institution, all rights reserved.

that both of the labels were made long after the original description of *E. minor* in 1866, with retrospective conjecture substituting for forgotten details of the locality.

Consequences of restoring holotype status to AMNH FF477

Edestus mirus Hay, 1912, was based on a specimen from Iowa that included two tooth whorls, apparently from the same individual (Figure 13). In distinguishing *E. mirus* from *E. minor*, Hay cited only differences from the Hitchcock specimen, as if that specimen were the holotype of *E. minor* (Hay 1912, p. 36). However, the crowns of the teeth, with the exception of the one labelled '11' in Figure 13, are not distinguishable from the true holotype of *E. minor*. Thus, *E. mirus* should be considered to be a junior synonym of *E. minor*. Given the position of tooth 11 near the posterior (lingual) end of the tooth whorls, it may be a newly-formed tooth, perhaps representing a later ontogenetic stage than the other teeth. It could also be pathological or deformed in some way. It is intermediate in shape between the crown of the *E. minor* holotype and the crowns of the Hitchcock specimen. Given the form of tooth 11, it could be that the Hitchcock specimen represents a different ontogenetic stage of *E. minor* or perhaps represents some type of heterodonty (such as a nonsymphyseal tooth) within *E. minor*. For that

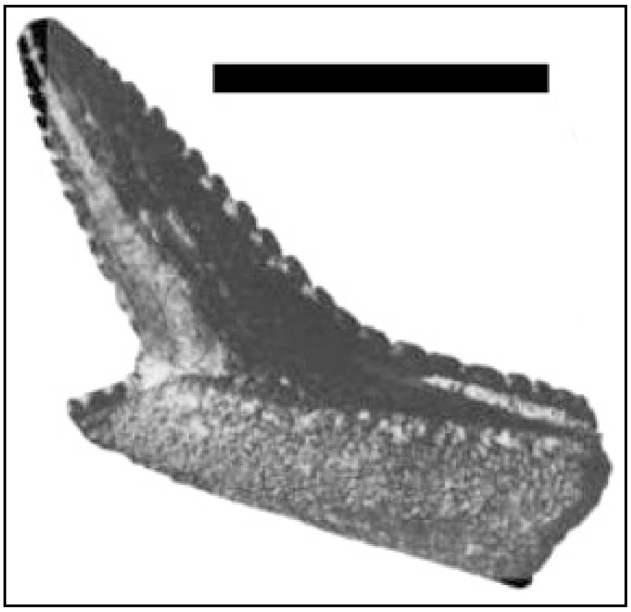


Figure 14. Holotype of* Edestus minusculus *Hay (Karpinsky 1899, pl. 4, fig. 13). TsNIGR 11/1865. Scale bar = 1 cm.

reason, it may be premature to refer the Hitchcock specimen to a species other than *E. minor*.

However, in the event that the Hitchcock specimen cannot be referred to *E. minor*, then it should be referred to the earliest-named valid species to which it **can** be referred. It appears that this is *Edestus minusculus* Hay, 1910 (Figure 14). Hay (1910) based *E. minusculus* on a single tooth recorded (but not given a new name) by Karpinsky (1899, text-fig. 17; pl. 4, figs. 12, 13). This tooth differs from the teeth of the Hitchcock specimen only in its smaller size. It is most likely that it represents a juvenile stage of the species represented by the Hitchcock specimen. Hay (1910) erred in assigning a Permian age to *E. minusculus*. He confused the locality of the holotype of *E. minusculus* with that of the holotype of *Helicoprion bessonowi* Karpinsky, 1899, which is established in the same article. In fact, the age of the holotype of *E. minusculus* is Middle Pennsylvanian, as are those of the Hitchcock specimen and of the holotype of *E. minor*. Most researchers seem to have taken account of the error, but occasionally *E. minusculus* is still incorrectly assigned a Permian age (e.g., Ginter *et al.* 2010, p. 131).

Other species close to *E. minor* include *E. triserratus* Newton, 1904, *E. pringlei* Watson, 1930, and *E. kolomnensis* (Lebedev, 2001). A full taxonomic review of all species similar to *E. minor* is beyond the scope of this article. Such a review would be very difficult, given the fragmentary nature of much of the type material.

Conclusions

The holotype of *Edestus minor* Newberry is the single tooth AMNH FF477, not the Hitchcock specimen, ACM 85. *Edestus mirus* Hay is a junior synonym of *Edestus minor* Newberry. The Hitchcock specimen may belong to *Edestus minor*, but if not, it should be referred to *Edestus minusculus* Hay. In neither case is it a type specimen.

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THE HISTORY OF PALAEONTOLOGY AT DONCASTER MUSEUM

by Alistair Bowden, Dean R. Lomax, Peter Robinson, Nigel R. Larkin

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This article summarises the history of palaeontology collections at Doncaster Museum, their uses, and the collectors and curators associated with them. It begins by outlining the general national context, then details Doncaster Museum's specific story, including the quantity and type of materials collected, collection care (or lack of it), exhibition and other uses. In brief, Doncaster's collections were formed at the end of the late Victorian field naturalist era, saw a slump in interest during the first half of the 20th century, were revitalised during the early 1960s, expanded hugely during the 1970s and early 1980s, and then received little attention in succeeding decades until the arrival of a keen local palaeontologist in 2008. This largely mirrors the national picture with two exceptions, both of which are related to key individuals: Elphinstone Forrest Gilmour was the highly charismatic Director between 1953-67, who gained support for and oversaw the building of the new museum in 1964, but who's career ended in ignominy; Dean Lomax is a passionate, local palaeontologist who's persistent enquiries and personal commitment resulted in the very successful Fabulous Fossils exhibition that then led onto the CIRCA project major, a review and revitalisation of the palaeontology collections.

Alistair Bowden, Dean R. Lomax, Peter Robinson and Nigel R. Larkin**, Doncaster Museum & Art Gallery, Chequer Road, Doncaster, DN1 2AE, UK. Email peter.robinson@doncaster.gov.uk*
**School of Earth, Atmospheric and Environmental Sciences, The University of Manchester, Oxford Rd, Manchester, M13 9PL, UK.*
***Cambridge University Museum of Zoology, Downing St, Cambridge, CB2 3EJ, UK.* *Received 7th July 2014. Accepted 4th August 2014.*

Introduction

The history of the palaeontology collections at Doncaster Museum is one of all too brief periods of activity - collection expansion, exhibition and/or documentation - followed by longer periods of quiescence. It is a story filled with interesting characters; people who devoted their working lives, leisure time and/or retirement to the pursuit of palaeontology, geology and natural history, both in the field and in the museum. It is a story that reflects national, regional and local events, in the world of palaeontology and geology more generally, but also the socio-economic events of the locale and the world.

This article aims to outline the history of the palaeontology collections at Doncaster Museum, within the context of the national picture. Using the 'roller-coaster' model of museum geology as a framework (Knell 1996), this study aims to explore to what extent the palaeontology collections at Doncaster have changed through time in relation to the national picture. It begins with a general overview of the national contextual picture, before detailing the specific Doncaster story. The discussion examines the similarities and dissimilarities between these two. Whilst the aim is to focus on the palaeontology collections at Doncaster, it is often not possible to separate the palaeontology from the more general story of geology, either at Doncaster or in the national picture. Therefore commonly the more general story of geology is given, but where possible the more specific palaeontology story is developed.

Museum Geology - the National Context

The history of geology collecting and the development of provincial museums across England are intrinsically linked. However, it is not a story of consistent growth. For more than two hundred years, the growth and decline in the popularity of collecting fossils, minerals and rocks, has correlated with the formation and success (or not) of many museums.

From the late sixteenth and early seventeenth century, the aristocracy and gentry began to create 'cabinets of curiosities'. These eclectic collections contained a wide range of natural history, antiquities and works of art, including fossils and minerals. Notable Yorkshire collections included Ralph Thoresby FRS (1658-1725), Jonathan Salt (1759-1815), John Leigh Philips (1761-1814) and Marmaduke Cuthbert Tunstall (1743-90) (Brears and Davies 1989; Alberti 2002). From the late 18th century, commercial museums began to emerge and a number of examples have been described in Yorkshire (Brears and Davies 1989).

From the beginning of the 19th century, five key periods in this so called roller-coaster of museum geology have been defined (Knell 1996): two periods of growth in interest, two falls of popularity and most recently a period which may in time be judged to be a resurgence or perhaps just a period of false optimism.

The Heroic Age of Geology (first rise)

The first great growth in museum geology, in the first half of the 19th century (mostly between 1820-40), has been termed the 'Heroic Age' of geology. Geology was the height of fashion and both the rural aristocracy and gentry as well as the growing urban middle class demonstrated their intellectual sophistication by taking an active interest in the development of the science. A series of remarkable new discoveries (marine reptiles, dinosaurs, pterosaurs, evidence from caves that exotic animals lived here in the recent past) kept the public enthralled and during this period of discovery works on regional geology by John Phillips and others, provided a model for local research that was mimicked around the country (Knell 1996).

Within this period of popular interest, the formation of literary and philosophical societies expanded rapidly in the 1820s, cementing the emergence of the new urban provincial middle classes (Alberti 2002). In Yorkshire this resulted in an array of new social and intellectual organisations - Leeds (1818), Bradford (1822), Hull (1822), Sheffield (1822), York (1822), Whitby (1822), Wakefield (1826), and Scarborough (1827). "Each town consolidated its emergent civic identity in an act of museum making [and] in these societies and museums, geology became the central recreation" (Knell 2007, p. 261). Not only was geology, in particular palaeontology, collecting at the forefront of the development of museums, but local museum collecting was at the forefront of the development of the science. Each was led by a charismatic single scientist, for example William Smith was the curator at Scarborough (Osborne 1999), John Phillips was keeper at York (Pyrah 1988) and George Young at Whitby (Osborne 1999), though the work of Louis Hunton also at Whitby should not be forgotten (Torrens and Getty 1984). Each of these men published works which were critical to the science of the day, but more importantly in terms of their scientific significance they are still quoted today.

Loss of the Great Men and the Decline of the Lit & Phils (first fall)

The second phase of the association between geology collecting and provincial museums in Britain was a fall in popularity and crisis in museums. This began around 1840 and continued until around 1870. The literary and philosophical societies and the museums they founded during the Heroic Age were increasingly having financial difficulties. They had never been well funded and museums were a particularly large drain, with grand buildings requiring maintenance, filled with specimens requiring management. A specific example is Scarborough where in 1848 "the collections were found to be disorganised, poorly labelled and unattractively displayed, there was poor financial control and the membership was rapidly declining due to general dissatisfaction with running of the institution" (Knell 1996, p. 36).

As well as financial pressures, a second major problem was the loss of the 'great men' who were critical to the development of the science and the fortunes of the local museum. Written after the event, this quotation seems to summarise this reliance: "It is ... a dangerous thing for a public museum to depend thus upon the support or interest of a single individual, or even on a few amateurs ... and it has indeed often happened that when the leading scientific spirit of a locality has been removed, the museum has degenerated, and lapsed into a state of neglect" (Ruddler 1877, quoted in Knell 1996, p. 39).

A contemporary source summarised the overall situation at this time well: "the Provincial Philosophical Societies of England have completed their career, they are the debris of an age that has passed away" (Hudson 1851, quoted in Alberti 2003, p. 342).

Field Naturalism and the Professionalisation of the Sciences (second rise)

The third phase of the development of geology in museums was a boom related to the rise in natural history societies and field clubs, from 1860-1870 until the 1920s. This latter 19th century rise in popularity was distinct from the early 19th century foundations. Natural history more generally had blossomed and was a common pastime at a local level, as evidenced in this contemporary quote: "there is scarcely a town in the kingdom, and in the North of England scarcely a village, in which some such society, either 'Botanical' or 'Entomological, or 'Naturalist' does not exist, whilst 'Field Clubs' are continually exploring every portion of Country" (The Naturalist, quoted in Alberti 2001, p. 119). In addition the natural sciences were professionalising, with civic colleges (later universities) beginning to be established from the 1870s onwards (Collini 2012) and academic positions in the natural sciences being founded (Alberti 2001).

During this naturalist-led boom there was a shift in museum ownership. Some field naturalist societies sought to establish their own museums imitating the literary and philosophical societies of the early 19th century, others took over ailing existing museums, whilst many had no association with a museum; only a quarter of these societies had their own museum in the 1880s (Knell 1996, pp. 40). Instead of local societies owning museums, this period is marked by the domination of municipal museums (Alberti 2002). The perceived significance of a museum being neatly summarised by a contemporary source "as necessary for the mental and moral health of the citizens as good sanitation arrangements, water supply and street lighting are for their physical health and comfort" (Greenwood, quoted in Alberti 2002, p. 305).

This shift in museum ownership did not affect the central position of natural history. During the early years of the Museums Association in the 1890s, natural sciences dominated proceedings and "at its annual meetings geology was a popular subject for focused discussion and for the illustration of more general principles" (Knell 1996, pp. 44). The critical debate during this time was the purpose of museums and their collections. The pre-existing focus on scientific research, adopted from the early 19th century philosophical society museums, had resulted in collections which were focused locally. Some commentators saw this as a strength, for example museums should "devote themselves to the thorough and complete working out of the productions of their own districts" (Ball *et al.* 1888: quoted in Knell 1996, p. 42). However others saw this as a great disadvantage, finding collections to be parochial and biased by the cabinets of local collectors, for example "our notions as to adequate provision for [such museums] are at present distinctly narrow" (Miall 1897, quoted in Alberti 2001, p. 130).

This alternative view of the scientific objectives of collections and museums, developed as a consequence of the Reform Act of 1867 and the Education Act of 1870, when the focus for museums became education. The local museum became the educational museum and its aim was to supply broad knowledge, not local knowledge. "The object of an educational museum should be to educate rather than collect. It is obvious that a museum which contained only local specimens would not teach geology" (Hutchinson 1893, quoted in Knell 1996, p. 42).

A related debate took place about exhibitions. Traditionalists argued that displays ought to be systematic, for example with fossils they ought to be arranged by stratigraphy and then by taxonomy, a method of display devised by William Smith a century earlier. However, museum audiences were changing and some argued that displays should be used to illustrate dynamic processes and interactions - adaptation, predation, defence, disease, death, Darwinian evolution - "which make people think" (Gray 1865, quoted in Knell 1996, p. 45).

Mid 20th Century Neglect (second fall)

The fourth period is a sad, slow decline beginning in the early part of the 20th century. Changes to the structure and purpose of the Science and Art Department prior to the First World War caused geology in Britain's museums once more to slip into a period of general decline. Of particular regret was the damage to collections, many dating back to the days of the pioneers. "Neglect and loss through sale, dumping, burial and theft was regrettably commonplace" (Knell 1996, p. 47-48).

Professionalisation of Curatorship (third rise or false optimism?)

The fifth and final period is the current era, which started with the formation of the Geological Curators Group (GCG) in 1974. This began an ongoing process of raising standards in geology collections, increasing accessibility and improving the academic and professional training of curators. The first critical step however was a nationwide review carried out by the GCG and its damning conclusions published as 'The State and Status of Geology in UK Museums' (Doughty 1981). As Phil Doughty described at the time "it reveals a frightening picture … of the science of geology in the museums of the UK. It exposes a situation of disorder, neglect, mismanagement and decay on an unsuspected scale" (1980, p. 351)

The repercussions of the State and Status report rippled far beyond geology museums. "The situation revealed was a national disgrace to individual museums, their owning authorities, the Museums Association and its training regime and the Standing Commission on Museums and Galleries. "It was clearly a damning indictment of Government policy (actually a policy vacuum) in the field of material culture" (Doughty 1999, pp. 6).

The State and Status report led to many changes in the museums world more generally, but specifically within the realm of geological curation. Within the first decade of its existence, the Geological Curators Group had made great strides in the objectives it had originally set itself (Doughty 1984). A number of milestone publications are worthy of note:

- The Guidelines for the Curation of Geological Materials (Brunton *et al.* 1985): rigorous and formal guidance on a high standard in collection care procedures
- Geology and the Local Museum (Knell and Taylor1989): well-illustrated, popular book on collection care and utilisation (perhaps most significantly pitched at new geology curators and non-specialist curators)
- Standards in the Museum Care of Geological Collections (MGC 1993): sets standards for collection care (e.g. curation, conservation, documentation etc.) and protection (e.g. against theft, fire, flood etc.)
- Directory of British Geological Museums (Nudds 1994): a seminal record stemming from the State and Status survey and report

As well as these discretely geological changes, there have been a series of other changes in the curatorial landscape since the publishing of the State and Status report in 1981:

- Probably the largest change was the invention of the Registration scheme, later Accreditation, in 1988 (overseen originally by the Museums and Galleries Commission, now Arts Council England). This has set and policed standards in collection care, which has slowly ratcheted up the quality over the past two decades.
- Similarly the Designation Scheme in England (and similar schemes in the other UK nations) has given additional acknowledgement to national and regional collections.
- Heritage Lottery Fund support has enabled both capital investment in buildings, stores and exhibitions and also revenue investment in activity such as documentation, digital access to collections, and reinvigorated exhibitions, events programmes and education provision.
- Renaissance in the Regions has pumped national public funding into the regional level infrastructure, though the extent to which this has impacted on the local infrastructure appears to be limited.
- The Museums Association inquiry Collections for the Future (2005), has done much to re-focus attention back on collections, attempting to shift curator's thinking towards perceiving them as a dynamic opportunity (rather than a static threat).
- The Esmée Fairbairn Foundation has played a critical role in supporting collection management work generally. Latterly its own Heritage Strand of funding and its funding of the Museums Association Effective Collections has been critical in implementing the actions from Collections for the Future.

All this then acts as a context to a second review of geological collections across the UK. Carried out twenty years after the original, The State and Status of Geological Collections in the United Kingdom: 2001 (Fothergill 2005) is the second instalment of a nationwide synthesis of understanding. The headline result is not uplifting: "fundamentally, little can be shown to have changed in the current state and status of those collections" (Fothergill 2005, p. 105).

Therefore whether or not this final era of the roller coaster of museum geology will be viewed as a rise or fall in fortunes, will have to be left to future historians to assess.

Museum Palaeontology and Geology in Doncaster

This section details the history of the palaeontology collections specifically and geology collections generally at Doncaster. It progresses chronologically from a general review of the early history of science and geology in the area, to the founding of Doncaster Museum and its development over its first century.

Early Science, Geology and Museums in Doncaster

The earliest form of museum, as a cabinet of curiosities, may have existed at Sprotbrough Hall a few miles west of Doncaster. This was the home of Sir Godfrey Copley (1653-1709), originator of Britain's earliest and most highly prized award for scientific achievement, the Copley Medal, awarded by the Royal Society. As a patron of the arts and sciences, it is known that he hosted a number of early natural scientists including John Ray, Martin Lister, Thomas Willisel and Thomas Lawson (Skidmore and Smith 1983). However the first recorded museums are the commercial enterprises of William Beilby's

Museum on Frenchgate (C.1790-1812), Hugh Reid's Museum also on Frenchgate (c.1812-53) and John White's Museum (?-1836) (Skidmore and Smith 1983).

There were also a number of mid-19th century intellectual societies, including the Lyceum or Literary, Scientific and Natural History Society (1834-44), the Society for the Acquisition of Knowledge, Campsall (1837-1839), the Thorne Literary & Philosophical Society (1840s), Great Northern Railway Mechanics Institute (1853-1920s), Doncaster Philosophical Society (1863-75) (Skidmore and Smith 1983). Of particular note is the Doncaster Lyceum, where it is noted that "a museum forms part of the plan for the institution; but until of late, owing to the limited extent and insecure tenure of premises occupied by the society, little has been done towards its formation. Within the last three months if has, however, made considerable progress. Many valuable donations have been made, including numerous beautiful specimens illustrative of Natural History and Geology" (Holl and Wood 1836, p. 294-5).

The origins of the current collections and museum can be traced to the founding of the Doncaster Microscopical Society in 1880 (Stiles 1924). One year later it broadened its brief and changed its name to the Doncaster Microscopical and General Scientific Society (it also changed its rules to allow the admission of lady members). The initial programme was made up of indoor meetings, a mix of invited lectures, talks given by members and conversaziones. In this way it seems typical of late Victorian Yorkshire (Alberti 2003); though unusually, a library was not part of its remit, perhaps because of its late foundation and the existence of the Doncaster Free Library founded 1869. From 1896 the programme included summer excursions. It should be emphasised that during this early period of the Scientific Society, "it may be said that more original work has been done in Geology than in any other branch of Science touched upon by our fellow members" (Stiles 1924, p. 9).

The earliest form of the current Doncaster Museum was opened 1900 and was operated by the Scientific Society. The need for a good local museum had been present in the minds of the members from the very beginning of the Society. However it was a one week exhibition in 1889 at the Mansion House that was attended by about 8,000 people, which really put a public museum on the local agenda. It took a crisis in 1899, when the varied collections of Alderman Cotterill Clark were to be sold and were at risk of being lost to the town, to bring the matter to fruition (Stiles 1924). The collection was purchased by the Corporation and a room was made available by them in the Guild Hall; the Scientific Society contributed funding to its fitting out and the Corporation gave an annual grant to support them in its running. Opening was limited, but the collections grew in size until the space was uncomfortably crowded.

Doncaster Corporation had an opportunity to create a proper public museum when Beechfield House (Figure 1) and its grounds became available. The Curator of Hull Museum, Tom Sheppard (a prominent natural historian of his day), arranged for Councillors to visit a number of other local museums and delivered a report to the Corporation on how Beechfield House could be converted into a successful museum (Sheppard 1909). Beechfield was duly purchased and opened on 23 March 1910 (Anon 1910).

Figure. 1. Photo of Beechfield.

The Founding Collection (1910)

The 'Stock Book', the hard bound register that records the initial accessions into Doncaster Museum, contains 267 donations of geology (Figure 2). These are dominated by fossils (196 accessions; 73% of all geology accessions), with a smaller amount of minerals (48 accessions), and a small number of rock or mixed donations (Figure 3). These palaeontology specimens are dominated by local material from the Carboniferous and Permian and from the Jurassic of the North Yorkshire coast. Specimens were also donated from other Carboniferous deposits across the UK, including several from the Hodder Valley, Lancashire. A variety of fossils including numerous plants, molluscs, brachiopods, trilobites and vertebrates were donated. Much of this material represents local specimens that can no longer be collected.

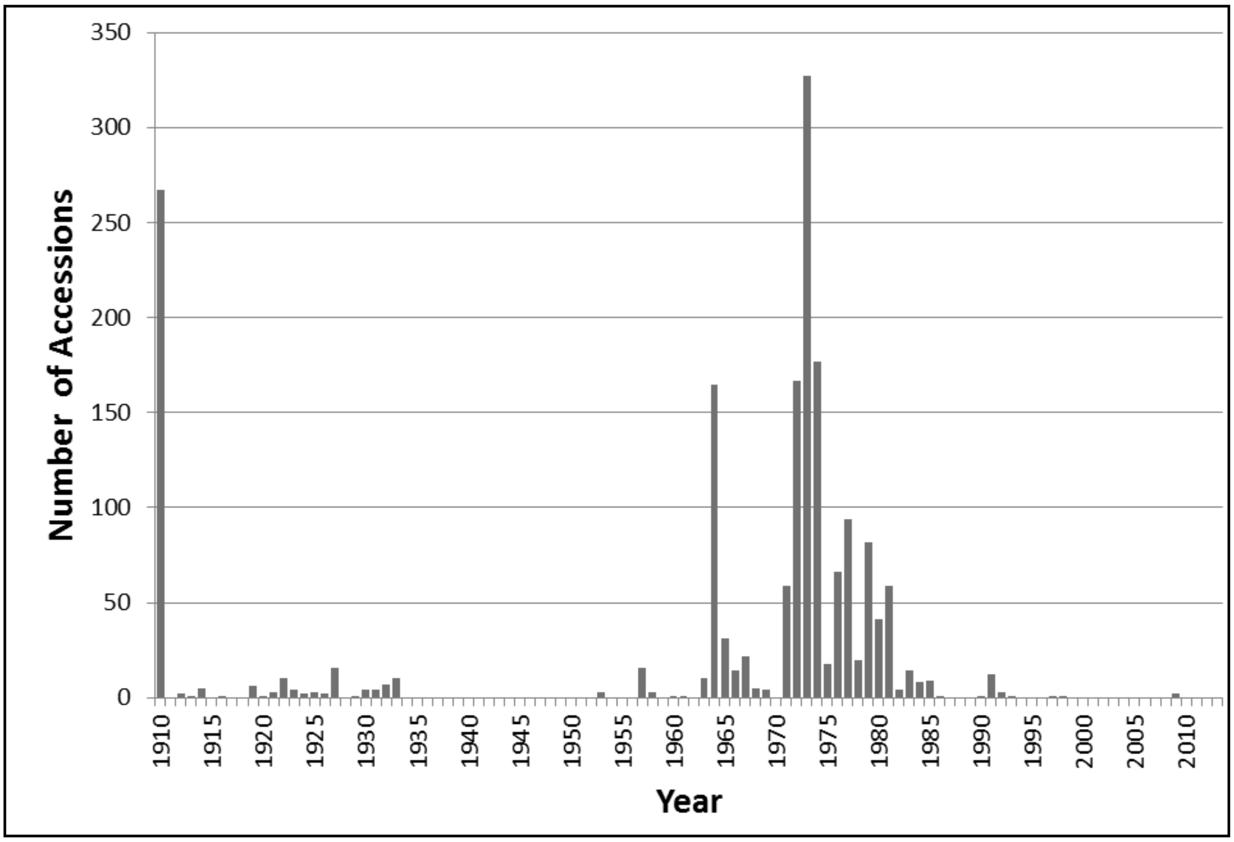

Figure. 2. Number of geological accessions each year from 1910-2012. (Note. This is the number of accessions not individual objects, however in most cases objects were accessioned individually with some exceptions, including a notable single accession of over 3000 mixed geological specimens.)

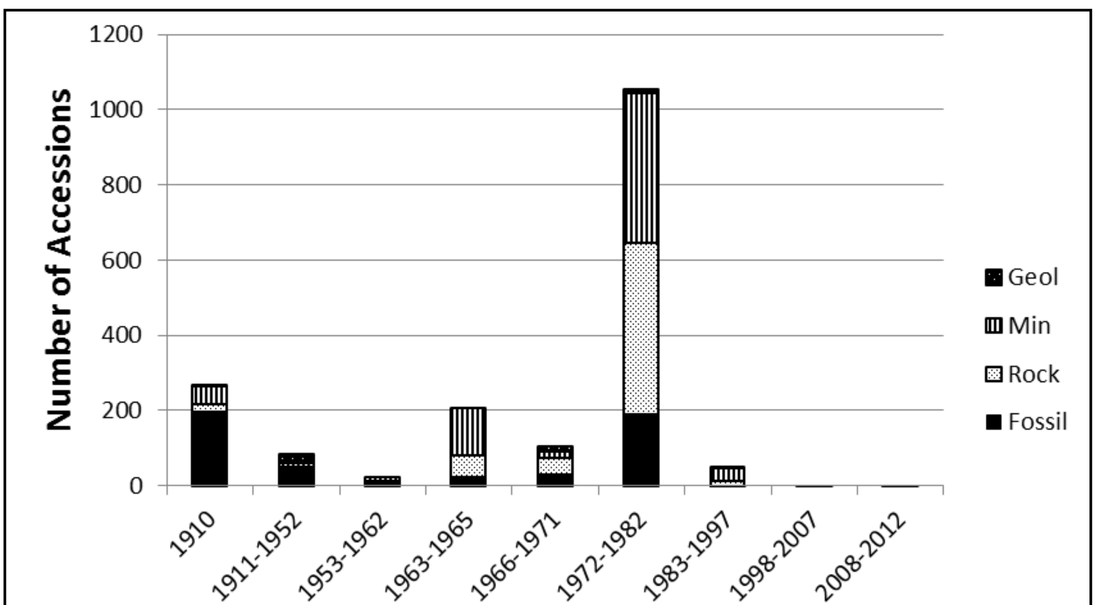

Figure. 3. Breakdown of the accessions by period into type of specimen (Geology is a mix of the other 3 categories: Mineral; Rock; Fossil).

A small group of four local men donated more than half of these specimens: almost two thirds of the accessions in the Stock Book can be clearly attributed to them, but as the donor of a quarter of accessions are unspecified, it may well be that the proportion donated by these geologically active men may be considerably higher. As they are the Founding Fathers of the collection and good scientists in their own right, a brief summary of each will be given describing each in order of their 'scientific career' in Doncaster.

Prof. Thomas Hill Easterfield K.B.E. (1866-1949) (Figure 4) was born in Doncaster and educated at Doncaster Grammar School, Yorkshire College Leeds, Clare College Cambridge and the University of Zurich (Askew 1950; Davis 2010). He wrote two articles on local geology (1883, 1891), the former on glacial deposits and the latter on an excursion near Conisborough. He took up the foundation chair of chemistry and physics at the Victoria University College, New Zealand and developed a very successful career as both an academic and administrator, winning New Zealand Institute's Hector Medal and being made a KBE in 1938. He donated 18 accessions, mainly lower Palaeozoic fossils (Figure 5).

Figure. 5. Typical Easterfield donation of a fragment of the trilobite* Paradoxides hicksii *from Tremadoc glued to yellow card (presumably for an early display) with the Stock Book number 220x, accompanied by an early hand written index card and a more recent handwritten label in blue ink pen written by Don Bramley.

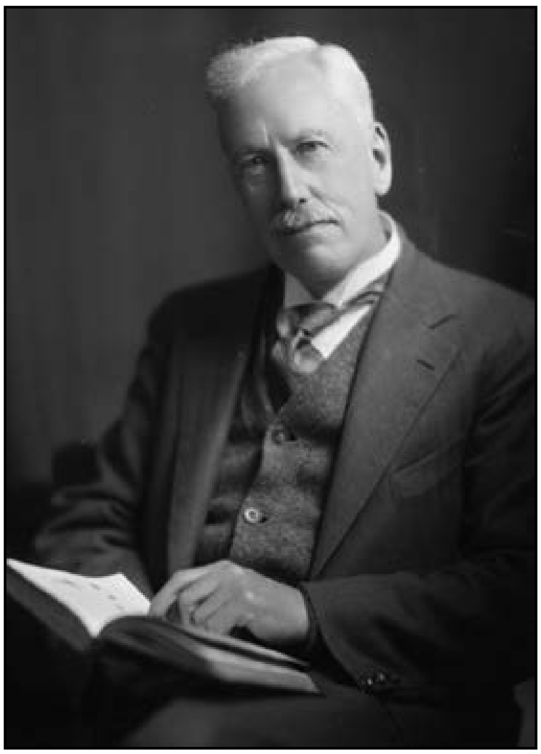

Figure. 4. Portrait of Thomas Hill Easterfield in 1933. (S P Andrew Ltd :Portrait negatives. Ref: 1/1-018719-F. Alexander Turnbull Library, Wellington, New Zealand. http://natlib.govt.nz/records/22847564).

Dr. Herbert Henry Corbett (1856-1921) (Figure 6) is notable in two regards: as a scientist and Doncaster Museum's first curator. He was born at Besses o'th'Barn, north of Manchester, studied medicine at Owen's College, Manchester and came to Doncaster in 1888 (Bayford 1921). He arrived in Doncaster as a good entomologist, but developed an interest and expertise in many fields of natural history: "to the botanist he was a botanist and to the geologist he was a geologist" (Bayford 1921, p. 148). Within geology, it was the Quaternary that attracted Corbett's attention and he contributed a number of articles on the boulder clay and large vertebrate fossils (Corbett 1898, 1903, 1906, 1907; Corbett and Kendall 1896). For this article, it is Corbett's role with the museum that is most important. "It was mainly due to Dr. Corbett's persistent advocacy that a municipal museum was established in Doncaster. ... He was the first [Hon.] Curator [at Beechfield] and as such the initial arrangement as well as acquisitions fell to his lot." (Bayford 1921, p. 146). Only ten accessions, representing several specimens, were donated by Dr. Corbett, almost all fossils, are recorded in the Stock Book (possibly written in his own hand as Hon. Curator). The specimens comprise local Pleistocene vertebrate remains, which are some of the only examples in the collection, and a variety of Jurassic specimens from the Yorkshire coast (Figure 7).

Figure. 6. Photo of Herbert Henry Corbett.

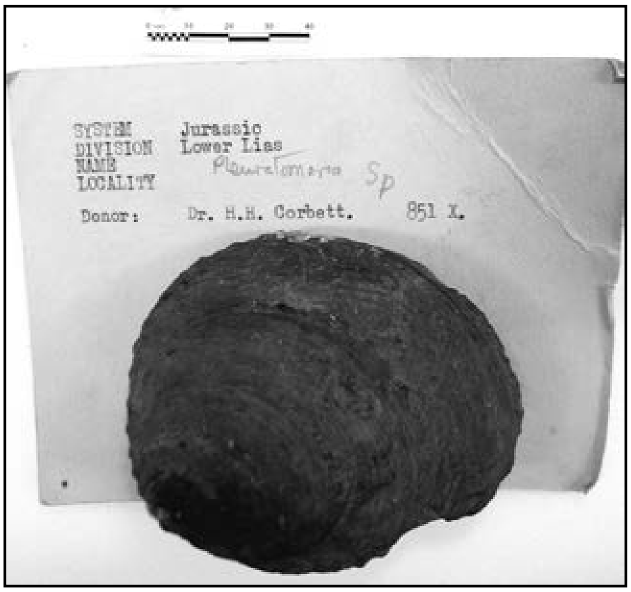

Figure. 7. Typical Corbett specimen of a Lower Jurassic gastropod (?*Pleurotomaria *sp.) stuck to yellow card similar to the Easterfield example.

Figure. 8. Photo of Culpin (Sheppard 1913).

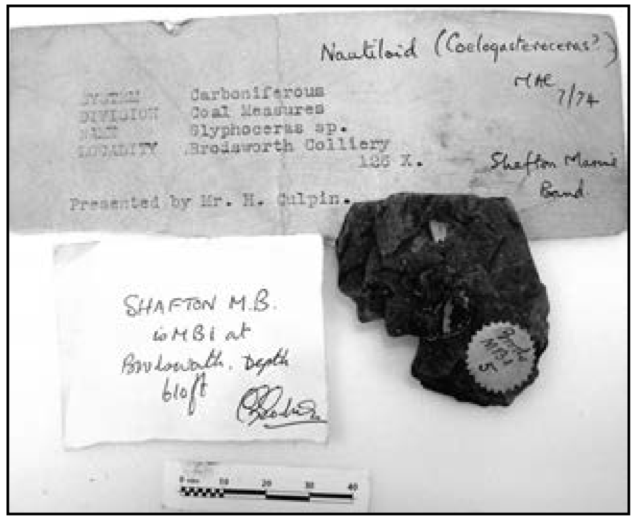

Figure. 9. Typical Culpin specimen of* Glyphoceras *sp. from the Shafton Marine Band in Brodsworth Colliery, with an original circular serrated-edged Culpin mark glued to the specimen, accompanied by a large label (top) with red capitalised type-writer text for the categories and black lower case for the specific details of this specimen, and a hand written note about the depth of the Shafton Marine Band at Brodsworth.

Thomas Henry Culpin (1861-1912) (Figure 8) was born near Peterborough but spent his latter career in Doncaster as Chief Locomotive Accountant for the Great Northern Railway (Gibson 1918; Sheppard 1913; Lomax in press). His interest in geology seems to have developed relatively late in life, after attending a course of University Extension Lectures on the Ice Age, probably those given by Percy Fry Kendall in 1896 (Stiles 1924, p. 11). His interest developed quickly and he published widely on Carboniferous, Permian and Quaternary (Culpin 1905, 1906, 1907, 1908b, 1909b, 1910; Culpin and Grace 1905a, 1905b, 1906). However his greatest contribution was on the marine horizons in the Yorkshire-Nottinghamshire coal measures (Culpin 1908a, 1909a); both papers were read before the British Association and abstracts appear in its Reports for the respective years. "On this subject he accumulated a vast amount of material .... Fossils new to science and many additional zones were discovered ... Only a fraction of his work was published ... His contributed papers were fledglings, but they possessed strong wings" (Gibson 1918, p. 317-8). Over a third of the geological accessions in the Stock Book were donated by Henry Culpin (109 accessions), almost all of which were fossils of the Upper Carboniferous and Permian of the Doncaster area (Figure 9). The remains represent a variety of taxa including vertebrates, plants, molluscs amongst other things, collected from Doncaster and other remains collected from across the UK (Lomax *in press*).

The final key individual that donated specimens that are recorded in the Stock Book is Dr. William Sawney Bisat F.R.S. (1886-1973) (Figure 10). Born in Doncaster, he went to Doncaster Grammar School and became a surveyor, working for H. Arnold & Son public works contactors for his entire career (Ramsbottom 1974; Stubblefield 1974). Bisat's father died when he was only 12, so it is perhaps this that led him to be influenced by his uncle George B. Bisat, an active member of the Doncaster Scientific Society and its President 1917-18 (Stiles 1924). Whatever the particular reason, "Bisat early became acquainted with H. Culpin and accompanied him on his regular inspections of the new coal shaft sinkings then being made in the Doncaster area [Note. Bisat's interest in marine bands must derive from this period.] ... During his work on the construction of Leighton Reservoir, in 1908, he became interested in the fossils from the Colsterdale Marine Beds found in the excavations" (Ramsbottom 1974, pp. 49). The research and subsequent paper on the Colsterdale

Marine Beds (Bisat 1914), carried out whilst Bisat was still living in Doncaster, led him to work with Wheelton Hind. Hind passed on his notes on goniatites to Bisat just before he died suddenly in 1920, around the time Bisat moved away from Doncaster, and this led him to a number of breakthroughs which resulted in his classic paper on goniatite zones published four years later (Bisat 1924). Bisat continued with his amateur career as a geologist and as well as his internationally important work on goniatite biostratigraphy, he also carried out pioneering work on glacial drift in East Yorkshire (also possibly inspired by his early life in Doncaster where he may have been exposed to the delights of boulder clay by Dr. Corbett). Bisat went on to become renowned as one of the greatest amateur geologists of the 20th century, being made an honorary doctor, Fellow of the Royal Society and being showered with scientific honours; in the words of Bill Ramsbottom, "we who are left can only build on his foundations" (1974, p. 51). Bisat donated two set of specimens: the first were part of the founding collection and included Carboniferous and Permian fossils; the second was a set of fossils and sedimentary rocks that were 'contributory material' (cf. Jeram 1997) relating to Bisat's work on The Millstone Grit sequence between Masham and Great Whernside (Bisat 1914).

Figure. 10. William Sawney Bisat in 1946 ©Godfrey Argent Studio (held in the Royal Society archive).

Figure. 11. Typical Bisat specimen of* Protoschizodus axiniformis *(label mistyped) from Leighten Reservoir (DONMG:1919.36.9).

The First Four Decades (1911-52)

There was a small but steady number of geological accessions over the first two decades after the museum opened at Beechfield House (82 accessions over the period 1911-1933). Again most of these were fossils (43 accessions; 52% of the total) including the specimens illustrated in figures 12 and 13, with lesser numbers of minerals (13 accessions), rocks (5 accessions) and a number of small sets of mixed specimens (21 accessions). Most of these specimens were from around Doncaster and the North Yorkshire coast, but there were also more exotic specimens from Japan, Tasmania, and South Africa.

The next two decades (1934-1952) were stark, with not a single geological accession. It appears to mark the demise of geology in the Doncaster Scientific Society. Corbett and Culpin had died and Bisat had moved away in the preceding period and there is no evidence of any serious geological interest from the group after this point. The amateur interest in geology appears to have sadly dried up.

The Infamous Elfie Gilmour (1953-1962)

The mid-late 1950s and early 1960s seem to mark a slow re-awakening. This is linked to the arrival of Elphinstone Forrest Gilmour (Figure 14) in December 1952. Elfie Gilmour is one of the most colourful and influential characters in the history of Doncaster Museum. People who knew him paint the picture of a dynamic, charismatic leader and during his time at Doncaster he certainly transformed the museum service. However there was a darker, morally dubious side to his character. He was an

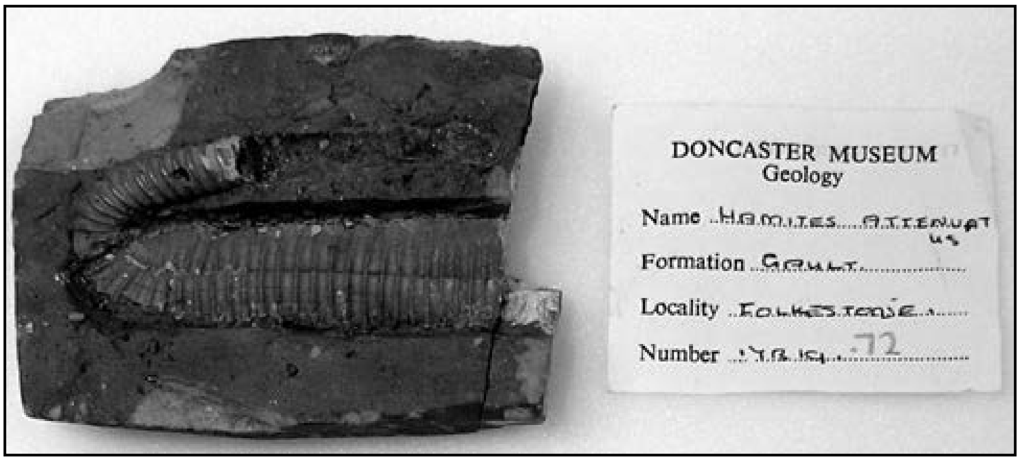

Figure. 12. Specimen from the Wyatt Collection (DONMG:1919.17b) of the heteromorphic ammonite* Hamites *from the Lower Cretaceous Gault Clay, with later label in Anne Pennington George's hand writing.

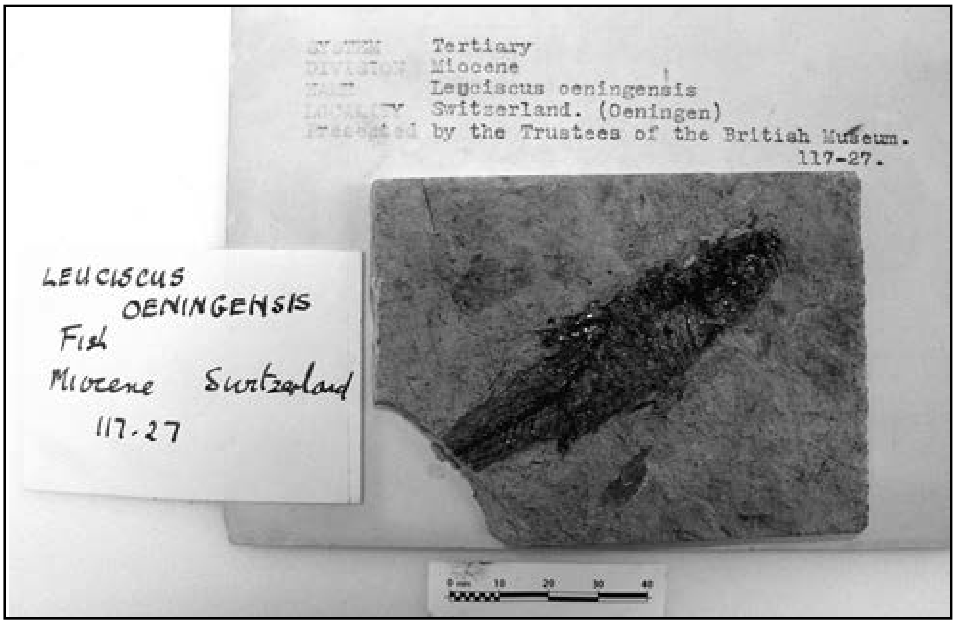

Figure. 13. One of the small number of accessions during this period was a set of specimens from the British Museum (Natural History) in 1927, which included this Miocene fish from Switzerland (DONMG:1927.117). (Notice the card it is stuck to has the type written - red caps category and black lower case specific information - shown in the Culpin specimen (Figure 9), so based on this accession the display both specimens were used in must post-date 1927.).

internationally renowned expert on cerambycid (long-horn) beetles and even before his arrival at Doncaster his inability to define the boundary between his personal collection and the collection of a museum had landed him in trouble. In 1949 he was convicted and sentenced to three months for stealing 160 beetles from the Natural History Museum (Northern Times 1949).

Figure 14. Photo of Gilmour.

At Doncaster, it is clear that from his appointment he was given the task (or perhaps took it upon himself) to build a new, more appropriate building for the museum and art gallery. Beechfield had provided a satisfactory home since 1910, but Gilmour was a persuasive visionary and Doncaster Corporation had a self-confidence and budget to support him. During the decade it took to build the new museum, based on the accession registers alone it would appear that the geology collections expanded slowly. There were only 24 accessions during this period and only two associated directly with Gilmour: a crinoid from Boggle Hole, Robin Hood's Bay (DONMG:1957.841) and a portion of a fossil plant (DONMG:1957.896). However there are many stories told within Doncaster Museum and Art Gallery of the extremely pro-active collecting undertaken by Gilmour (during this 1953-62 period and the succeeding 1963-65 period) that were either not accessioned or accessioned much later. There was a loan of material from Woodend Museum, Scarborough in 1963 that is thought to be related to the presence of Robin Lidster on the staff in Doncaster whose father John was the curator at

Figure. 15. Part of the Dick Institute collection, this label is from a Eurypterid specimen from the Hunter-Selkirk Collection (Lomax* et al*. 2011).

Woodend. This material comprised a variety of specimens that were to be placed on display in the new museum. Several fossils from the Whitby coast, including rare fish and a large multi ammonite block were among the highlights, other remains included echinoderms, and bivalves from areas across the British Isles, a cast of a tooth from the famous Mastodon described by Georges Cuvier, an isolated reptilian bone and a whole host of Italian bivalves. The latter were not recorded in the accession register, but labelled as on loan from Woodend. Around the same time there were a set of fossils that were gifted from the Dick Institute (Figure 15), Kilmarnock, which contain a fine set of eurypterids (Lomax *et al.* 2011). In addition there were collections brought into the museum from Worksop Museum (200 specimens picked up from Worksop Museum and Public Library on18/10/1965 and accessioned as DONMG:1971.1.1-200), the Smalldale Collection and Brighouse Museum (249 geology specimens were purchased on 10/9/1957, mainly fossils from the Carboniferous, Jurassic, Cretaceous and Tertiary (Figure 16)) of which very little is known about the timing or reasons for donation. This material represents a wide range of fossil types, representing numerous specimens collected from across the British Isles, many were collected from the Yorkshire coast.

The first geology curator Tim Riley and the new museum (1963-1965)

Tim Riley Assistant Keeper, Geology arrived in 1963 and in that year he made one of the most remarkable geology accessions in any of the registers. His first donation of nine specimens constitute some of the most carefully collected and most accurately accessioned in the entire collection; they cover the metamorphic aureole of the Skiddaw granite and the Carrock Fell Mine and are unique in containing six figure National Grid References.

In October 1964 the new Doncaster Museum & Art Gallery opened (Figure 17), but the impact was far reaching - much more than just the opening of a new building. Gilmour had an aspiration for Doncaster Museum to become regionally significant and he was clear how this would be achieved: "through sheer weight of collections" (unattributed quotation from a member of Gilmour's staff at that time, given by Carolyn Dalton the current Director). Critical to this vision was quantity, not quality, and the new museum building had large stores that needed filling.

In the year of the new museum's opening, more than double the number of geology specimens were collected than in all the time since the original museum had opened in 1910. Perhaps to redress a perceived imbalance with the collection, which since its formation had been dominated by palaeontology, this new collecting was mainly minerals (126 specimens) and rocks (54 specimens) but a significant number were fossils (45 specimens). The most significant donations were a set

Figure. 16. An example of a Brighouse Museum plant fossil specimen, Ulodendron from Clifton SE of Brighouse, showing typical Brighouse label glued to specimen.

Figure. 17. Photo of new museum from opening brochure.

of 101 minerals and rocks from the Mineralogy Department of the British Museum (Natural History) ranging from Britain, Europe, North America, Africa and India and mainly covering igneous petrology and economic mineral, and 20 British fossils from the Geological Survey and Museum, South Kensington ranging from the Cambrian to Pleistocene Red Crag. This seems to signal an appetite for collecting bulk collections that derives from Gilmour's desire to build large collections. Also notable during this period are the museum's first purchases of 26 specimens, mainly British and foreign minerals, from a Mr. RFD Parkinson from Doulting, Shepton Mallet, Somerset (Figure 18).

Figure. 18. Photo of displays from this period.

It was during this period that the extensive geology exhibitions in the new museum began to be fitted out (Figure 19). These displays were the single most significant public use of the collections. They contained fossil specimens from the Cambrian to the Quaternary, coal mining, bricks, minerals and some rocks. Most of these displays were a chronological story of each period of geological history, presented as a series of dioramas. Tim Riley, Peter Skidmore (Keeper, Natural History and talented painter) and Chris Devlin (Technician and talented model maker) began work on creating the extensive geology galleries in the new museum. These were in pride of place next to the entrance and were to survive for almost 30 years.

Leaderless and curatorless (1966-71)

This period is marked by a sudden drop in collecting and appears to have two causes. The first is the sudden departure of Elfie Gilmour. In early 1967 he was suspended (Doncaster Evening Post 1967) and later that year pleaded guilty of five charges including publishing an obscene article, a film, sending a package containing six indecent colour transparencies through the post, stealing screen entomological cabinets belonging to Doncaster Corporation, stealing a camera belonging to Doncaster Corporation, and obtaining two cheques amounting to £224 by false pretences (The Times 1967). His pleas of not guilty to two charges of publishing obscene articles and not guilty to stealing 20,749 beetles valued at £850, were accepted by the prosecution. Gilmour was put on probation for two years and was dismissed as Director. After 15 years of forceful leadership, the expansion of the professional team of staff and the development of a new museum, the museum lost its figurehead and impetus. Secondly, the first curator Tim Riley moved jobs to Sheffield Museum, and there was a significant gap before he was replaced. Work on expanding the collection during this period dropped off significantly. Of the 68 accessions during this period, 41 were minerals, 16 were rocks and 6 were a mix of the two, the majority being from the UK with some foreign material; only 6 accessions were fossils (all local Coal Measures material).

The work on the geology displays continued during this period and, in the absence of a geology curator, when Colin Howes (Assistant Keeper, Natural History) arrived in 1969 he remembers well that an early task was to work with Peter Skidmore and Chris Devlin on continuing the chronological series of dioramas.

Also during this period, the collections were accessed for the only known time (until 2007 - see below) for research purposes. Geoff Gaunt from the Institute of Geological Sciences (now British Geological Survey) looked at the collections as part of the survey of the area (Gaunt *et al.* 1994) and re-identified some of the Carboniferous and Permian fossils.

The significant arrival during the period was Don Bramley in 1971 (Figure 19). Don was a very supportive volunteer whose link to the museum began because of his active role within the Danum Lapidary Society and continued through his involvement in the Doncaster Naturalists (Howes and Skidmore 1998). In the first year of his involvement he made 19 donations and over the next decade he made almost 200 donations, his main interests being in igneous and metamorphic petrology and mineralogy.

Figure. 19. Don Bramley.

Figure. 20. Anne Pennington George of Doncaster Museum examines a part of a fossilised tree fern "Sigillaria" from Hickleton Main Colliery (Doncaster Evening Post, 10/9/1976).

The second geology curator: Anne Pennington George (1972-82)

If Elfie Gilmour was the Great (but fallible) Man of Doncaster Museum, Anne Pennington George (a.k.a. APG) was the Great Woman of the geology collections (Figure 20). She worked at the museum for 25 years and had by far the greatest impact on building and shaping the collections. Around two thirds of the total number of accessions took place during her tenure.

After completing a Post Graduate Certificate in Museum Studies from Leicester University, Anne began work two days a week in 1972 after (also working part time at Doncaster Technical College and Doncaster Grammar School), before going full time from 1974. Her first task was to work with Peter Skidmore, Chris Devlin and Colin Howes to complete the geology displays. They had been working steadily through the diorama-based stratigraphic cases, so Anne was tasked with the non-chronologically arranged cases. These covered themes which included minerals, economic geology, coal mining, use of rocks and building materials. Intensive research on local bricks from Coal Measures mudstone and boulder clay, led her to become the secretary of the British Brick Society. This seems to demonstrate a willingness to tackle new subjects and a commitment to doing a comprehensive, high quality job, which included a significant amount of work on documentation backlogs (Figure 21).

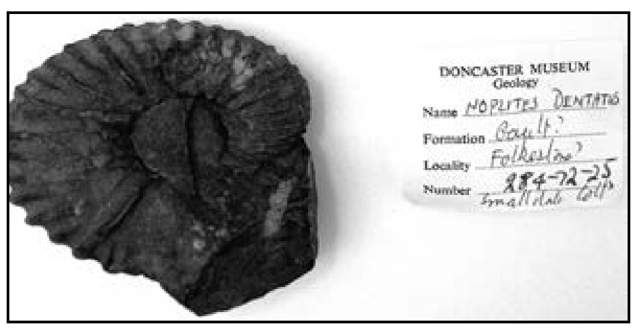

Figure. 21. Example of a specimen from the Smalldale Collection, thought to have been brought into the museum by Gilmour in the late 1950s or early 1960s, but only accessioned much later (DONMG:1972.284.25).

Anne's initial interest was palaeontology, but she experienced repeated rebuffs from the local National Coal Board geologists who were reluctant to work with Anne or donate material to the museum. Thus her lifelong frustration with the nature of the

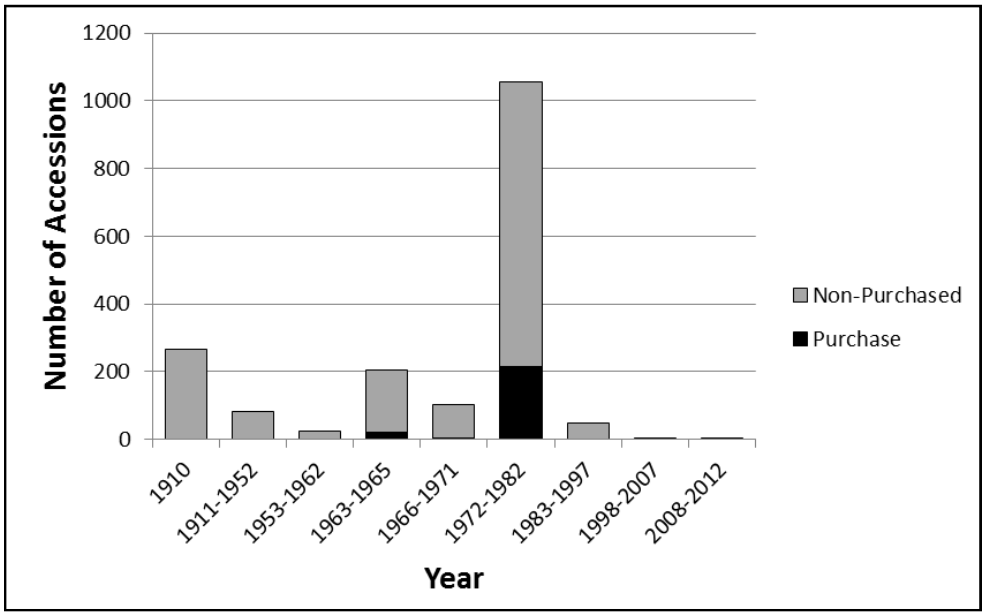

Figure. 22. Breakdown of the accessions by period into purchased and non- purchased.

collecting during her tenure: "it should have been based on Coal Measures fossils!" (pers. comm.). It was however a chance meeting with Alan Jobbins, Mineralogy Curator of the Geological Museum in South Kensington, which changed Anne's course and the nature of the geology collections most. Alan had visited Doncaster Museum as part of an Area Museum Council visit and Anne had been invited down to London to see the collections. Over coming years and a number of visits to South Kensington, Alan became a mentor and Anne's interest in minerals blossomed.

This period marked the greatest expansion and diversification of the collection. In her own words Anne "wanted Doncaster people to see other things, spectacular things". In quantitative terms the collection expanded rapidly, but it also expanded to include more specimens from elsewhere in the UK and around the world, to include more mineralogy and petrology and it also included more exotic iconic specimens.

In detail, the collections shifted away from what had remained a palaeontology dominated collection. Up to the time that Anne started, almost half of the accessions in the geology collections were palaeontology (44%), with the others being minerals, rocks and mixed accessions. By the end of this period the proportion of the overall accessions in the entire geology collections was only 28% palaeontology, with 34% rocks and 35% minerals. Also significantly, many of these minerals and gems were purchased (Figure 22). Until this time only 4% accession were by purchase, but during this time 20% accessions were by purchase. These purchases came from Hilary Corke (Dorking, Surrey) from whom the greatest number of purchases were made, Max Davis (Oxford Street, London), Derwent Crafts (Stonegate, York), A. Massey & Son (Sheffield), Mr K Parkinson (11 Fitzroy Street, Hull), Gregory, Bottley & Co. (Chelsea, London), Mr Munty (Sandbeck Road, Doncaster), R. Rubin (Antwerp,

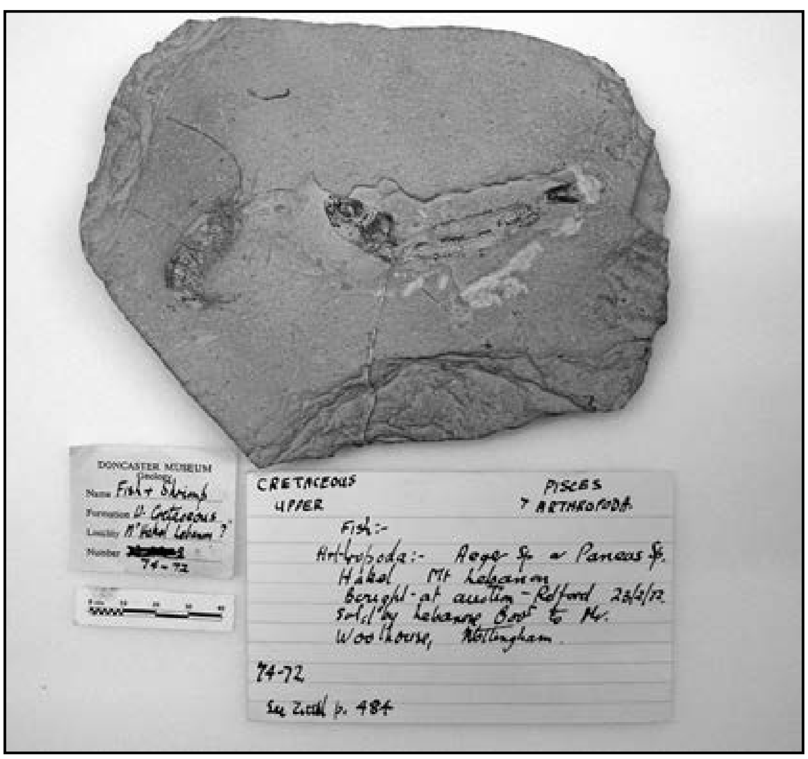

Figure. 23. Lebanese lagerstätten with beautifully preserved fish and crustacean (DONMG:1972.74). Both the smaller label and larger index card were written by Don Bramley.

Belgium), Ruppenthaal (Hatton Gardens, London) and Mr. M.W.J. Townsend (Barton on Humber). Also noteworthy is the fact that no purchases have been made after this period. A notable purchase of palaeontology material was also made during this time; a set of Cretaceous fossils from Hakel in Lebanon bought at auction in Retford (Figure 23).

Almost curatorless (1983-97)

In mid-1983 Anne Pennington George migrated into the role of Education Officer (she had maintained her interest in education since her initial part time roles at the Technical College and Grammar School). Few new accessions were made to the collections during this period (50 accessions in 14 years), though there were noteworthy purchases. The most important is the ichthyosaur purchased from Hilary Corke Minerals. This specimen has since become iconic to the Doncaster collection (see Fabulous Fossils below) and scientifically significant (Lomax, 2010b; Lomax and Massare in press). Originally it was purchased for its 'WOW' factor and used as a centre-piece in the education provision developed by Anne. Further noteworthy purchases during this period included a dinosaur egg (from Simon Cohen) and a large nugget of native gold, an uncut cubic diamond and slices of an iron and a stony meteorite (from Gregory, Bottley & Lloyd, Rickett Street, London), as well as a number of other precious and semi-precious gems.

On a sadder note, this period also saw the removal of the long-standing geology galleries that so much work had gone into producing in the late 60s and early 70s. From being the first displays that a member of the public saw when they entered the museum, the geology collections were relegated to the stores and were not on display again until 2009 (see Fabulous Fossils below).

Curatorless again (1998-2007)

In 1997 Anne Pennington George moved on to a job in Leeds and since then there hasn't been a geology curator. During this decade there was only a single geology accession. Considering the hope and aspiration that must have existed when Elfie Gilmour and his team opened the new museum three decades before, it seems a shame that the palaeontology and geology collections were again moribund.

Fabulous Fossils and planning for the CIRCA Project (2008-2012)

In 2008 Dean Lomax began volunteering with the museum, under the supervision of Peter Robinson. Based upon requests from the public, it was decided that a small fossil exhibition would be created and displayed in the foyer of the museum. The idea was to use material held in the museum's collection and also to use specimens from Dean's personal collection. At that time it was thought that the museum may have around 1,000-2,000 individual specimens, though later work during the CIRCA Project proved this to be a large underestimate as the collection turned out to comprise over 12,000 specimens (Robinson and Bowden 2013).

During late 2008 and early 2009, the small foyer exhibition was curated. The aim was to produce a high impact display that would attract attention from a wide variety of museum visitors. Research on other geology/palaeontology exhibitions stimulated possible thematic structures, approaches to interpretation and how to layer text to appeal to people with different levels of interest. The exhibition looked at several themes in palaeontology, from the history of the science to the fossilisation of organisms, and this high level information was displayed as a series of text panels. Material was selected from the collections at Doncaster and from Dean's personal collection. Each specimen selected was briefly researched to determine the age, taxonomy etc. They were displayed in chronological order, each with a label colour coded to a timeline; some had artist reconstructions of what the animal may have looked like in life (Lomax, 2010a).

The exhibition, titled 'Fabulous Fossils', opened to the public in April 2009 (Figure 24). Approximately 150 fossils went on display. In conjunction with the exhibit, several public events were also undertaken, including controlled handling sessions and lectures. The exhibit was set to run for an initial 6 months, however due to an overwhelming amount of positive comments and visitor feedback, the exhibit is still on display, although due to renovations in the museum part of it was recently taken down.

After the creation and display of Fabulous Fossils, Dean continued research into several specimens that he had deemed potentially of scientific significance. This included the ichthyosaur specimen (DONMG:1983.98), which had erroneously been mistaken for a cast. Research on this specimen determined that it was a rare example, possibly representing a new species (Lomax, 2010b). Continued research over succeeding years, including visits to observe all Lower Jurassic ichthyosaurs held in UK museum collections, determined that the specimen was a new species (Lomax and Massare in

Figure. 24. Photo of Fabulous Fossils in the foyer at Doncaster Museum and Art Gallery.

press). Other work looked at a collection of 23 finely preserved eurypterid specimens from the famous locality of Lesmahagow, Scotland. Such specimens represent fossils that can no longer be readily collected from this location and should be considered in any future taxonomic work (Lomax *et al.* 2011). Dean also noted several other specimens that may be of further scientific and local significance. In addition, some rediscovered specimens from the collection were featured in a fossil identification handbook (Lomax, 2011).

During this time Lindsay Percival volunteered at the museum and carried out cataloguing work on the palaeontology collection (October 2010 - June 2011). She added 1100 records onto the MODES database and where specimens had no previous accession number she assigned a temporary ZG number (Figure 25): Z is a prefix used for all temporary numbers at Doncaster; G for geology; followed by a simple running number.

Figure. 25. Example of a new label produced by Lindsay Percival with a temporary ZG number.

In 2009, a year before the centennial of the Museum & Art Gallery, Doncaster Museums Service began a holistic collections review and rationalisation project, named 'Taking Stock'. The Fabulous Fossils exhibition and research undertaken by Dean led to the development of a dedicated project, within the context of Taking Stock, focused on the palaeontology collections. The CIRCA (Catalogued, Interpreted, Researched, Conserved, Accessible) Project was supported by a grant of £82,785 from the Esmée Fairbairn Foundation, and ran between May 2012 and October 2013 (Robinson and Bowden 2013). During this eighteen month period three contractors successfully tendered to deliver elements of the project: Alistair Bowden (project management of the curatorial aspects of the project); Dean Lomax (day to day project delivery, research and work on collections); Nigel Larkin (conservation aspects of the project). Peter Robinson acted as overall project manager and ensured standards were met as part of the broader Taking Stock programme. The project contained a number of key elements. First, a bespoke methodology was developed for a collection review and this was then applied to the entire collection. Second, the documentation of all specimens was thoroughly updated and improved. Third, new shelving was installed and all specimens were re-packed and rehoused. Fourth, a conservation assessment of the whole collection, stabilisation of at risk specimens and preparation of key specimens (e.g. the ichthyosaur). Fifth, a new education handling collection has been formed to stimulate the use of the collection by schools. Finally further research has taken place on the collection, most critically on the ichthyosaur which is now thought to be a new species (Lomax and Massare in press), on Henry Culpin (Lomax in press) and on recently collected Coal Measures material, now accessioned into the collections, from colliery spoil from a nearby deep coal mine (Lomax *et al.* in press).

Discussion

The formation of Doncaster Museum began after the heroic age of museum geology in the 1820s-1840s, when some Yorkshire collections like York, Scarborough and Whitby were founded. Its foundation occurred at the very end of the second great period of museum geology - the second rise of Knell's 'Roller Coaster' (1996). This late 19th to early 20th century boom in field naturalism coincided with the development of deep coal mines around Doncaster. This provided new scientific impetus, particularly for Henry Culpin and William Sawney Bisat, but it was perhaps also the confidence and aspiration from the expanding population (and tax revenues) that was the catalyst for the formation of a museum. Doncaster Museum opened at Beechfield House in 1910 and as with the museums of the Heroic Age almost a century before, geology generally and palaeontology specifically was at its heart.

After its founding, Doncaster's palaeontology and geology collections went on to suffer the same fate as many such collections in the first half of the 20th century. With the death of Corbett and Culpin, and Bisat moving to Leeds, scientific research and donations to the collection dried up.

Where the development of Doncaster Museum's palaeontology and geology collections really differ from the national trend described by Knell (1996), is with the arrival of Elfie Gilmour as Director in 1953. Gilmour's charismatic leadership began a period of rising aspiration, and a related expansion of collections and staff ultimately resulting in the move to the brand new museum building on Chequer Road in 1964. This phase of activity was distinct from and pre-dated the national third rise in the fortunes of museum geology that occurred in the early 1970s. It is quite unique to Doncaster Museum and its repercussions are still being felt today. Critically for example, Gilmour's vision for the museum to be of regional importance due to the sheer size of the collections, has created many of the problems that face the museum today and which are being addressed through the CIRCA Project and Taking Stock more generally (Robinson and Bowden 2013).

The arrival of Anne Pennington George in the early 1970s, as a recent Master of Museum Studies graduate, is more typical of the national picture. Anne brought a professionalisation to the curation of the collections. This is not to denigrate the work of Tim Riley, but he was only in post for a short period preceding Anne's arrival. It was under Anne's tenure that the collections expanded, diversified and were fully documented and stored rationally. Albeit the shelving was not ideal and the packing together of specimens was dense, but nevertheless the collection was alive, dynamic and well cared for, and it was displayed in pride of place as the first set of displays that visitors saw. However it ought to be emphasised that whilst Anne's arrival fitted in with Knell's third rise in museum geology (1996), it was by no means normal. The State and Status of Geology in United Kingdom Museums (Doughty 1981) highlighted a general lack of curatorial expertise in local museums around the country and in this regard Doncaster was at the forefront of this wave of change.

The period from Anne Pennington George becoming the Education Officer in 1983 and moving on to pastures new in 1997, until the development of Fabulous Fossils in 2008, is another unfortunate sad decline. It doesn't particularly correlate with the national picture, when the optimistic view is that museums generally became more professional, the collections became better curated and access was more effective (Knell 1996). However, it does perhaps fit in with the picture documented in the second State and Status report carried out 20 years after the first (Fothergill 2005), which found that the picture nationally had not improved during the intervening period.

But let us end on a very positive note. Fabulous Fossils was a great success and has led to the CIRCA project. A number of research publications (Lomax 2010a; 2010b; Lomax *et al.* 2011; Lomax and Massare in press) have highlighted that a number of scientific gems exist in the collections. Added to which the forthcoming paper on Henry Culpin (Lomax *in press*) and this paper will aid the dissemination of a deeper understanding of the history of the collections and people associated with them. The CIRCA Project has yet again breathed life into the palaeontology collections at Doncaster.

Dedication and Acknowledgements

This paper is dedicated to Phil Doughty, who did so much to raise standards in museum geology. In the words of Bill Ramsbottom "we who are left can only build on his foundations". (1974; quoted in the main body from his obituary of Bisat).

The help of Colin Howes, Paul Buckland, Anne Munby (nee Anne Pennington George) in detailing the latter part of the history of the collections is gratefully acknowledged.

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PRESENTATION OF THE A.G. BRIGHTON MEDAL TO PHILIP DOUGHTY

In December 2010, as out-going chairman of GCG, I had the great honour of presenting the 9th Brighton Medal to Philip Doughty.

It was with great sadness that I heard of Phil's death in 2013. He welcomed me to Northern Ireland, was a genial host and a great story teller as well as a great geological curator.

The Brighton Medal was inaugurated in 1992 with the aims of recognising the work of A.G. "Bertie" Brighton, curator of the Sedgwick Museum, Cambridge from 1931-1968, and acknowledging the importance of good curation in advancing geological science.

Whilst I had known Philip Doughty by reputation, which for me has been a little daunting at times (!), I relied on his friends and colleagues, and Philip himself for a more "historical" and personal picture. When I asked Phil how and why he came to work not only in geology, but also in museums.... well the following are Philips' own words:

> "Difficult to say really… reared in Wombwell, South Yorkshire, very much a coalmining town with four working collieries. Our next door neighbour was a pit deputy and he used to bring home fossils from the "cockle bands" below the coals, some perfectly preserved and to tell tales of great forests standing up in the coal seams. If I was a good lad he would give me the fossils so I was a collector from an early age. Like all my generation we used to receive the BBC schools programme "How things began" and I still remember Uncle Bill's adventures in time with his nephew and niece projected through an enormous fret-worked wireless to an attentive audience in the school hall. I can still retell the episode with the dinosaurs. At about the same time I discovered Doncaster Museum next to the old Waterdale bus station, both now long gone, which to me was a wonderland of armour, weapons, an observation beehive, butterflies, beetles, local glass and pottery, trophy heads of African and Asian mammals but particularly fossils and, what seemed to me at the time, miraculous minerals. From then on interest in museums has never dimmed.
>
> As a teenager I started hiking and quickly graduated onto rock climbing on the grit-stone edges of the Derbyshire and Yorkshire Pennines. Then in the Sixth Form an excellent geography teacher introduced us to Holmes's Principles of Physical Geology and that was it, I never looked back."

His story, as we talked and compared notes, appeared to be similar to my own of Yorkshire quarries & fossils, tramping hills, millstone grit, great geography teachers, and a constant thread of the local museum..... Perhaps it was appropriate that I picked up the role of GCG Recorder just as we were pulling together the results from the 2001 State & Status Survey, begun by Glenyss Wass.

Phil produced the ground breaking survey and report "The State & Status of Geology in UK Museums" between 1979 and 1981. I had the task of attempting to repeat this work and still stand in awe of the amount of work Philip had to commit to without the advantages of email, electronic forms, Excel graphs and mapping tools. I repeated Phil's words shamelessly in the second report, as frankly, he said it all so well. As a *relatively* young member of the GCG committee (at the time) I felt that his shoes were far too big to fill and his contribution to the role of GCG was never in doubt. Though when I nervously sent the draft report to him, he was nothing but supportive.

After serving as Recorder, he went on to be Chairman of GCG between December 1983 and December 1986.

Philip Doughty, a founder member of the GCG and Ulster Museum's first keeper of geology, has been instrumental in alerting the museum world and the general public to the importance and variety of geology, geo-conservation and geological collections in the UK & Ireland.

But to return to Philip's association with the Ulster Museum....

Kenneth James, our host for the meeting in December 2010, provided the photograph below of Philip with daughter Sarah and son James at an opening in the Ulster Museum in the 1970s. He went on to say that not only was Philip the first Keeper of Geology at Ulster Museum, but he was also the first keeper there to plan for the computerisation of accession records. According to Kenneth "*The Geology Dept was always better organised in its accession and archive records than any other Ulster Museum department, due to Philip's drive in this field.*"

In later years he was far from quiet and had taken up the flag for geo-conservation through a number of groups and popular geo-science publications such as ES2k (Earth Science 2000). In the past few years he could be regularly encountered leading guided walks promoting geo-conservation.

Each person I spoke to about Phil has praised his dedication to geology as a whole and the world of geology in museums.

Not only was his name suggested, independently, to me as a worthy recipient of the Brighton medal, it seems that planets have aligned.... as the author of the first and best "State & Status", as a fellow Yorkshireman (well if I was Chair**man**, Yorkshire**man** will do as well!), as a highly regarded museum curator in our meeting's host venue, it gave me great pleasure to award the 9th Brighton Medal to Philip Doughty, in Ulster Museum in December 2010 in front of a small but intrepid gathering of GCG members.

Helen Fothergill, GCG Chairman 2008 - 2010

PRESENTATION OF THE A.G. BRIGHTON MEDAL TO JOHN FAITHFULL

Today, as outgoing Chairman of GCG, I have the honour of presenting the 10th Brighton Medal. The Brighton Medal was inaugurated in 1992 with the aim of recognising the work of A.G. "Bertie" Brighton, curator of the Sedgwick Museum, Cambridge from 1931 - 1968, during which time he documented over 375,000 specimens, at an average rate of over 10,000 a year. It acknowledges the importance of good curation in advancing geological science.

John W. Faithfull at the Scotgold mine development at Cononish, near Tyndrum.

The medal was the idea of the late Dr David Price, Assistant Curator of the Sedgwick Museum from 1972, and then Curator. David was well aware that the meticulous work of curatorial staff, essential to the progress of research, was frequently unrecognised, or worse - belittled - by senior management. Sadly, this contributed to his suicide in November 1991. As well as the Brighton medal, David's legacy to the organisation of collections was the pioneering use of digital databases. The Sedgwick Museum's system, building on the basic digitising work of the 1970s, reached its acme in the 1980's, with a system much superior to many of those in use today. Its information retrieval was particularly impressive. It used a fussy search technique, breaking down search terms into small fragments and searching for each, before recombining the results into a list of decreasing similarity. Thus searching for the Sholeshook Limestone would also bring back specimens entered as being from the Sholeshook Limestone Formation, the Sholeshook Limestone Horizon, and various alternative spellings and

John W. Faithfull enjoying some rocks at the Hunterian's Thurso St. collections annexe.

mis-spellings. This search brought back 856 specimens, rather than the 384 specimens that would have been returned by a simple search. David was posthumously awarded one of the first two Brighton Medals for his contribution.

In awarding the 10th Medal, I should like to mark another curator who has opened up access to collections through digital databases, in this case online. At this point I should like to go back to 12 o'clock on 15th May 2002 in the BGS de la Beche lecture theatre, when the medal recipient gave a talk entitled "9 years of INCA: evolution of a museum catalogue". He debugged the notion that online catalogues had to be expensive and demonstrated a system using freeware running on a discarded PC. Since then he has continued to make quiet progress and now many of the Hunterian Museum specimens, including images, are online.

I am, of course, talking about John Faithfull, Curator of Geology at the Hunterian Museum and Art gallery, University of Glasgow. John has a BSc in Geology and a PhD on layered igneous rocks from Rum (both from the University of Durham). After a spell as Curator of Mineralogy and Petrology at Leicester University, from 1984 to 1991, he has been Curator of Mineralogy and Petrology at the Hunterian since 1992. During this time he has pioneered online access to museum catalogues, and I should like to mark this with the award of the Brighton Medal. A secondary reason, known to few, is that John has helped to safeguard the UK Continental Shelf hydrocarbon well core and sample collection, upon which much of the ongoing oil and gas exploration depends. John chaired the committee that drew up the methodology for moving the material safely from Edinburgh to Keyworth and at the same time providing core photographs on the web, freely accessible by all. It is true to say that John has played a small but important part in helping to keep the nation's lights on.

It gives me great pleasure to award the 10th Brighton medal to Dr John Faithfull.

Mike Howe, GCG Chairman 2011 - 2013

Brighton Medal 2013 recipient John Faithfull writes…

[reproduced from Coprolite 72]

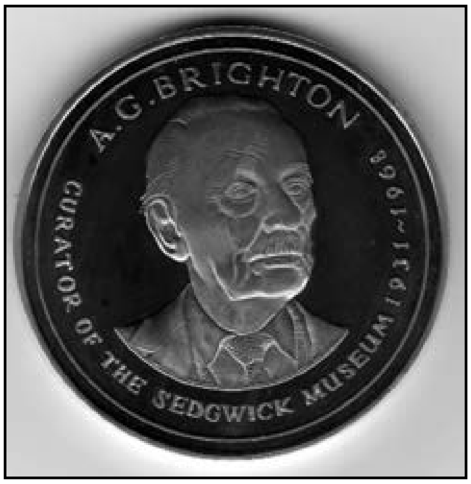
Those of you who were at the GCG meeting at Canterbury in December will have heard Mike Howe's presentation of the Brighton Medal. Due to technical problems, I was unable to say "thank you" via Skype at the time, so I thought it would be nice to respond via Coprolite.

I am extremely honoured. This is the first medal I've had since the Duke of Edinburgh's Bronze Award (some time ago!), and the first unsolicited one I've ever received. It's very encouraging to feel appreciated by others, and I'm grateful and surprised that my work has been considered of significance. Looking at the past Brighton Medal recipients, including my mentor at the University of Leicester, Roy Clements, two feelings arise: first, do I really deserve this? And second, I must be getting old, if my career is long enough to be considered worthy.
To my amazement, this will be my 30th year in the curatorial business. During this time, I have held two posts, both with the same title: Curator of Mineralogy and Petrology. First, at the University of Leicester Geology Department (1984-1991), and from 1992 at the Hunterian, University of Glasgow. Despite the job titles, at both places, I have spent an awful lot of time on other areas of work, and in particular, on writing software related to museum documentation. I've been lucky in having worked with some wonderful, and insightful people, and most of what I've done has been based on listening to others. Here are some thoughts:

Working alongside more experienced colleagues provides unique and invaluable knowledge transfer. People like Roy Clements, and Graham Durant have been a huge influence on me. This overlap in working lives seems to me one of the most precious and important aspects of gaining useful experience. This is now under threat, as specialist curatorial work and perspectives are undervalued and under-resourced in the current museum sector. Curatorial partnerships and teams provide a much better service, and in the long run, better value for money through better collections use and advocacy.

Don't just listen to specialists. This is not to devalue specialism - any good multidisciplinary work depends on sound and rigorous disciplinary knowledge. However, specialists' views of their own issues are not necessarily the only ones, and may not be the basis for optimum and generally applicable solutions. By taking a broad view of what a specimen may be, you can create tools which will work not just mineralogy, petrology and palaeontology, but also for numismatics, anatomy, or art collections.

Don't be proprietorial about data: they don't belong to you. If you look after a public collection, the data are for the public. Get the stuff out there -



POSTSCRIPT: The Brighton Medal is cast in silver, and a batch of 10 were produced by the Tower Mint, in London in 1992. The medal is 44.5 mm in diameter, and 3.5 mm tick, and weighs a satisfyingly chunky 47g. If you want see what it looks like in colour, there are images here: http://tinyurl.com/kf2d2tr.

open it up to peer review and re-use as soon as possible. You'll learn things from users, and your users will learn about your collections.

We need space to be creative. Having time and space to get out and about, and to engage with academic and applied geologists, research and other users, documentation and computer people, other collections, and bodies such as GCG, SPNHC is vital. This is increasingly important, and alas, increasingly difficult in the UK museum sector given lack of priority given to specialist curatorial posts.

There is no formula. Effective collections development, management, documentation and access is not delivered by following some ideal set of procedures. It is about making the best of circumstances, prioritising outputs, being opportunistic and imaginative, and developing and listening to potential users.

Good tea/coffee rooms are invaluable. Informal communication is the most important and useful way of generating ideas and broadening perspectives. Drink, chat, listen and ponder.

HISTORY OF THE A.G. BRIGHTON MEDAL

Introduction.

A.G. 'Bertie' Brighton (1900-1988) was Curator of the Sedgwick Museum from 1931 until 1968. His career was characterised by prodigious cataloguing. Brighton recorded on average 10,000 specimens each year and it is estimated that in his lifetime he was responsible for documenting 375,000 fossils. He was the epitome of the dedicated, professional, geological curator.

References to Bertie Brighton, the Brighton Medal and awards of the medal.

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Geological Curator, 6(1): 44-5. 1994. 3 December 1992, at Scunthorpe. *Award of the first A.G. Brighton Medal to Dr Charles Waterston.*

Geological Curator, 6(7): 287-9. 1997. 29 November 1995, at Ludlow. *Award of the A.G. Brighton Medal to Dr Bob King.*

Geological Curator, 7(3): 131-2. 2000. 2 December 1998, at Nottingham. *Award of the A.G. Brighton Medal to Dr Roy G. Clements*.
Geological Curator, 7(9): 349-50. 2003. 5 December 2001, at Oxford University Museum. *Award of the A.G. Brighton Medal to H. Philip Powell*.

Geological Curator, 8(6): 287-8. 2006. 18 January 2005, at Hancock Museum, Newcastle. *Award of the A.G. Brighton Medal to Hugh S. Torrens*.

Geological Curator, 8(10): 487-8. 2008. 3 December 2007, at National Museum, Dublin. *Award of the A.G. Brighton Medal to Geoffrey Tresise*.

Geological Curator, 10(1): 47-48. 2014. 7 December 2010, at the Ulster Museum, Belfast. *Award of the A.G. Brighton Medal to Philip Doughty*.

Geological Curator, 10(1): 49-51. 2014. 3 December 2013, at the Beaney Art Museum and Library, Canterbury. *Award of the A.G. Brighton Medal to John Faithfull*.

Kindly compiled by Kenneth James, Ulster Museum

GEOLOGICAL CURATORS' GROUP

38th Annual General Meeting

38th Annual General Meeting of the Geological Curators' Group.
The Discovery Centre, Leeds. 6th December 2011.

1. Apologies for absence.
A. Doyle, M. Parkes, T. Sharpe, J. Liston, H-L. Chalk, S. Turner, J. Radley, S. Baldwin, D. Johnson, M. Evans, G. Miller.

2. Minutes of the EGM of the Geological Curators' Group. London. 19th January 2011.
Agreed and accepted.

3. Matters arising. None.

4. Chairman's Report.
2011 has been an unusual and difficult year by any standards, eerily foretold by the Belfast Annual General meeting that never was. Kenneth James, Curator (Geology) at the Ulster Museum was the local host for an excellent and somewhat controversial seminar entitled "The New Ulster Museum: record visitor figures, awards and vanishing curators". The Ulster Museum had reopened in October 2009, following a three-year closure and a £17.2 m redevelopment. Since then it had attracted 600,000 visitors and won several awards, including the £100,000 Art Fund Prize for museums and galleries. However, the curators had been moved to offices 9 miles from the museum, the collections had been moved to an industrial estate 6 miles from the curators, and the numbers of curators continued to shrink to "endangered species" level, whilst the management positions multiplied. The general belief was that the Museum would never again be able to redevelop its displays in such a way because it had lost the necessary curatorial knowledge of its collections. At the May committee meeting, we agreed to support Earth Science 2K's attempts to raise this as a concern.

Heavy snow kept many delegates away, and my election as Chairman was invalid when it was realised that the meeting did not have a quorum. Fortunately, a good number of members made an EGM at the Geological Society premises in London on 19th January, and the AGM business was conducted uneventfully.

Museum cuts.
During the year, museum cuts came fast and frequent, with Hampshire, Maidstone, Norfolk, Liverpool and Warwick amongst the many loosing posts. This was not restricted to the UK, with posts in the USA going, including the New York State Palaeontologist, a post that had been in existence for more than 170 years. I find it a matter of grave concern that previous generations considered museums and public education of such importance that, even though resources were much more limited than they are today, they still considered such expenditure essential, yet in today's relatively affluent society, they are not considered important. Against this background, I am not sure that writing letters of concern to local councils will make any difference, and I believe we need to look for more productive approaches.

New working groups.
At the January EGM I outlined my intention to establish three working parties:
· Development of a strategy to respond to proposed cuts.
· Publicising success stories from museums, raising the good news profile.
· "Citizen Science" projects, bringing amateurs on board.
Unfortunately, time pressure on members and the Committee has delayed progress on these. The cuts have made it harder for many committee members to devote so much of their time to GCG, and we have been experimenting with Google Documents in an attempt to work "smarter".

International and national scientific databases.
One optimistic development has been a growing interest in international access to earth science collections through such initiatives as "The International Sample Numbering System". There has also been a growing realisation that individual specimens or collections will benefit from URIs or "Uniform Resource Identifiers". These are permanent, unchanging specimen identifiers. We already almost have them with sample registration numbers and MDI codes, but they need to link the web directly to the specimen, or at least a metadata entry and probably an image or even a digital model. Using these will enable research papers to cite actual specimens in a machine-readable manner, and it will then become a relatively trivial database matter to automatically assemble a list of citations, reuses or refer-

ences fro any specimen. As a means of highlighting the importance and significance of the specimens we care for, this must be second to none. Exporting sample information to databases such as that funded through the JISC project in which GCG is a partner will be a simple way to benefit from this.

Committee.
Finally, I would like to thank the Committee for all their hard work over the past year. At the January meeting, Helen Kerbey bravely volunteered to help and was shortly afterwards co-opted as Secretary, when David Gelsthorpe resigned through pressure of work. I would like to thank David for his contributions over the past few years, and Helen for stepping in at short notice. I would also like to thank all the other Officers, including Steve McLean, Programme Secretary; John Nudds, Treasurer; Tony Morgan, Minutes Secretary; Matthew Parkes, Journal Editor and Guidelines Project Manager; David Craven, Newsletter Editor; and the Committee members, Mark Evans, Jeff Liston, Jon Radley and Owen Green. I should also like to thank the co-opted members, including Webmaster Hannah Chalk; Membership Secretary Cindy Howells; ICON Representative Adrian Doyle; NatSCA Representative Leslie Noé and of course Tom Sharpe, who has been looking after the arrangements for bringing the constitution up to date.
Report accepted.

5. Secretary's Report.
I would firstly like to thank David Gelsthorpe for his work as Secretary up until the beginning of this year. It has been fairly quiet since then but during the year I have written to the Geological Society in support of the Library after the Group was requested to name the journals it would like to keep for a cost cutting exercise. I have just started to advertise our meetings on the Geological Society web pages, which I hope, will raise our profile and increase our involvement with other society events.

I have also been finishing off our changes to the constitution since Tom Sharpe, who has been working on this, is currently away. The subject of the constitution will be discussed under any other business later in the agenda.Report accepted.

6. Treasurer's Report & Membership Secretary's Report.

For the first three years of my Chancellorship we ended the year significantly up on the previous year's balance. However, we have ended the last two years slightly down on our previous balance, although I still maintain that this is not a cause for any alarm. This year you will observe that subscriptions are significantly down by almost £1,500, which is the real cause of our shortfall. We are still expecting, however, to receive outstanding subscriptions from 30 institutional members and from 20 individual members, which would bring in a further £900 and would put us in a much more healthy position. We have had a disappointing cancellation of a number of institutional memberships. In addition to this you will note that these accounts do not include any contribution from Gift Aid, due to my decision to reduce administration and apply for two years together in 2012. This normally brings in around £500 p.a., and we will see the added benefit of this next year. Finally, last year's bank fraud has been repaid in full. Workshop expenditure almost matches workshop income which is good news as we encourage meeting organisers at least to cover their costs. Expenditure on all other items is similar to most years, except that we have only had one edition of Coprolite in 2011 compared to our normal three editions.

The American dollar account stands at $ 2,511.42 ($ 2,327.42 last year), and the European account stands at 1,153.15 (202.44 last year), a significant increase on last year. I record my thanks to Tiffany Adrain and Matthew Parkes for looking after these respective accounts, and once again to Caroline Buttler (NMW) for careful auditing of the accounts.

Income.		**Expenditure.**	
Subscriptions	£3,347.83 (£4,803.55)	Geol Curator	£2,163.80 (£2,880.00)
Workshop income	£375.00 (435.00)	Coprolite	£488.86 (£1,472.00)
Bank repayment	£8.99	Workshop expenses	£378.70 (£514.78)
		Committee expenses	£794.84 (£779.92)
		Web site fees	£83.14 (£74.95)
		Brighton Medal	£18.00
	£3,731.82		£3,926.33
Balance 12/11/2010	£10,875.91	Balance 14.1.2011	£10,681.40
	£14,607.73		£14,607.73.

Membership Secretary's Report

Personal UK	154	(169)
Personal Overseas	18	(18)
UK Institutions	40	(53)
Overseas Institutions	24	(28)
Honorary	7	(7)
Total	243	(275)

As you can see by the figures, we are somewhat down on subscriptions this year. 5 institutions have written to cancel and 5 more have been deleted through non-payment. Similar numbers of personal members have been lost through retirement, job moves or non-payment. It is also taking longer each year to get both institutions and personal members to pay their subscriptions - so we are still waiting on around 20 of each. I am assuming most of these will pay at some point, although I suspect we may lose a few more institutions as so many are suffering cuts.
Several institutions have written to say they are cancelling all their journal subscriptions at present, so it is up to you, the Curator, to try to support GCG and to encourage your institution to continue with their subscription wherever possible - at just £20 it is much better value than some others!

On a positive note we have had 5 new personal members this year, and I would like to welcome them to the group, and hope we will see some of them at meetings soon. Do recommend us to your colleagues and remember that GCG is the only specialist group for geological curators, and we welcome all with an interest in geological specimens, collections, sites, conservation, etc.

We were asked about introducing a new concessionary rate for the unwaged (retired, volunteers, students and those out of work). We suggest that £10 would be a suitable sum for this and in order to agree this for 2012 we will be asking you to vote on it later. Lastly, subscriptions for 2012 are now due. We are keeping the other rates the same for this year and I will accept cheques any time - don't wait to be asked.
Report accepted.

7. Programme Secretary's Report.
Summary of 2011 programme.
7th -8th December 2010.
Seminar and 37th AGM. The Ulster Museum, Belfast. New Ulster Museum: record visitor figures, awards and vanishing curators.

In this seminar, former and current Ulster Museum staff recounted the history of geology in the museum, describing the recent redevelopment and outlining plans for the future. The relationship between museum management and curatorship was also discussed. There were tours of the museum's galleries, which, as well as the sciences, included antiquities, art and history displays, and tours if the museum's Collections Store and conservation facilities.

Unfortunately attendance was not high (the weather was very difficult) and as a result GCG committee had to call an EGM in January at the Geological Society in London, in order to be quorate. Despite this, the meeting was well received and my thanks to Kenneth James for organising the event, and to all the speakers: Sinead McCartan, Peter Crowther, Dominic Sore, Pamela Green, Philip Doughty, Mike Simms, Kenneth James, Fiona Baird, Karen Parkes, Siobhan Stephenson.

17th May 2011. Yorkshire Museum, York.
GCG Seminar - So you've got a geology collection - now what!!

A seminar for non-specialist curators who find themselves responsible for a museum geology collection. This session provided practical advice and ideas about how geology collections can be used in the museum, from teaching and research to informal learning and public programmes, as well as a look at the refurbished Yorkshire Museum.

Around a dozen members and non-members attended this event (plus speakers). Our thanks particularly to Isla Gladstone and Martin Watts from York Museums trust, along with all the speakers: Will Watts, Nicci Toft, Vicky Tunstall, David Craven, Helen Kerbey, Heather Jackson and Nigel Larkin, and to Stuart Ogilvie and Isla Gladstone for the museum tour.

12th -17th September 2011. Lyme Regis.
59th Symposium of Vertebrate Palaeontology and Comparative Anatomy. Joint meeting - 20th meeting of the Symposium of Palaeontological Preparation and Conservation, and the Geological Curators' Group.
A joint meeting predominately organised by Richard Forrest and Richard Edmonds, so my sincere thanks to them for all their hard work. GCG collaborated with SPPC to provide a number of speakers for our joint session and again my thanks for their contributions. They were Frank Osbæck, Mike Howe, Philip Hadland, Jeff Liston, Mark Evans, Trine Sørensen, Martin Abrahamsson, Pedro A. Viegas, Remmert Scouten, Ed Drewitt, Michael J. Benton, and Scott Moore-Fay. Other members of GCG spoke at SVPCA sessions. Particular thanks to Mark Evans and Mike Howe for chairing sessions.

18th October 2011. Oxford University Museum of Natural History.
GCG Workshop - the care and conservation of mineral collections.
Practical advice on the care and conservation of mineral collections led by Monica Price exploring how to evaluate a mineral collection and assess the condition of specimens and their documentation, assessing conservation problems and potential hazards. Monica looked at cleaning, sorting, ordering and documenting mineral collections, and discussed options for addressing some common conservation problems. There was even an insight into gemstones and meteorites. The session was very well received and attracted 11 attendees (full capacity!). My sincere thanks to Monica for organising and delivering such an excellent session.

2nd December 2011. World Museum Liverpool.
Joint World Museum Liverpool and GCG Seminar - Dinosaur interpretation for a Non Specialist Audience.
An excellent session organised by Phil Phillips of National Museums Liverpool, which attracted around 50 participants. This was a late but welcome addition to the planned programme. It coincided with the new Age of the Dinosaur exhibition from the Natural History Museum which delegates were able to view at WML. My thanks to Phil in particular for organising the event and to all the speakers who were Steve Judd, Alan Bowden, Scott Wright, Steve McLean, Nigel Patterson, Paul Barrett, Mike Benton, Mark Kirkby, John Hutchinson and Jen Bloom.

2012 GCG Programme.
The programme for 2012 is not finalised but should be ready for inclusion in the February edition of Coprolite. For regular updates please refer to the GCG website or sign on to the GeoCurators mail list. As ever, any ideas, comment etc should e addressed to GCG committee for future programmes.
Report accepted.

8. Journal Editor's Report.
Volume 9 No 5 of Geological Curator was published in May 2011. It included some experimentation with style of binding and use of colour inside. Thanks to those who provided feedback to my request for reactions and preferences. I will probably continue to use colour if the content merits it, but the cost balance between having digital printing of colour with a perfect binding versus a black and white journal done on an offset litho machine and saddle stitched (i.e. stapled) are difficult to judge. Our print run means that the traditional litho is generally cheaper, but blocks of colour can be added, and in short, you may see some switching between styles in different issues depending on content, and the most effective style at the lowest cost.

Volume 9 No 6 is in production but delayed due to the editor's workload in other areas. However, it will be produced and posted to members before Christmas. There are a reasonably healthy number of papers being submitted, and material in the pipeline for the first issue of 2012. One issue of 2012 may be a planned but delayed "special" on Hugh Miller. Further submissions of regular papers but especially of other types of possible contribution, are always welcomed. Anyone with ideas for thematic issues and guest editors should contact me whenever possible. My thanks to David Craven for book reviews. I would also like to thank all the referees who have reviewed papers, very often to a rapid timetable. Whilst I am happy to continue as Journal Editor, if there is anyone with potential interest in the role, or fresh ideas for the journal, please contact me or talk to the committee.

I am hoping that a reduction in other commitments in the New Year will allow me to fully engage with the proposed second edition of the Guidelines for the Curation of Geological Materials. We have a Committee approved team and a plan, but it has stalled with me for a while. Report accepted.

9. Newsletter Editor's report.
The Newsletter was to have two co-editors this year, but this was not possible due to work pressures, so apologies for the reduction in issues this year.
Coprolite is the Groups newsletter, so please send in any items of news for inclusion. This helps the editor. Book reviews can be included and we are always happy for members to offer to review books, or submit reviews, to either the Newsletter or the Journal. Please contact Mathew Parkes if you want to be involved. Report accepted.

10. Recorder's Report.
Main features were covered in Chairman's Report (Item 4) above.

11. Election of officers and Committee for 2012. Election of Auditors.
Committee.
The posts of Programme Secretary and Newsletter Editor are vacant. We have one nomination for Newsletter Editor - Helen Kerbey. Election agreed.
Two vacancies for ordinary Committee members. Nominations: Steve McLean and Giles Miller. Proposed by Cindy Howells, seconded by John Nudds. Election agreed.

NatSCA representative. David Craven has been proposed but this has to be ratified by the NatSCA Committee at their AGM.
All other Officers have agreed to stay on Committee for another year.
Election of Auditors.
Caroline Buttler nominated. Proposed by John Nudds, seconded by Steve McLean. Election agreed.

12. Any Other Business.
1. Concessionary rate.
We propose that a concessionary membership rate is introduced to cover the unwaged. This will be £10. (See Membership Secretary's report above). GCG may retain or gain members with this new rate. Proposed by Mike Howe, seconded by Helen Kerbey. Agreed.

2. Webmaster's report.
Email from Hannah Chalk and report circulated and read by Helen Kerbey.
Blogs. Do we want to add a page of blog links to the website? If so, does anyone have any suggestions? I have put together some basic categories, which may need more thought. Any suggestions would be appreciated. Blogs by geo-curators, Collections-related blogs, Blogs from UK Museums with Geological Collections.

Also, another plea for any news that I could post onto the website - I think that this is something that could really be improved as the 'news' section is relatively redundant. If there are any gallery redevelopments, changes to staff, funding sources, issues relating to cuts, or other such items, then please send me the relevant information. The GCG website has a Flickr link where members can post images and a JISCMail link which good for getting up to date news and information.

3. Constitution
It came to our attention after the failed AGM in December 2010 that Honorary Members were not entitled to a vote. This is due to a mistake in the way that we define membership as someone who pays subscriptions. There have also been many other changes since we were first set up that need to be updated. In order to change we have to inform both the Charities Commission, and the Geological Society. We then have to give the membership at least 21 days notice before holding a meeting for our members to vote.
A summary of the changes is below, however rather than go through all the proposals now I will be publishing them in Coprolite once they are in their final form. We will then either hold a mid-year EGM to vote on the changes or leave it until the next AGM depending on how long it takes.

· Make Web Officer and Membership Secretary full committee members, remove Recorder, and then reduce the number of general Committee Members from four to three
· Change the wording of the categories of membership so that Honorary members have a vote.
· Remove superfluous rules such as allowing Members of the Museums Association to come to meetings. - our meetings are open to all.
· Change Biology Curators' Group to NatSCA
· Add new definitions to terms in the introduction as suggested by the Geological Society.
· Change the Charity Commission text to simplify the need to involve them for constitution changes and include some legal words.

As well as changing some of the wording, I propose changing the style to match that suggested by the Geological Society. The Charities Commission has responded favourably, and made some suggestions for us to update our wording regarding their involvement. Ourcurrent constitution can be found on our web site. I welcome any comments and suggestions, but recommend that people wait until the proposals are fully published in Coprolite.

13. Date and venue of next Annual General Meeting.
December 2012. Leicester. Date and venue to be confirmed.

On behalf of GCG, Mike Howe thanked the Committee members for their reports and Clare Brown, Camilla Nichol and the other staff at Leeds Museum Discovery Centre for their hospitality.

GEOLOGICAL CURATORS' GROUP
39th Annual General Meeting

39th Annual General Meeting of the Geological Curators' Group.
New Walk Museum, Leicester. 4th Dec 2012.

1. Apologies for absence.
Stuart Baldwin, Emma Bernard, Hannah-Lee Chalk, Adrian Doyle, Steve Howe, Kenneth James, Jon Radley, Steve McLean, Matthew Parkes, Kathryn Riddington, Tom Sharpe, Sue Turner.

2. Acceptance of the minutes of the 38th AGM held at Leeds. Agreed. No amendments.

3. Matters arising. No matters raised.

4. Chairman's report.
2012 has been another unusual and difficult year, in many ways a continuation of 2011. At the last AGM in Leeds, I talked about vanishing curators in the Earth and Natural Sciences. The story of the Ulster Museum has been mirrored in many other museums around the country. I understand, for example, that the Dinosaur Isle Museum on the Isle of Wight is under threat, the local council having decided to "dispose of the building", effectively putting it out to tender as an attraction. A Museums Association report published in 2012 found that 51% of respondents had had their budgets reduced since April 2011 and 42% of respondents had reduced staffing levels.

a. The importance of collections.
I had a brief moment of optimism in May, when the Museums Association emailed me asking if the Geological Curators' Group would be interested in holding a fringe meeting at their November meeting in Edinburgh - could the MA at last be showing serious interest in geological and natural science curators? No, the MA was merely trying to fill some small breakout rooms with meetings limited to MA members already attending the conference. The MA is generally perceived as having no policy supporting geological and natural science collections and curators. However, in the flurry of emails, it transpired that Dr Tim Ewin was talking on the importance of good curation at the Collections Link's OpenCulture 2012 Conference in June. The resulting "Campaign for Good Curatorship" is now being supported by the Collections Link. My optimism has cautiously returned.

Running in parallel to this has been the Museums Association Museums 2020 consultation, workshops and vision, and other events, such as Leicester University's debate at the Science Museum: Museums in the information age: Evolution or extinction. Is the primary responsibility of a museum to safeguard collections for the future, or to make a difference to people's lives? (If you don't do the first, you can't do the second - but the current fashion for measuring impact measures the second).

My own view is that the web offers the means of creating an impact out of all proportion to the resources available to the host institution. My own organisation moved from the Geological Museum, South Kensington to Keyworth near Nottingham in 1985. In doing so, it lost most public access to its collections and it has taken twenty years for the web to develop to the point where it can provide a solution. We are now well along the path to providing public access to most of our collections through the web, using databases, high quality images and digital models - so you can even download and 3D print your own copy of a prize specimen. This technology then offers the ability to make a quantum leap in displays. It offers the possibility for anyone anywhere in the world to design their own exhibitions drawing on material from anywhere in the world. A current example is the Open University Virtual Microscope, which pulls geological maps from the BGS website. The evidence to date suggests that a museum putting material on the web increases its footfall rather than reducing it, so this technology may become an important tool for most museums around the world.

b. Chairman's working groups.
At the January 2011 AGM/EGM/Committee meeting, I outlined my intention to establish working parties on the development of a strategy to responding to proposed cuts, publicising success stories from museums and raising the good news profile, and "Citizen Science" projects bringing amateurs on board. Unfortunately, time pressure on members and the committee has continued to delay formal progress on these. The cuts have made it harder for many committee members to devote as much of their time to GCG. Nevertheless, the "Campaign for Good Curatorship" may help to address the first issue, the JISC funded GB3D type fossils online is contributing towards the second issue and it is good to see some

Geological Curators' Group
39th Annual General Meeting, Leicester 4/12/2012
2012 Accounts 14/11/11 - 13/11/12

Income			**Expenditure**		
Subscriptions	£ 3,469.12	(3,347.83)	Geol Curator	£1,620.00	(2,162.80
Workshop income	£496.50	(375.00)	Coprolite	£1,464.52	(488.86)
JISC GB/3D grant	£9,000.00		Workshop expenses	£470.60	(378.70)
Gift Aid	£1,054.00		Committee expenses	£939.58	(794.83)
			Web site fees	£170.12	(83.14)
			Reimbursement of subs	£12.00	
			JISC GB/3D payment	£ 90.00	
	£14,019.62			£4,766.82	
Balance as at 14/11/2011	£10,681.40		Balance as at 13/11/2012	£19,934.20	
	£24,701.02			£24,701.02	

NOTES
American Account currently at $ 2,791.42
European Account currently at 210.60

J R Nudds Treasurer 13/11/2012 Auditor: Caroline Buttler

amateur curators, in the traditional sense of the word, here today.

c. JISC - GB3D type fossils online.

The JISC GB3D type fossils online project is a partnership between the British Geological Survey, the National Museum Wales Cardiff, the Sedgwick Museum Cambridge, the Oxford Museum of Natural History and the Geological Curators' Group. The GCG is representing the many other museums around the country. The project is building a web-based database of the fossil types in the partner museums, including high quality images, stereo anaglyphs and some 3D digital models produced by laser scanning the fossils. The project has been funded by a £691k grant from JISC and contributions from the main partners. Progress is on target, and the mobile team has already visited Sheffield, Nottingham, Liverpool and the Zoology Museum in Cambridge. Some of the museums have issued press releases highlighting the visits, so the project is helping to raise awareness of the importance of the museums' holdings.

d. The Committee.

Finally, I would like to thank the Committee for all their hard work over the past year. Pressure of work and changing jobs have forced a number to step down, and I would like to thank Jeff Liston and Steve McLean for their work on the programme, and David Craven for his contribution as Newsletter Editor and NatSCA rep. I should like to thank Helen Kerbey for stepping in to take over from David. I should also like to thank all the other Committee members, including John Nudds, Treasurer; Tony Morgan, Minutes Secretary; Matthew Parkes, Journal Editor and Guidelines Project Manager; and the other Committee members, Giles Miller, John Radley, and Owen Green. I should also like to thank the co-opted members, including the Webmaster, Hannah Chalk; the Membership Secretary, Cindy Howells; the ICON representative, Adrian Doyle; and of course, Tom Sharpe, who has been looking after the arrangements for bringing the constitution up to date.
Report accepted.

5. Secretary's Report.

This has been a busy year for responding to challenges and opportunities for UK museums.
a. We have written letters of support for the Lapworth Museum of Geology in its bid for a Heritage Lottery Fund Development grant. We are pleased that this application has been successful.
b. We have offered advice to Doncaster Museum and Art Gallery over their Collections Review. Doncaster Museum Service is undergoing a review of its collections, which will involve the removal from its collections (de-accessioning) of some items that are no longer required.
c. Dinosaur Isle Museum, Isle of Wight. The Isle of Wight council have decided to transfer the management of Dinosaur Isle to an independent body. Concerns have been raised about the future of the museum itself and the collections. GCG has written to try to obtain more information on future plans should an independent body take over running of the museum. Report accepted.

6. Treasurer's and Membership Secretary's Reports.

Treasurer's report.
This year's balance of almost £20,000 may look healthy, but includes the JISC grant of £9000 for the GB3D Type fossils online projects. If we consider the balance without the grant, it will be seen that we actually have just under £11,000 in our reserves. Our annual balance has been close to this figure for the last five years since year end 2008, whereas in the two previous years we were increasing our balance by c. £2,000 per year. But there is no cause for concern just yet and I recommend that subscriptions remain at their current level for at least another year.

This year's Gift Aid includes 2 years and is a welcome addition to our income. If you have not signed a Gift Aid form, can I encourage you to do so.

Workshop income more than matches workshop expenditure which is good news as we encourage meeting organisers at least to cover their costs. Expenditure on most items is similar to other years, except that we have had three editions of Coprolite printed in 2012 compared to only one last year. The two volumes of Geological Curator have seemingly cost less than usual, but these costs have been offset by part payment from the European account. Unfortunately, committee expenses continue to rise alarmingly, and once again I encourage committee members to make advance purchases of travel tickets which can help us considerably.

The American Dollar account stands at $2,791.42 ($2,511.42 last year), and the European account stands at 210.60 (1,153.15 last year). I record my thanks to Tiffany Adrain and Matthew Parkes for looking after these respective accounts, and once again to Caroline Buttler and Christian Baars (NMW) for careful auditing of the accounts.
Report accepted.

Membership Secretary's Report.

Personal UK	150	(154)
Personal Overseas	21	(18)
UK Institutions	38	(40)
Overseas Institutions	24	(24)
Honorary	7	(7)
Total	240	(243)

Once again a slight decline in numbers, although not quite to the same extent as last year. We have had several institutions cancel as they have lost their Geologist, or have been asked to cut back subscriptions. At least the one thing in our favour is our relatively low subscription rate. I hope that we won't need to increase this in the near future.

Although we have lost a few personal members due to retirement and changes of job, we are still gaining others. I would like to welcome 2 new, and 1 returning lapsed member within the UK, and 4 from overseas. Please continue to recommend the Group to your colleagues, and promote it wherever you can. Also remind your institution that we are a group that is directly involved in collection care, and the Journal is of use to all staff caring for the collections, not just Geologists. Remember that GCG is the only specialist group for geological curators, and we welcome everyone with an interest in geological specimens, collections, sites, conservation, exhibitions etc. Also we now have the new concessionary £10 rate for the unwaged, so I hope there is now less need for anyone to cancel their subscription upon retirement.

Lastly, subscriptions for 2013 are now due. We are keeping all rates the same for this year, and I will accept cheques any time. Alternatively, you can fill out a Standing Order form for an annual payment.
Report accepted.

7. Programme Secretary's Report.
No report received. Jeff Liston has taken up a post abroad.
April 2013. GCG Study Tour to Guernsey.
Alan Howell outlined some of the changes that have taken place at Guernsey museum and its stores recently. New storage means all of the natural history collections, including geology, are now in one place. Members will be able to see these new facilities, and have a fieldtrip around Guernsey if they attend the Study Tour. Alan Howell, John Nudds and Helen Kerbey are happy to take any of your enquiries on this event, and your bookings.

8. Journal Editor's report.
Volume 9, Number 7 was issued in July with 4 papers covering 48 pages. Volume 9, Number 8 will be distributed before the end of the year, as it is nearly ready for production. Whilst it will be relatively light on papers, due to delays with several planned contributions, there is a healthy flow of papers and planned submissions for 2013. Given this, it is the Editor's intention to focus on delivery of the long planned Guidelines 2nd edition, via the GCG website, and compiled incrementally, as previously agreed at Committee. Report accepted.

9. Newsletter Editor's report.
This year we have produced three issues of Coprolite. As well as material sent in by post or email for the newsletter, we also encourage members to submit material to the GCG JISCMail site.
Sponsorship.
We are hoping to find a new sponsor, or sponsors, to cover the costs of printing and distributing Coprolite. Advertising space is available in the newsletter if you know of any suitable companies or groups who would like to advertise with us. Report accepted.

10. Recorder's report.
All items covered in Chairman's report above.

11. Election of officers and Committee for 2013 and election of Auditors.

We have received a nomination for NatSCA representative and one for an ordinary Committee Member.
Ordinary Committee Member: Emma Bernard. Proposed by Giles Miller. Agreed.
NatSCA representative. Kathryn Riddington. Proposed by NatSCA Committee. Agreed.

Programme Secretary. Post is currently vacant, although talks are taking place with someone who is interested in taking over the role.

All other Officers and Committee members are willing to continue in their current roles.

Election of auditors.
The current auditors, Caroline Buttler and Christian Baars have agreed to continue in this role. Agreed.

12. Any other business.
a). Constitution.
Tom Sharpe has been liaising with the Charity Commission over changes to the GCG Constitution. These had been proposed at the 2011 AGM in Leeds and have been reported in Coprolite.
Committee proposed to change the number of Ordinary Committee members from four to three, with each now serving for three years. This will be on a rolling programme with one new committee member being elected each year.

Questions from the floor:
Roy Clements. Will three Committee members be enough to fill posts and perform tasks when needed? Helen Kerbey replied that it would be as we can still co-opt members with particular skills as needed.
Voting took place. Members present agreed to accept these changes.

b). BGS Advisory Committee.
GCG can nominate a member to attend the BGS Advisory Committee. Mike Howe proposed nominating Dr Roy Clements.
Agreed.

13. Date and venue of the next Annual General Meeting.
Date and venue: To be confirmed.
Phillip Hadland offered Canterbury as a venue. Committee will inform membership when details are finalised.

Meeting ended at 17.00.

BOOK REVIEWS

Planetary Geology: An Introduction. 2nd edition. Claudio Vita-Finzi and Dominic Fortes. Published by Dunedin Academic Press Ltd, June 2013. £25, paperback, x+ 206 pages. ISBN 978-1-78046-015-4.

Being reviewed, as it is here, in a geological publication might seem appropriate for this book, but in fact its title is somewhat misleading. Just a cursory scan of the contents page reveals that the book's scope extends far beyond what is implied by the term 'geology'. Those expecting a discourse on Solar System rocks, planet by planet, may be in for a surprise because what the book does cover is actually more akin to the increasingly trendy 'Earth system science' than geology alone. It addresses this in twelve themed chapters which extend from traditional aspects of geology, such as volcanics, tectonics and planetary structure, through geomorphic processes and orbital cycles, and into oceans, atmospheres, and even a final chapter on planetary biology. In many instances their approach is to compare and/or contrast features on other planets with similar features on Earth in order to gain an understanding of the processes that operate on these planets and which may have formed the supposed extraterrestrial analogues. However, as an Earth-based geologist I do have some misgivings on their coverage of terrestrial processes and events. For instance, there appears to be considerable confusion surrounding basic stratigraphic succession and dates, while several well-documented glacial periods, including that at the end-Ordovician, are omitted. They also seem to accept, uncritically, several hypotheses which are at best highly speculative and, amongst many geologists, now largely discredited. In this respect they refer to the 26 million year extinction periodicity hypothesis without any additional comment about the implied extraterrestrial control, while elsewhere they suggest a link between large impacts and terrestrial flood basalts. Niggling points like these might have been corrected if a terrestrial geologist had been involved. I suspect that there may be significantly fewer errors when the authors are on their home ground, as it were, of other planets, although the number of Martian meteorites they cite is an order of magnitude too low. The last chapter, on planetary biology, is the weakest and tends to drift onto other topics such as impacts, extinctions, and human modification of Earth systems.

'Terrestrial' criticisms aside, as a geologist I found this book hugely informative without swamping me in excessive detail. It provides an excellent and affordable summary of the current state of knowledge of 'planet systems science', even making reference to some Mars Curiosity results from 2013. If you have an interest in 'geology' beyond your own planet then this is a great introduction.

Michael J. Simms, Ulster Museum, Belfast.
12th May 2014

Scottish Fossils, by Nigel Trewin. Published March 2013 by Dunedin Academic Press Ltd. £30/ Euro 45/ $55, hardback, 118 pages, illustrated in full colour throughout. ISBN 9781780460192

It is difficult at first glance to identify who this book is aimed at, but closer examination suggests it could appeal to a very wide audience, particularly anyone with an interest in palaeontology, but also to those with a pride in Scotland. Many of the illustrated specimens tell stories of international importance such as the conodont animals from the Granton Shrimp Bed near Edinburgh. The famous Rhynie Chert provides 5 of the different examples. Achanarras in Caithness provides several Devonian fish and Devonian and Carboniferous amphibians are also included from classic localities.

Nigel Trewin's knowledge, and choice of Scottish fossils to include, is broad in stratigraphical and geographical coverage, with Cambrian trace fossils such as the famous Skolithos of the Pipe Rock through to sub recent Lynx from caves in Sutherland. As well as representatives of the main phyla like brachiopods, molluscs, echinoderms, arthropods, corals, plants and vertebrates (fish, amphibians, reptiles and mammals) there are some minor groups like worms, sponges, algae, bacteria, bryozoan, graptolites and trace fossils. Very many of the photographed specimens are from Scottish museums and although some are on display, many others are not and this book does a service to the curators by publicising such specimens. A list on pages 6-7 describes a range of large and small museums and heritage centres where fossils are on display for public consumption.

The illustrations are critical to the book, and by and large they are good, but a very few are not quite as sharp in the printing as I would have expected from a book of this quality. Where required, the illustrated specimens are amplified by line drawings or colour reconstructions of the animal, sometimes in its environmental setting. However, the text also tells of interesting historical significance, morphological details, location backgrounds and a host of other information, but in a concise and readable form. There is a mix of the commonplace fossils that an amateur collector might find, alongside the scientific rarities.

Whilst the main appeal will obviously be within Scotland, I would recommend this as book to have in any geology museum library for the curators' use and also one that could sell well in a museum shop as a general interest book on fossils. For a full colour, hardback book covering 104 different fossils, the price is not unreasonable but could be a little steep for some prospective purchasers.

Matthew Parkes, Natural History Museum, Dublin, Ireland.

Introducing tectonics, rock structures and mountain belts by Graham Park Published May 2012 by Dunedin Academic Press Ltd. xii + 132 pages. £14.99, Euro 22, $29.95. ISBN 978 1 906716 26 4

I am a great fan of the Dunedin Academic Press series of 'Introducing Geology' and its companions on Palaeontology, Volcanology, Geomorphology and so on. They are highly accessible, well written and illustrated and great for geological curators to recommend to museum shops, to individuals with a new interest or for a quick explanation of something that arises in a public identification enquiry. Graham Park, the author of this has contributed several others to the stable of small handy books. Therefore, I was a bit confused initially by this book, when I opened the envelope, as it is a larger size and with more pages, and a quick glance through shows it is much more detailed and expansive in content than the predecessors. However, the accompanying letter and preface in the book clarifies that is really an undergraduate level textbook. I feel it is unfortunate that the same 'Introducing' title was used as in the real beginner's style series, as it misleads slightly and may confuse potential purchasers looking at a range side by side in a bookshop. Perhaps 'Essentials of' might have been a better choice. Perhaps the format is sufficient to distinguish the title and other more academic titles from the 'popular' books but for me it was not apparent.

This criticism aside, the content of the book is much to be admired, for its clarity and conciseness. Much could be learned by curators struggling with exhibition texts. The colour line illustrations are all complementary to the text but tend to work well alone in summarising the specific topic or point. Photographic examples are all well-chosen and often annotated. Structural geology is delivered in 12 chapters beginning with the large scale structure of the Earth, and plate tectonics as a context for looking then at deformation, fractures, faults, earthquakes, folding and fabrics. Later chapters look at the structural styles and effects of igneous intrusions and also the role of gravity. The last three chapters explore orogenic belts - how to interpret them, examples of modern and ancient ones.

As an undergraduate level textbook, it also includes an appendix explaining stratigraphical and a few rock classification tables that are freely used in geology, which if you do not know how to read them, are not a lot of use. As with other Dunedin books of this broad type, a glossary explains a large number of technical terms that are highlighted in the text. Often though, the explanation of the term is clear through its use in the main text, with plain language descriptions and explanations of structural phenomena. A very brief section of suggested further reading partially reminds you that the book does not cover everything. The classical interpretation of geological maps is not addressed, nor the structures within sedimentary rocks. A definite intention by the author to avoid the mathematical side of structural geology in order not to put people off is successful, and thus this book is a concise primer, but other works would be needed within a comprehensive structural geology course to tackle the numerical side.

In reading this, I was able to enjoy relearning what I learnt many years ago, but also bring myself up-to-date with concepts in structural geology and in the development of some of the main orogenic belts in Britain and internationally. It is definitely a recommended book for almost any level of interest in structural geology. Just remember to get your museum shop to display it separately from the smaller 'Introducing' titles!

Matthew Parkes, Natural History Museum, Dublin, Ireland.

Geology and landscapes of Scotland, by Con Gillen. Published July 2013 by Dunedin Academic Press Ltd. £24.99, paperback, viii + 246 pages. Second edition. ISBN 978 1 78046 009 3

Three of my favourite geology books when I was young were the Penguin titles 'Geology and Scenery in Scotland', 'Geology and Scenery in Ireland' and the 'Geology and Scenery in England and Wales'. This book now fills a similar niche in my shelves, and is a similar work, but thoroughly modern with full colour throughout, instead of a set of black and white photos in a middle spread, and black and white line drawings illustrating key points. Superb photographs, many of them quite stunning, grace the book in every chapter, with accompanying diagrams explaining key points. The text is clear and easy to read, at a level that would best suit an amateur or professional interest in geology, but is one that anyone could read, with a substantial glossary provided to address some of the more technical content. Readers such as climbers, walkers, tourists, landowners or indeed any visitor to Scotland would find this book a useful resource to understand the wonderful landscape in all parts of the country.

The approach is much more a geological explanation than in the previously mentioned Penguin books, which had a geomorphological perspective to the landscape. My initial reaction to the book brought the excellent series of 'A landscape fashioned by geology' to mind. These booklets produced by Scottish Natural Heritage and the British Geological Survey are brilliant explorations and explanations of the geological foundations to iconic areas of Scotland. Whilst there are many similarities, Gillen's book is more than the collation of these booklets. There is greater depth and a geological regional approach, with thorough coverage.

Gillen's book starts with an explanation of the science of geology, which is itself an eloquent and comprehensive introduction to the following chapters. These tackle Scotland by region, beginning with the oldest rocks in the far northwest, moving through the Caledonian Mountains, to the lowland areas. The North Sea and Inner Hebrides get a chapter, and the Hebridean volcanoes are the subject of a particularly well illustrated chapter. Ice Age Scotland naturally gets a significant chapter, but the last chapter is a really interesting synthesis of how Earth resources have shaped the interaction of people with the landscape, including metal mining, fossil fuels and a wide range of industrial minerals and materials including building stones as well as raw materials for industry.

I have not seen the first edition, originally produced by Terra Publishing, whose titles have been taken over by Dunedin, and therefore cannot comment on how much has been changed in the second edition. I can recommend this book without reservation to anyone with an interest in Scottish geology. As a curator it is disappointing not to find any apparent mention of the geological museums of Scotland within the appendix covering 'taking it further' or in the excellent bibliography covering websites as well as traditional book and guidebook titles. However, any such museums would do well to stock this title in their shops.

Matthew Parkes, Natural History Museum, Dublin, Ireland.

THE GEOLOGICAL CURATOR

Publication scheme

Two issues of The Geological Curator are published for each year (usually in the Spring and the Autumn); a complete volume consists of ten issues (covering five years) and an index.

Notes to authors

Articles should be submitted as hard copy in the journal style, on good quality paper (A4 size) double spaced, with wide margins, and on disk (although e-mail submissions are also accepted). Three copies should be sent to the Editor, Matthew A. Parkes, Natural History Museum, Merrion St., Dublin 2, Ireland (tel 353-87-122-1967; e-mail: mparkes@museum.ie). Line drawings should be prepared in black ink at the desired publication size. Photographs for halftone reproduction should be printed on glossy paper. Both drawings and photographs should be proportioned to utilise either the full width of one column (85mm) or two (175mm). References in the text follow the Harvard system, i.e. name and date '(Jones 1980)' or 'Jones (1980)'. All references are listed alphabetically at the end of the article and journal titles should be cited in full. Authors will normally receive proofs of text for correction. Major articles are refereed. Copyright is retained by authors.

If submitting articles electronically please note the following:

1. Do not 'upper case' headings. Keep all headings in upper and lower case.
2. Use italics rather than underline for latin names and expressions, journal names and book titles. Use bold for volume numbers in references.
3. Line spacing. Your hard copy should be double spaced. If possible, single space your copy on disk. Use a single (hard) carriage return at the end of each paragraph.
4. Single space-bar between words, double space-bar between sentences.
5. Do not attempt to format your article into columns. Use a minimum of tabs and indents.

Regular features

LOST AND FOUND enables requests for information concerning collections and collectors to reach a wide audience. It also contains any responses to such requests from the readership, and thereby provides an invaluable medium for information exchanges. All items relating to this column should be sent to the Editor (address above).

FACT FILE contains basic information for the use of curators. All items relating to this column should be sent to the Editor (address above)

NOTES comprising short pieces of less than two pages are particularly welcome. Please send contributions to the Editor (address above).

GALLERY REVIEW comprising short pieces on new museums or exhibitions.

CONSERVATION FORUM helps keep you up to date with developments in specimen conservation. Information on techniques, publications, courses, conferences etc. to Dr Caroline Buttler, National Museums and Galleries of Wales, Cathays Park, Cardiff CF10 3NP, Wales, UK.

BOOK REVIEWS contains informed opinion about recently published books of particular relevance to geology in museums. The Editor welcomes suggestions of suitable titles for review, and unsolicited reviews (of 500 words maximum) can be accepted at his discretion. Publishers should submit books for review to David Craven (see inside front cover for address).

INFORMATION SERIES ON GEOLOGICAL COLLECTION LABELS consists of loose A4 size sheets, issued irregularly, which carry reproductions of specimen labels usually written by a collector of historic importance. The aim of the series is to aid recognition of specimens originating from historically important collections. Contact the Editor.

Advertisement charges

Full A4 page	£80 per issue
Half A4 page	£60 per issue
Quarter A4 page	£40 per issue

25% discount for space bought in three or more issues. Further details from the Editor.

Inserts such as publishers' 'flyers' can be mailed with issues of The Geological Curator for a fee of £80 per issue. 350 copies of any insert should be sent to the Editor.

Subscription charges 2014

UK Personal Membership	£15 per year
Overseas Personal Membership	£18/ US$32/ EURO 25 per year
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All enquiries to the Treasurer, John Nudds, Department of Earth Sciences, University of Manchester, Oxford Road, Manchester M13 9PL, U.K. (tel: +44 161 275 7861; e-mail: john.nudds@manchester.ac.uk).

Backnumbers

Backnumbers of The Geological Curator (and its predecessor, the Newsletter of the Geological Curators' Group) are available - please enquire with your requirements. All issues are available for download from www.geocurator.org.

THE GEOLOGICAL CURATOR

VOLUME 10, NO. 1

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