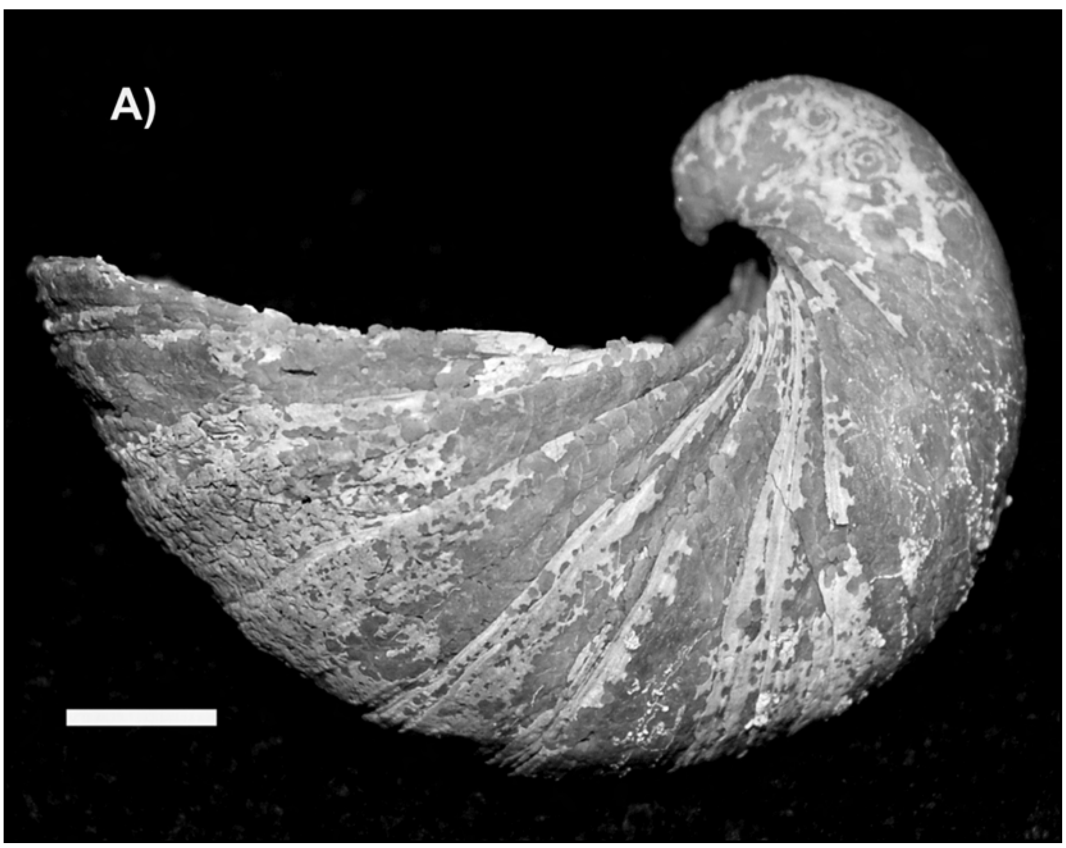
GEOLOGICAL CURATOR

GCG

Volume 9 Number 1



GEOLOGICAL CURATORS' GROUP

Registered Charity No. 296050

The Group is affiliated to the Geological Society of London. It was founded in 1974 to improve the status of geology in museums and similar institutions, and to improve the standard of geological curation in general by:

- holding meetings to promote the exchange of information
- providing information and advice on all matters relating to geology in museums
- the surveillance of collections of geological specimens and information with a view to ensuring their well being
- the maintenance of a code of practice for the curation and deployment of collections
- the advancement of the documentation and conservation of geological sites
- initiating and conducting surveys relating to the aims of the Group.

2009 COMMITTEE

The views expressed by authors in *The Geological Curator* are entirely their own and do not represent those of either the Geological Curators' Group or the Geological Society of London unless otherwise stated.

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Cover: Left valve of *Gryphaea arcuata* shell after acid digestion; scale bar 1 cm. [See paper by Baar on pages 29-33]

THE GEOLOGICAL CURATOR

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GEOLOGICAL CURATORS' GROUP - December 2008

LOST & FOUND

Enquiries and information, please to Matthew Parkes, (National Museum of Ireland - Natural History, Merrion Street, Dublin 2, Ireland; e-mail: mparkes@museum.ie). Include full personal and institutional names and addressess, full biographical details of publications mentioned, and credits for any illustrations submitted.

The index to 'Lost & Found' Volumes 1-4 was published in *The Geological Curator* 5(2), 79-85. The index for Volume 5 was published in *The Geological Curator* 6(4), 175-177.

Abbreviations:

CLEEVELY - Cleevely, R.J. 1983. *World Palaeontological Collections*. British Museum (Natural History() and Mansell Publishing Company, London.
GCG - *Newsletter of the Geological Curators' Group*, continued as *The Geological Curator*.
LF - 'Lost & Found' reference number in GCG.

263. A portrait of the Comte de Bournon?

Jess Shepherd, St. Aubyn Project, Plymouth City Museum and Art Gallery, Drake Circus, Plymouth, PL4 8AJ, UK; Tel: 01752 30 4774; e-mail: st.aubyn@plymouth.gov.uk

I was wondering if anyone knew of a portrait of a gentleman called Comte Jacques Louis de Bournon (1751-1825)? Both Plymouth City Museum and Art Gallery and The Natural History Museum in Paris are desperately trying to locate a portrait of this man. Any information would be gratefully received.

264. Pliosaur; request to search for a missing bit

Richard Edmonds.
e-mail: r.edmonds@dorsetcc.gov.uk

We have purchased a huge pliosaur skull from the Black Head area of Osmington, Dorset, using money from the HLF Collecting Cultures fund secured by Dave Tucker, our Museums Advisor here in Dorset. The specimen includes the skull and the lower jaws but the spatulate end of the jaws is missing. Judging by the weathering and selenite on the bones, they have been weathering near the cliff face for a good few years so the missing section, the spatulate end joining the jaws together, must have been exposed many years ago.This would be a very distinctive piece of bone - assuming it is in one piece, which is possible, it should be about 40cm long. The broken faces of the bone are about 20cm in cross section.

I know that this is a long shot but does anyone have a specimen matching this description from the area? It would be an amazing feat to link them up together again!

Attached is a photo of the beast. The jaws are obviously arranged wider apart than they would originally have been. We are working on some exciting ideas on how to display this specimen. What ever we do it is going to be impressive!
Richard

THE COLLECTION OF CONULARIIDS OF THE NATURAL HISTORY MUSEUM OF LONDON

by Consuelo Sendino and Jill Darrell

Sendino, C. and Darrell, J. 2008. The collection of conulariids of The Natural History Museum of London. *The Geological Curator* 9 (1), 3 - 20.

The present work describes the collection of conulariids in the Natural History Museum, London, with sections on the history of the collection, its stratigraphic and geographical distribution, and its taxonomic diversity and abundance. Determinations of 753 out of 1131 specimens in the collection have been revised and all associated information has been catalogued. We conclude that this is the most important collection of conulariids, scyphozoan cnidarians with conical, phosphatic skeletons, in the world.

C. Sendino and J. Darrell. *Department of Palaeontology. Natural History Museum, Cromwell Road, London SW7 5BD (UK)(1) Email: c.sendino-lara@nhm.ac.uk; (2) Email: j.darrell@nhm.ac.uk.* *Received 5th October 2008. Revised version received 17th June 2009.*

Introduction

Conulariids are extinct cnidarians (Van Iten *et al.*, 2006), with a worldwide distribution in the fossil record. They have been found from the Ediacarian (Caster, 1957; He, 1984; Ivantson and Fedonkin, 2002) to the Triassic (however, some authors have recorded supposed Lower Jurassic conulariids: Argéliez, 1856; Dana, 1863; Kayser, 1924; Zittel, 1924, 1927). This comprises a geological duration of more than 400 million years, with 52 genera and 357 described species. The Natural History Museum in London houses specimens belonging to more than 11 genera and 85 species.

These fossils have exoskeletons with a four-sided, acute pyramidal shape (Figure 1). They are usually preserved in the original calcium phosphate, or as internal moulds (steinkerns). Their size ranges from a few millimetres up to about 500 millimetres (Kiderlen, 1937; Boucek, 1939). The stratigraphical record of conulariids extends from the Upper Precambrian, in the Nama Series of South Africa (Caster 1957) to the Lower Jurassic of Avéyron (France) (Argéliez 1856) and North America (Dana 1863; Kayser 1924; Zittel 1927).

An important part of our historical heritage is contained in museums, and natural history museums are storekeepers of that heritage concerning the evolution of life. Fossils are key to the understanding of the evolution of both extinct and extant species, and their study may also provide us with a glimpse of the future for life on Earth. The Natural History Museum (NHM) in London contains the most diverse collection of conulariids in the world. In terms of diversity the NHM collection surpasses that of the Národní Museum (National Museum, Prague) in which more than 2,000 specimens from Ordovician to Devonian rocks in the Prague Basin are housed, collections that include conulariids collected by Barrande, one of the early authors to have been interested in these fossils.

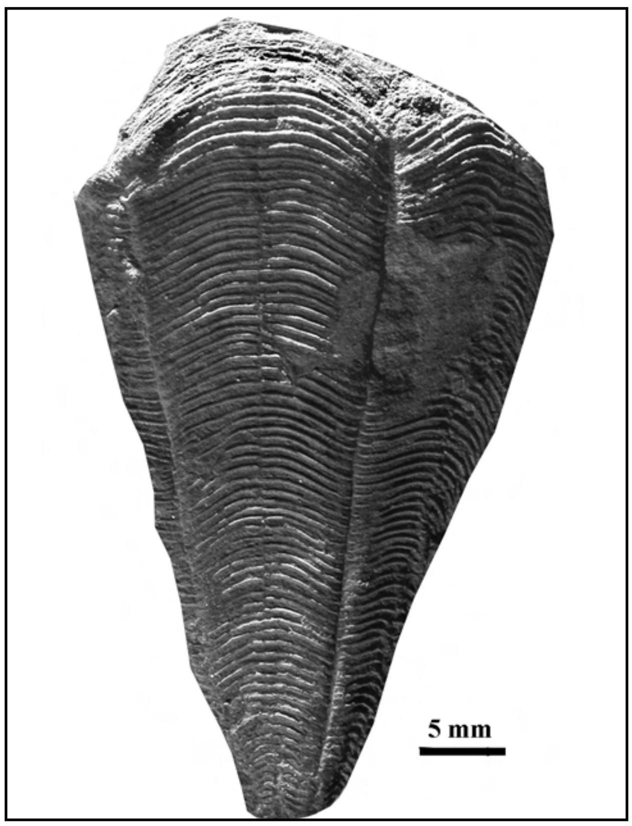


Figure 1 Example of a well preserved conulariid,* Conularia subcarbonaria *(NHM G35) from the Carboniferous of Indiana (surrounding matrix digitally removed).

The NHM contains an historical collection of conulariids that began in 1841, and includes contributions from one of the most important collectors of Palaeozoic invertebrates during the 19th century, Mrs Elizabeth Gray.

The NHM collection is one of the most emblematic for any naturalist, its fossil cnidarian collection containing 76 type specimens of which 17 are of conulariids. The wide geographical coverage of the NHM fossil collections reflects the extension of the British colonies across all continents, frequent exchanges with other museums, and the purchase of individual specimens and entire collections.

The conulariid collection consists of 1,131 specimens, ranging from Upper Cambrian to Upper Triassic, a geological timespan of some 300 million years. This collection was important during systematic and taxonomic studies of conulariids at the beginning of the 20th century, and it remains a crucial reference collection for modern researchers. It is the most significant international collection because of its taxonomic diversity and it embraces the greatest geographical and stratigraphical range, with 165 localities distributed all over the world. Most of the 17 type specimens are from the monograph on British conulariids by Slater (1907).

The history of the NHM conulariid collection began in 1841, 20 years after James Sowerby described the genus *Conularia* Miller in his work *The Mineral Conchology of Great Britain* (Sowerby 1821). The first conulariid to be acquired was a specimen of *Paraconularia quadrisulcata* (Sowerby 1821). This specimen came from the Gilbertson Collection, assembled by the chemist William Gilbertson (1789-1845) who collected fossils from the Carboniferous of northeast Lancashire, close to Preston where he lived. The NHM conulariid collection increased in size gradually until the end of the 1970s, with the discovery of several conulariids by two NHM scientists (S.F. Morris and R.P.S. Jefferies) at in an excavation in Scotland. The collection currently consists of 1,131 specimens that are distributed among 11 genera and at least 85 species.

Origin and date of acquisition of the specimens

One of the most important collections of conulariids in the NHM collection is that of Elisabeth Gray. Mrs Robert L. Gray (née Anderson) (1831-1924) was the first woman known to have collected conulariids. Her material came from Girvan in Ayrshire, Scotland and represents the first recording of this locality (Oldroyd 1990). All of the specimens that she collected were acquired by the NHM in either 1920 or 1937, and they form an important part of the Museum's conulariid collection, totalling 463 specimens.

Other collections of conulariids worth highlighting include that of Dr Joaquim Barrande who sold a total

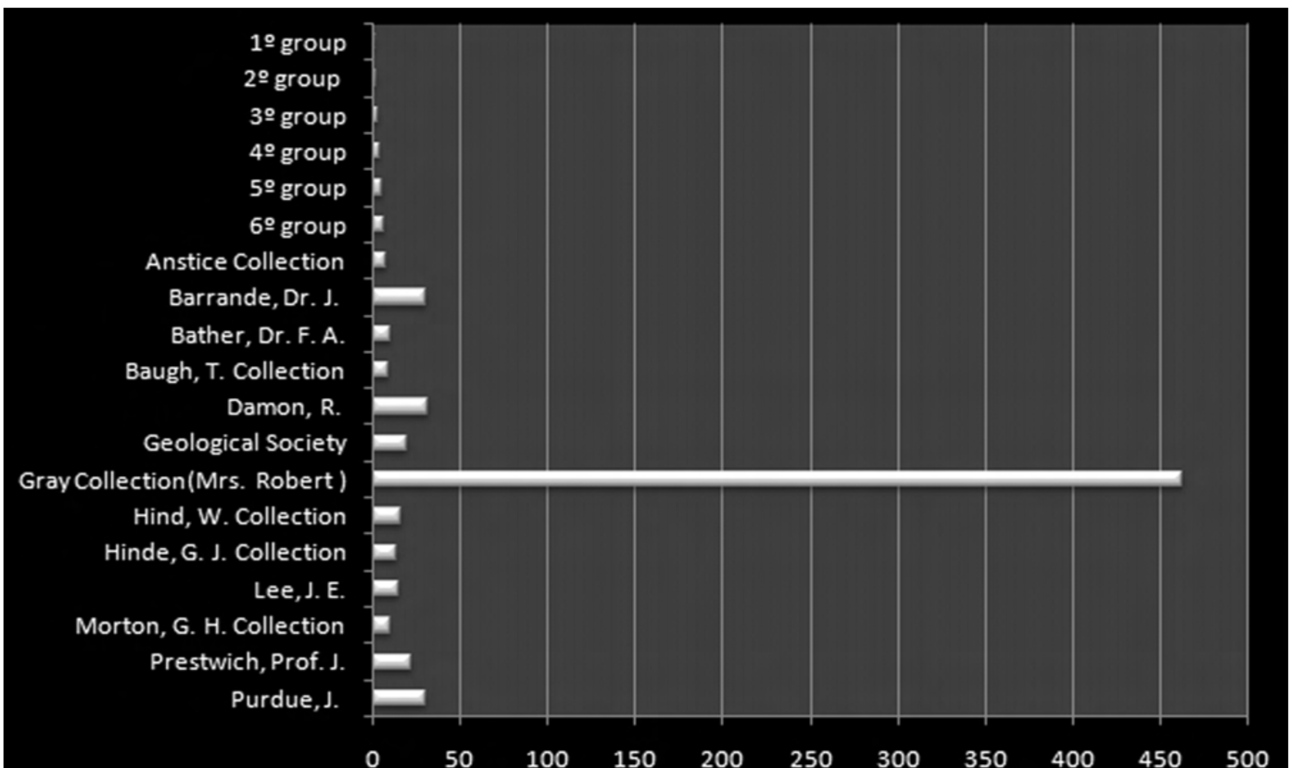


Figure 2. Origin versus abundance of the conulariid collection in the NHM.

of 30 specimens to the NHM in 1856. Thirty specimens were acquired from the Rev. John Purdue in 1870, 15 from James E. Lee in 1885, 22 from Professor Joseph Prestwich in 1894, and 19 from the Geological Society of London in 1911. The remaining conulariids incorporated comprise smaller collections that accumulated progressively through time, such as specimens from the Bath Royal Literary and Scientific Institution and from the Ludlow Museum that were acquired between 1905 and 1939, and also some purchases, bequests by other palaeontologists and contributions by Museum staff members, for example Dr Francis Arthur Bather (1863-1934) in 1907 and Dr William T. Dean in 1956. The origins and incorporation dates are not recorded for every conulariid accessioned, but this data is available for more than 70% of the collection (Figures 3 and 4).

In the graphic representation of the origin of conulariids in the NHM collections (Figure 2), accessions of fewer than seven specimens have been grouped according to the exact number of specimens (i.e. 1, 2, 3, 4, 5 or 6).

38 accessions comprise only one specimen; these came from the following sources: W.E Balston; S. Bowerbank; F.W. Cassirer ; R. Chaplin ; A.J. Charig; W.N. Croft; M.C. Crosfield; L.G. de Koninck, C.L. Dixon (collection of the British Honduras Geological Survey); V. Fric; E.J. Garwood; W. Gilbertson; J. Gray; J. Hamling; F. Harford; H. Hicks; D. Homfray; Governors of King's School Sherborne (Dorset); W. Legrand; M. Lindström; J.A. Moy Thomas ; Musèe Royal d'Histoire naturelle de Belgique (Brussels) ; Muséum national d'Histoire naturelle (Paris); P.E. Negus; R.B. Newton; K.P. Oakley; J. Parrot; S.J. Pollen; G.H. Piper; T. Ruddy; Shrewsbury Museum and Art Gallery (Rowley's House); Sowerby Collection; T.S. Steven; J. Tennant ; T. Tesson ; C.T. Trechmann; G.R. Vine, G.R. snr; W.F. Whittard.

Accessions comprising two specimens are: C. Croft; R. Etheridge Snr; T.T. Johnson; C. Kloucek; M. Marston; S.F. Morris and R.P.S. Jefferies; H. Pearce; A.S. Piret; A. Schubert; S. Smith; I.A. Stigand; A. Templeman; Rheinisches Mineralien-Kontor (Bonn); W.R. Smith; W. Vicary.

Accessions comprising three specimens: Bath Royal Literary and Scientific Institution; C. Birley; W.T. Dean; W.M. Lechmann; W. McPherson; Museum of Practical Geology (London); C. Purdom Clarke.

Accessions comprising four specimens: F.H. Butler; W. Ogier; S.P. Pratt; B. Stürtz.

Accessions comprising five specimens: B. Dunstan; T.R.R. Stebbing; Percy Sladen Trust Expedition.

Accessions comprising six specimens: C.C. Grant; Ludlow Museum Collection.

Three stages are evident in the incorporation of new material into the collection (Figure 3). During the first stage, from 1841-1911, the collection grew at an almost constant rate, with the exception of a decrease in the decade 1871 -1880.

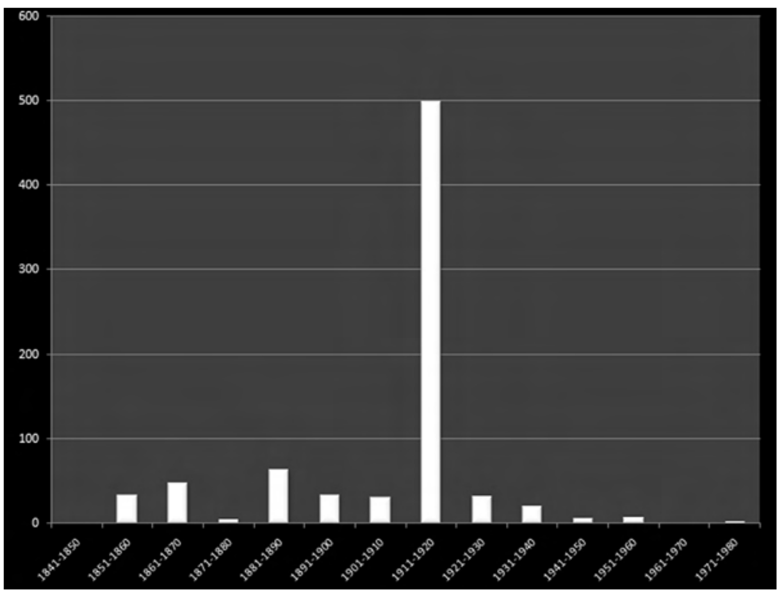


Figure 3. Temporal distribution of accessions of conulariids into the NHM collection.

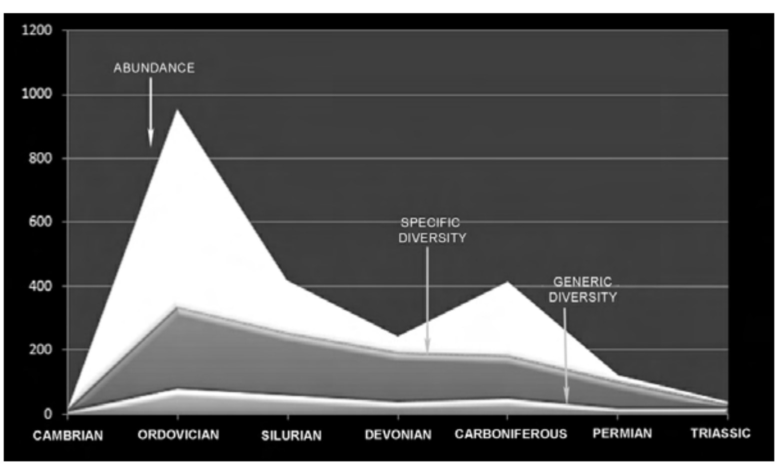


Figure 4. Stratigraphical distribution and generic and specific diversity of the collection of conulariids in the NHM. Note that whereas abundance values can be read directly, correct diversity values are obtained by dividing the number of the vertical axis by 10.

The second stage entailed incorporation of the Mrs Robert Gray Collection, that of the Geological Society of London, the G.J. Hinde Collection, and the contributions of F.A. Bather, F.H. Butler, I.A. Stigand, C. Kloucek, R.B. Newton, and T. Ruddy in the decade 1911-1920. This led to the growth of the conulariid collection to almost 500 specimens. The final stage was one of progressive decline in acquisitions until the last register entry in April 1979, consisting of two specimens collected by S.F. Morris and R.P.S. Jefferies (NHM) from an excavation in the Ordovician of Girvan (Ayrshire, Scotland). The decline in acquisitions of new samples may be due to a lack of scientists studying conulariids in the United Kingdom, in contrast to Brazil which lacked a tradition in conulariid study until recently and where collections have been increasing through new discoveries (Rodrigues *et al.* 2003).

The NHM collection begins in the Cambrian with a specimen from the Agnostus Shales of Krekling (Norway), and multiplies in the Ordovician with 624 specimens, followed by the Carboniferous and the Silurian, with 234 and 167 samples respectively (Figure 4). Species to highlight are *Conularia planiseptata* Slater, 1907, and *Metaconularia slateri* (Reed, 1933), with 118 and 83 specimens respectively. They come from the Starfish Bed (Ardmillan Series, Upper Drummuck Group) of Girvan, Ayrshire, Scotland, at that time part of the ancient continent of Laurentia. These samples are mainly from the Mrs Robert Gray Collection.

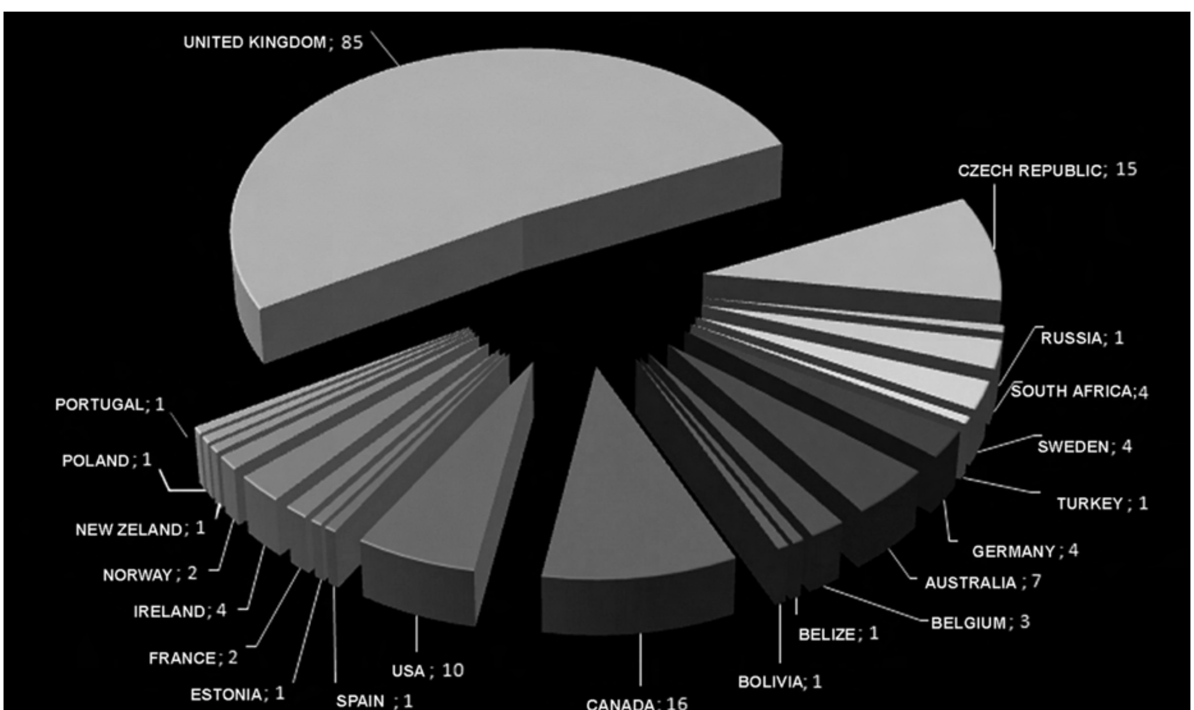
The Ordovician collection contains the greatest diversity with 8 genera and 25 species, followed by the Silurian with 6 genera and 19 species.

In general, abundance parallels diversity in conulariids, except for the high abundance in the Silurian. The abundant Silurian material described by Jerre (1993) from Gotland (Sweden) is fragmentary and of low diversity (two genera, six species).

Geographical distribution

The 165 localities represented in the NHM conulariid collection are spread among 21 countries (Figure 5), embracing more than any other museum of the world. This reflects the old British colonies that were distributed almost globally, for there are samples from places as distant as South Africa, Australia, Canada and the Falkland Islands. Localities from the United Kingdom (85) predominate, with the most prolific being in Girvan, from where Elisabeth Gray contributed almost half of the NHM collection. These localities are comparable in abundance, but not diversity, to those in the Bohemian Basin that are represented in the collections of the Národní muzeum (National Museum, Prague). The NHM material embraces the palaeocontinents of Avalonia, Baltic, Gondwana and Laurentia, but is notably lacking in material from China, Siberia and Kazakhstan. Other places from where there are no specimens have almost no representation in the stratigraphical record. Therefore, the NHM collection is sufficiently representative for palaeobiogeographical studies due to its representation and abundance.

Figure 5. Distribution of conulariid localities represented in the NHM by country.



Specimen labels

More than 90% of the conulariid specimens have labels (Figure 6). These labels not only give stratigraphical and geographical data but also give us the history of the specimens, forming a valuable source of curatorial information.

Some of the labels are standard NHM labels, others derive from earlier repositories. The latter are always retained. Two kinds of labels are more important than the others: standard NHM specimen labels, and labels stuck onto the specimens that note the original collection and stratigraphical and geographical information. Within label categories there is a great variety depending on the writing type (by hand or by printer), type of ink (seal, fountain pen, pencil, pen), colour of the ink (black, blue and red), if they are on paper or Bristol Board, and which colour.

Figure 6. Types of labels found in the NHM conulariid collection.

Of particular historical importance are Slater's (1907) handwritten identifications on several labels. Slater's handwriting can be inferred thanks to the existence of a letter of hers in the NHM (Figure 7), as well as fragments of paper on which are written determinations from her monograph on the British conulariids.

According to their importance, labels can be classified as follows:

TYPE 1: These are the standard NHM labels (Figure 6A). They have the following fields, not all of which are always completed: (1) taxon determination; (2) stratigraphical level; (3) geographical locality; (4) origin and date of acquisition; and (5) registration number. In the case of type specimens, like those of Slater (1907), type status information is also given. Labels are square, of white paper, with a standard measurement of 45 x 45 millimetres (2 x 2 inches), with writing in black ink. They have a black line forming a border two millimetres from the perimeter. Some were written with a pen, others a pencil, or they may be stamped (Figure 6B) diagonally to indicate that the determination was made by Slater (1907) with the words "*Miss I. L. Slater determination*". However, the stamping was done much later at the time of registration of the specimens in 1960.

TYPE 2: Printed NHM labels are afixed to the wooden tablets of some specimens (Figure 6C). These are square, and have a size appropriate to the size of the specimen. As with the previous type, such labels are made of white paper and they have a border with a black line forming a frame to the label. These labels are usually only found in well-preserved and figured specimens, giving information on author, publication and figure. They indicate that the specimen was formerly on exhibit in the public galleries of the NHM.

TYPE 3: Labels of the NHM, on square white paper, written by hand or printed in black ink, stuck to the specimens with only the following information: "Starfish Bed. Upper Bala. GRAY" (Figure 8). Those written by hand vary in size according to the size of the fossil, and are all written with the same calligraphy and fountain pen. In contrast, those that are printed have a standard size of about 15 x 7 millimetres (Figure 8). These samples belong to the Mrs Robert Gray Collection.

TYPE 4: White, square paper labels of various sizes were stuck to the undersides of some specimens before they came to the NHM (Figure 6D). They are written by hand, with pen and in black, with all the information except for the year of acquisition. Such labels are found only on the largest conulariids (e.g. *Metaconularia pyramidata* (d'Orbigny)) because the labels exceed 60 millimetres in width.

TYPE 5: These are circular labels, about 29 mm in diameter, of white paper, written by hand, with pencil or red or black pen. They are on the lids of small tubes housing the conulariids (Figure 6E) and include the determination and registration number.

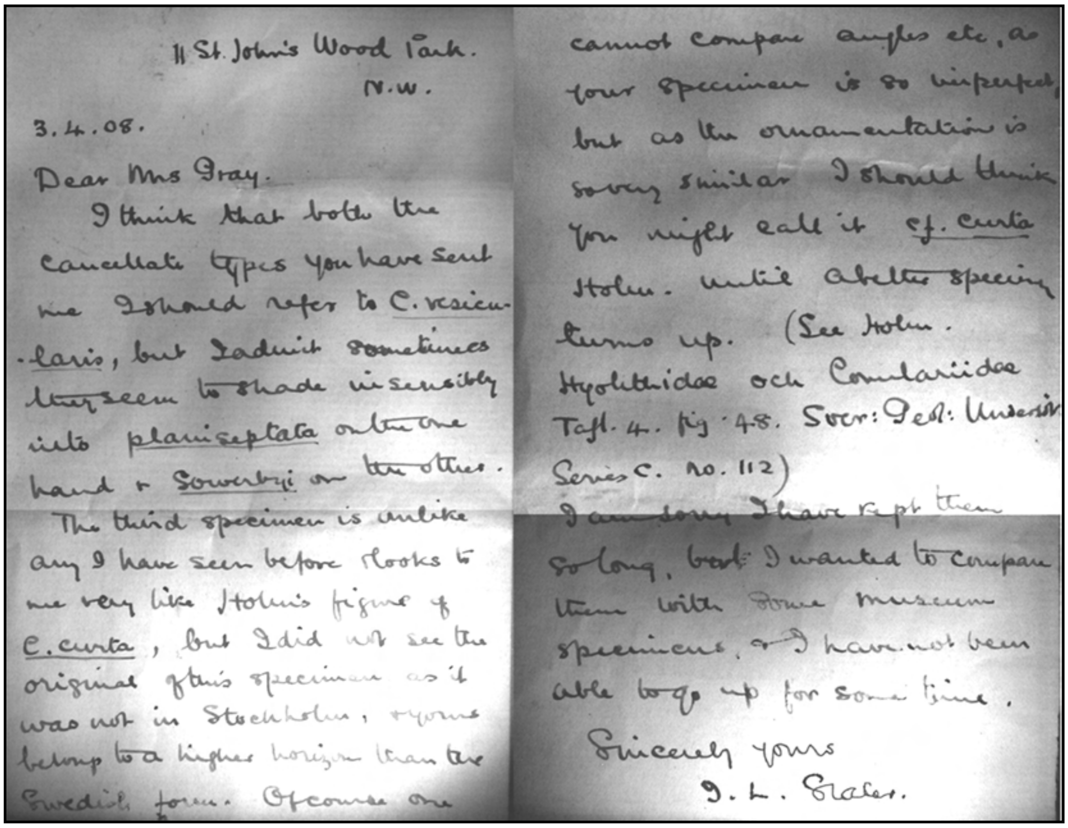
TYPE 6: Hexagonal labels of six unequal sides, written with fountain pen and much deteriorated, measure approximately 15-27.5 millimetres. They are made of white Bristol Board (Figure 6F), and give only the determination and registration number. It is likely that they were part of boxes that once housed the specimens.

TYPE 7: These labels have the original determinations of Slater (1907) written using fountain pen on white paper. They comprise ripped paper, very variable in size and irregular in shape (Figure 6G). The registration number was added later in a different graphic. The determination and the figure and pages where they are described in Slater's *Monograph of British Conulariae* are written on the labels.

TYPE 8: Other labels with the determinations of the original collectors comprise white or blue paper, and are written in black ink. They are as varied as the number of collectors (Figure 6H-6J), some with a standard format but others without. They contain much the same information as the standard NHM labels.

TYPE 9: These comprise labels produced during revisions of the samples made in the last 32 years. For example, there is the redetermination that was carried out by K. Brood in 1976 of a hypotype of

Figure 8. Conulariids with printed labels glued onto them



11 St. John's Wood Park.
N.W.
3.4.08.
Dear Mrs Gray.
I think that both the cancellate types you have sent me I should refer to C. vesicu-laris, but I admit sometimes they seem to shade insensibly into planiseptata on the one hand & Sowerbyi on the other.
The third specimen is unlike any I have seen before & looks to me very like Holm's figure of C. curta, but I did not see the original of this specimen as it was not in Stockholm, & yours belong to a higher horizon than the Swedish form. Of course one cannot compare angles etc., as your specimen is so imperfect, but as the ornamentation is so very similar I should think you might call it cf. curta Holm. until a better specimen turns up. (See Holm. Hyolithidae och Conulariidae Tafl. 4. fig. 48. Sver: Geol: Undersök Series C. No. 112)
I am sorry I have kept them so long, but I wanted to compare them with some museum specimens, & I have not been able to go up for some time.
Sincerely yours
I. L. Slater.

Figure 7. Letter about conulariids from Ida Slater to Elisabeth Gray, written in 1908.

Conularia aspersa Lindström, 1884 (Slater 1907: 19-20, pl. 1: fig. 5) as *Metaconularia slateri*, in which he used a white paper label of the Naturhistoriska Riksmuseet, Stockholm (Swedish Museum Natural of History) that includes the usual fields (registration number, determination, stratigraphical bed, locality, author of determination and year) and with a similar design to the format of the NHM labels. In 1984, J. Mortin redetermined 52 specimens, writing his identifications on pieces of lined white paper using a blue pen (Figure 6K). Redetermination, author and year are given, sometimes without format. More recently Dr Heyo Van Iten (Hanover College, Indiana) (Figure 6L) has written some labels in the format of the NHM, with registration number, determination, author and date. They are rectangular, 82 x 40 mm in size, and written with blue pen.

TYPE 10: This type of label has morphological remarks pertaining to the associated specimens. There is no date, determination, or other kind of information. The labels are on white Bristol Board and written with a pen, without format and varied in size according to the information that they contain (Figure 6M). There are also labels with the stratigraphical horizon and locality, written without any format, and on white paper (Figure 6N).

Finally, registration numbers written in Chinese ink on oval, 7.5 x 10 mm yellow stickers of cotton paper are stuck onto most of the specimens (Figure 6O). In the case of types, there is also a 5-6 mm circular sticker in red or green. There are 13 unregistered specimens that are numbered with a black indelible marker on white paint.

For specimens that have been determined or redetermined, the corresponding labels have new details added. Deterioration of the oldest labels is evident (Figures 6J, 6N).

Conulariid collection

The Appendix lists the entire NHM conulariid collection according to: registration number (RN); previous determination (PD); stratigraphic horizon (SH); geographical locality (GL); and collection and dates of acquisition (CDA).

The genera and species are in alphabetical order. Taxa with open nomenclature (Bengtson 1988) are listed at the end of each genus. Note that some registration numbers that are repeated for more than one species.

Although most specimens have their origin and incorporation date, 173 are unregistered, of which 36 have little information, and most (133) are from the Mrs Robert Gray Collection. It is inferred that the latter come from the Starfish Bed (Hirnantian) of Girvan. Only 3.6% of specimens have no record of stratigraphy or locality.

Conclusions

The spread of this collection shows its historical value, beginning in 1841 with the first specimen (*Paraconularia quadrisulcata* (Sowerby, 1821)) originally coming from the Gilbertson Collection. The last accessions (*Conularia planiseptata* Slater, 1907 and *Metaconularia slateri* (Reed, 1933)) date from 1979 and were collected by staff of the NHM (S.F. Morris and R.P.S. Jefferies).

The historical value of the conulariid collection is reflected in the amount of type material, summarized as follows:
Holotypes: 7 specimens (Slater 1907)
Paratypes: 3 specimens (Slater 1907)
Syntypes: 17 specimens (Sowerby 1821; Slater 1907)
"Hypotypes": 11 specimens (Sharpe 1856; La Touche, 1884; Reed 1904; Slater 1907; Richter & Richter 1930; Trechmann 1918; Babcock *et al.* 1987).

The NHM conulariid collection has great scientific and historical value because of its diversity and representation from almost all the geological periods and continents. This makes it an essential reference for research on this group of extinct marine organisms encompassing palaeodiversity, palaeobiogeography and other palaeobiological studies.

Acknowledgements

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APPENDIX: A CATALOGUE OF CONULARIIDS IN THE NATURAL HISTORY MUSEUM, LONDON

SA = sample abbreviation (record number)
PD = previous determination
SB = stratigraphic bed
GL = geographical locality
CDA = collection and dates of acquisition

Genus *Archaeoconularia* Boucek, 1939

Archaeoconularia sp.

SA: PG 4448.
PD: No record.
SB: Harnagian Reuscholithus reuschi Zone (Ordovician).
GL: Horderley, Shropshire (England).
CDA: Dr. W. T. Dean, 1956.

Archaeoconularia coronata (Slater, 1907)

SA: G 17660 (holotype).
PD: *Conularia coronata* Slater.
SB: Middle Ordovician.
GL: Ritton Castle, Shropshire (England).
CDA: Rev. C. Croft, 1873.

SA: G 7736.
PD: *Conularia coronata* Slater.
SB: Middle Ordovician.
GL: Llandrindod Wells, Powys (Wales).
CDA: Rev. C. Croft, 1873.

Archaeoconularia fecunda (Barrande, 1867)

SA: 80220a-c.
PD: *Conularia sosia* Barrande.
SB: Étage E Barrande (Silurian).
GL: Sedlec (= Sedletz) (Czech Republic).
CDA: No record.

SA: 80220d.
PD: *Conularia sosia* Barrande.
SB: Étage E Barrande (Silurian).
GL: St. Ivan (= Sv. Jan) (Czech Republic).
CDA: No record.

SA: 80220e.
PD: *Conularia sosia* Barrande.
SB: Étage D Barrande (Ordovician).
GL: No record.
CDA: No record.

SA: 80223, 80223a-d, 80223f-h.
PD: *Conularia fecunda* Barrande.
SB: Étage D Barrande (Ordovician).
GL: Lodénice (= Lodenitz) (Czech Republic).
CDA: Dr. J. Barrande, 1856.

Archaeoconularia homfrayi (Salter, 1866)

SA: 73320.
PD: *Conularia homfrayi*.
SB: Tremadocian (Lower Ordovician).
GL: Garth, Carnavonshire (Wales).
CDA: J. Parrot, 1874.

SA: G 774.
PD: *Conularia homfrayi*.
SB: Tremadocian (Lower Ordovician).
GL: Tu-Hynt-Yr-Bwlch, Carnarvonshire (Wales).
CDA: D. Homfray, 1882.

Archaeoconularia insignis (Barrande, 1867)

SA: No sample abbreviation.
PD: No determination.
SB: Starfish Bed (Upper Ordovician).
GL: Girvan, Ayshire (Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

Conularia llanvirnensis (Hicks, 1875)

SA: G 1523.
PD: *Conularia llanvirnensis*.
SB: Middle Ordovician.
GL: St. David's, Pembrokeshire (Wales).
CDA: Dr. H. Hicks, 1884.

Genus *Calloconularia* Sinclair, 1952

Calloconularia cf. *holdenvillae* (Girty, 1911)

SA: G 43183.
PD: *Calloconularia*.
SB: Pennsylvanian (Carboniferous).
GL: Graham (Texas).
CDA: The Percy Sladen Trust Expedition, 1921, and collected by D. M. S. W. Watson, 1915.

Genus *Climacoconus* Sinclair, 1942

Climacoconus cf. *bottnicus* (Holm, 1893)

SA: G 46639.
PD: *Conularia*.
SB: Lower Ardmillan series (Upper Ordovician).
GL: Balclatchie, Girvan (Ayshire, Scotland).
CDA: No record.

Genus *Conularia* Miller in Sowerby, 1821

Conularia albertensis Reed, 1925

SA: No sample abbreviation.
PD: *Conularia albertensis* Reed.
SB: ? Devonian.
GL: Andes Centrales.
CDA: No record.

Conularia breviconventa Slater, 1907

SA: G 17667 (holotype).
PD: *Conularia breviconventa* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No record.

SA: G 6272.
PD: *Conularia breviconventa* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No record.

SA: G 21394.
PD: *Conularia breviconventa* Slater.
SB: Wenlock (Silurian).
GL: May Hill, Gloucestershire (England).
CDA: No record.

SA: No sample abbreviation.
PD: *Conularia breviconventa* Slater.
SB: ? Wenlock (Silurian).
GL: No record.
CDA: No record.

Conularia bundenbachia Richter & Richter, 1930

SA: PG 4201 (topotype).
PD: *Conularia bundenbachia* Richter.
SB: Hunsrückschiefer (Lower Devonian).
GL: Bundenbach, Hünsruck (Germany).
CDA: W. M. Lechmann, 1935.

Conularia crassa Slater, 1907

SA: G 6271 (holotype).
PD: *Conularia crassa* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: Johnson Collection, 1886.

SA: 47838 (paratype).
PD: *Conularia crassa* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No record.

SA: 73898.
PD: *Conularia crassa* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No record.

SA: G 6270.
PD: *Conularia crassa* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: Johnson Collection, 1886.

SA: G 20658.
PD: *Conularia crassa* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: Caroline Birley, 1907.

Conularia desiderata Hall, 1861

SA: PG 4317.
PD: *Conularia*.
SB: Ludloville Formation (Middle Devonian).
GL: Schoharie (New York).
CDA: Geological Society of London, 1911.

Conularia destinezi Moreels, 1888

SA: PG 4361.
PD: *Conularia destinezi* Moreels .
SB: Facies Namuriense (Pennsylvanian, Carboniferous).
GL: Schoharie (New York).
CDA: Musè Royal d'Histoire Naturelle de Belgique, 1935.

Conularia forbesi n. sp.

SA: PG 4461.
PD: *Conularia forbesi*.
SB: Silurian.
GL: Andes Centrales (Bolivia).
CDA: Geological Society of London (David Forbes Collection), 1911.

Conularia gemuendina Richter & Richter, 1930

SA: PG 4200.
PD: *Conularia gemündina* Richter.
SB: Hunsrückschiefer (Lower Devonian).
GL: Gemünden, Hünsruck (Germany).
CDA: W. M. Lechmann, 1935.

Conularia gerolsteinensis Archiac & Verneuil, 1842

SA: G 4512.
PD: *Conularia gerolsteinensis* de Verneuil.
SB: Lower Devonian.
GL: Gerolstein, Eifel (Germany).
CDA: J. E. Lee, 1885.

Conularia mediorhenana Fuchs, 1915

SA: G 29331.
PD: *Conularia mediorhenana*.
SB: Lower Devonian.
GL: Bundenbach, Hünsruck (Germany).
CDA: B. Stürtz, 1922.

Conularia montana Spriestersbach, 1925

SA: PG 4462.
PD: *Conularia montana*.
SB: Silurian.
GL: Andes Centrales (Bolivia).
CDA: Geological Society of London (David Forbes Collection), 1911.

Conularia niagarensis Hall, 1852

SA: G 4671.
PD: *Conularia niagarensis* Hall.
SB: Niagara Group (Ludlow, Silurian).
GL: Hamilton (Ontario).
CDA: C. C. Grant Collection, 1885.

SA: G 14826, G 16813.
PD: *Conularia niagarensis* Hall.
SB: Niagara Group (Ludlow, Silurian).
GL: Ontario.
CDA: C. C. Grant Collection, 1903.

SA: G 19621-G 19622.
PD: *Conularia niagarensis* Hall.
SB: Niagara Group (Ludlow, Silurian).
GL: Ontario.
CDA: C. C. Grant Collection, 1908.

SA: 63983.
PD: *Conularia niagarensis* Hall.
SB: Ludlow-Pridoli (Silurian).
GL: Kentucky.
CDA: No record.

Conularia perneri elízko, 1911

SA: G 29332 (two samples).
PD: *Conularia perneri* elízko.
SB: Lower Devonian.
GL: Kosov (Czech Republic).
CDA: A. Schubert Collection, 1922.

Conularia planiseptata Slater, 1907

SA: G 46844 (syntype).
PD: *Conularia planiseptata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46704-G 46708, G 46723-G 46734, G 46750-G 46756, G 46815-G 46843, G 46845, PG 4250.
PD: *Conularia planiseptata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46693-G 46703, G 46709-G 46715, G 46735-46739.
PD: *Conularia*.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46848-G 46850.
PD: *Conularia plicata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46852-G 46853.
PD: *Conularia planiseptata* Slater.
SB: Mulloch Hill Group (Llandovery, Silurian).
GL: Mulloch Hill, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46854-G 46859.
PD: *Conularia*.
SB: Saugh Hill Group (Llandovery, Silurian).
GL: Wooland Point, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46860-G 46878.
PD: *Conularia planiseptata* Slater.
SB: Saugh Hill Group (Llandovery, Silurian).
GL: Wooland Point, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: PG 4214.
PD: *Conularia planiseptata* Slater.
SB: Hirnantian (Upper Ordovician).
GL: Graig Wen Qy, Montgomeryshire (Wales).
CDA: Mrs. Robert Gray Collection, 1920.

SA: PG 5091-PG 5111, PG 5192, PG 5195.
PD: *Conularia planiseptata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: No sample abbreviation for three specimens.
PD: *Conularia*.
SB: Facies Llandeilo (Middle Ordovician).
GL: Balclatchie, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: No sample abbreviation.
PD: *Conularia planiseptata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: 250038.
PD: *Conularia planiseptata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Girvan (Ayshire, Scotland).
CDA: S. Morris and R. Jefferies, 1979.

Conularia plicata Slater, 1907

SA: G 46763-G 46764 (syntype).
PD: *Conularia plicata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46757-G 46762.
PD: *Conularia plicata* Slater.
SB: Whitehouse Group (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46765-G 46791, G 46846-G 46847
PD: *Conularia plicata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

Conularia proteica Barrande, 1867

SA: 80214.
PD: *Conularia proteica* Barrande.
SB: Étage E of Barrande (Silurian).
GL: St. Ivan (= Sv. Jan) (Czech Republic).
CDA: No record.

SA: 80225a-80225d.
PD: *Conularia proteica* Barrande.
SB: Étage E of Barrande (Silurian).
GL: Lodénice (= Lodenitz) and Sedlec (= Sedletz) (Czech Republic).
CDA: No record.

Conularia sica n. sp. [sic]

SA: PG 4463.
PD: *Conularia sica*.
SB: Silurian.
GL: Andes Centrales (Bolivia).
CDA: Geological Society of London (David Forbes Collection), 1911.

Conularia simplex Barrande, 1867

SA: PG 4464.
PD: *Conularia simplex*.
SB: Silurian.
GL: Andes Centrales (Bolivia).
CDA: Geological Society of London (David Forbes Collection), 1911.

Conularia subcarbonaria Meek & Worthen, 1865

SA: G 35 (three samples).
PD: *Conularia subcarbonaria* Meek & Worthen.
SB: Keokuk Group (Mississippian, Carboniferous).
GL: Floyd (Indiana).
CDA: No record.

SA: G 38 (ten samples).
PD: *Conularia subcarbonaria* Meek & Worthen.
SB: Keokuk Group (Mississippian, Carboniferous).
GL: Floyd (Indiana).
CDA: No record.

SA: G 24853.
PD: *Conularia*.
SB: Mississippian (Carboniferous).
GL: Crawfordsville (Indiana).
CDA: G. J. Hinde Collection, 1918.

Conularia subparallela Sandberger, 1847

SA: G 19560.
PD: *Conularia subparallela* Sandberger.
SB: Lower Devonian.
GL: Winterberg, NW Harz (Germany).
CDA: No record.

Conularia trentonensis Hall, 1847

SA: G 19919-G 19920.
PD: *Conularia trentonensis*.
SB: Trenton Limestone (Upper Ordovician).
GL: Belleville (Ontario).
CDA: W. R. Smith, 1909.

SA: G 24840-G 248241.
PD: *Conularia trentonensis*.
SB: Utica Shale (Upper Ordovician).
GL: Manitoulin Island (Ontario).
CDA: G. J. Hinde Collection, 1918.

SA: G 24842-G 248244.
PD: *Conularia trentonensis* Hall.
SB: Trenton Formation (Upper Ordovician).
GL: Montmorency (Québec).
CDA: G. J. Hinde Collection, 1918.

SA: G 24852.
PD: ? *Conularia trentonensis* Hall.
SB: Trenton Limestone (Upper Ordovician).
GL: Peterborough (Ontario).
CDA: G. J. Hinde Collection, 1918.

SA: G 27877.
PD: *Conularia trentonensis* Hall.
SB: Trenton Limestone (Upper Ordovician).
GL: Calborne (Ontario).
CDA: G. J. Hinde Collection, 1918.

Conularia undulata Conrad, 1841

SA: 66374.
PD: *Conularia grandis* Roemer.
SB: Marcellus Slate (Middle Devonian).
GL: Cazenovia, Madison (New York).
CDA: No record.

Conularia sp.

SA: 55624.
PD: No determination.
SB: Silurian.
GL: Lauzon (Québec).
CDA: No record.

SA: 80216 (two samples).
PD: *Conularia* sp.
SB: Upper Ordovician.
GL: Czech Republic.
CDA: No record.

SA: G 34.
PD: *Conularia* sp.
SB: Keokuk Group (Mississippian, Carboniferous).
GL: Crawfordsville (Indiana).
CDA: No record.

SA: G 1710.
PD: *Conularia* sp.
SB: Devonian.
GL: Hottenberg Bay (South Africa).
CDA: W. E. Balston, 1885.

SA: G 7036.
PD: *Conularia* sp.
SB: No record.
GL: No record.
CDA: No record.

SA: G 7374.
PD: *Conularia* sp.
SB: Wenlock (Silurian).
GL: Builwas Bridge, Shropshire (England).
CDA: No record.

SA: G 12573.
PD: *Conularia* sp.
SB: Wenlock (Silurian).
GL: ? Dudley, Worcestershire (England).
CDA: No record.

SA: G 14619.
PD: *Conularia* sp.
SB: Mississippian (Carboniferous).
GL: Gut of Canso (New Scotland).
CDA: No record.

SA: G 15287, G15289-G 15292, G 15295.
PD: *Conularia* sp.
SB: Budleigh Salterton Pebble Beds (Lower Triassic).
GL: Budleigh - Salterton, Devonshire (England).
CDA: No record.

SA: G 15293.
PD: *Conularia* sp.
SB: Budleigh Salterton Pebble Beds (Lower Triassic).
GL: Budleigh - Salterton, Devonshire (England).
CDA: No recorded original collection, year 1903.

SA: G 19553.
PD: No determination.
SB: Silurian.
GL: Ledbury, Herefordshire (England).
CDA: No record.

SA: G 19557.
PD: *Conularia* sp.
SB: Devonian.
GL: Spain.
CDA: No record.

SA: G 22063.
PD: *Conularia* sp.
SB: Chasmops macrurus limestone (Middle Ordovician).
GL: Trenched brook, Öland (Sweden).
CDA: Dr. F. A. Bather, 1907.

SA: G 22462.
PD: *Conularia* sp.
SB: Mississippian (Carboniferous).
GL: Carrigaline, Cork (Ireland).
CDA: No record.

SA: G 22494-G 22495.
PD: *Conularia* sp.
SB: Mississippian (Carboniferous).
GL: Midleton, Cork (Ireland).
CDA: No record.

SA: G 23290, G 46823, G 46841, PG 4376.
PD: *Conularia* sp.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: No record.

SA: G 23897.
PD: *Conularia* sp.
SB: Upper Devonian.
GL: Anchor Wood, Devonshire (England).
CDA: No record.

SA: G 24845-G 24846.
PD: No determination.
SB: Niagara Group (Ludlow, Silurian).
GL: Dundas (Ontario).
CDA: No record.

SA: G 24847-G 24849.
PD: *Conularia* sp.
SB: Niagara Group (Ludlow, Silurian).
GL: Rockwood (Ontario).
CDA: No record.

SA: G 24860.
PD: No determination.
SB: Agnostus Shales (Upper Cambrian).
GL: Krekling, Oslo (Norway).
CDA: G. J. Hinde Collection, 1918.

SA: G 41204.
PD: *Conularia* sp.
SB: Pendleside series (Mississippian, Carboniferous).
GL: Congleton Edge, Cheshire (England).
CDA: No record.

SA: G 41205.
PD: *Conularia* sp.
SB: Facies Viseense (Mississippian, Carboniferous).
GL: Castleton, Derbyshire (England).
CDA: No record.

SA: G 41206.
PD: *Conularia* sp.
SB: Calciferous Sandstone series (Mississippian, Carboniferous).
GL: Glencartholm, Dumfriesshire (Scotland).
CDA: No record.

SA: G 43180-G 43183.
PD: *Conularia* sp.
SB: Balclatchie Group (Upper Ordovician).
GL: Ardmillan, Girvan (Ayshire, Scotland).
CDA: The Percy Sladen Trust Expedition, 1921, and picked up by D. M. S. W. Watson, 1915.

SA: G 46610-G 46611.
PD: *Conularia* sp.
SB: Stinchar limestone (Middle Ordovician).
GL: Craighead, Girvan (Ayshire, Scotland).
CDA: No record.

SA: G 46659- G 46660.
PD: *Conularia* sp.
SB: Balclatchie Group (Upper Ordovician).
GL: Ardmillan, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46661.
PD: *Conularia* sp.
SB: Whitehouse Group (Upper Ordovician).
GL: Whitehouse Bay, Girvan (Ayshire, Scotland).
CDA: No record.

SA: G 46751.
PD: No determination.
SB: Starfish Bed (Upper Ordovician).
GL: No record.
CDA: No record.

SA: G 6860-G 6864.
PD: No determination.
SB: Llandovery (Silurian).
GL: Wooland Point, Girvan (Ayshire, Scotland).
CDA: No record.

SA: GG 21816, GG 21818.
PD: No determination.
SB: Silurian.
GL: Nantglyn, Denbighshire (Wales).
CDA: No record.

SA: GG 21817.
PD: *Conularia* sp.
SB: Silurian.
GL: Nantglyn, Denbighshire (Wales).
CDA: No record.

SA: P 46612-P 46617.
PD: *Conularia* sp.
SB: Stinchar limestone (Middle Ordovician).
GL: Craighead, Girvan (Ayshire, Scotland).
CDA: No record.

SA: PG.
PD: *Conularia* sp.
SB: Devonian.
GL: Port Arthur Cone Padshow, Cornwall (England).
CDA: No record.

SA: PG 4215.
PD: *Conularia* sp.
SB: Calymene quadrata beds (Upper Ordovician).
GL: Merford, Montgomeryshire (Wales).
CDA: K. P. Oakley, 1937.

SA: PG 4252.
PD: *Conularia* sp.
SB: Crangopsis Bed (Mississippian, Carboniferous).
GL: Perdross, Fifeshire (Scotland).
CDA: No record.

SA: PG 4319.
PD: *Conularia* sp.
SB: Carboniferous.
GL: Big Rock, Shubenacadia (New Scotland).
CDA: No record.

SA: PG 4320.
PD: *Conularia* sp.
SB: Carboniferous.
GL: Big Rock (New Scotland).
CDA: Geological Society of London (Sir C. Lyell Collection), 1911.

SA: PG 4324-PG 4327.
PD: *Conularia* sp.
SB: No determination.
GL: Bras Lior Lake, Cape Breton Island (New Scotland).
CDA: No record.

SA: PG 4346-PG 4347.
PD: No determination.
SB: Leptaena Limestone (Upper Ordovician).
GL: Bodabacken (Dalercalia, Sweden).
CDA: Dr. F. A. Bather, 1911.

SA: PG 4350.
PD: No determination.
SB: Daleje Shale (Lower Devonian).
GL: Snorgerka (Czech Republic).
CDA: Dr. F. A. Bather, 1923.

SA: PG 4351.
PD: *Conularia* sp.
SB: Étage H of Barrande (Middle Devonian).
GL: Hlubocepy, next to Praga (Czech Republic).
CDA: No record.

SA: PG 4352-PG 4358.
PD: *Conularia* sp.
SB: Étage G2 of Barrande (Lower Devonian).
GL: Hlubocepy, next to Praga (Czech Republic).
CDA: No record.

SA: PG 4404.
PD: *Conularia* sp.
SB: Makal Series, Calcareous Shale (Permo-Carboniferous).
GL: Mountain Pine Ridge (Belice).
CDA: British Honduras Geological Survey (C. L. Dixon Collection), 1953.

SA: PG 4442-PG 4443.
PD: *Conularia* sp.
SB: Mississippian (Carboniferous).
GL: Eskdale, Cumberland (England).
CDA: No record.

SA: PG 4445, PG 4447.
PD: *Conularia* sp.
SB: Reuscholithus reuschi Zone (Upper Ordovician).
GL: Horderley, Shropshire (England).
CDA: No record.

SA: PG 4449.
PD: *Conularia* sp.
SB: Reuscholithus reuschi Zone (Upper Ordovician).
GL: Horderley, Shropshire (England).
CDA: Dr. W. T. Dean, 1956.

SA: PG 4453.
PD: No determination.
SB: Onnia superba zone (Upper Ordovician).
GL: River Onny, Shropshire (England).
CDA: Dr. W. T. Dean, 1956.

SA: PG 4476.
PD: *Conularia* sp.
SB: Silurian.
GL: Dudley, Worcestershire (England).
CDA: No record.

SA: PG 4500 (three specimens).
PD: *Conularia* sp.
SB: Gothograptus nassa zone (Ludlow, Silurian).
GL: Pragowric, Holy Cross Mts. (Polonia).
CDA: No record.

SA: PG 43708.
PD: *Conularia* sp.
SB: Buildwas beds (Wenlock, Silurian).
GL: Buildwas, Shropshire (England).
CDA: No record.

SA: PG 64216.
PD: *Conularia* sp.
SB: Calymene quadrata beds (Upper Ordovician).
GL: Llanfylin, Montgomeryshire (Wales).
CDA: No record.

SA: R 50312.
PD: *Conularia* sp.
SB: Craighead Limestone (Upper Ordovician).
GL: Craighead Quarry, Girvan (Ayshire, Scotland).
CDA: No record.

SA: 22 (two samples).
PD: No determination.
SB: No record.
GL: No record.
CDA: No record.

Genus *Ctenoconularia* Sinclair, 1952

Ctenoconularia cunctata (Reed, 1933)

SA: PG 4313.
PD: *Conularia cunctata*.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1937.

Ctenoconularia triangularis (Slater, 1907)

SA: G 19143 (holotype).
PD: *Conularia triangularis* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No determination.

Ctenonularia hispida (Slater, 1907)

SA: G 10041 (holotype).
PD: *Conularia hispida* Slater.
SB: Wenlock Beds (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No determination.

SA: G 11796 (paratype).
PD: *Conularia hispida* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: G. H. Piper Collection, 1898.

SA: G 46840 (paratype).
PD: *Conularia hispida* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 19129.
PD: *Conularia hispida* Slater.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: John Gray Collection, 1861.

SA: G 46656-G 46858.
PD: *Conularia hispida* Slater.
SB: Balclatchie Group (Upper Ordovician).
GL: Ardmillan, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46662-G 46671, G 46836-G 46837.
PD: *Conularia hispida* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Girvan, Ayshire (Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46837.
PD: *Conularia hispida* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

Genus *Eoconularia* Sinclair, 1943

Eoconularia linnarssoni (Salter, 1866)

SA: G 46605-G 46609.
PD: *Conularia linnarssoni* Holm.
SB: Stinchar limestone (Middle Ordovician).
GL: Craighead, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46618-G 46629.
PD: *Conularia linnarssoni* Holm.
SB: Llandeilo (Middle Ordovician).
GL: Craighead, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46630-G 46633, G 46635-G 46637.
PD: *Conularia linnarssoni* Holm.
SB: Balclatchie Group (Upper Ordovician).
GL: Dow Hill, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46638-G 46655.
PD: *Conularia linnarssoni* Holm.
SB: Balclatchie Group (Upper Ordovician).
GL: Balclatchie, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46845.
PD: *Conularia linnarssoni* Holm.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: PG 4217.
PD: ? *Conularia homfrayi*
SB: Tremadociense (Lower Ordovician)
GL: Nanty Caios, Carmarthen (Wales)
CDA: M. C. Crosfield, 1937

SA: PG 5112.
PD: *Conularia linnarssoni* Holm.
SB: Middle Ordovician.
GL: Balclatchie, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

Genus *Mesoconularia* Boucek, 1939

Mesoconularia elegans (Slater, 1907)

SA: G 17665 (holotype).
PD: *Conularia elegans* Slater.
SB: Mississippian (Carboniferous).
GL: Farlow, Shropshire (England).
CDA: Thomas Baugh Collection, 1870.

SA: 97842.
PD: *Conularia elegans* Slater.
SB: Mississippian (Carboniferous).
GL: ? Farlow, Shropshire (England).
CDA: Thomas Baugh Collection, 1870.

Mesoconularia fragilis (Barrande, 1867)

SA: G 4067.
PD: *Mesoconularia fragilis* Barrande.
SB: Koneprusy Limestone (Lower Devonian).
GL: Konéprusy (= Konieprus) (Czech Republic).
CDA: Dr. V. Fric, 1885.

SA: No sample abbreviation.
PD: *Mesoconularia fragilis* Barrande.
SB: Koneprusy Limestone (Lower Devonian).
GL: Konéprusy (= Konieprus) (Czech Republic).
CDA: No record.

Genus *Metaconularia* Foerste, 1928

Metaconularia anomala (Barrande, 1867)

SA: 80388 (threee samples), 80219k-l.
PD: *Conularia anomala* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Veselá (= Wesela) (Czech Republic).
CDA: Dr. J. Barrande, 1856.

SA: G 1478 (three samples).
PD: *Conularia anomala* Barrande.
SB: Étage D2 of Barrande (Upper Ordovician).
GL: Drabov (Czech Republic).
CDA: B. Stürtz, 1884.

SA: G 10045.
PD: *Conularia anomala* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Veselá (= Wesela) (Czech Republic).
CDA: F. H. Butler, 1889.

SA: 80215a-f.
PD: *Conularia rugulosa* Barrande.
SB: Étage D2 of Barrande (Upper Ordovician).
GL: Mt. Ded (= Mt. Drabov) (Czech Republic).
CDA: No record.

SA: 80219.
PD: *Conularia anomala* Barrande.
SB: Étage D2 of Barrande (Upper Ordovician).
GL: Mt. Ded (= Mt. Drabov) (Czech Republic).
CDA: No record.

SA: 80219a-b (the same sample, positive and negative mold), 80219c (two samples), 80219d-j.
PD: *Conularia anomala* Barrande.
SB: Étage D2 of Barrande (Upper Ordovician).
GL: Mt. Ded (= Mt. Drabov) (Czech Republic).
CDA: No record.

SA: 80219n.
PD: *Conularia anomala* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Veselá (= Wesela) (Czech Republic).
CDA: No record.

SA: 80386a-f, 80387a-h.
PD: *Conularia anomala* Barrande.
SB: Étage D2 of Barrande (Upper Ordovician).
GL: Mt. Ded (= Mt. Drabov) (Czech Republic).
CDA: No record.

Metaconularia aspersa (Lindström, 1884)

SA: G 4603-G 4604. Described and illustrated by Slater (1907: 19-20, pl. 1: figs. 6a-c, 7).
PD: *Metaconularia aspersa* G. Lindström.
SB: Lower Ludlow (Silurian).
GL: Church Hill, Herefordshire (England).
CDA: J. E. Lee, 1885.

SA: G 5373. Described and illustrated by Slater (1907: 19-20, pl. 1: fig. 5).
PD: *Metaconularia slateri* (Brood).
SB: Lower Ludlow (Silurian).
GL: Church Hill, Herefordshire (England).
CDA: No record.

SA: G 12243.
PD: *Metaconularia aspersa* G. Lindström.
SB: Lower Ludlow (Silurian).
GL: Church Hill, Herefordshire (England).
CDA: Dr. F. A. Bather, 1901.

SA: G 12576, G 12577 (two samples), G 12578 (two samples), G 12579.
PD: *Metaconularia aspersa* G. Lindström.
SB: Ludlow (Silurian).
GL: Leintwardine, Herefordshire (England).
CDA: G. H. Morton Collection (Miss Morton), 1900.

SA: G 12238.
PD: *Metaconularia aspersa* G. Lindström.
SB: Lower Ludlow (Silurian).
GL: Church Hill, Herefordshire (England).
CDA: F. H. Butler, 1911.

SA: PG 4436-PG 4437.
PD: *Metaconularia aspersa* G. Lindström.
SB: Lower Ludlow (Silurian).
GL: Church Hill, Herefordshire (England).
CDA: Ludlow Museum Collection, 1939.

SA: PG 4438-PG 4440.
PD: *Metaconularia aspersa* G. Lindström.
SB: Lower Ludlow (Silurian).
GL: Church Hill, Herefordshire (England).
CDA: Ludlow Museum Collection, 1947.

SA: 38342 (two samples).
PD: *Metaconularia aspersa* G. Lindström.
SB: Lower Ludlow (Silurian).
GL: Leintwardine, Herefordshire (England).
CDA: Mr. Marston, no year recorded.

SA: GG 21815.
PD: *Metaconularia aspersa* G. Lindström.
SB: Silurian.
GL: Nantglyn, Denbighire (Wales).
CDA: No record.

Metaconularia consobrina (Barrande, 1855)

SA: 80221a-d.
PD: *Conularia consobrina* Barrande.
SB: Étage D2 of Barrande (Upper Ordovician).
GL: Mt. Ded (= Mt. Drabov) (Czech Republic).
CDA: No record.

Metaconularia exquisita (Barrande, 1867)

SA: 80217a, 80217c-d.
PD: *Conularia bohemica* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Vrá (= Wra) (Czech Republic).
CDA: Dr. J. Barrande, 1856.

SA: 80217b.
PD: *Conularia bohemica* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Lodénice (= Lodenitz) (Czech Republic).
CDA: Dr. J. Barrande, 1856.

SA: 80222a-f.
PD: *Conularia exquisita* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Lodénice (= Lodenitz) (Czech Republic).
CDA: No record.

SA: 80389a-d.
PD: *Conularia bohemica* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Czech Republic.
CDA: No record.

SA: 80390.
PD: *Conularia bohemica* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Vrá (= Wra) (Czech Republic).
CDA: No record.

SA: 80391a-c.
PD: *Conularia bohemica* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Czech Republic.
CDA: Dr. J. Barrande, 1856.

Metaconularia imperialis (Barrande, 1867)

SA: G 22225.
PD: ? *Conularia imperialis* Barrande
SB: Middle Ordovician.
GL: Karýzek (Czech Republic).
CDA: Prof. Kloucek, 1912.

SA: No sample abbreviation for five specimens.
PD: *Conularia imperialis* Barrande.
SB: Middle Ordovician.
GL: Karýzek (Czech Republic).
CDA: No record.

Metaconularia microscopica (Slater, 1907)

SA: G 17668 (paratype).
PD: *Conularia microscopica* Slater.
SB: Wenlock (Silurian).
GL: Buildwas, Shropshire (England).
CDA: No record.

SA: G 15707-G 15714, G 17507-G 17508.
PD: *Conularia microscopica* Slater.
SB: Wenlock (Silurian).
GL: Buildwas, Shropshire (England).
CDA: Anstice Collection, 1906.

SA: G 7374.
PD: *Conularia microscopica* Slater.
SB: Wenlock (Silurian).
GL: Buildwas, Shropshire (England).
CDA: No record.

Metaconularia modesta (Barrande, 1867)

SA: 80224a-c.
PD: *Conularia modesta* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Winica, Trubïn (= Trubín) (Czech Republic).
CDA: No record.

Metaconularia aff. *modesta* (Barrande, 1867)

SA: G 22224.
PD: ? *Conularia modesta* Barrande.
SB: Middle Ordovician.
GL: Osek (= Vosek) (Czech Republic).
CDA: Prof. Kloucek, 1912.

Metaconularia punctata (Slater, 1907)

SA: G 46879 (syntype).
PD: *Conularia punctata* Slater.
SB: Saugh Hill Group (Llandovery, Silurian).
GL: Wooland Point, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46880 (syntype).
PD: *Conularia punctata* Slater.
SB: Penkill Group (Llandovery, Silurian).
GL: Penkill, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G46881 (syntype).
PD: *Conularia punctata* Slater.
SB: Penkill Group (Llandovery, Silurian).
GL: Penkill, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46882 (syntype).
PD: *Conularia punctata* Slater.
SB: Penkill Group (Llandovery, Silurian).
GL: Penkill, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

Metaconularia cf. *punctata* (Slater, 1907)

SA: G 21334-G 21335.
PD: *Conularia*.
SB: Floiense (Lower Ordovician).
GL: Dwyros Farm, Carnarvonshire (Wales).
CDA: F. H. Butler, 1911.

Metaconularia pyramidata (Hoeninghaus, 1832)

SA: C 3408d.
PD: *Conularia pyramidata* Hoeninghaus.
SB: Grés de May (Upper Ordovician).
GL: May-sur-Orne, Calvados (Normandía).
CDA: Dr. Ogier Ward Collection, 1869.

SA: C 3406.
PD: *Conularia pyramidata* Hoeninghaus.
SB: Grés de May (Upper Ordovician).
GL: May-sur-Orne, Calvados (Normandía).
CDA: T. Tesson Collection, 1857.

SA: C 3407.
PD: *Conularia pyramidata* Hoeninghaus.
SB: Grés de May (Upper Ordovician).
GL: May-sur-Orne, Calvados (Normandía).
CDA: S. P. Pratt, 1857.

SA: C 3408a-c.
PD: *Conularia pyramidata* Hoeninghaus.
SB: Grés de May (Upper Ordovician).
GL: May-sur-Orne, Calvados (Normandía).
CDA: Dr. Ogier Ward Collection, 1869.

SA: C 3409a-b.
PD: *Conularia pyramidata* Hoeninghaus.
SB: Grés de May (Upper Ordovician).
GL: May-sur-Orne, Calvados (Normandía).
CDA: No record.

SA: G 15288, G 15294.
PD: *Conularia* sp.
SB: Budleigh Salterton Pebble Beds (Lower Triassic).
GL: Budleigh - Salterton, Devonshire (England).
CDA: W. Vicary Collection, 1903.

SA: PG 4465-PG 4466.
PD: *Conularia pyramidata* Hoeninghaus.
SB: Grés de May (Upper Ordovician).
GL: May-sur-Orne, Calvados (Normandy).
CDA: Geological Society of London, 1911.

SA: No sample abbreviation.
PD: *Conularia pyramidata*.
SB: Ordovician.
GL: May-sur-Orne, Calvados (Normandía).
CDA: Muséum national d'Histoire naturelle of Paris, no year.

Metaconularia slateri (Reed, 1933)

SA: 250038.
PD: *Archaeoconularia slateri* Reed.
SB: Starfish Bed (Upper Ordovician).
GL: South Thraive Farm, Girvan (Ayshire, Scotland).
CDA: S. Morris & R. Jefferies, 1979.

SA: G 44672-G 44680, G 46688-G 46692, G 46792-G 46809.
PD: *Archaeoconularia slateri* Reed, 1933.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46672-G 46680, G 46681-G 46687, G 46716-G 46722, G 46740-G 46749.
PD: *Conularia*.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46810. Described and illustrated by Slater (1907, pág. 21, pl. 1: figs. 13a-b).
PD: *Conularia* sp. cf. *aspersa* Lindström.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46811.
PD: *Conularia* cf. *punctata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46823-G 46824.
PD: *Conularia*.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: G 46825-G 46835.
PD: *Conularia* cf. *punctata* Slater.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: PG 4251.
PD: *Conularia* sp. cf. *aspersa* Lindström.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1937.

SA: PG 5113.
PD: *Archaeoconularia slateri* Reed.
SB: Starfish Bed (Upper Ordovician).
GL: Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1937.

SA: No sample abbreviation.
PD: *Archaeoconularia slateri*.
SB: Starfish Bed (Upper Ordovician).
GL: No record.
CDA: No record.

Metaconularia sowerbyi (Verneuil, 1845)

SA: G 6327 (two samples). One of specimens Described and illustrated by Slater (1907: 37-38, pl. 5: figs. 7a-b).
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No record.

SA: 64550.
PD: *Conularia cancellata* Sandberger.
SB: Silurian.
GL: Visby, Gotland (Sweden).
CDA: M. Lindström, 1865.

SA: G 62.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: No record.
CDA: No record.

SA: G 460.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Ledbury, Herefordshire (England).
CDA: No record.

SA: G 461, G 6274, G 9779, G 69779.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No record.

SA: G 6273.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Malvern, Worcestershire (England).
CDA: No record.

SA: G 6275, G 11795 (two samples), G 12574.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Dudley, Wocestershire (England).
CDA: No record.

SA: G 7374.
PD: *Conularia quadrisulcata* Sowerby.
SB: Wenlock (Silurian).
GL: Buildwas Bridge, Shropshire (England).
CDA: G. R. Vine Collection, 1891.

SA: G 10043.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Dudley, Wocestershire (England).
CDA: No record.

SA: G 17500-G 17504.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Buildwas Bridge, Shropshire (England).
CDA: Anstice Collection, 1906.

SA: G 11794 (three samples).
PD: *Conularia cancellata* Sandberger.
SB: Lower Lyckholm beds (Middle Ordovician).
GL: Oddalem, SW Kegel (Estonia).
CDA: Dr. F. A. Bather, 1907.

SA: G 11795, G 11800.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Ledbury, Herefordshire (England).
CDA: No record.

SA: G 11799. Described and illustrated by Slater (1907: 37-38, pl. 5: 9).
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Ledbury, Herefordshire (England).
CDA: No record.

SA: G 11801.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Purlieu Lane, Worcestershire (England).
CDA: No record.

SA: G 12181.
PD: *Conularia sowerbyi* de Verneuil.
SB: Bala (Upper Ordovician).
GL: Cynwyd, Merionethshire (Wales).
CDA: No record.

SA: G 17505.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Buildwas, Shropshire (England).
CDA: No record.

SA: G 19552.
PD: *Conularia* sp.
SB: Ordovician.
GL: Québec.
CDA: No record.

SA: G 19639-G 19640.
PD: *Conularia cancellata* Sandberger.
SB: Chasmops macrurus limestone (Middle Ordovician).
GL: Rabeck, Öland (Sweden).
CDA: Dr. F. A. Bather, 1907.

SA: G 23715-G 23717, G 23725
PD: *Conularia sowerbyi* de Verneuil.
SB: Trilobite zone (Upper Ordovician).
GL: Blaendinan, Merionethshire (Wales).
CDA: No record.

SA: G 23718-G 23720.
PD: *Conularia sowerbyi* de Verneuil.
SB: Trilobite zone (Upper Ordovician).
GL: Cynwyd, Merionethshire (Wales).
CDA: No record.

SA: G 23721-G 23722.
PD: *Conularia sowerbyi* de Verneuil.
SB: Orthisina zone (Upper Ordovician).
GL: Cerigcoedog, Denbighshire (Wales).
CDA: No record.

SA: G 23723.
PD: *Conularia sowerbyi* de Verneuil.
SB: Orthisina zone (Upper Ordovician).
GL: Pont Hafodgynfor, Denbighshire (Wales).
CDA: No record.

SA: G 24850-G 24851.
PD: *Conularia quadrisulcata* Sowerby.
SB: Niagara Group (Ludlow, Silurian).
GL: Grimsby, Hamilton (Ontario).
CDA: G. J. Hinde Collection, 1918.

SA: G 43208.
PD: *Conularia sowerbyi* de Verneuil.
SB: Lower Ludlow (Silurian).
GL: Mocktree, Shropshire (England).
CDA: No record.

SA: G 43209.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: ? Onny River, Shropshire (England).
CDA: No record.

SA: G 43210.
PD: *Conularia sowerbyi* de Verneuil.
SB: Wenlock (Silurian).
GL: Shropshire (England).
CDA: No record.

SA: G 43237.
PD: *Conularia sowerbyi* de Verneuil.
SB: Upper Ludlow (Silurian).
GL: Aldon, Shropshire (England).
CDA: No record.

SA: PG 4318.
PD: *Conularia quadrisulcata* Sowerby.
SB: Niagara (Rochester) Shale (Ludlow, Silurian).
GL: Lockport (New York).
CDA: Geological Society of London, 1911.

SA: PG 4428. Described and illustrated by La Touche (1884, p. 62, pl. 7: fig. 152).
PD: *Conularia sowerbyi* Defrance.
SB: Pentamerus sandstone (Llandovery, Silurian).
GL: Norbury, Shropshire (England).
CDA: Ludlow Museum Collection, 1939.

SA: PG 4429.
PD: *Conularia sowerbyi* Defrance.
SB: Upper Ludlow (Silurian).
GL: Sheldenton, Shropshire (England).
CDA: No record.

SA: PG 4548.
PD: *Conularia sowerbyi* Defrance.
SB: Acton Scott Beds (Upper Ordovician).
GL: Gretton, Northamptonshire (England).
CDA: No record.

SA: No sample abbreviation for three specimens.
PD: *Conularia sowerbyi* Defrance.
SB: Wenlock (Silurian).
GL: Dudley, Worcestershire (England).
CDA: No record.

SA: No sample abbreviation.
PD: *Conularia sowerbyi* Defrance.
SB: ? Wenlock (Silurian).
GL: ? Ludlow, Shropshire (England).
CDA: No record.

SA: No sample abbreviation.
PD: *Conularia sowerbyi* Defrance.
SB: Silurian.
GL: No record.
CDA: No record.

Metaconularia cf. *sowerbyi* (Verneuil, 1845)

SA: PG 4452.
PD: *Conularia* cf. *sowerbyi* Slater.
SB: Upper Ordovician.
GL: Gretton, Northamptonshire (England).
CDA: No record.

SA: No sample abbreviation.
PD: *Conularia*.
SB: Ordovician.
GL: Hovedön, Oslo (Norway).
CDA: No record.

Metaconularia vesicularis (Slater, 1907)

SA: 48700.
PD: *Conularia vesicularis* (Slater).
SB: Bala (Upper Ordovician).
GL: Bwlch-y-Gasey, Merionethshire (Wales).
CDA: No record.

SA: G 4684.
PD: *Conularia vesicularis* (Slater).
SB: Hirnantiense (Upper Ordovician).
GL: Nantyr, Denbighshire (Wales).
CDA: J. E. Lee, 1885.

SA: G 12580.
PD: *Conularia vesicularis* (Slater).
SB: Bala (Upper Ordovician).
GL: Llangolleri, Denbighshire (Wales).
CDA: No record.

SA: G 19127.
PD: *Conularia vesicularis* (Slater).
SB: Upper Ordovician.
GL: Acton Scott, Shropshire (England).
CDA: No record.

SA: G 46842.
PD: *Conularia vesicularis* (Slater).
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: No record.

SA: PG 4451.
PD: *Conularia vesicularis* (Slater).
SB: Upper Ordovician.
GL: River Onny, Jack Selither (England).
CDA: No record.

SA: PG 4454.
PD: *Conularia vesicularis* (Slater).
SB: Acton Scott Beds s.str. (Upper Ordovician).
GL: Gretton, Northamptonshire (England).
CDA: No record.

Genus *Notoconularia* Thomas, 1969

Notoconularia inornata (Dana, 1849)

SA: G 5224-G 5225.
PD: *Conularia inornata* J. D. Dana.
SB: Permo-Carbonifero.
GL: Australia.
CDA: Sir C. Purdom Clarke, 1889.

SA: G 17334-G 17335.
PD: *Conularia inornata* J. D. Dana.
SB: Permo-Carbonifero.
GL: Stony Creek, New South Wales (Australia).
CDA: Bath Royal Literary and Scientific Institution, 1905.

SA: G 17340, G 17368.
PD: *Conularia inornata* J. D. Dana.
SB: Permo-Carbonifero.
GL: Maitland, New South Wales (Australia).
CDA: Museum of Practical Geology, 1880.

SA: G 32783.
PD: *Conularia*.
SB: Permo-Carbonifero.
GL: Branxton, New South Wales (Australia).
CDA: R. B. Newton, 1914.

SA: PG 4264-PG 4265.
PD: *Conularia inornata* J. D. Dana.
SB: ? Cisuraliense (Permian).
GL: Ravenswood, New South Wales (Australia).
CDA: B. Dunstan Collection, 1935.

SA: PG 4314-PG 4315.
PD: *Conularia inornata* J. D. Dana.
SB: Permo-Carbonifero.
GL: Coal Seam, New South Wales (Australia).
CDA: Geological Society of London, 1911.

Notoconularia neozeolandensis n. sp.

SA: G 37495. Described and illustrated by Trechmann (1918, pág. 189, pl. 18: fig. 1).
PD: *Conularia* cf. *laevigata* Morris.
SB: Carnian Formation (Lower Triassic).
GL: Otamita, Hokonui Hills (New Zeland).
CDA: Dr. C. T. Trechmann, 1925.

Notoconularia n. sp.

SA: G 889.
PD: *Conularia* sp.
SB: Mississippian (Carboniferous).
GL: Terranova (Canadá).
CDA: No record.

Genus *Paraconularia* Sinclair, 1940

Paraconularia acuta (Roemer, 1843)

SA: G 19558.
PD: *Conularia acuta* Roemer.
SB: Ibergerkalk (Upper Devonian).
GL: Grund, NW Harz (Germany).
CDA: No record.

SA: G 19559.
PD: *Conularia acuta* Roemer.
SB: Ibergerkalk (Upper Devonian).
GL: Winterberg, NW Harz (Germany).
CDA: No record.

Paraconularia acutilirata (Fletcher, 1938)

SA: G 17336.
PD: *Conularia inornata* J. D. Dana.
SB: Permo-Carboniferous.
GL: New South Wales (Australia).
CDA: No record.

Paraconularia africana (Sharpe, 1856)

SA PG 4278-PG 4279 (syntypes).
PD: *Conularia africana* Sharpe.
SB: Bokkeveld Beds (Lower Devonian).
GL: Cedarberg (South Africa).
CDA: Geological Society, 1911.

SA: 18 (four samples).
PD: *Conularia*.
SB: No record.
GL: No record.
CDA: No record.

SA: 19 (four samples).
PD: *Conularia*.
SB: No record.
GL: No record.
CDA: No record.

SA: 733 (two samples), T73.
PD: *Conularia africana*.
SB: Bokkeveld Beds (Lower Devonian).
GL: Hex River (South Africa).
CDA: No record.

SA: PG 4280, PG 4282-PG 4286.
PD: *Conularia*.
SB: Bokkeveld Beds (Lower Devonian).
GL: Cedarberg (South Africa).
CDA: Geological Society (A. G. Bain Collection), 1911.

SA: G 19556, PG 4281.
PD: *Conularia* sp.
SB: Bokkeveld Beds (Lower Devonian).
GL: Cedarberg (South Africa).
CDA: No record.

SA: No sample abbreviation.
PD: *Conularia africana*.
SB: No record.
GL: No record.
CDA: No record.

SA: No sample abbreviation.
PD: *Conularia*.
SB: No record.
GL: No record.
CDA: No record.

Paraconularia cf. *africana* (Sharpe, 1856)

SA: PG 4374.
PD: *Conularia* cf. *africana* Sharpe.
SB: Devonian.
GL: Fox Bay, Falkland Islands (Reino Unido).
CDA: W. N. Craft, 1947.

SA: No sample abbreviation.
PD: No determination.
SB: Devonian.
GL: No record.
CDA: No record.

Paraconularia australiensis n. sp.

SA: G 5225.
PD: *Conularia inornata* J. D. Dana.
SB: Permo-Carboniferous.
GL: Australia.
CDA: Sir C. Purdom Clarke, 1889.

Paraconularia complanata (Slater, 1907)

SA: G 17666 (holotype).
PD: *Conularia* complanata Slater.
SB: Mississippian (Carboniferous).
GL: Farlow, Shropshire (England).
CDA: No record.

SA: 97841.
PD: *Conularia complanata* Slater.
SB: Mississippian (Carboniferous).
GL: Oreton, Shropshire (England).
CDA: Thomas Baugh Collection, 1870.

SA: G 409.
PD: *Conularia complanata* Slater.
SB: Mississippian (Carboniferous).
GL: Oreton, Shropshire (England).
CDA: J. Tennant, 1882.

SA: G 12435.
PD: *Conularia complanata* Slater.
SB: Mississippian (Carboniferous).
GL: Oreton, Shropshire (England).
CDA: No record.

SA: G 19130.
PD: *Conularia complanata* Slater.
SB: Mississippian (Carboniferous).
GL: No record.
CDA: No record.

SA: G 19509, G 49510-G 49511.
PD: *Conularia complanata* Slater.
SB: Mississippian (Carboniferous).
GL: Farlow, Shropshire (England).
CDA: No record.

Paraconularia cf. *complanata* (Slater, 1907).

SA: G 8229. Described by Slater (1907, pág. 35).
PD: ? *Conularia complanata* Slater.
SB: Devonian.
GL: Constatine Bay, Cornwall (England).
CDA: No record.

SA: G 9030. Described by Slater (1907, pág. 35).
PD: ? *Conularia complanata* Slater.
SB: Mississippian (Carboniferous).
GL: Hodder, Lancashire (England).
CDA: Rev. Father S. J. Pollen, 1893.

Paraconularia crawfordsvillensis (Owen, 1862)

SA: G 36.
PD: *Conularia crawfordsvillensis* Owen.
SB: Keokuk Group (Mississippian, Carboniferous).
GL: Crawfordsville (Indiana).
CDA: No record.

Paraconularia aff. *crawfordsvillensis* (Owen, 1862)

SA: G 46634.
PD: *Conularia*.
SB: Balclatchie Group (Upper Ordovician).
GL: Dow Hill, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

Paraconularia crustula (White, 1880)

SA: R 50244.
PD: *Conularia crustula*.
SB: Wewoka Formation (Pennsylvanian, Carboniferous).
GL: Holdenville (Oklahoma).
CDA: P. E. Negus, 1978.

Paraconularia derwentensis (Johnston, 1887)

SA: 42697.
PD: *Conularia tasmanica* Johnson.
SB: Permo-Carboniferous.
GL: Tasmania (Australia).
CDA: W. Legrand, no year.

SA: G 17336.
PD: *Conularia*.
SB: Permo-Carboniferous.
GL: Stony Creek, New South Wales (Australia).
CDA: Bath Royal Literary and Scientific Institution, 1905.

Paraconularia inaequicostata (De Koninck, 1883)

SA: G 18798.
PD: *Conularia inaequicostata* De Koninck.
SB: Facies Tournasiense (Mississippian, Carboniferous).
GL: Tournay (Belgium).
CDA: A. S. Piret Collection, 1905.

SA: G 18897.
PD: *Conularia* n. sp.
SB: Facies Tournasiense (Mississippian, Carboniferous).
GL: Tournay (Belgium).
CDA: A. S. Piret Collection, 1907.

SA: PG 4371.
PD: *Conularia inaequicostata* De Koninck.
SB: Facies Tournasiense (Mississippian, Carboniferous).
GL: Tournay (Belgium).
CDA: E. J. Garwood, 1950.

Paraconularia irregularis (De Koninck, 1842-1844)

SA: G 4865.
PD: *Conularia irregularis* De Koninck.
SB: Facies Viseense (Mississippian, Carboniferous).
GL: Visé (Belgium).
CDA: Prof. L. G. De Koninck, 1868.

SA: G 19616.
PD: *Conularia irregularis* De Koninck.
SB: Facies Viseense (Mississippian, Carboniferous).
GL: Visé (Belgium).
CDA: No record.

Paraconularia cf. *irregularis* (De Koninck, 1842-1844)

SA: G 306.
PD: *Conularia irregularis* De Koninck.
SB: Mississippian (Carboniferous).
GL: Bolland, Yorkshire (England).
CDA: No record.

Paraconularia larae n. sp.

SA: G 22095-G 22096.
PD: *Conularia laevigata* Morris.
SB: Zechstein Formation (Lopingiense, Permian).
GL: Baitungan, NE of Samara (Russia).
CDA: I. A. Stigand, 1912.

Paraconularia maculosa (Slater, 1907)

SA: G 17663 (syntype).
PD: *Conularia tenuis* var. *maculosa* Slater.
SB: Mississippian (Carboniferous).
GL: Glencartholm, Dumfriesshire (Scotland).
CDA: No record.

SA: G 19134 (syntype).
PD: *Conularia tenuis* var. *maculosa* Slater.
SB: Calciferous Sandstone series (Mississippian, Carboniferous).
GL: Eskdale, Dumfriesshire (Scotland).
CDA: No record.

Paraconularia missouriensis (Swallow, 1860)

SA: G 24838-G 24839.
PD: *Conularia missouriensis* Swallow.
SB: Spergen Formation (Mississippian, Carboniferous).
GL: Elletsville, Monroe (Indiana).
CDA: G. J. Hinde Collection, 1918.

Paraconularia aff. *missouriensis* (Swallow, 1860)

SA: PG 4202.
PD: *Conularia* aff. *missouriensis* Swallow.
SB: Burlington Group (Mississippian, Carboniferous).
GL: Wyandotte, Ottawa (Oklahoma).
CDA: W. M. Lechmann, 1935.

Paraconularia quadrisulcata (Sowerby, 1821)

SA: C 3448 (syntype).
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Salop, Shropshire (England).
CDA: No record.

SA: 1689.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Dublin (Ireland).
CDA: Steven, no year recorded.

SA: 1690.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Dublin (Ireland).
CDA: No record.

SA: 38348.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: No record.
CDA: A. J. Charig, 1959.

SA: 43843.
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: No record.
CDA: No record.

SA: 46784 (30 samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Carboniferous.
GL: Carluke, Lankarshire (Scotland).
CDA: J. Purdue, 1870.

SA: 48818 (two samples), G 19128.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Farlow, Shropshire (England).
CDA: Thomas Baugh Collection, 1870.

SA: 52576 (two samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Bewdley, Worcestershire (England).
CDA: Thomas Baugh Collection, 1870.

SA: 66697 (two samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Coalbrookdale, Shropshire (England).
CDA: Etheridge Collection, 1869.

SA: 66697-66698, G 364, G 4014 (two samples), G 6697-G 6698.
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Coalbrookdale, Shropshire (England).
CDA: No record.

SA: 97683.
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Martley, Worcestershire (England).
CDA: Bowerbank Collection, 1865.

SA: G 39.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Worcestershire (England).
CDA: No record.

SA: G 61 (two samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Thornliebank, Renfrewshire (Scotland).
CDA: No record.

SA: G 270.
PD: *Conularia*.
SB: Mississippian (Carboniferous).
GL: Bolland, Yorkshire (England).
CDA: Gilbertson Collection, 1841.

SA: G 803 (two samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Modeley, Shropshire (England).
CDA: H. Pearce, 1883.

SA: G 3480.
PD: *Conularia quadrisulcata* Sowerby.
SB: Carboniferous.
GL: Roscobie, Fifeshire (Scotland).
CDA: T. Stock, 1885.

SA: G 4454.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Redescale, Northumberland (England).
CDA: J. E. Lee, 1885.

SA: G 5310.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Derbyshire (England).
CDA: F. Harford, 1889.

SA: G 8305 (16 samples), G 8808 (six samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Coalbrookdale, Shropshire (England).
CDA: Prof. Prestwich, 1894.

SA: G 10321.
PD: *Conularia quadrisulcata* Sowerby.
SB: Pilton Group (Upper Devonian).
GL: Frankmarsh, Devonshire (England).
CDA: No record.

SA: G 12434 (four samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Coalbrookdale, Shropshire (England).
CDA: G. H. Morton Collection, 1900.

SA: G 19131-G 19133.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Coalbrookdale, Shropshire (England).
CDA: S. P. Pratt, 1857.

SA: G 19135.
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: No record.
CDA: No record.

SA: G 19136-G 19139.
PD: *Conularia quadrisulcata* Sowerby.
SB: Carboniferous.
GL: Reino Unido.
CDA: No record.

SA: G 20659 (two samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Eccup, Yorkshire (England).
CDA: Caroline Birley, 1907.

SA: G 24051.
PD: *Conularia quadrisulcata* Sowerby.
SB: Lower Culm (Mississippian, Carboniferous).
GL: Codden Hill, Devonshire (England).
CDA: J. G. Hamling, no year recorded.

SA: G 26797-G 26798.
PD: *Conularia quadrisulcata* Sowerby.
SB: Bernician Redesdale I Shale (Mississippian, Carboniferous).
GL: Billingham, Durham (England).
CDA: Dr. Stanley Smith, 1921.

SA: G 40810.
PD: *Conularia quadrisulcata* Sowerby.
SB: Cam Beck Shales (Mississippian, Carboniferous).
GL: Settle, Yorkshire (England).
CDA: T. Roscoe Rede Stebbing, 1924.

SA: G 40811 (four samples).
PD: *Conularia quadrisulcata* Sowerby.
SB: Cam Beck Shales (Mississippian, Carboniferous).
GL: Ribblehead, Yorkshire (England).
CDA: T. Roscoe Rede Stebbing, 1924.

SA: G 41200.
PD: *Conularia*.
SB: Zone d2 Hardrowsear (Mississippian, Carboniferous).
GL: Settle, Yorkshire (England).
CDA: Wheelton Hind Collection, 1921.

SA: G 41201-G 41203.
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Coalbrookdale, Shropshire (England).
CDA: Wheelton Hind Collection, 1921.

SA: G 41207-G 41209.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Thornliebank, Renfrewshire (Scotland).
CDA: Wheelton Hind Collection, 1921.

SA: G 41210-G 41218.
PD: *Conularia quadrisulcata* Sowerby.
SB: Facies Viseense (Mississippian, Carboniferous).
GL: Redescale, Northumberland (England).
CDA: Wheelton Hind Collection, 1921.

SA: PG 4254.
PD: *Conularia quadrisulcata* Sowerby.
SB: Crangopsis Bed (Mississippian, Carboniferous).
GL: Etie, Fifeshire (Scotland).
CDA: J. A. Moy-Thomas, 1938.

SA: PG 4344.
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Modeley, Shropshire (England).
CDA: A. Templeman Collection, 1948.

SA: PG 4345.
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Coalbrookdale, Shropshire (England).
CDA: A. Templeman Collection, 1948.

SA: PG 4428 (nine samples).
PD: No determination.
SB: Pentamerus sandstone (Llandovery, Silurian).
GL: Norbury, Shropshire (England).
CDA: J. E. Lee, 1885.

SA: PG 4444. Figured by Sowerby (1841: pl. 4: fig. 2).
PD: *Conularia quadrisulcata* Sowerby.
SB: Coal Measures (Pennsylvanian, Carboniferous).
GL: Coalbrookdale, Shropshire (England).
CDA: Shrewsbury Museum and Art Gallery, 1956.

SA: PG 4480.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: Thorneybank, Renfrewshire (Scotland).
CDA: R. Chaplin, 1960.

SA: No sample abbreviation.
PD: *Conularia quadrisulcata* Sowerby.
SB: Mississippian (Carboniferous).
GL: No record.
CDA: Governors of King's School of Sherborne, 1960.

Paraconularia ravenswoodiensis n. sp.

SA: PG 4266.
PD: *Conularia inornata* J. D. Dana.
SB: ? Cisuraliense (Permian).
GL: Ravenswood, New South Wales (Australia).
CDA: B. Dunstan Collection, 1935.

SA: PG 4267.
PD: *Conularia inornata* J. D. Dana.
SB: ? Cisuraliense (Permian).
GL: Ravenswood, New South Wales (Australia).
CDA: B. Dunstan Collection, 1935.

Paraconularia raymondiensis n. sp.

SA: PG 4268.
PD: *Conularia laevigata* Morris.
SB: Marine beds (Permian).
GL: Raymond Terrace, New South Wales (Australia).
CDA: B. Dunstan Collection, 1935.

Paraconularia salteri (Fletcher, 1938)

SA: G 23724.
PD: *Conularia laevigata* Morris.
SB: Trilobite zone (Upper Ordovician).
GL: Blaendiam, Merionethshire (Wales).
CDA: Thomas Ruddy Collection, 1915.

SA: G 23726, G 23729.
PD: *Conularia laevigata* Morris.
SB: Trilobite zone (Upper Ordovician).
GL: Bwlch-y-gasey, Merionethshire (Wales).
CDA: No record.

SA: G 23727-G 23728.
PD: *Conularia laevigata* Morris.
SB: Trilobite zone (Upper Ordovician).
GL: Blaendiam, Merionethshire (Wales).
CDA: No record.

Paraconularia sp.

SA: 41601.
PD: *Conularia* sp.
SB: Devonian.
GL: St. Francis Bay, Cape of Good Hope (South Africa).
CDA: No record.

Paraconularia n. sp.

SA: PG 4316.
PD: *Conularia*.
SB: Coal Seam (Permian).
GL: New South Wales (Australia).
CDA: Geological Society of London, 1911.

Paraconularia n. sp.

SA: G 11798.
PD: *Conularia* sp.
SB: Wenlock (Silurian).
GL: Ledbury Dome, Herefordshire (England).
CDA: No record.

Paraconularia subtilis (Salter, 1855)

SA: 43843 (syntype).
PD: *Conularia quadrisulcata*.
SB: Transition-Limestone Millstone Grit Series (Pennsylvanian, Carboniferous).
GL: Keswick, Westmmorland (England).
CDA: Sowerby Collection, 1860.

SA: G 8744.
PD: *Conularia subtilis* Salter.
SB: Ludlow (Silurian).
GL: Deerhope, Pentland Hills (Scotland).
CDA: No record.

SA: G 4602.
PD: *Conularia subtilis* Salter.
SB: Upper Ludlow (Silurian).
GL: Usk, Monmouthshire (England).
CDA: J. E. Lee, 1885.

SA: 4290.
PD: *Conularia subtilis* Salter.
SB: Upper Ludlow (Silurian).
GL: Benson Knot, Westmoreland (England).
CDA: No record.

SA: G 122.
PD: *Conularia subtilis* Salter.
SB: Ludlow (Silurian).
GL: Collingfield, Westmoreland (England).
CDA: No record.

SA: G 12575.
PD: *Conularia subtilis* Salter.
SB: Lower Ludlow (Silurian).
GL: Ludlow, Shropshire (England).
CDA: No record.

Paraconularia tenuis (Slater, 1907)

SA: G 17661-G 17662 (paratypes).
PD: *Conularia tenuis* Slater.
SB: Mississippian (Carboniferous).
GL: Glencartholm, Dumfriesshire (Scotland).
CDA: No record.

SA: G 17664 (paratype).
PD: *Conularia tenuis* Slater.
SB: Crangopsis Bed (Mississippian, Carboniferous).
GL: Glencartholm, Dumfriesshire (Scotland).
CDA: No record.

SA: G 790 (31 samples) (paratypes).
PD: *Conularia tenuis* Slater.
SB: Crangopsis Bed (Mississippian, Carboniferous).
GL: Glencartholm, Dumfriesshire (Scotland).
CDA: R. Damon, 1883.

SA: G 19507-G 19508 (paratypes).
PD: *Conularia tenuis* Slater.
SB: Calciferous Sandstone series (Mississippian, Carboniferous).
GL: Glencartholm, Dumfriesshire (Scotland).
CDA: No record.

SA: G 19508 (paratype).
PD: *Conularia tenuis* Slater.
SB: Mississippian (Carboniferous).
GL: Glencartholm, Dumfriesshire (Scotland).
CDA: No record.

SA: No sample abbreviation (paratype).
PD: *Conularia tenuis* Slater.
SB: Crangopsis Bed (Mississippian, Carboniferous).
GL: Glencartholm, Dumfriesshire (Scotland).
CDA: No record.

Paraconularia ulrichiana (Clarke, 1913)

SA: PG 4272 (two samples).
PD: *Conularia ulrichana* Clarke.
SB: Lower Devonian.
GL: Icla, Chuquisaca (Bolivia).
CDA: Rheinisches Mineralien-Kontor of Bonn, 1937.

Genus *Pseudoconularia* Boucek, 1939

Pseudoconularia grandissima (Barrande, 1867)

SA: 19.
PD: No determination.
SB: No record.
GL: No record.
CDA: No record.

SA: 80213 (four samples), 80213a-c, 80213e.
PD: *Conularia grandis* Barrande.
SB: Étage D2 of Barrande (Upper Ordovician).
GL: Vrá (= Wra) and Zahorany (= Zahorzan) (Czech Republic).
CDA: Dr. J. Barrande, 1856.

SA: G 19555.
PD: *Conularia grandis* Barrande.
SB: Étage D of Barrande (Ordovician).
GL: Czech Republic.
CDA: Dr. J. Barrande, 1856.

SA: H 5477.
PD: *Conularia grandissima* Barrande.
SB: Upper Hope Shales (Middle Ordovician).
GL: Shelve, Shropshire (England).
CDA: Whittard Collection, noyear recorded.

SA: PG 4253.
PD: *Conularia grandissima* Barrande.
SB: Zahorany Beds (Upper Ordovician).
GL: Nucice (" Vinice") (Czech Republic).
CDA: F. W. Cassirer, 1938.

SA: No sample abbreviation.
PD: *Conularia*.
SB: Silurian.
GL: No record.
CDA: No record.

Pseudoconularia magnifica (Spencer, 1879)

SA: G 14827.
PD: *Conularia magnifica* Spencer.
SB: Niagara Limestone (Ludlow, Silurian).
GL: Hamilton (Ontario).
CDA: C. C. Grant Collection, 1904.

Pseudoconularia megista Lamont, 1946

SA: G 23287-G 23288, G 23306.
PD: *Pseudoconularia megista / currieae*.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: W. McPherson Collection, 1913-1914.

Pseudoconularia nobilis (Barrande, 1867)

SA: G 46839, G 46851.
PD: *Conularia* cf. *curta* Holm.
SB: Starfish Bed (Upper Ordovician).
GL: Thraive Glen, Girvan (Ayshire, Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

SA: 80218.
PD: *Conularia nobilis*.
SB: Étage D2 of Barrande (Upper Ordovician).
GL: Zahorany (= Zahorzan) (Czech Republic).
CDA: No record.

Pseudoconularia sp.

SA: No sample abbreviation.
PD: *Conularia*.
SB: Devonian.
GL: Second Range Cascade Mts (EE.UU.).
CDA: Museum of Practical Geology, 1880.

No determination

SA: PC 4353.
PD: No determination.
SB: No record.
GL: ? Czech Republic.
CDA: No record.

SA: PG 4472-PG 4475.
PD: No determination.
SB: Greseis (Silurian).
GL: Val Mourai, Serra of Bussaco (Portugal).
CDA: No record.

SA: G 29333 (three samples).
PD: ? *Hyolithes* n.sp. (Novák).
SB: Étage F1 of Barrande (Lower Devonian).
GL: Kosor (= Kozorz) and Radotin (Czech Republic).
CDA: No record.

SA: No sample abbreviation for 14 specimens.
PD: No determination.
SB: Bedinan Formation (Upper Ordovician).
GL: O of Bedinan (Turkey).
CDA: No record.

SA: No sample abbreviation.
PD: No determination.
SB: Drybrook Sandstone (Mississippian, Carboniferous).
GL: Hazel Hill Quarry Puddlebrook, Gloucester (England).
CDA: No record.

SA: No sample abbreviation for two specimens.
PD: No determination.
SB: No record.
GL: No record.
CDA: No record.

SA: No sample abbreviation for two specimens.
PD: No determination.
SB: Mississippian (Carboniferous).
GL: ? United Kingdom.
CDA: No record.

SA: No sample abbreviation for 114 specimens.
PD: No determination.
SB: Starfish Bed (Upper Ordovician).
GL: Girvan, Ayshire (Scotland).
CDA: Mrs. Robert Gray Collection, 1920.

Incertae sedis

SA: PG 5114-PG 5115.
PD: *Zitteloceras costatum* Teichert.
SB: Starfish Bed (Upper Ordovician).
GL: Girvan, Ayshire (Scotland).
CDA: No record.

IN FROM THE COLD: AN OVERVIEW OF THE BRITISH ANTARCTIC SURVEY FOSSIL COLLECTIONS

by Hilary J. Blagbrough

Blagbrough, H.J. 2009.. In from the cold: an overview of the British Antarctic Survey fossil collections. *The Geological Curator* 9 (1): 21 - 28.

The British Antarctic Survey is the custodian of more than 57,000 Antarctic fossils, of which some 2,500 are Type & Figured specimens. In addition to these, the geological collections include over 100,000 rock and mineral specimens representing all the main lithologies. Gathered over the last 60 years, the collections form an invaluable taxonomic and lithographic resource for the study of biodiversity, environmental change and planetary evolution. Methods of analysis are constantly being refined and up-dated so the collection needs to be effectively managed, stored and recorded if it is to continue to function as an investigative resource. Good curation is especially important given the high cost, in both time and money, of collecting specimens from such a remote and hostile environment. For the most part, the material is well documented but more curatorial time needs to be spent on the specimens if they are not to deteriorate through contamination or neglect.

British Antarctic Survey, Cambridge, UK. Received 27th July 2009.

Introduction

The British Antarctic Survey (BAS) fossil collections form a unique taxonomic resource for scientific research. As a wholly-owned Natural Environment Research Council (NERC) establishment, BAS has a duty of care so that future use of the material is not compromised (NERC, 2007). The specimens need to be curated in such a way that advances in analytical techniques can be accommodated with existing specimens (Howe *et al.* 2004). Since no one can anticipate exactly what may be required in the future, it is important to maintain specimens in as near original condition as possible. Any conservation or preparation work carried out must be of limited impact or of a reversible nature (Brunton *et al.* 1985). It is essential that the documentation accompanying each specimen is as detailed as possible.

In the present economic climate, requests for funding must be fully justified. It is therefore important that unique collections such as those at BAS are recognised by management and research scientists as the valuable resource they are. Such realisation can only be brought about by demonstrating the usefulness of the collections through detailed documentation, not only of the specimens but also of the use made of the collections by researchers and others. Data on specimens, catalogues of collections, directories of publications can all be listed in interactive databases whilst registers of loans and of visitors can effectively demonstrate collection use. Such datasets can be powerful management tools that benefit users by providing easy and clear access to information. They also benefit the collections by enabling controlled curation and highlighting areas where improvements can or should be made.

In the case of the BAS collections, it makes good sense to be aware of the possibilities available from re-use of previously collected specimens. It may not always be possible to travel to Antarctica to collect new material and therefore it is worth maintaining specimens currently in the collections since they could be all the material that is available to science if political or environmental conditions change. Dialogue between management, researchers and technical support staff can ensure that the fossil collections receive the care and attention they need to continue to provide a valuable scientific resource into the future (Blagbrough 2008).

Acquisition of specimens

Any expedition to collect fossils in Antarctica is made under license as part of a science programme and as such will have a well-planned strategy for collection. The scientists record location data using sophisticated GPS systems and also compile field notebooks showing this and other contextual data. Each locality is issued with a unique identity and as there can be several hundred specimens collected at a given locality, each is given a unique identifier. The specimens are packed, often wrapped in newspaper, into wooden boxes and sent back to the UK by ship.

Antarctica is generally a very cold place and, although temperature fluctuations do mean some areas are snow-free during the summer months, the specimens are likely to be packed if not actually frozen then at the very least, wet and even with a snow component in the boxes if conditions are unfavourable. Shipping the specimens back to the UK means passing through the warmer and more humid tropics and by the time the specimens reach this country any that were frozen will have fully thawed and may have begun to dry out or even break up. On arrival at BAS, the boxes of specimens are stored in the logistics yard and inclement British weather can inflict more damage either by water ingress or by baking.

When the specimens are unpacked, the rocks are allowed to dry out as necessary. The sample number is checked and made more permanent by use of emulsion paint and India-ink pens. The fossils are then put into plastic trays and either added to the reserve collection or taken for immediate study. All of the above tasks are undertaken by the collectors themselves, with little input from the technical support staff.

The technical support staff attached to the geological department, whilst having a geological background, are not specifically employed as curators. This should not be an issue since, as Doughty (1981) states, collections in the care of geologists fare better than those in the hands of non-specialists. It does mean that due to other duties only a very small proportion of time can be given to collection management and care. However, the technicians' other activities ensure that they access the reserve stores regularly and so are in a good position to notice and report any developing problems.

If the specimens are going straight into the reserve collection, the technicians issue box numbers and log the specimens in the storage database, which also locates the box within a storage-bay area. Most recently, fossil collections have been made as part of AFI (Antarctic Funding Initiative) projects supported by BAS (see the web site: http://www.antarctica.ac.uk/afi/ for details) through various university departments. The result of this is that the specimens are removed to those establishments for study and information may not be available to the technicians as to what has been taken off-site. There is an understanding that specimens will be returned to BAS when the project is completed, preferably with a copy of the field notes.

Once the fossil specimens are returned to BAS, they are allocated box and bay numbers and logged on the database. Most of the large volumes of fossils relate to PhD work, which is not currently regarded as cited or figured material so the specimens remain in the reserve collection. When a paper is published, the fossils are recovered from the reserve store and incorporated into the Type & Figured collection, sometimes with photographs.

It has been recognised by others (Howe *et al.* 2008) that the work of cataloguing collections and particularly taxonomic specimens listed in publications is an arduous task not least because there is no universally-recognised system of nomenclature used. Online databases are becoming important to the scientific community (Allmon 2004) for research purposes but the digital curation process needed to make them accessible is often neglected through lack of technical expertise, funding or managerial support.

Storage of fossils

The Rock Store (Figure1) is a large storage room with two banks of movable racking as well as fixed racks on the walls and a long bench with shelves beneath. The largest part of this area is taken up with the archived rock collection, followed in descending volume by the reserve fossils, the processed rock material and the working rock collection.

Figure 1: Part of the reserve fossil collection in the Rock Store at the British Antarctic Survey, Cambridge.

The reserve fossil collection includes over 55,000 fossil specimens which are held in plastic trays stacked on the movable racking and beneath the bench. Specimens are often stacked within the trays and may still be wrapped in newspaper. Weight of material in the trays varies with the mineralisation of the fossils and where this exceeds the strength of the trays the bases can become cracked and broken. The top of the racking is close to the ceiling and access to material stored there is often difficult and potentially hazardous to users.

There are two doors - one gives onto the logistics yard and one onto the interior of the building. There is a bank of windows overlooking the yard, which has racking in front and there is no air-conditioning. This area is where all specimens of rocks and fossils are brought into the geology department. It is also used to store various bulk supplies and equipment as well as being the area utilised for packing field equipment before sending it South.

Housed in two west-facing laboratories on the ground floor of the building, the Type & Figured collection of approximately 2,500 specimens is stored in a series of traditional mahogany cabinets with unlined, wooden drawers (Figure 2) that were originally obtained from the Natural History Museum, London.

Figure 2. One of the Type & Figured fossil collection cabinets showing labelled specimens in cardboard trays in the wooden drawers.

Specimens are kept in cardboard trays and are generally single stacked in the drawers. There are benches below the windows of the laboratories and against the back walls, which have shelving beneath and are used to store some reserve collection material in plastic trays. Some large Type & Figured material is also stored in these trays. Researchers needing to inspect the collections are accommodated in one of the palæontology labs, which is also where fossil displays are set up as needed for other visitors.

Appendix 1 summarises the storage facilities both at the Cambridge site and at an off-site storage unit used mainly for non-fossil specimens. It shows the packing used and the environmental monitoring systems in place (Blagbrough and Tate 2008).

Specimens in the cabinets are generally dust-free but those kept on or beneath the benches are often in a filthy condition and need to be cleaned before they can be used. Some of the oversize material is extremely heavy, causing the plastic trays to warp and split under their weight. This is clearly not an ideal situation as it could cause damage to the specimens and is a danger to users.

Use of the fossil collections

Researchers wishing to visit the British Antarctic Survey fossil collections will generally make an initial approach through an appropriate scientific contact who will then liaise with the technicians regarding dates and times of the proposed visit, as well as indicating what material will be required. Where possible, specimens are retrieved from store in advance. If items are taken from the Type & Figured collection, an information card is left to show where the specimen has gone.

Specimens to be sampled or removed from the premises for further analysis require authorisation from a senior scientist. Type & Figured specimens may not be subjected to any destructive sampling; all reserve material can be drilled or processed, with the correct permissions. A loan form is completed with details of the treatment permitted so that there can be no argument about destruction or sub-sampling of the specimens at a later date. A paper copy of the form is signed and given to the borrower for their reference whilst a photocopy is held on file at BAS. Specimens are then bubble-wrapped and boxed for transport.

Loans are logged on an Access™ database which allows the records to be searched. Storage location data are recorded on the loan forms for use when the specimens are returned. Loans are generally for an initial period of six months or less and may be renewed by written request; the database generates automatic emails to the technical staff as a loan falls due so that follow-ups can be made.

When specimens are returned to the British Antarctic Survey at the end of the loan period, they are unpacked and checked for damage. Notes are made of any problems and the specimens are put back in their storage locations. The loan is then signed off on the database and the paper copy is crossed out and filed in the records.

Occasionally, other non-research visitors come to see the collections. VIPs, small school parties, student and teacher groups and film crews have all been accommodated on tours of the facilities. When the need arises, fossil specimens are displayed on the window bench in one of the palæontology laboratories or as table-top presentations in one of the office areas. As this requires repeated handling of potentially fragile specimens, care must be taken to ensure that damage is kept to a minimum. This is not an ideal situation but current circumstances do not allow for any alternative if the specimens are to be utilised for display purposes.

In May 2009, the display specimens as well as some Type & Figured material were taken for exhibition (Figure 3) at the Lyme Regis Fossil Festival 2009 - Evolution Rocks! There were several logistical problems to be overcome, not least the security of the Type & Figured material. Lockable display cases were obtained for the smaller or more valuable items and it is planned to incorporate their use in a more permanent display area at BAS.

Environmental monitoring

Six Hoboware™ data loggers are in place in the collections storage areas. These were purchased as a research project to review and record the environmental conditions faced by specimens in the various storage areas. Reports are made bi-monthly to the senior management. Appendix 2 shows a plot of readings obtained during the period April 2008 - June 2008 and includes both temperature readings and humidity.

One data logger is situated in the reserve fossil collection bays in the Rock Store and two in each of the palæontology laboratories, positioned on the back walls and in the cabinets. The final data logger was kept in the thin-section storage cabinets. This logger has recently been moved to the Rock Store to check conditions in the covered boxes there. The positions were chosen to give an indication of the amount of environmental buffering offered by the cabinets (Blagbrough and Tate 2008) and to monitor conditions.

As can be seen in Appendix 2, the temperature and RH% vary considerably in both of the open rooms and the Rock Store but although the temperature continues to vary in the cabinets, the RH% is effectively buffered to give a reading of 43.5% ± 2%. The East Midlands Museum Service provides a range of acceptable relative humidity percentages on its web site at *http://www.emms.org.uk/Preventive%20 Conservation.htm* which suggests that this is at the bottom of the range appropriate for general geological samples. It is recommended that shale, which is one of the most common fossil-bearing rock types in Antarctica, should be kept at a relative humidity of no less than 40%, whereas fossils containing pyrite should be kept around RH 30% and at no more that 50%. The BAS Type & Figured storage cabinets are maintained, by accident rather than design, at a level that is suitable for the majority of the fossil specimens therein. Unfortunately this is not the case outside of the cabinets where the RH% varies from approximately 30% to 60% and gives some cause for concern.

Since their collection and removal from Antarctic conditions, the fossils have been subjected to significant environmental fluctuations. In the most extreme cases, these

Figure 3: The British Antarctic Survey display at Lyme Regis Fossil Festival 2009 - Evolution Rocks! (Photograph: T. Foord)

fluctuations can reduce the specimen to a mush of silt (McLean 1999). Moisture content in the specimens is often high at first and this can cause salt-leeching and de-lamination in susceptible materials as the fossils and their matrix dry out. The increased humidity from damp wrappings in the boxes encourages mould growth (Frost 1999; Brysbaert 2006), which can be a hazard to users. The findings from environmental monitoring over the past year show that to avoid further stress on the fossils, all specimens should be kept in the cabinets. This is not practicable at the present time due to financial and spatial constraints. Only the Type & Figured collection has been prioritised to receive cabinet storage.

Temperature and humidity variations are only two of the environmental factors that can affect the fossil collections at BAS. As was detailed earlier, the fossils in the reserve collection are stored in plastic trays, sometimes still with their newspaper wrappings. The trays are generally stacked up to four high on a shelf. Those stacked on top of the racking usually have lids on the top tray but there is no room to lid the trays in the shelves. A past problem associated with the un-lidded trays has been nesting rodents. These use the paper wrappings as nesting material and can destroy specimens by their actions. Pest traps have been installed and there does not appear to be a continuing problem.

A more frequently noticed problem is dust. The Rock Store is a dusty environment and, over time, particulates collect on the specimens (Moore 2006; Brysbaert 2006) obscuring their detail and potentially causing the fossil matrix to deteriorate. Scrubbing in water to remove the dust (the method employed on hard rock specimens) is inappropriate as is brushing. Either method can cause damage to the fossil specimen and should be avoided. Blowing gently with compressed air is perhaps the most appropriate means of removing the dust but it would be better if the trays were lidded and the specimens protected from this contaminant.

Procedures and documentation

In terms of documentation of the fossil collections, there are several systems dependent upon the status of the material. Field notebooks are retained by the collectors for their own working reference. On departure or retirement from BAS, the notebooks are passed to the central archives for digitisation and storage. Station and specimen records are held by the geological department in a series of registers that are available to all staff. These are also undergoing digitisation.

The Archives Service holds most of the historical documentary information concerning work in and around Antarctica and offers a 'by appointment only' service to public researchers. The Archives hold data for all the science disciplines as well as logistics information concerning the support of that science in Antarctica. Further information about the service can be found on the web site at *http://www.antarctica.ac.uk/about_bas/our_organisation/eid/archives.php*

Internal databases hold information on stations, specimens, storage locations, loans, crushed-rock preparations and thin-sections. These are searchable and in some instances linked, providing a valuable dataset of information. Preparation and thin-section data is also maintained on a card index held by the technical staff. The British Antarctic Survey fossils web site *http://www.antarctica.ac.uk/bas_research/data/access/fossildatabase/* provides a searchable, public-access database for the Type & Figured collection. It holds photographic images of many of the specimens as well as listing citations. The website gives such data on the individual specimens as the collection locality, the collector and, where available, the identity of the specimen down to genus level. There is an email address connected to the site which is reviewed regularly by the technical staff and any enquiries are dealt with appropriately. New citations are being added as they are published and photographs are incorporated where possible. It is intended to eventually have all specimens, both Type & Figured and reserve, photographed for inclusion on the website. Thin-sections and micro-palæontological slides are also being included in this process, with material being scanned so that images are available for research.

Conclusion

The fossil collections at the British Antarctic Survey are held for the purpose of scientific research but are not subjected to the intensity of curatorial focus that a museum collection would be. This is not an ideal situation since, although documentarily well provenanced, the collections in their current state are potentially physically inadequate for future use. It needs to be appreciated by management as well as technicians and users that, without proper care, the specimens could become scientifically un-usable due to contamination and neglect. Considering how remote and hostile an environment the Antarctic is, it seems irrational that the efforts put into collecting the fossils are not matched by commensurate efforts for their care once they are returned to the UK.

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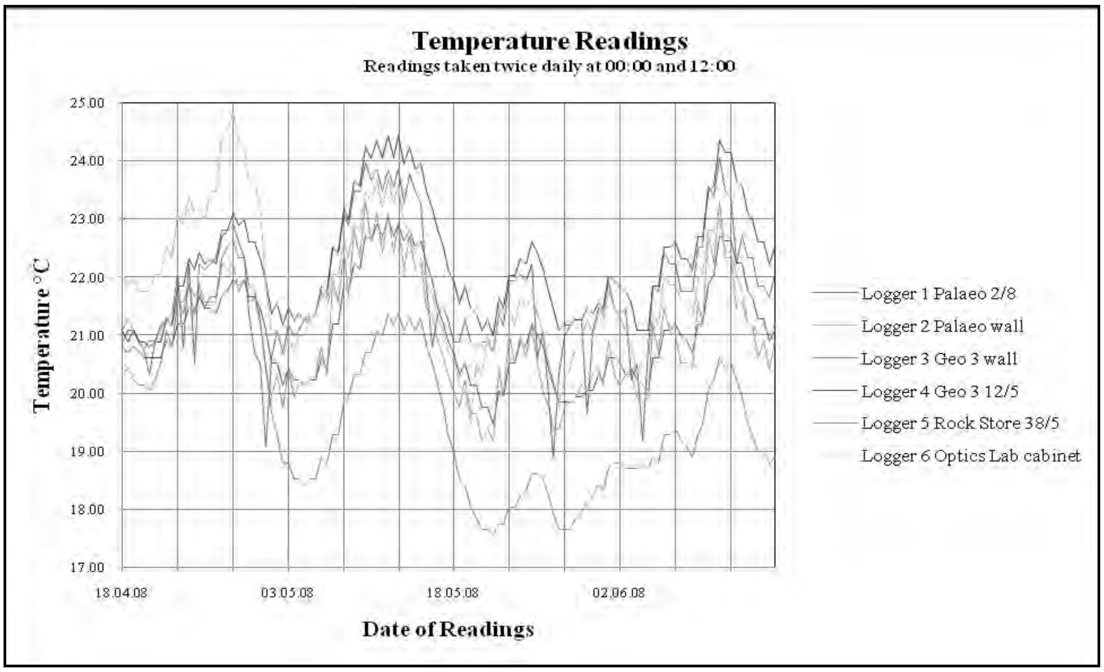
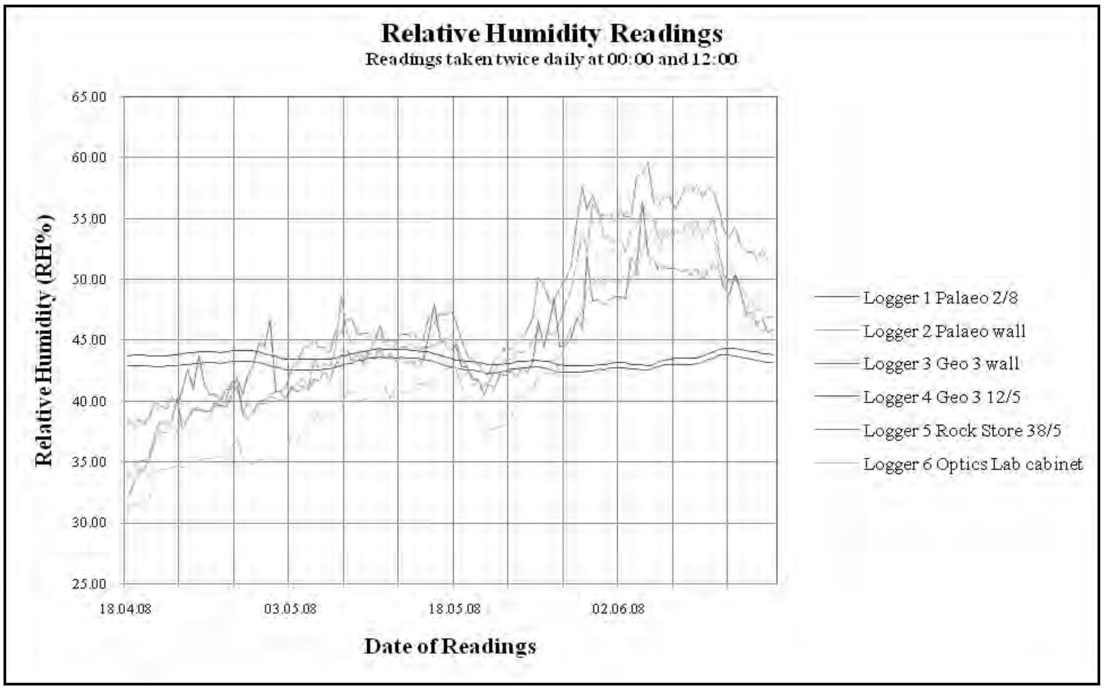
Collection	Collection location	Accessioned	Wooden cabinets, fixed height draws	Warehouse-style, fixed height, metal racking	Benching	Metal cabinets with fitted inserts	Metal pallets	Plastic trays	Plastic crates	Lids	Cardboard boxes	Card trays	Environmental monitoring	Pest control	Smoke detector	Comments
Type & Figured Fossils	BAS geology lab	*	*									*	*		*	Occasionally stacked within draws
Non T&F Fossils		*	*										*		*	
		*			*			*					*		*	Often stacked within trays
	BAS rock store	*		*				*					*	*	*	
		*		*									*	*	*	Multiple specimens stored in the same crates, as space allows
Working Rocks				*					*				*	*	*	
Archive Rocks		*		*					*				*	*	*	
	Off-site warehousing	*					*		*	*				*		
Granules & powders	BAS rock store	*									*		*	*	*	
Thin Sections	BAS optics lab	*				*					*	*	*	*	*	Non-standard sizes packed in draws in cardboard boxes

Appendix 1. A breakdown of the geological storage facilities both on- and off-site at the British Antarctic Survey (Blagbrough and Tate 2008).





Appendix 2. Temperature and RH% graphs for the period April 2008 - June 2008 in the specimen storage areas at the British Antarctic Survey. Note the extent of RH% buffering provided by the cabinets - logger 1 and logger 4 (the extra numbers shown are cabinet and shelf identifiers)

ACID DIGESTION OF SILICIFIED SHELLS

by Christian Baars

Baars, C. 2009. Acid digestion of silicified shells. *The Geological Curator* 9 (1): 29 - 33.

Many fossils can be extracted from their host rock by using acid digestion. Whether this technique is suitable depends upon the mode of preservation. Very good results can be achieved for silicified fossils within a carbonate-rich host rock. However, incomplete silicification may lead to partial loss of fossils in the laboratory. Therefore, prior to commencing acid treatment it is helpful to have some knowledge of the taphonomy of the sample and its ambient depositional environment, as there are important geological factors that have a significant influence on the preparation process.

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Introduction

The effect of poor preservation on taxonomic research and museum collections is hardly mentioned in the literature. While there are several studies relating the taphonomy of silicified fossils to the (pre-) diagenetic environment (for example, Boyd and Newell 1972, Wilson 1966) and much discussion has focussed on the strength and type of acid used in the recovery process (for example, Bitter and Millar-Campbell 1984 and references therein, Jeppson *et al.* 1985), the important role of taphonomy on the silicification process and subsequent recovery of fossils in the laboratory is poorly researched. Rarely - if ever - are comparisons made of the state of preservation pre and post acid digestion. Popov *et al.* (2007) discussed some of the problems caused by mode of preservation when studying the ontogeny of fossilised brachiopods, which requires exceptional preservation and preparation. Hypothetically, even exquisitely silicified specimens, following acid digestion, may not be representative of what was actually contained in the rock matrix prior to preparation. Therefore, the question arose: does acid digestion produce specimens that are truly representative of the original material?

Acid digestion is a technique routinely used at National Museum Wales as part of specimen preparation. In particular, silicified shells, for example brachiopods and bivalves, are being extracted from a calcareous matrix using dilute (5 - 10 %) acetic acid. Preparation is mainly for research, which requires both very good preservation and careful preparation of specimens.

For the purposes of research it is implicitly assumed that acid preparation does not alter the shell structure, if silicification is complete. If shells are obviously damaged following acid digestion it is assumed that silicification was incomplete. If, at first glance, shells appear to be in good condition following acid digestion, the assumption is that preservation is good enough for research purposes.

In all likelihood, if visual inspection of a specimen prepared using acid by an experienced researcher results in said researcher being satisfied with the outcome, all morphological features are present and the specimen can be classed as completely silicified for the purposes of morphological and taxonomic research. What may be overlooked at a visual inspection are microscopic changes within the shell, which may result in structural research being difficult or, at worst, impossible. And once a sample has been committed to the acid bath it is too late to recognise that valuable information has been lost as a result of incomplete silicification and hasty preparation.

In an attempt to consider the potential changes to silicified material during acid digestion, a small study using a limited number of specimens was undertaken. Samples of early Jurassic silicified *Gryphaea arcuata* were analysed and examined pre and post treatment with acetic acid.

Methods

Samples of Lower Jurassic (Blue Lias) micritic limestone rocks containing *Gryphaea arcuata* Lamarck were collected from a new road cutting at

Southerndown (SS 885 731), Vale of Glamorgan, South Wales. Small samples were taken of fresh, unprepared shell. Whole rocks were then immersed in buckets with 10% acetic acid. After a period of 2 weeks, the rocks were thoroughly washed of all acid residues before small shell samples were taken. Subsequently, the rocks were immersed again in 10% acetic acid and digested until the shells were completely free of all rock matrix. Again, the shells were thoroughly washed and small shell samples taken.

The specimens were hollow following acid digestion - only the most exterior shell layers were preserved as silica. As a consequence, the shells were quite fragile and had to be consolidated (using dilute Paraloid/B72) prior to handling.

Two shell samples each of pre, during and post digestion were analysed for their chemical composition using the ED analyser on a CamScan Maxim scanning electron microscope, and for mineralogy using a PANalytical XPert PRO XRD analyser. Thin sections were also prepared of untreated samples and examined using a Leitz Ortholux polarizing petrographic microscope.

Results

The untreated shell samples were composed of quartz with traces of calcite, minor constituents containing (generally <3%) of aluminium, iron, magnesium, potassium, calcium, titanium and copper. The shells were dotted with many (c. 200 per mm^2) small (largest diameter: 10 mm) spots of heavy element accumulations; these were mainly made up of copper with some iron.

The shell samples treated for 2 weeks had markedly less spots of heavy elements; these consisted of iron. No trace elements were detected in the shells analysed.

Shells following completed digestion were homogenously composed of quartz, with very minor traces of calcite. No heavy elements were detected.

The relative silica proportion increased from an average of 16% (to 23%) to 47% between the pre and post digestion samples, with other elements decreasing rapidly during the first 2 weeks of acid treatment.

Analysis of thin sections of untreated specimens revealed that silica replacement of the shells was incomplete, and a large proportion of the inner shell layers was preserved as calcite. This calcite was dissolved by the acid digestion treatment, resulting in two thin outer silica shell layers enclosing a hollow space, rendering the shells quite fragile.

Discussion

Gryphaea arcuata preferred protected environments on more or less argillaceous and calcareous parts of shelves (Nori and Lathuiliere 2003). This pre-destined their shells for silicification, as silicified fossils occur primarily in shallow-water marine carbonate-rich sediments (Schubert *et al.* 1997), at least during the Palaeozoic - silicification in post Palaeozoic rocks is comparatively rare (Schubert *et al.* 1997).

Examination of *G. arcuata* shells preserved at Southerndown revealed that different styles of silicification were present on the same specimen. Externally visible surfaces were preserved as beekite (concretionary chalcedonic shell replacements) which was seen prior to etching, as in most bivalve shells - as opposed to brachiopods where beekite is not usually visible until a surface layer of calcite is dissolved away (Holdaway and Clayton 1982). While beekite often only preserves crude features, the *G. arcuata* specimens exhibited some fine detail of growth lines and muscle scars, and in many specimens both valves were preserved *in toto*. Beekite rings generally occurred in the area of the umbo, and as a result the shell structure was not as well preserved here as in other parts of the same specimen.

On internal surfaces - facing hollow spaces within the shells - the shells were coated with small quartz crystals. This most likely reflects shell morphology as well as the mode of silicification and differences in the degree of silica availability during diagenesis, a view further enhanced by the presence of coarse quartz crystals partially filling a hollow space found post acid digestion within the shell near the umbo.

It proved difficult during this study to demonstrate the form of silica deposited in the walls of *G. arcuata*. However, it appears plausible that the original calcite components of the *G. arcuata* shells were replaced by chalcedony. Beekite is made up of chalcedony, and true replacements of bioclast structures are usually formed by chalcedony, whereas megaquartz and microcrystalline quartz infill pore spaces, forming a cast (Carson 1991). Chalcedony can form at low temperatures (< 100°C; White *et al.* 1956, Heaney 1993). For example, the silicified corals and shells of the Hillsborough Bay Formation in Florida appear to have been silicified by chalcedony replacement in the shallow sub-surface, probably involving precipitation from meteoric fluids (Strom *et al.* 1981).

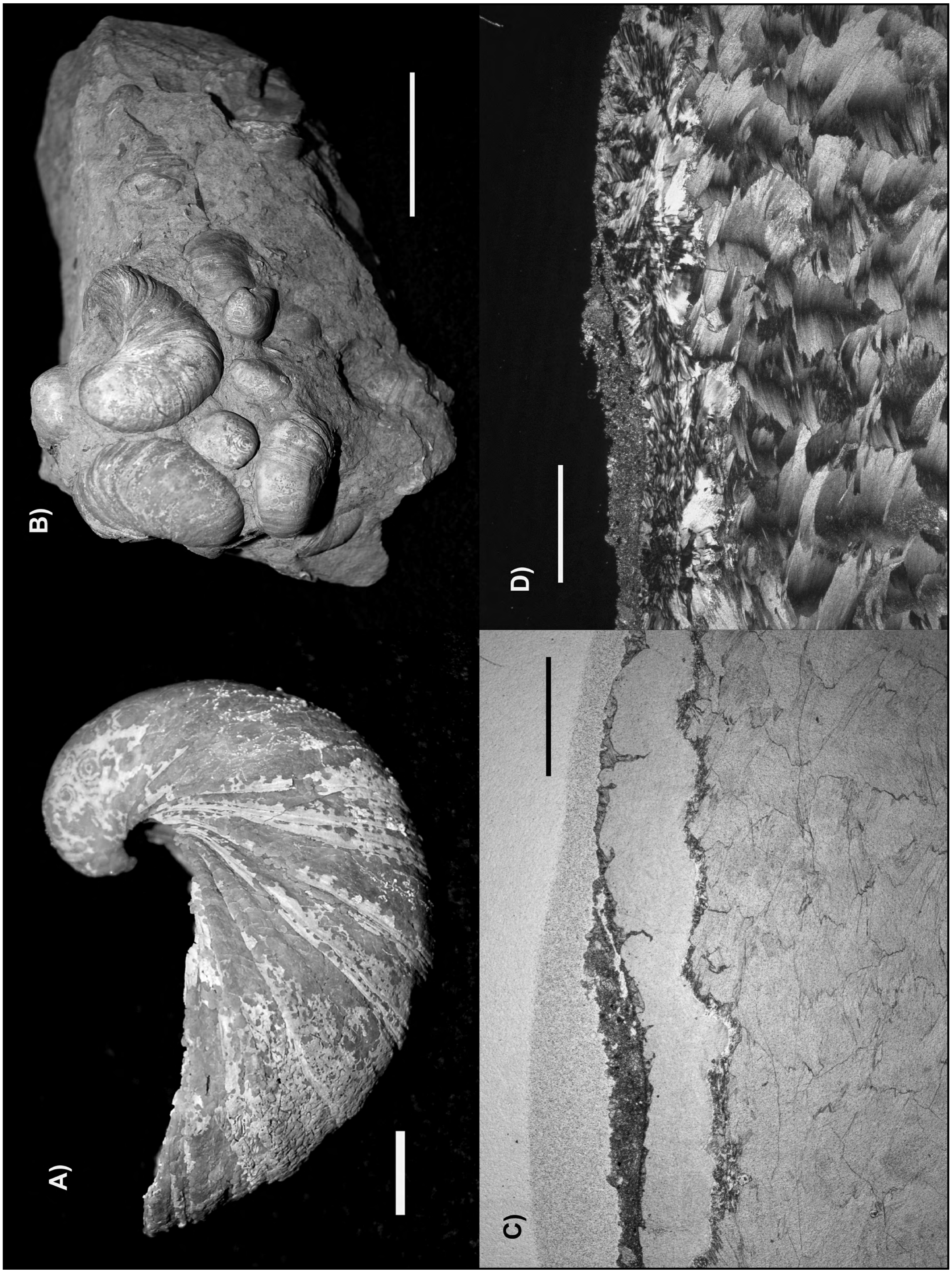

Figure 1: A) Left valve of* Gryphaea arcuata *shell after acid digestion; scale bar 1 cm. B) Silicified* G. arcuata *shells with carbonate-rich host rock prior to preparation; scale bar 5 cm. C) Thin section through* G. arcuata *shell; from top to bottom: the dark broken layer is adhering sediment (micritic limestone), the light continuous layer is the silicified part of the shell, and the bottom half of the image is taken up by calcite; in between the silicified and calcite layers is a very thin contact zone where the calcite is partially dissolved; scale bar 1 mm. D) Same view as C, with crossed nicols; better visible here is the spherulitic chalcedony of the outer part of the silicified layer, with some larger quartz crystals bordering the calcitic part of the shell; scale bar 1 mm.

The timing of replacement of the original shell material can be constrained by one particular event. Silica replacement is commonly an early diagenetic phenomenon (Schubert *et al.* 1997). There are indications that in the case of the *G. arcuata* examined here, aragonite dissolution predated silicification: originally aragonitic fauna have not been silicified - notably ammonites, which were present in the same formation but are only preserved as internal casts. Thin section analysis revealed that *G. arcuata* shells displayed sharp contacts between the original calcite and the replacement chalcedony - similar to the partially silicified corals of the Hillsborough Bay Formation (Strom *et al.* 1981). This suggests that dissolution of calcite was followed directly by precipitation of chalcedony.

An important question with a view as to how potentially damaging acid preparation may be: was calcite dissolution complete prior to silicification? Following acid digestion, the shells exhibited a hollow space between two silicified layers. The side of each layer facing the hollow space displayed microcrystalline quartz, while the side facing the sediment was preserved as beekite. The microcrystalline quartz did not represent fine scale replacement; rather, the shell layer was preserved as a fine covering of small quartz crystals on the inside of the outwards-facing beekite layer.

This indicates three things. Firstly, initial beekite deposition on the exterior part of the shell was the first phase of the silicification process. Silica precipitation occurs only at sites of carbonate dissolution and immediately fills all available space at these sites (Holdaway and Clayton 1982). It seems plausible that the outermost layer of the shell was dissolved first, and immediately replaced by beekite. Additionally, the thickest part of the shell - in bivalves: the umbo - is where beekite replacement most commonly starts (Holdaway and Clayton 1982). In the *G. arcuata* shells observed for this study, coarse beekite rings were seen around the umbonal region, while the rest of the shells preserved in beekite of finer detail, indicating rapid silica precipitation around the umbo and slower precipitation elsewhere.

Secondly, following initial beekite deposition, more calcite was dissolved from the interior of the shells, creating small cavities within these thick-shelled ostreaceans, and in many specimens adjacent to the beekite. Quartz deposition commenced on the inward-facing side of the beekite layer, resulting in the fine covering of quartz crystals. Larger quartz crystals grew inside the cavities, partially filling them. However, not all calcite was dissolved, as revealed by analysis of chemical and imaging data of untreated shells. Some cavity space was infilled by ingress of sediment - many specimens were shown to contain sediment within the hollow space between the two silicified outer shell layers prior to complete acid digestion of all rock matrix. Thirdly, calcite dissolution must have been interrupted and ceased for shells not to be completely silicified. Whether this would have been accompanied by a lack of mobile silica within the sediment is difficult to answer.

A similar mode of preservation was found by Malchus and Aberhan (1998) in Lower Jurassic gryphaeidaeids from Chile: the outermost layers of the shells were often either missing or silicified, with inner shell layers not silicified. As in the Southerndown specimens, the shells had not been completely silicified. Malchus and Aberhan (1998) attributed the state of preservation of their specimens to dissolution of the outermost shell layers before or shortly after burial, with silicification during post-burial diagenesis. In essence, it appears that in the Chilean example calcite dissolution stopped early during diagenesis, which prevented further silicification, regardless of the availability of silica within the sediment.

Conclusions

How then does the mode of preservation at Southerndown as outlined above affect the quality of specimen preparation by acid digestion? Silica replacement, as opposed to silica permineralization, does not necessarily result in the preservation of very fine structural detail. Beekite preservation results in orbicular structures that were not part of the original shell, and is therefore not a faithful representation of the original, even though the broad structure of *G. arcuata* shells is identifiable in the current study.

Additionally, the appearance of hollow spaces within the shell which were not present prior to preparation indicates a loss of material by acid digestion, resulting from incomplete silicification. Arguably, most morphological features required for species identification are recognisable from the exterior, silicified parts of the shells. If the sole purpose of the acid preparation is identification of the species it may be irrelevant if the internal part of the shell is missing.

However, partial internal silicification may also reduce the likelihood of faithfully complete external silicification, and increase the chances of information being lost by acid digestion. As long as it can be shown that silicification of specimens is incomplete, acid preparation has to proceed with extreme caution. It should not be assumed that specimens post preparation are a true image of the original specimen. If there is any chance that the collection may be used for shell structural or ontogenetic research the whole sample should not be enthusiastically committed to the happily fizzing acid bath. If in doubt it is always advisable to check the petrology first, and to experiment with a small number of specimens.

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BOOK REVIEW

Richard West 2009. From Brandon to Bungay. An exploration of the landscape history and geology of the Little Ouse and Waveney Rivers. Suffolk Naturalist's Society, Ipswich, 137pp. No ISBN, paperback. £12 inc. p&p from Ipswich Museum, High Street, Ipswich, Suffolk, IP1 3QH.

To quote the summary provided by the author: "The survey took the form of walking down the Little Ouse valley from Lopham Ford to Brandon to the west and from Lopham Ford to Bungay in the east. The features encountered are described and their origin discussed." Whilst this makes it sound as if it was a matter of a few weeks, it is rapidly clear that some five years of fieldwork, observations and study have gone into this project.

This book is not a volume for the casual tourist, but is a serious volume of work for both professional geologists and geomorphologists. However, I suspect that those who may get most out of it are the interested amateur geologists of the region, the members of the Suffolk Naturalists' Society and more enlightened walkers and visitors to the area. The Palaeolithic archaeology of the region is fully integrated and widens the potential audience, since this area is important in the history of Palaeolithic archaeology in Britain.

For it is not often that one can find a well researched, lucid and informed work explaining the shallowest of lumps and bumps and the subtleties of an eastern England landscape that would be regarded as essentially flat by most people. These most recent landscape evolution events are documented and explained with a sequence of ice sheet blockages modifying former patterns with impounded lakes, overflow drainage channels against a background of Chalk solution. The Breckland heaths of today are a former sandy lakebed.

The crux of the matter though is the Lopham Ford area, which is the watershed between Little Ouse River flowing westward and the Waveney River flowing east. A flat terrace crosses a major east-west valley. Understanding this and explaining the story to a wider audience is the motivation behind the book.

The book is not a end-to-end read, but more of a field guide with 100 pages of area/locality based descriptions and analysis. Plenty of illustrative figures and diagrams explain the development of the individual areas. For me though, the remainder of the book makes the whole story more comprehensible, with 38 full colour plates. These are high quality illustrations, bringing out the somewhat subtle features and details clearly. Many are full page oblique aerial photos, annotated with labels to elaborate on the landforms and features present.

This kind of labour of love will never be mass audience material, but it deserves to be successful, through documenting, explaining and illustrating well some of the most difficult geomorphological and geological landscape to deal with.

Matthew Parkes, Natural History Museum, Merrion Street, Dublin 2, Ireland. 8th September 2009.

HOWARD BRUNTON (1935-2008)

Howard Brunton spent virtually all of his career at the Natural History Museum, London (NHM), undertaking substantial and international research, chiefly on Carboniferous and Recent brachiopods. He was also a past President of the Geological Curators' Group (GCG).

Charles Howard Campbell Brunton, although born in Surrey on 30th May 1935, grew up in Cheshire and went on to board at Bootham School, York. A firm Quaker, he volunteered for the Friends Ambulance Service as his National Service, rather than the Armed Forces. In fact, since his unit was heavily involved in the vicious Algerian civil war, he saw more bloodshed than most of his contemporaries, and was even locked up in a dismal Algerian gaol for two nights (wrong place - wrong time, he laconically said!). He then read geology at Liverpool University (1957-61), and subsequently went on to doctoral work at The Queen's University, Belfast, under the supervision of Alwyn Williams, the leading brachiopod worker of the day. The topic was the chiefly systematic description of a previously undescribed and extremely diverse and important silicified Carboniferous Limestone brachiopod fauna from Co. Fermanagh, subsequently published in three substantial parts of the *Bulletin of the British Museum (Natural History)*. In 1964 he applied for and got a job at the Palaeontology Department of the NHM to succeed Helen Muir-Wood in brachiopod research, and remained there until his formal retirement in 1996, although he continued active research long after that. During that long period he published over eighty papers; and in particular played a leading part in the writing and assembly of the six-volume revised *Treatise on Invertebrate Paleontology: Volume H, Brachiopoda*. Not only did he write the substantial sections on productids (with Dick Grant and Stanislav Lazarev) and orthotetoids (with Alwyn Williams) in the *Treatise*, but took over the overall coordinating editorship of that immense project after the death of Alwyn Williams, and oversaw its completion in 2007.

In addition to essential systematic work on his beloved brachiopod faunas, he was forever trying to work out their biology and lifestyle, publishing astute papers on growth, shape and function and on many other aspects of those apparently simple but actually complex animals. He was one of the innovators in the study of brachiopod shell structure using the scanning electron microscope, of which the

NHM was well equipped. Initially to shed insight into his Palaeozoic faunas, but subsequently for their own interest, he also wrote several papers on Recent brachiopods, including those towed across the Atlantic on the hull of the wrecked *S.S. Great Britain*, which had originated in the Falkland Isles. Howard was one of the small group which organised the Millennium Brachiopod Congress at the NHM in 2000 and also one of the editors of the subsequent volume *Brachiopods past and present* (Taylor and Francis, 2001).

As well as research, he took a very active interest in all aspects of palaeontological conservation and curation, and was a founder member of the GCG, serving on Council for many years and eventually becoming President of the group. A landmark publication was the 218-page looseleaf volume published by the Geological Society of London in 1985, *Guidelines for the curation of geological materials* and edited by Brunton, T.P. Besterman and J.A. Cooper. Howard was also an innovator in the early days of digital curation, experimenting extensively firstly with punched card file systems, then early calculators, and finally digital computers.

As a youth and young man Howard was extremely active, playing hockey for Cheshire Schoolboys and spending much of his spare time in mountaineering, including expeditions to Greenland, Turkey and elsewhere, and was a member of the Alpine Club. But tragedy struck in 1972, when Howard was accidentally pulled off a mountain in the Lake District by a novice to whom he was roped, and fell more than a hundred feet to break his spine and badly injure his shoulder. There followed months of treatment and many operations in the famous specialised Stoke Mandeville Hospital, Buckinghamshire, and more than a year off work, and he subsequently lived the rest of his days in a wheelchair. He spent endless hours in specialised exercises to maintain high fitness in his upper torso, but suffered much pain, which continued until the end. Eileen (née Roberts), whom he had married in 1965, gave up her job as a chemist and changed her profession to move to the NHM as a librarian, and thus gave immense support to Howard as he got back to work and for the rest of his life. It was fortuitous that the new Palaeontology Wing was then under construction at the NHM, and thus Howard was able to become instrumental in ensuring that appropriate facilities for the disabled would be included within it. Howard and Eileen moved from Horsham (from which Howard had previously commuted by train) to a wheelchair-friendly bungalow in Putney, London, from where they could drive to the NHM in an adapted car, and where they stayed until they moved to South Petherton, Somerset, for the last few years until he died on 20th July 2008. It was characteristic of the man that he became influential in aiding other paraplegics like himself: he helped set up a new charity which specially adapted canal barges for holidays; he was for many years on the Management Committee of the Spinal Injuries Association, and was the first Chairman of the Somerset Local Access Forum, amongst many other related activities. But all this did not stop him travelling: Howard and Eileen went round Britain and abroad many times, both for tourism and to attend conferences, at which Howard often spoke and chaired sessions.

Despite his appalling medical problems, Howard was consistently cheerful (I can still hear his rich chuckle), and very good company within the small group which gathered for coffee on the third floor of the Palaeontology Department. He was invariably welcoming to the many visitors to the Brachiopod section, and co-authored papers with colleagues from home and overseas, particularly Fernando Alvarez (Spain), Dave Mackinnon and Daphne Lee (New Zealand), and David Mundy (Canada), as well as several with Alwyn Williams, his original supervisor. Our heartfelt sympathies go out to Eileen.

Robin Cocks

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