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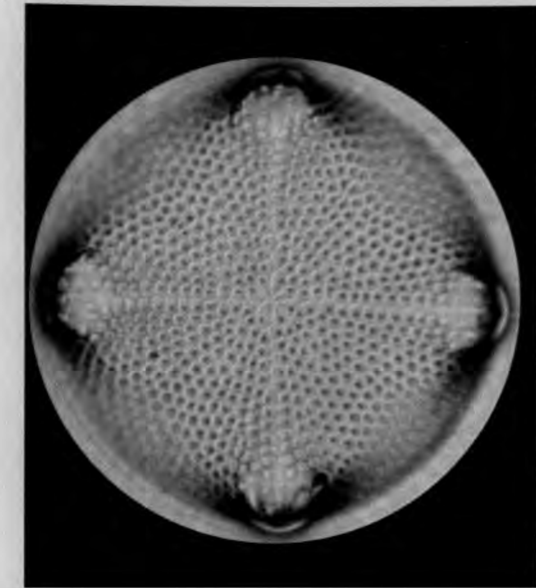
The Amateur Diatomist

Vol. I. No. IV. **March 2003**

Little Imp Publications



In this Issue:-

This issue marks the end of our first Volume. We have managed to publish four issues with our own funds. We cannot continue to finance this alone and have now determined to request subscriptions for the four issues of Volume 2. A subscription sheet is included with this issue.

The publishers welcome contributions to the content of the publication, including articles, letters, photographs, etc. These may be submitted by post in electronic or hard copy format or by email (address details on the back cover).

Advertising in this publication is free to private individuals. Commercial organisations should remit a small contribution towards costs.

There is no strict editorial policy.

Cover Picture: Aulacodiscus notatus - a digital photograph by Steve Edgar

Fragilaria Harrisonii

by Dr. Kenneth R. Green

This diatom was named after the Hull naturalist Harrison.

A.Schmidt's Atlas der Diatomaceenkunde t.296 f.16-18

In the mid 1800s a virtually pure culture of this species abounded in the springs of Halternprice (about 2 miles South West of Cottingham, see map). Haltenprice was a priory founded at Newton by the d'Estutville family on the site of a miraculous well known as 'Lady Well', which produced this diatom in vast quantities, although the distribution elsewhere in Yorkshire was quite rare. The priory church was dedicated to 'The Holy Cross' (St. Crux) and together with the priory buildings was totally lost in 1538 after the Dissolution, being used as a convenient 'quarry' by the landed gentry as dressed stone was hard to come by in the East Riding of Yorkshire! As the diatom is cruciform in shape and is rare in distribution I think it very fitting that it should be closely associated with the priory of the Holy Cross. Sadly due to extensive water extraction by Hull City the water table has dropped considerably and the springs of the area no longer rise and the diatom is no longer with us at this site. There are occasional frustules appearing in recent strews from the East Yorkshire Derwent but the species itself appears to be quite rare. Any notices of other locations in East Yorkshire where this diatom is to be found will be gratefully received.

Amazing Fact - I

Diatomite, or diatomaceous earth, was apparently used by the ancient Greeks as an abrasive and in making lightweight building blocks. In 532 A.D., blocks of diatomite were used for the 32.6 metre-diameter dome of the Church of St. Sophia in Istanbul, Turkey (Maurrasse, 1978, p. 263). However, it only became of industrial interest in Europe in the mid-1800's. One of the first uses at that time was as insulating brick.

A note about Xanthoplasts

by Dr. Maurice O. Moss

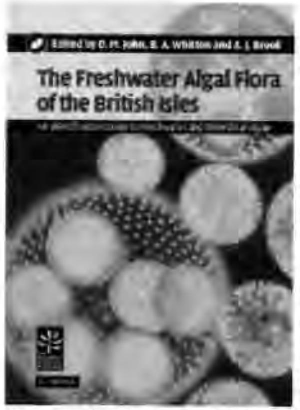
In Issue No. 1 'What is a Diatom' there is the possibility of the reader misinterpreting the comment about the terms xanthoplast and chloroplast.

The chloroplasts of diatoms DO contain chlorophyll as well as xanthophyll (which are deeply coloured carotenoids which mask the green chlorophylls). Yes, the xanthophylls are involved in photosynthesis as auxiliary light gathering pigments but the chlorophylls are the molecules which finally convert light energy into chemical energy. The carotenoids may also play a role in protecting the chlorophylls from the more damaging effects of light (especially the presence of activated oxygen). The term plastid is a more general term which includes the chloroplast.

(Editor's Note:- There will be a small article on paper chromatography in the future which will describe these chlorophyll/xanthophyll combinations).

Book Review

by Mark Burgess



The Freshwater Algal Flora of the British Isles - An Identification Guide to Freshwater and Terrestrial Algae - D. M. John, B. A. Whitton, A. J. Brook

Cambridge University Press ISBN: 0521770513 (Hardcover) 714pp illus. (2000 line diagrams 11 half-tones 500 colour images on CD) £75.00

The British have long been fascinated by algae. Perhaps the first mention of algae in these isles is a chronicle that describes the monastery of Soulseat (near Straraer) as monasterium viridis stagnii: the monastery of the green ponds. (This book offers the Victorian mis-translation "the Monastery of the Green Stank.")

Scientific treatment of our algal flora properly began with Dillwyn's British Confervae1, of only 87 pages, which appeared between 1802-1809. Robert Kaye Greville produced a section on diatoms for the second volume of Sir William Hooker's British Flora2 and in 1845 came Hassall's A History of the British Freshwater Algae3. John Ralfs produced his British Desmidae4 in 1848 followed by Smith's Synopsis of the British Diatomaceae between 1853 and 18565.

So by 1860, Great Britain had an impressive selection of works devoted to a group of unsurpassed beauty whose accurate diagnosis required a light microscope and, at least in the case of the diatoms, one working close to its theoretical limit.

Books on British algae took a bit of a stumble with the works of Mordecai Cubitt Cooke 6, 7, an expert on fungi who was an indefatigable if sometimes slapdash writer on all sorts of natural history subjects, especially the microscopic (he founded the Quekett Microscopical Club). West and Fritsch8 commented: "It may be doubted if 25 per cent of the British freshwater algae could be identified with certainty from Cooke's book."

The father and son team of William and George West made a huge contribution to the study of British algae: "a model of what such researches should be," wrote Fritsch8. Together they wrote the Ray Society volumes on the desmids9 and in 1904 George West wrote A Treatise on the British Freshwater Algae 10.

It is unlikely that West would have believed that his book would be the only comprehensive treatment of British algae for nearly a century. It was revised by F. E. Fritsch in 1927 and in that form reprinted in 1968, but, effectively, there has been no comprehensive work on British freshwater algae since.

West and Fritsch dealt with 250 genera; there are now 550. A new book had been needed for a long time, in fact for the lifetime of most living phycologists. There have been some good introductions, especially that by Pentecost 198411, but for comprehensive guides phycologists have had to rely on works in French12, 13, 14, German15 and even Polish16, 17, 18. Incidentally, the introduction to The Freshwater Algal Flora of the British Isles includes Pentecost's Introduction to Freshwater Algae in a list of books which are "[not] comprehensive enough to identify the majority of the species in most mixed field samples". This is more than harsh; it is wrong, unless I have collected only boringly predictable samples in the last 10 years.

The Freshwater Algal Flora of the British Isles has been 10 years in the making. It began as a

proposal from David John and Brian Whitton in 1991. The marine phycologists of the British Phycological Society started their series of identification guides 50 years ago (and have still not finished). To get the book done (relatively) quickly, the authors had to make cuts. There are about 5,000 species of algae in the UK (2,200 excluding diatoms) and this book covers 1,700. Of the 800 species of desmids only 300 of the commonest are here. The major omission is, however, the diatoms.

Why? West and West and Fritsch managed to include them, and Pentecost has a good key to the commoner forms. Even Hilary Belcher and Erica Swale managed to include a few diatoms, and their work19 is only 48 pages long. The reason, explains the preface, is that in 1998 the diatomists on the committee withdrew "believing it impossible to include diatoms until much further taxonomic research had been carried out." It continues: "Fortunately, diatoms are one of the few algal groups for which there already exist fairly comprehensive identification guides." That fairly is good.

The book begins with the fine sentence: "No waterbody in the British Isles has been reported to have conditions extreme enough to prevent algal growth", introducing a section on the scope of the Flora and proceeds through a discussion on distribution and ecology to a history of freshwater algal studies in the British Isles and then field and laboratory methods. The last two are full of good advice on general collection and forcing reproductive structures. Sampling by placing microslides in ponds is not as difficult as suggested here (I use a bulldog clip attached to a string running through a cork: if you are interested you can spot it on the Viaduct Pond, Hampstead). And to say "a permanent photographic record can be made using a photographic system fitted to the compound microscope" is surely stating the obvious, and doing so rather in the manner of Henry James.

A short section on classification is followed by a key to the main groups. The blue-green, the yellow-green, the green, the brown the golden brown and the red are organised in phyla, so we have Cyanophyta, Rhodophyta; Euglenophyta, Cryptophyta, Pyrrophyta, Raphidophyta, Haptophyta, Chrysophyta, Xanthophyta, Eustigmatophyta, Bacillariophyta (only just), Phaeophyta, Prasinophyta, Chlorophyta and Glaucophyta. I am not taxonomist enough to argue with this, but common sense asks: is there really a phylum's worth of difference between Microspora (Chlorophyta) and Tribonema (Xanthophyta)? It's not easy even to tell them apart.

The first phylum to be considered is the blue-green algae, the Cyanophyta or Cyanobacteria. Brian Whitton turns in one of the finest chapters in the book. It is unlikely that anyone now living knows as much about the blue-greens as Professor Whitton and he communicates his store of knowledge clearly and well. His chapter also includes marine species as a sort of bonus and is good on practical advice. The keys are excellent - especially on difficult genera such as Oscillatoria and Lingbya - and the illustrations lucid. He discusses, but is not unduly concerned or delayed by, the anomaly of some authors classifying the blue-greens under the International Code of Bacteriological Nomenclature and some under the International Code of Botanical Nomenclature.

Next is the red algae, the Rhodophyta by Robert Sheath and Alison Sherwood. This chapter omits any reference to Shigeru Kumano's thorough revision of the order Rhodophyceae in 200020 and the 1997 work of Tim Entwisle and Helen Foard21. I was brought up short by statements like this: "probably cosmopolitan; only found in a single site in Scotland" [on Audouinella pygmaea]. The chapter is unusual in being illustrated by half-tone photographs, not very successfully.

Konrad Wolowski produces a very good account of the euglenoids, another difficult group and Gianofranco Novarino tackles the cryptomonads, a very difficult group. The dinoflagellates

(Pyrrophyta) are next, by Jane Lewis and John Dodge. They bring together all historical accounts and records for the British Isles but there are likely to be undiscovered species out there: as the authors say, coverage of dinoflagellates has been sporadic and partial. Allan Pentecost looks at the Raphidophyta, a small group of unicellular flagellates and Hans Preisig writes on the Haptophyta; flagellates well represented in marine waters (about 300 species in 80 genera) but with only five species recorded from British freshwaters.

The Introduction states: "Little consideration is given to ultrastructural detail, since most users of this volume will not have access to scanning or transmission electron microscopy." This is a problem for the next chapter, on the golden-browns (Chrysophyta). Most of the silica-scaled forms can only certainly identified with the electron microscope. Jorgen Kristiansen therefore confines himself to those which can be identified by light microscopy. The illustrations of Dinobryon are odd in showing only the outline of the 'flasks' with no detail of the contents or scale patterns. His own book22 on the Chrysophyta does not appear in the references.

Leslie Johnson writes on the yellow-greens (Xanthophyta) next, which includes the familiar Vaucheria and Tribonema. The illustrations in this chapter are very well done. David John has but three species to write about in the Eustigmatophyta, small unicellular coccoid algae most often found, when at all, in soil cultures. There are well over 2,000 species of diatoms, and one can sympathise with the editors not wanting to add to an already weighty book (2.33kg) with them all.

Martyn Kelly and Elizabeth Haworth in the short section on Bacillariophyta explain that the widespread use of the scanning electron microscope in diatom studies has shown morphological characteristics "not visible with light microscopy". This had led to chaos in the group's taxonomy, and until the dust settles it would be premature to produce a British flora. The chapter refers the reader to various modern guides including the FBA guide23 and Eileen Cox's book on the identification of live, or at least unprepared, diatom material24. The book's Foreword by J. W. G. Lund expresses the hope that "it will not be long before there is a diatom Flora of the British Isles" but I fear it will be. We have waited nearly a century for this replacement of A Treatise on the British Freshwater Algae. The Foreword continues: "it is surely better to have even an imperfect account than no account at all." Well, not if it queers the pitch for anyone else. The chapter on the brown algae is written by John Wehr. This mainly marine group has two, perhaps three, freshwater representatives in the British Isles, mainly on submerged rocks or wood. Øvind Moestrup writes on the Prasinophyta next. This is a small group of small yellow-green algae - named after the Greek for leek (prasou), Moestrup says - that are the oldest group of algae and may even date back to the Pre-Cambrian.

The green algae, the chlorophytes, are the most species-rich and diverse group of all the algae. This mighty chapter, 326 pages long, is written by Allan Pentecost (Tetrasporales, Volvocales, Oedogoniales), David John (Chaetophorales, Klebsormidiales, Microsporales, Ulotrichales, Cladophorales, Coleochaetales, Prasiolales, Sphaeropleales, Trentepohliales, Chlorococcales), Petro Tsarenko (Chlorococcales), Robert Huxley (Oedogoniales), Ian Tittley (Ulvales), Alan Brook (Zygnematales), Leslie Johnson (Zygnematales), Jenny Bryant (Charales) and Nicky Stewart (Charales). It is a massive undertaking and one is stunned at the thought of all the hard work that has gone into it. There are so many genera in the chlorophytes that are a pain to identify - Spirogyra being only the most obvious - it is good to have, at last, a set of clear keys, based on morphology as often as possible, which have been written by people with a perspective of years of experience and familiarity.

The last phylum is Glaucophyta, those algae that have cyanelles rather than chloroplasts.

There is a glossary a list of references and taxonomic and subject indices. Oh, and tucked inside the back cover is a CD-ROM with 500 coloured pictures of various species. The CD-ROM will run on any graphical web browser, such as Netscape or Internet Explorer. The recommended minimum specifications are a Pentium II with a 350MHz processor, 64Mb of memory, 24x CD-ROM and a 8Mb graphics card. To use, you click on the phylum and scroll the alphabetical arranged list of taxa. You can search it using a 'search on page' function but if you don't know the phylum, you'll have to look it up in the book.

So, was it worth the wait? Do we have something to set alongside Bourrelly? Can we now retire our West and Fritsch. Yes to all of that. This is an exceptional book that lives up to its claim in the preface, a book designed for "non-specialists requiring a user-friendly, well-illustrated guide written in English that describes as many of the British freshwater algae as possible". There are some areas where it disappoints slightly, and there is no excuse for getting the caption to the cover photograph wrong; someone among the team should know the difference between dark-field and differential interference contrast. But the few shortcomings could be put right only by much greater resources, an army of phycologists working shifts, India paper and all sorts of things. Everyone who studies algae will be grateful for this book. Now those who were inspired by Hilda Carter-Lund and John W G Lund's book25 have no excuse not to pursue the study of a fascinating, diverse and visually ravishing group.

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The Geological Time Scale and the diatoms place in it.

- Precambrian Time (544 - 4500 million years ago)
  - Hadean (Priscoan) Era (3800 - 4500 million years ago)
  - Archaean Era (2500 - 3800 million years ago)
  - Proterozoic Era (544 - 2500 million years ago)
    - Vendian Period (544 - 650 million years ago)
- Phanerozoic Eon (present day - 544 million years ago)
  - Paleozoic Era (248 - 544 million years ago)
    - Cambrian Period (505 - 544 million years ago)
    - Ordovician Period (440 - 505 million years ago)
    - Silurian Period (410 - 440 million years ago)
    - Devonian Period (360 - 410 million years ago)
    - Carboniferous Period (286 - 360 million years ago)
      - Mississippian Period (325 - 360 million years ago)
      - Pennsylvanian Period (286 - 325 million years ago)
    - Permian Period (248 - 286 million years ago)
  - Mesozoic Era (65 - 248 million years ago)
    - Triassic Period (213 - 248 million years ago)
    - Jurassic Period (145 - 213 million years ago)
    - Cretaceous Period (65 - 145 million years ago)
      - First diatoms identified from 120 million years ago
  - Cenozoic Era (present day - 65 million years ago)
    - Tertiary Period (1.8 - 65 million years ago)
      - Paleocene Epoch (55.5 - 65 million years ago)
      - Eocene Epoch (33.7 - 55.5 million years ago)
      - Oligocene Epoch (23.8 - 33.7 million years ago)
      - Miocene Epoch (5.3 - 23.8 million years ago)
      - Pliocene Epoch (1.8 - 5.3 million years ago)
    - Quarternary Period (present day - 1.8 million years ago)
      - Pleistocene Epoch (8000 - 1.8 million years ago)
      - Holocene Epoch (present day - 8,000 years ago)

Diatoms are a geologically recent group, first appearing in the fossil record in the mid Cretaceous. This means that our beloved denizens of glass houses are mere striplings in the great scheme of things. The Earth had been going for some 4380 million years before a diatom built the first frustule.

From that time to the present day, as the diatoms died, their silex frustules sank to the bottom of the oceans. Since the frustule material, Silex, is practically inert they don't decay and are preserved in the sediments and indeed their remains, as the millenia tick by, more and more valves, form ever deeper deposits of diatomaceous ooze. In the depths of the oceans where this ooze occurs there is little movement save for gradual compression of the material under its own weight and eventually the movements of the crust bring the material to the surface which we then know as diatomaceous earth. This deposit may then be analysed, using our knowledge of modern diatoms, to give an indication of the conditions prevailing when the deposit was laid down.

We can, for instance, determine the likely water temperature by comparing the number of cold water species with the number of warm water varieties. It is also possible, using this technique to determine the preferred temperature of a species which no longer exists by association with fossil species which are still extant.

Stratigraphy

Stratigraphy is the science of arranging rock layers found in various regions of the earth into successions. Stratigraphic Classification is then used to define the layers and groups of layers. The next step is to arrange those layers into sequences and then matching the layers of different regions. This is known as Stratigraphic Correlation. Correlation can help in resolving the unknowns concerning the Earth in general and the Earth's crust in particular. It aims to provide an understanding of the Earth's processes active in a region in the past. Stratigraphy is thus an important tool in locating mineral deposits.

Stratigraphic Correlation

The following criteria assist in establishing stratigraphic correlation within a region and between different regions.

1. Order of Superposition.
2. Palaeontology
3. Geophysics
4. Structural Geology
5. Petrography

Superposition

Under normal conditions, rocks laid down on the Earth's surface - sedimentary or volcanic - generally lie in a horizontal plane and younger rocks are laid down on top of older ones. Therefore, in successions with simple structures the order of superposition is going to determine the relative ages of each successive layer. The top layer in such instances is younger than the layers below it. In successions that have experienced some deformation due to crust movements and upheavals, a part of the succession under study may actually be an inverted or vertical sequence. The order of superposition in these scenarios cannot be used to determine relative ages because of the more complex and, possibly, incomplete structure.

Palaeontology

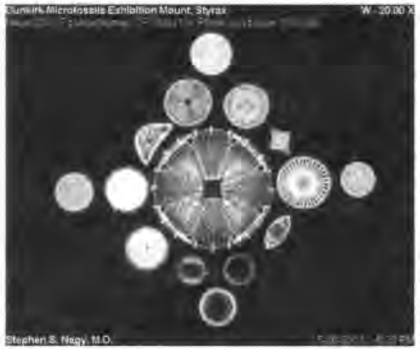
Even though recent advances in geochronology and geophysics have been legion, palaeontology remains an important and popular tool in stratigraphical assessment. Correlation of rocks of sedimentary origin, in particular those deposited during the Phanerozoic eon, is often established based on the nature of the fossil record within those layers.

Fossil groups are characteristically associated with periods in the geological time-scale. Some groups may have extended over many time periods whilst others may be quite unique to a particular time. These latter examples, if they are commonly fossilised, may be used to fairly accurately date a layer and in such instances these life-forms are known as index fossils. Though index fossils are useful it can be foolhardy to use rare index fossils to indicate the age of strata and a much more accurate method is to utilise a fossil assemblage. This eliminates the likelihood of error and there is a much greater opportunity to cross-check your estimates with many more known examples.

Whilst the larger fossils can be studied with a hand-lens the much smaller microfossils occur in very large number in many sedimentary rocks. Foraminifera fossils occur abundantly in marine formations, whereas ostracods occur in both marine and river deposits and diatom frustules occur in both.

A selection from Dunkirk, Maryland, U.S.A.

by Stephen S. Nagy M.D.



A small arrangement from the fossil material of Dunkirk, Maryland. The centric in the centre is 120 microns diameter; the small one on the edge at 6:30 is a Rhaphidodiscus marylandicus, quite rare and would have been impossible to find without it's characteristic appearance in darkfield illustrated nicely in the photograph.

The diatoms in the mount were selected from fossil material from Dunkirk, Maryland, cleaned by the hot acid method, and separated into two sub-specimens: those retained on a 200 mesh screen, and, with the material that passed through, those retained on a 635 mesh screen. A strew was made of the latter specimen and individual diatoms selected from this strew using a Kemp micromanipulator. They were arranged and mounted using styrax, and then photographed using a Nikon phase contrast condenser set to use the 100x annulus with a 10x CF planachromat objective, using a Kodak MDS 100. The light source was filtered of infrared using two 1/8" thick infrared-blocking filters, a method suggested to me by David J. Jackson of River Edge, New Jersey. Material from this location is available for exchange. please see the Sales, Wants and Exchanges section.

Mounting Techniques - IV

Fluid Mounts

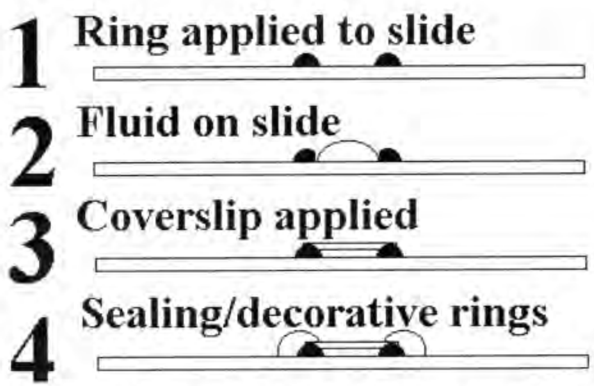
This article is going to describe fluid mounts of cleaned frustules and not of preserved live material which will form the subject matter of a future part. This method is from a description by Cedric N. Walter. (Some may have slides with a red label marked C. N. Walter)

Step 1. Take a clean slide and apply a ring of polyurethane varnish which is slightly larger in diameter than that of the coverslip.

Prepare a small vial of diluted, cleaned diatom suspension. Add to this two drops of Formaldehyde. This will ensure that no mould will invade the cell.

Step 2. When the varnish ring is tacky (this is best determined by applying a similar ring, at the same time, to a scrap piece of glass) swirl the diatoms into suspension and , using a pipette, place a drop of the liquid into the ring.

Step 3. You are now ready to apply the coverslip. You may choose to place the slip in the normal diagonal manner, that is one side down and then allowing the other side to drop. This is alright but has a tendency to force diatoms to be expelled with any excess liquor. A better method, which is less violent, is to take a small piece of glass tubing which has been annealed at its end. Wet this with a little saliva and then pick up the coverslip by simply dabbing the rod onto its surface. The coverslip may now be applied to the ring flat and excess liquor is expelled evenly all the way round the cell. Apply gentle pressure to bed the coverslip onto the varnish ring. Be careful not to apply too much force or the coverslip will crack. On lifting the glass rod the contact between coverslip and varnish is sufficient to release the hold on the coverslip by the rod. Use filter paper to mop up any fluid that has been expelled onto the slide.



This process takes a little practice to judge the amount of suspension to use such that no bubbles are formed inside the cell.

Step 4. Allow any moisture on the varnish ring to evaporate and then apply a varnish ring atop the original and overlapping the coverslip. This will seal the mount. Leave for 24 hours to dry and then apply a second ring. When dry the whole cell should be completely sealed and you may then proceed to apply whatever decorative ringing you prefer.

If you prefer you may make the initial ring with paraffin wax and simply use a heated needle run around the edge of the coverslip to bed it in.

The method used is similar to that used in creating dry mounts. It does, however, introduce a new technique for handling coverslips which can be used advantageously in other mounting procedures.

Cleaning Diatoms

by Steve Gill

Part 4. - Processing Fossil Diatomite

There are principally two tried and tested methods of processing fossil material. You must judge for yourself which method is more suitable and which you prefer. I am simply informing you of the methods I use and I cannot be held responsible for any mishaps you may encounter when working with acids. Most fossil material is received in blocks or small nodules that to all intents and purposes are rock. That is they are not friable. To process this the 'rock' needs to be broken up. Hitting it with a hammer might well break it up but the chances of finding whole valves thereafter is somewhat reduced. The breaking up requires to be done in a gentle manner.

Method 1. - Freeze and thaw.

For particularly hard diatomite this is the preferred methodology. Diatomite is porous and will absorb quite a lot of water. Soak the fragment to be processed in water overnight or if you prefer boil it up in a wide test tube. The air is forced out of the rock and is replaced with water. Once you are satisfied that you have a thoroughly saturated specimen transfer it with the water to a plastic freezer bag which you should firmly knot to ensure that subsequent processing will not result in the loss of any of your sample. Place the bag in the very coldest spot in your freezer. In about 2 hours the whole will be frozen solid. Take it from the freezer and dip the bag into hot water. DO NOT EVEN THINK ABOUT USING THE MICROWAVE! This last statement requires a little clarification. Microwaves have a tendency to heat things up from the inside and highly active water molecules inside rock have a tendency to erupt with as much force as an Icelandic geyser and if they can't make it to the outside world fast enough blow the rock apart with similar force evinced during the eruption of Krakatoa. Unfortunately the somewhat thin freezer bag provides little resistance to this with the result that your sample (and possibly your microwave) are liberally distributed throughout your kitchen. Repeat the above safe procedure until the contents of the freezer bag have turned into a slurry. You may now proceed with cleaning using the hot acid method described in a previous article by Mike Samworth.

Method 2. - This method should really only be considered on small samples that are quite light in weight and thus not densely compacted. East African diatomite is usually of this type, Oamaru diatomite isn't.

Place your small sample in a test tube and add concentrated Hydrochloric Acid to twice the depth of the sample. Leave overnight. If there is some effervescence when you first add the acid let this subside before adding more. Add the acid drop by drop to avoid ejection of the whole if there is some bubbling. Heat to boiling point and then leave overnight. The next morning take a glass rod and gently break the specimen up. At first this will seem difficult but after a brief time the whole sample should crumble. You should then dilute the acid using a distilled water applicator running the water down the side of the test tube and agitating vigorously. This particular exercise is fraught with danger and goes against all known recommendations for the mixing of acids and water. The agitation is to ensure that no separation is maintained in the liquids, the juncture of which heats up and results in the violent ejection of the contents. If you choose to use this method then you should take all necessary precautions. If you wish to add the acid to water then you should do so by gently decanting the contents of the test tube into a beaker of water sitting in an ice bath. I mean that the beaker should be in an ice bath, not you. Once you have a dilute solution you must centrifuge and wash repeatedly until all traces of acid have been removed. With luck you will have a cleaned sample at this stage.

Results of a random survey.

We were interested to know how the format of the publication had been received. It was determined that the best way to elicit this information was to canvas some of our readership and collate the results.

The following table represents the returns expressed as a percentage of the questionnaires returned.

Question	**Yes**	**No**	**Not sure**
Does the Amateur Diatomist address a gap in the currently available publications?	100%	0%	0%
Do you think the format is appropriate?	87%	0%	13%
Would you like to see an associated web site created?	62%	0%	38%
Would you be prepared to pay for the publication?	85%	0%	15%
Would you contribute an article, some notes, a letter or any other material for publication?	25%	0%	75%
	Enhance	**Detract**	**Don't Care**
Does advertising enhance or detract from the publication?	63%	0%	37%

As you can see we didn't have any out and out NOs to any of the questions, but that might have been as a result of how we phrased them.

The 100% result for the issue of whether the publication filled a need is particularly encouraging.

The format, though not universally accepted as correct, at least didn't elicit any major criticism.

The creation of a web site result is slightly more difficult to interpret even though there is a 2:1 ratio Yes to Don't Cares. In hindsight, what we failed to ask was how many of those respondents had access to an Internet capable computer.

The question concerning readers willingness to pay for the publication was set not because we wish to do so, but because the parting with cash tends to focus peoples mind on whether or not something is sufficiently good to warrant purchase. A pleasing result then, in that 85% would be prepared to purchase. We really need to find out what the remaining 15% would like to see to make them change their mind.

Advertising has always been a contentious issue when publishing an interest journal of this nature. The response to the question concerning advertising is not only of interest to ourselves but perhaps more so to our advertisers. The figures here are a true representation of returns so we should all base our judgements upon them. We don't think they are too bad. Of the 85% of those prepared to pay for the journal 71% of those believed that advertising enhanced the content and the remaining 29% were ambivalent towards advertising. A number of returns were made where the reader wasn't interested in the advertising but was also unsure as to whether they would be prepared to pay for the journal. At least they didn't completely condemn advertising!

Diatom Genera List - I,J,K,L,M,N and O

The list contains the naming authority and the date when the genus was first described.

Genus	Described by	Date
Iconella	A. Jurilj	1949
Ikebea	S. Komura	1975
Incisoria	M. Hajós in M. Hajós & H. Stradner	1975
Inoderma	F. T. Kützing	1833
Insilella	C. G. Ehrenberg	1845
Isodiscus	J. Rattray	1888
Isthmia	C. A. Agardh	1832
Isthmiella	P. T. Cleve	1873
Janischia	A. Grunow in Henri-Ferdinand van Heurck	1882
Jousea	Z. I. Glezer	1967
Kannoa	S. Komura	1980
Karayevia	F. E. Round & L. Bukhtiyarova	1996
Katahiraia	S. Komura	1976
Kentrodiscus	J. Pantocsek	1889
Keratophora	J. Pantocsek	1889
Kerkis	R. Gersonde & D.M. Harwood	1990
Kidoa	S. Komura	1979
Kisseleviella	V. S. Scheschukova-Poretskaya	1962
Kittonia	E. Grove & G. Sturt	1887
Klinodiscus	A. Jurilj	1949
Koizumia	Y. Yanagisawa	1994
Kolbesia	F. E. Round & L. Bukhtiyarova	1996
Kozloviella	A. P. Jousé	1974
Krasskella	R. Ross & P.A. Sims	1978
Kreagra	R. Gersonde & D.M. Harwood	1990
Ktenodiscus	J. Pantocsek	1889
Kuemmerlea	J. A. Krenner	1926
Lamella	J. Brun	1894
Lampriscus	Adolf Schmidt.	1882
Lamprotediscus	J. Pantocsek	1892
Lancineis	G. W. Andrews	1990
Lauderia	P. T. Cleve	1873
Lauderiopsis	C. H. Ostenfeld & J. Schmidt	1901
Lemnicola	F. E. Round& P. W. Basson	1997
Lepidodiscus	O. N. Witt	1886
Leptocylindrus	P. T. Cleve in C.G.J. Petersen	1889
Leptoscaphos	H. -J. Schrader	1969
Leudugeria	Jean-ClodiusTempère ex Henri-Ferdinand van Heurck	1896
Leyanella	G. R. Hasle, H.A. von Stosch & E.E. Syvertsen	1983

Libellus	P. T. Cleve	1873
Licmophora	C. A. Agardh	1827
Licmosphenia	C. Mereschkowsky I	902
Lindavia	(F. Schütt) G.B. De Toni & A. Forti	1900
Lingulatium	A. G. Vologdin	1962
Lioloma	G. R. Hasle in G.R. Hasle & E.E. Syvertsen	1996
Lioneis	C. G. Ehrenberg	1862
Liostephania	C. G. Ehrenberg	1847
Liparogyra	C. G. Ehrenberg	1848
Liradiscus	R. K. Greville	1865
Liriogramma	R. W. Kolbe	1954
Lisitzinia	A. P. Jousé	1978
Lithobotrys	C. G. Ehrenberg	1844
Lithocampe	C. G. Ehrenberg	1844
Lithodesmioides	H. A. von Stosch	1987
Lithodesmium	C. G. Ehrenberg	1839
Lobarzewskya	V. B. A. Trevisan di San Leon	1848
Lobodiscus	E. G. Lupikina & G.K. Khursevich	1991
Longinata	M. Hajós in M. Hajós & H. Stradner	1975
Lophotheca	H. -J. Schrader	1969
Lunella	P. Snoeijs	1996
Lunulina	J. B. M. Bory de Saint-Vincent	1822
Luticola	D. G. Mann in F.E. Round, R.M. Crawford & D.G. Mann	1990
Lyngbyea	S. C. Sommerfelt	1826
Lyrella	N. I. Karayeva	1978
Lysicyclia	C. G. Ehrenberg	1856
Lysigonium	H. F. Link	1820
Macrora	G. D. Hanna	1932
Maluina	R. Ross & P.A. Sims	1987
Mammidion	J. A. Long, D.P. Fuge & J. Smith	1946
Mammula	G. Karsten in A. Engler & K. Prantl	1928
Manguinea	T. B. B. Paddock	1988
Mannsia	T. B. B. Paddock	1988
Margaritoxon	C. Janisch	1862
Margaritum	H. Moreira Filho	1968
Martyana	F. E. Round in F.E. Round, R.M. Crawford & D.G. Mann	1990
Mastodiscus	J. W. Bailey	1854
Mastogloia	G. H. K. Thwaites in W. Smith	1856
Mastogonia	C. G. Ehrenberg	1844
Mastoneis	P. T. Cleve	1894
Mediaria	V. S. Scheschukova-Poretzkaja	1962
Melchersiela	C. Teixeira	1958
Melonavicula	T. Christian	1886

Melosira	C. A. Agardh	1824
Membraneis	T. B. B. Paddock	1988
Meretrosulus	G. D. Hanna	1927
Meridion	C. A. Agardh	1824
Meristosolen	D. M. Harwood & R. Gersonde	1990
Mesasterias	C. G. Ehrenberg	1872
Mesodictyon	E. Theriot & J.P. Bradbury	1987
Meuniera	P. C. Silva in G.R. Hasle & E.E. Syvertsen	1996
Micrampulla	G. D. Hanna	1927
Micromega	C. A. Agardh	1827
Microneis	P. T. Cleve	1895
Microorbis	R. Gersonde & D.M. Harwood	1990
Microsiphona	C. I. Weber	1970
Microspodiscus	A. Grunow in Henri-Ferdinand van Heurck	1883
Microstigma	(P. T. Cleve) F. Meister	1919
Microtabella	F. E. Round in F.E. Round, R.M. Crawford & D.G. Mann	1990
Microtheca	C. G. Ehrenberg	1838
Minidiscus	G. R. Hasle	1973
Minutocellus	G. R. Hasle, H.A. von Stosch & E.E. Syvertsen	1983
Miraltia	D. Marino, M. Montresor & A. Zingone	1987
Mitralifer	A. G. Vologdin	1962
Moelleria	P. T. Cleve	1873
Monema	M. J. Berkeley	1833
Monema	R. K. Greville	1827
Monile	R. Ross & P.A. Sims	1987
Monobrachia	H. -J. Schrader in H.-J. Schrader & J. Fenner	1976
Monoceros	A. C. J. Van Goor	1924
Monocis	P. Lefébure	1947
Monogramma	C. G. Ehrenberg	1843
Monopsia	E. Grove & G. Sturt	1887
Muelleria	(J. Frenguelli) J. Frenguelli	1945
Muelleriella	Henri-Ferdinand van Heurck	1896
Muelleriopsis	N. I. Hendey	1972
Nanoneis	R. E. Norris	1973
Naunema	C. G. Ehrenberg	1838
Navicella	K. Krammer	1997
Navicula	J. B. M. Bory de Saint-Vincent	1822
Naviculadicta	H. Lange-Bertalot in H. Lange Bertalot & G. Moser	1994
Naviculopsis	V. A. Nikolaev	1966
Neidium	E. Pfitzer	1871
Nematoplata	J. B. M. Bory de Saint-Vincent	1822
Neobrunia	O. Kuntze	1894
Neodelphineis	H. Takano	1982

Neodenticula	F. Akiba & Y. Yanagisawa	1985
Neodiatoma	A.Kanitz	1887
Neofragilaria	D. M. Williams & F.E. Round	1988
Neofragilaria	T. V. Desikachary, A.K.S.K. Prasad & P. Prema in Desikachary & Prema	1987
Neograya	O. Kuntze	1898
Neohuttonia	O. Kuntze	1898
Neostreptotheca	H. A. von Stosch	1977
Neosynedra	D. M. Williams & F.E. Round	1986
Nephroneis	M. C. Amspoker	1989
Nitzschia	A. H. Hassall	1845
Nitzschiella	L. Rabenhorst	1864
Nitzschiopsidea	J. Gruss	1928
Noszkya	P. Lefébure & E. Chenevière	1939
Nothoceratium	G. B. De Toni	1894
Novilla	P. A. C. Heiberg	1863
Nupela	W. Vyverman & P. Compère	1991
Ocularia	E. J. Quekett	1844
Odontella	C. A. Agardh	1832
Odontella-Lampriscus	Henri-Ferdinand van Heurck	1884
Odontidium	F. T. Kützing	1844
Odontodiscus	C. G. Ehrenberg	1845
Odontotropis	A. Grunow	1884
Oestrupia	H. Heiden ex Friedrich Hustedt	1935
Okedenia	C. Mereschkowsky	1901
Okedenia	T. Eulenstein ex G.B. De Toni	1891
Omphalopelta	C. G. Ehrenberg	1844
Omphalopsis	R. K. Greville	1863
Omphalotheca	C. G. Ehrenberg	1854
Oncobyrsa	C. A. Agardh	1827
Oncodiscus	J. W. Bailey x	
Oncosphenia	C. G. Ehrenberg	1845
Opephora	P. Petit	1888
Opephoropsis	J. Frenguelli	1945
Ophidocampa	C. G. Ehrenberg	1870
Ornithocercus	F. Stein	1883
Orthoneis	A. Grunow	1867
Orthoseira	G. H. K. Thwaites	1848
Orthosira	W. Smith	1855
Oscillaria	C. Pollini	1816
Oscillatoria	J. -P. Vaucher	1803
Oshitea	S. Komura	1993
Oxyneis	F. E. Round in F.E. Round, R.M. Crawford & D.G. Mann	1990

Old Papers - Revisited

In this series of articles we will reproduce some hard to find papers from years gone by.

On the Genus Arachnoidiscus by Fred. Kitton, Norwich.

Originally appearing in Hardwicke's Science Gossip 1875 No. 126 pp. 121-122.

The following remarks on the above-named genus may assist the young diatomist to discriminate the few species contained in it.

It might naturally be supposed that a genus containing not more than four species (Editors Note:- Not true these days!)- these by no means uncommon, and not requiring any great amplification, - could not offer much difficulty in their identification; but such is not the fact, as I frequently receive specimens wrongly named.

This beautiful genus was originally detected in a perfect state by Mr. Henry Deane, and brought before the Microscopical Society in 1847.

Mr. Shadbolt read a paper before the same society on the "Structure of the Siliceous Lorica of the Genus Arachnoidiscus," afterwards published in the third volume of the "Transactions of the Microsocpical Society," 1849 (this was previous to the amalgamation with the Quarterly Microscopical Journal), and illustrated with some very excellent drawings by Mr. Legg.

Single valves and fragments had previously been detected in Ichaboe guano by Mr. Deane, Topping, and others. This deposit seems to have been discovered in 1843, and exhausted in 1844. This form was therefore known to some microscopical observers thirty years ago.

Ehrenberg, in 1848, describes (in the "Monats-Berichten der Berliner Academie") one of the species under the name Hemiptychus, but as there was a Hemiptycha, a genus of Hemipterous insects, the name was withdrawn.

As Mr. Shadbolt's description of the structure, &c. is very interesting, I shall give some portions of it in his own words.

"The following observations apply to the shells alone, and not to the animals inhabiting them (if animals they be); for although the specimens submitted to examination were recent, they were not in my possession until they had been dead some months." (The supposed animal nature of this form may probably excite a smile in the present generation of diatomists, but thirty years ago diatoms were generally supposed to be animalcules, and it was gravely stated that they possessed mouths, were ciliated and many-stomached (hence called Polygastrica). That their animality was but little doubted is evident from the following passage.

"In viewing these disks as transparent objects mounted in balsam, it is by no means easy to determine whether they have or have not a central aperture; but on viewing them as opaque objects it becomes indisputably evident that a central opening is present. When in situ these openings are partially covered internally by a delicate cup-like process, so as to form a species of valve. I consider it highly probable that at these openings nutriment is taken in, and from the peculiar radiating arrangement of the siliceous parts immediately around them, it seems not improbable that the animal may be provided with organs somewhat resembling in arrangement the tentacula of madrepores. This is supposing the objects to be of animal nature, of which I confess I think there is little doubt."

I need scarcely remark that no central pore exists, and that tentacula are never protruded.

The author then proceeds to describe "two annular valves lying between the two discoid ones. These valves consist of a siliceous ring, within which (extending a slight distance towards the centre) is an annular membrane, and when in situ , the valves are placed so that the membranes are in contact; and thus the space included between the two discoid valves is partially divided into two (not three) chambers. The membrane is so thin that when mounted in balsam it is not visible. I have, however, been able to detect it upon one or two occasions." This annular valve is of course the cingulum or connecting-zone, and no membrane is present.

The description of the valves is more accurate.

"The two parts of the disks consist of, firstly, a very thin membrane, somewhat flexible and elastic, and capable of resisting the action of boiling nitric acid, and on this membrane are the characteristic spider's-web-like markings which have given rise to the name of the genus; secondly each disk is composed of a siliceous framework admirably adapted to support and strengthen the outer membrane, and bears a very close resemblance to a circular Gothic window."

The author is mistaken in supposing that the thin valve is uppermost; the upper valve is stout, and the so-called siliceous framework, so far as I can make out, is an integral portion of it. The thin valve is below, and is probably an early state of a newly-formed valve, and which will, after self-division has taken place, form the opposite valve of the frustule.

The species of Arachnoidiscus hitherto described are the following:- A. Ehrenbergii, A. ornatus, A. Grevilleanus, A. Hardmannianus, A. Indicus=A. Ehrenbergii. The form figured and described by Mr. Shadbolt is the second in the list, and is apparently more widely distributed than A. Ehrenbergii. It is distinguished from the latter by the transverse costae between the radiating lines; those near the margin are irregularly branched, resembling the venation of the leaves of a dicotyledonous plant; the spaces between the costae are delicately punctate, the puncta becoming larger as they approach the centre.=Hemiptychus ornatus (Ehrenberg), Arachnoidiscus Japonicus (Shadbolt), A. Nicobaricus (Ehrenberg), A. ornatus (C.Janisch, in "Zur Charakteristik des Guano's von verscheidenen Fundorten," p.12, Taf.1, fig.3. South Africa, Nicobar Islands, West Coast of S. America).

Arachnoidiscus Ehrenbergii may be easily recognised by the absence of the transverse costae, the large irregularly-shaped granules between the radiating lines. These granules, when examined with oblique light appear to consist of closely-packed beads. A. Indicus, Ehrenberg, "Microgeologie," Puget's Sound, Moneterey Stone, Vancouver's Island.

The form figured in the Synopsis is probably the above, but there can be little doubt that it never lived in any British locality; moreover, the form figured was not from the photograph of De Brebisson;s. Tuffen West told me that the drawing was made from an actual specimen. This fact accounts for the non-agreement of Smith's generic character with the figure (Frustules adherent, disciform; valves plane or slightly convex, cellular, marked with concentric and radiating lines; pseudo-nodule central, conspicuous).

Bailey in a letter to Dr. Arnott (Walker Arnott on Arachnoidiscus, Quart. Journ. Mic. Soc., vol. iv, p.1616), says, "I see that Smith in his Brit. Diat. gives me as the founder of the genus. This is not correct; but the species is mine, and is very different from A. Japonicus, with which Smith confounds it."

Arachnoidiscus Grevilleanus is a rare species occurring in the Barbadoes deposit: it possess the radiating costae characteristic of the genus, which reach nearly to the centre of the disk; alternating with these are shorter rays, above one-third of the length of the principal rays, but the central smooth space surrounded by a circle of elongated cellules is wanting, the centre being occupied by a little star composed of five or six minute elongated cellules. The margin of the valve has several rows of small cellules, which become larger midway between the centre and margin, and again becoming smaller and scattered as they approach the centre. (Greville, in Trans. Royal Mic. Soc., vol. xiii. p. 47, pl. v. fig. 7)

The last species of this genus was placed by Dr. Greville in his genus Stictodiscus, but its affinities, judging from his figure and description, are with the present genus. As I have never seen this species, I can only give Greville's specific characters.

"Stictodiscus Hardmanianus. - Large; radiating compartments numerous, reaching nearly to the centre, with five or six rows of minute puncta at the base (margin of valve), followed by a single row of pseudo-pores; centre occupied by two circles of granules, and a minute cluster at the unbilicus; diameter .0050". Monetery deposit. Mr. Hardman."

It will be seen from the above description that this species only differs from the type forms in the absence of the circle of elongated cellules, and which are represented by a circle of large moniliform granules.

The probability of the specimen of Arachnoidiscus being a British form is to my mind very doubtful, although two cases have been published of its occurrence; viz., one frustule br De Brebisson, as cited in the Synopsis and one by Captain Hutton, F.G.S. (Quart. Journ. Mic. Science, vol. v. n.s., p. 132). If this form had really lived on our coasts, more than three specimens would have been discovered in thirty years. Captain Hutton's specimens were supposed to have been in a gathering made from a small brackish water pool at Malahide, but were probably attached to the test-tube in which the gathering had been boiled. The writer remarks that he had not cleaned any material containing Arachnoidiscus for ten months, and the tube had been in constant service; still it is more probable that these specimens had become detached from the tube, than that they had lived in the pool.

Species List

A list of diatoms found in samples from various locations in Malham Tarn

by Steve Edgar and Douglas T. Richardson (August 2000).

Further to the Favourite Location article in Vol. 1. No. II.

There are undoubtedly further species yet to be identified in both the material and the slides prepared during the trip. An updated list will appear in due course.

The table includes those species found by Horace Barber on a trip in 1981, for comparison purposes.

Species/Authority		**Douglas T. Richardson**	**Steve Edgar**	**Horace Barber 1981**
Achnanthes affinis	Grun	*	*	*
Achnanthes Clevei	Grun.			*
Achnanthes lanceolata	Breb.			*
Amphora ovalis		*	*	
Amphora ovalis v. pediculus	Kutz.			*
Amphora pediculus			*	
Amphora sp.		*	*	
Asterionella formosa		*		
Caloneis bacillaris			*	

Species/Authority		**Douglas T. Richardson**	**Steve Edgar**	**Horace Barber 1981**
Caloneis sp.		*		
Cocconeis flexella v. aepestris	Brun.			*
Cocconeis lineata			*	
Cocconeis pediculus	Ehr.	*		*
Cocconeis placentula	(Ehr.) Hust.	*	*	*
Cymatopleura elliptica				
Cymatopleura solea v. constricta(librile?)	Grun.		*	*
Cymbella ? cistula fa. ? turgida fa.		*		*
Cymbella ? helvetica fa.	Kutz.			*
Cymbella affinis	Kz			*
Cymbella helvetica	Kutz.		*	*
Cymbella lanceolata	(Ehr.)H.V.H.	*		*
Cymbella microcephala	Grun.			*
Cymbella obtusa	Greg.			*
Cymbella prostrata v. aurswaldii	(Rabh.)Reim	*	*	*
Cymbella sturii fa.	Grun.			*
Cymbella tumida				*
Cymbella ventricosa	Kz			*
Denticula ?			*	
Denticula tenuis v. crassula	(Naeg.)Hust.			*
Diatoma ?moniliforme		*		
Diatoma elongatum	Agardh.		*	*
Diatoma hyemale var. mesodon		*		
Diatoma sp.		*	*	*
Diatoma vulgare		*	*	*
Diatoma vulgare v. ? auxosporeform				*
Diatoma vulgare v. grandis	(Sui Sui) Grun.			*
Diatoma vulgare v. producta	Grun.			*
Diploneis marginestriata	Hust.			*
Diploneis marginestriata fa.	Hust.			*
Epithemia sp.			*	
Epithemia zebra	(Ehr.)Kutz.			*
Eunotia arcus		*		
Eunotia arcus fa.	Ehr.			*
Fragilaria construens	(Ehr.) Grun.			*
Fragilaria construens v. subsalina	Hust.			*
Fragilaria construens v. ventis fa.	(Ehr.) Grun.			*
Fragilaria crotonensis	Kitton			*
Fragilaria intermedia	Grun.			*
Fragilaria intermedia fa.	Grun.			*
Fragilaria leptostauron	(Ehr.)Hust.			*
Fragilaria leptostauron v. harrisonii	Wm.Sm.			*
Fragilaria sp. ? var. ventis	(Ehr.) Grun.	*	*	*
Fragillaria construens		*		
Fragillaria crotonensis		*		
Gomphonema accuminatum v. coronata	(Ehr.)Wm. Sm.			*
Gomphonema acuminatum		*		
Gomphonema angustatum	(Kutz.)Rab.			*
Gomphonema augur fa.	Ehr.			*

Gomphonema Brebissonii			*	
Gomphonema constrictum				*
Gomphonema olivaceum	(Lyng.)Kutz.			*
Gomphonema sp.		*		*
Gyrosigma attenuatum	(Kutz.)Rabh.		*	*
Melosira varians	Agardh.			*
Meridion circulare	Agardh	*		*
Navicula intermedia (Near)	Grun.			*
Navicula radiosa (lanceolate form)	Kutz.	*	*	*
Navicula radiosa (rhombic form)	Kutz.			*
Navicula radiosa v. tenella	Breb.			*
Navicula sp.		*	*	*
Navicula sp. Near N. veneta				*
Nitzschia augustata v. acuta	Grun.			*
Nitzschia dissipata	(Kutz.)Grun.			*
Nitzschia sp.				*
Nitzschia sp. (?Gracilis)(?acuta)				*
Pinnularia viridis			*	*
Stauroneis acuta			*	
Surirella linearis fa.				*
Surirella spiralis?				*
Synedra actinostroides	Lemm			*
Synedra sp. ? gracillina	Mayer			*
Synedra ulna	(Nitz.) Ehr.		*	*
Tabellaria flocculosa(Roth.)	Kutz.	*		*

Amazing Facts - II - Dynamite

Alfred Nobel was born in 1833 in Sweden. Nobel's family owned and operated a factory that manufactured a mixture of nitroglycerin and gunpowder for explosives. The factory opened in 1863. There were a number of serious explosions, which killed several people, including Nobel's brother. Nobel decided to experiment with nitroglycerin in order to find a safer alternative to gunpowder or nitroglycerin. In 1866, Nobel discovered that a combination of nitroglycerin and a diatomaceous earth, called kieselguhr, exploded in a safer manner than previously used explosives. Nobel named his discovery "dynamite".

Useful Notes

In this section we will be publishing those ephemera that we all compile when pursuing one line of interest or another. These snippets get filed away in the drawer designated 'things that will come in useful', never to see the light of day again. The very fact that it was necessary to compile them meant that either they had not been done before or were generally unavailable. Many others must have these hoards of 'Useful Information'. Rather than leave them gathering dust and book mites why not have them printed here for others to use.

Following the conversion table in the first issue the following table enables you to look up quickly and simply the measurements of frustules given in inches and read off the equivalent in microns.

There are 25,400 microns to the inch so it is a relatively simple calculation to do. However, it is so much more convenient to have a table of the values to hand.

Inches	Microns	0.0054	137.16	0.0099	251.46	0.0144	365.76
0.0010	25.40	0.0055	139.70	0.0100	254.00	0.0145	368.30
0.0011	27.94	0.0056	142.24	0.0101	256.54	0.0146	370.84
0.0012	30.48	0.0057	144.78	0.0102	259.08	0.0147	373.38
0.0013	33.02	0.0058	147.32	0.0103	261.62	0.0148	375.92
0.0014	35.56	0.0059	149.86	0.0104	264.16	0.0149	378.46
0.0015	38.10	0.0060	152.40	0.0105	266.70	0.0150	381.00
0.0016	40.64	0.0061	154.94	0.0106	269.24	0.0151	383.54
0.0017	43.18	0.0062	157.48	0.0107	271.78	0.0152	386.08
0.0018	45.72	0.0063	160.02	0.0108	274.32	0.0153	388.62
0.0019	48.26	0.0064	162.56	0.0109	276.86	0.0154	391.16
0.0020	50.80	0.0065	165.10	0.0110	279.40	0.0155	393.70
0.0021	53.34	0.0066	167.64	0.0111	281.94	0.0156	396.24
0.0022	55.88	0.0067	170.18	0.0112	284.48	0.0157	398.78
0.0023	58.42	0.0068	172.72	0.0113	287.02	0.0158	401.32
0.0024	60.96	0.0069	175.26	0.0114	289.56	0.0159	403.86
0.0025	63.50	0.0070	177.80	0.0115	292.10	0.0160	406.40
0.0026	66.04	0.0071	180.34	0.0116	294.64	0.0161	408.94
0.0027	68.58	0.0072	182.88	0.0117	297.18	0.0162	411.48
0.0028	71.12	0.0073	185.42	0.0118	299.72	0.0163	414.02
0.0029	73.66	0.0074	187.96	0.0119	302.26	0.0164	416.56
0.0030	76.20	0.0075	190.50	0.0120	304.80	0.0165	419.10
0.0031	78.74	0.0076	193.04	0.0121	307.34	0.0166	421.64
0.0032	81.28	0.0077	195.58	0.0122	309.88	0.0167	424.18
0.0033	83.82	0.0078	198.12	0.0123	312.42	0.0168	426.72
0.0034	86.36	0.0079	200.66	0.0124	314.96	0.0169	429.26
0.0035	88.90	0.0080	203.20	0.0125	317.50	0.0170	431.80
0.0036	91.44	0.0081	205.74	0.0126	320.04	0.0171	434.34
0.0037	93.98	0.0082	208.28	0.0127	322.58	0.0172	436.88
0.0038	96.52	0.0083	210.82	0.0128	325.12	0.0173	439.42
0.0039	99.06	0.0084	213.36	0.0129	327.66	0.0174	441.96
0.0040	101.60	0.0085	215.90	0.0130	330.20	0.0175	444.50
0.0041	104.14	0.0086	218.44	0.0131	332.74	0.0176	447.04
0.0042	106.68	0.0087	220.98	0.0132	335.28	0.0177	449.58
0.0043	109.22	0.0088	223.52	0.0133	337.82	0.0178	452.12
0.0044	111.76	0.0089	226.06	0.0134	340.36	0.0179	454.66
0.0045	114.30	0.0090	228.60	0.0135	342.90	0.0180	457.20
0.0046	116.84	0.0091	231.14	0.0136	345.44	0.0181	459.74
0.0047	119.38	0.0092	233.68	0.0137	347.98	0.0182	462.28
0.0048	121.92	0.0093	236.22	0.0138	350.52	0.0183	464.82
0.0049	124.46	0.0094	238.76	0.0139	353.06	0.0184	467.36
0.0050	127.00	0.0095	241.30	0.0140	355.60	0.0185	469.90
0.0051	129.54	0.0096	243.84	0.0141	358.14	0.0186	472.44
0.0052	132.08	0.0097	246.38	0.0142	360.68	0.0187	474.98
0.0053	134.62	0.0098	248.92	0.0143	363.22	0.0188	477.52

0.0189	480.06	0.0234	594.36	0.0279	708.66	0.0324	822.96
0.0190	482.60	0.0235	596.90	0.0280	711.20	0.0325	825.50
0.0191	485.14	0.0236	599.44	0.0281	713.74	0.0326	828.04
0.0192	487.68	0.0237	601.98	0.0282	716.28	0.0327	830.58
0.0193	490.22	0.0238	604.52	0.0283	718.82	0.0328	833.12
0.0194	492.76	0.0239	607.06	0.0284	721.36	0.0329	835.66
0.0195	495.30	0.0240	609.60	0.0285	723.90	0.0330	838.20
0.0196	497.84	0.0241	612.14	0.0286	726.44	0.0331	840.74
0.0197	500.38	0.0242	614.68	0.0287	728.98	0.0332	843.28
0.0198	502.92	0.0243	617.22	0.0288	731.52	0.0333	845.82
0.0199	505.46	0.0244	619.76	0.0289	734.06	0.0334	848.36
0.0200	508.00	0.0245	622.30	0.0290	736.60	0.0335	850.90
0.0201	510.54	0.0246	624.84	0.0291	739.14	0.0336	853.44
0.0202	513.08	0.0247	627.38	0.0292	741.68	0.0337	855.98
0.0203	515.62	0.0248	629.92	0.0293	744.22	0.0338	858.52
0.0204	518.16	0.0249	632.46	0.0294	746.76	0.0339	861.06
0.0205	520.70	0.0250	635.00	0.0295	749.30	0.0340	863.60
0.0206	523.24	0.0251	637.54	0.0296	751.84	0.0341	866.14
0.0207	525.78	0.0252	640.08	0.0297	754.38	0.0342	868.68
0.0208	528.32	0.0253	642.62	0.0298	756.92	0.0343	871.22
0.0209	530.86	0.0254	645.16	0.0299	759.46	0.0344	873.76
0.0210	533.40	0.0255	647.70	0.0300	762.00	0.0345	876.30
0.0211	535.94	0.0256	650.24	0.0301	764.54	0.0346	878.84
0.0212	538.48	0.0257	652.78	0.0302	767.08	0.0347	881.38
0.0213	541.02	0.0258	655.32	0.0303	769.62	0.0348	883.92
0.0214	543.56	0.0259	657.86	0.0304	772.16	0.0349	886.46
0.0215	546.10	0.0260	660.40	0.0305	774.70	0.0350	889.00
0.0216	548.64	0.0261	662.94	0.0306	777.24	0.0351	891.54
0.0217	551.18	0.0262	665.48	0.0307	779.78	0.0352	894.08
0.0218	553.72	0.0263	668.02	0.0308	782.32	0.0353	896.62
0.0219	556.26	0.0264	670.56	0.0309	784.86	0.0354	899.16
0.0220	558.80	0.0265	673.10	0.0310	787.40	0.0355	901.70
0.0221	561.34	0.0266	675.64	0.0311	789.94	0.0356	904.24
0.0222	563.88	0.0267	678.18	0.0312	792.48	0.0357	906.78
0.0223	566.42	0.0268	680.72	0.0313	795.02	0.0358	909.32
0.0224	568.96	0.0269	683.26	0.0314	797.56	0.0359	911.86
0.0225	571.50	0.0270	685.80	0.0315	800.10	0.0360	914.40
0.0226	574.04	0.0271	688.34	0.0316	802.64	0.0361	916.94
0.0227	576.58	0.0272	690.88	0.0317	805.18	0.0362	919.48
0.0228	579.12	0.0273	693.42	0.0318	807.72	0.0363	922.02
0.0229	581.66	0.0274	695.96	0.0319	810.26	0.0364	924.56
0.0230	584.20	0.0275	698.50	0.0320	812.80	0.0365	927.10
0.0231	586.74	0.0276	701.04	0.0321	815.34	0.0366	929.64
0.0232	589.28	0.0277	703.58	0.0322	817.88	0.0367	932.18
0.0233	591.82	0.0278	706.12	0.0323	820.42	0.0368	934.72

0.0369	937.26	0.0402	1021.08	0.0435	1104.90	0.0468	1188.72
0.0370	939.80	0.0403	1023.62	0.0436	1107.44	0.0469	1191.26
0.0371	942.34	0.0404	1026.16	0.0437	1109.98	0.0470	1193.80
0.0372	944.88	0.0405	1028.70	0.0438	1112.52	0.0471	1196.34
0.0373	947.42	0.0406	1031.24	0.0439	1115.06	0.0472	1198.88
0.0374	949.96	0.0407	1033.78	0.0440	1117.60	0.0473	1201.42
0.0375	952.50	0.0408	1036.32	0.0441	1120.14	0.0474	1203.96
0.0376	955.04	0.0409	1038.86	0.0442	1122.68	0.0475	1206.50
0.0377	957.58	0.0410	1041.40	0.0443	1125.22	0.0476	1209.04
0.0378	960.12	0.0411	1043.94	0.0444	1127.76	0.0477	1211.58
0.0379	962.66	0.0412	1046.48	0.0445	1130.30	0.0478	1214.12
0.0380	965.20	0.0413	1049.02	0.0446	1132.84	0.0479	1216.66
0.0381	967.74	0.0414	1051.56	0.0447	1135.38	0.0480	1219.20
0.0382	970.28	0.0415	1054.10	0.0448	1137.92	0.0481	1221.74
0.0383	972.82	0.0416	1056.64	0.0449	1140.46	0.0482	1224.28
0.0384	975.36	0.0417	1059.18	0.0450	1143.00	0.0483	1226.82
0.0385	977.90	0.0418	1061.72	0.0451	1145.54	0.0484	1229.36
0.0386	980.44	0.0419	1064.26	0.0452	1148.08	0.0485	1231.90
0.0387	982.98	0.0420	1066.80	0.0453	1150.62	0.0486	1234.44
0.0388	985.52	0.0421	1069.34	0.0454	1153.16	0.0487	1236.98
0.0389	988.06	0.0422	1071.88	0.0455	1155.70	0.0488	1239.52
0.0390	990.60	0.0423	1074.42	0.0456	1158.24	0.0489	1242.06
0.0391	993.14	0.0424	1076.96	0.0457	1160.78	0.0490	1244.6
0.0392	995.68	0.0425	1079.50	0.0458	1163.32	0.0491	1247.14
0.0393	998.22	.0426	1082.04	0.0459	1165.86	0.0492	1249.68
0.0394	1000.76	0.0427	1084.58	0.0460	1168.40	0.0493	1252.22
0.0395	1003.30	0.0428	1087.12	0.0461	1170.94	0.0494	1254.76
0.0396	1005.84	0.0429	1089.66	0.0462	1173.48	0.0495	1257.30
0.0397	1008.38	0.0430	1092.20	0.0463	1176.02	0.0496	1259.84
0.0398	1010.92	0.0431	1094.74	0.0464	1178.56	0.0497	1262.38
0.0399	1013.46	0.0432	1097.28	0.0465	1181.10	0.0498	1264.92
0.0400	1016.00	0.0433	1099.82	0.0466	1183.64	0.0499	1267.46
0.0401	1018.54	0.0434	1102.36	0.0467	1186.18	0.0500	1270.00

Guano.

Some background.

The word guano comes from the Quichua language of the Inca civilisation where it means "the droppings of sea birds". The word today, however, is used to describe both bat and sea bird manure. Perhaps the best known source of bird guano, the type we as Diatomists are interested in, is Peru. On the coast of this country the guano collects on the rainless islands and cliffs. Peru's most important and productive guano islands are:-

The Chinchas
The Ballestras
The Lobos
The Macabi and Guanape islands.

Other islands around the world, off Africa, the Caribbean, and the Pacific islands, also at one time hosted abundant guano reserves.

The proximity of the Humboldt or Peruvian Current, which moves cold water from Antarctica to the equator along Peru's coast, creates an interesting weather pattern where cold water and warm air inhibits the fall of rain in this part of the world.

This feature of the climate ensures minimal leaching of the excreted nutrients. Another factor that makes guano an effective fertiliser is that its contents originate from fish-eating birds. The vast fish reserves, primarily anchovetas, have caused a huge congregation of birds and seals on the islands. Because of the islands (and cliffs) relative isolation and inaccessibility they are havens where there are few if any natural predators. The guano producing birds come to the islands and cliffs in the breeding season in their millions. Over the course of hundreds to thousands of years these birds had deposited accumulated guano reserves of 100 to 150 feet deep. Three species of birds can be considered the primary producers of guano:-

White-breasted Cormorant (Phalacrocorax carbo lucidus)
Grey Pelican (Pelecanus philippensis)
Peruvian Booby or Piquero peruano (Sula variegata)

It has been estimated that these birds, around a million can reside on one island, are able to generate in excess of 11,000 tons of guano/year.

These guano deposits were jealously guarded by the Inca peoples of the region, who used it as a fertiliser. Access to the deposits was strictly regulated and anyone disturbing the birds during the breeding season, when most of the deposits are made, would risk sever punishment, possibly death.

Guano has been an international commodity for almost 200 years. Because of the improved crop yields that guano produced for farmers, guano became a heavily sought after commodity. Foreign traders, especially the British, set up trading houses to ship guano back to England and Europe for trade and distribution.

In both the United States and the UK guano became an important source of nitrogenous fertiliser. At the peak of the guano importation the U.S. government started to become concerned that demand would outstrip supply and their economy and particularly their agriculture had come to depend on the guano resources, that drastic steps were taken to maintain the supply to the U.S. farmer.

"On August 18, 1856 Congress passed an act (the U.S. Guano Island Act 1856) to authorise

protection to be given to citizens of the United States who may discover guano. Under which any citizen of the United States was authorised to take possession of and occupy any unclaimed island, rock or key containing guano. The discoverers of such islands were entitled to exclusive rights to the deposits thereon, but the guano could only be removed for the use of the citizens of the United States."

This was deemed necessary as by this time the British had what amounted to a monopoly of the Peruvian Guano extraction and export.

Under this legislation around 60 islands were acquired or claimed e.g. Pacific islands such as Howland, Baker, and Jarvis islands, and Caribbean islands like Serranilla Keys, Navassa, and Petrel islands. These were maintained under U.S. Authority but later released when the market for guano diminished during the 20th century. As the 19th century came to a close artificial fertilisers were developed and guano became less important. The producing countries like Peru suffered a major economic downturn and resulted in the generation of huge foreign debts as the money earned during the boom years had been mismanaged.

The golden years for Peru's Guano industry were the period between 1840 and 1880. It has been estimated that the Peruvians excavated over 20 million tons of guano for export which created huge profits. Constant excavation of the resource meant that in the collection year of 1909/10, the whole of Peru's guano reserves were so depleted that they could yield only around 48,000 tons. It was at this juncture that the Peruvian Government took steps to conserve its guano reserves by establishing a Guano Administration body whose responsibility was to manage the natural resource by protecting the birds and their environment. This included restricting the mining of the guano. To do this they restricted access to the guano islands and cliffs, allowing the mining companies only 6 months of the year to collect the guano and leaving the sea birds the other half year to freshen the deposits and safely rear the next generation. The Authority also set strict commercial fishing quotas to preserve the fish stocks which formed the staple food of the seabird colonies. In addition to these two measures large reserves were formed where no disturbance was allowed at any time of year, thus ensuring the populations for years to come.

Though guano was used in ground and pelletised forms for agricultural fertiliser there were other manufacturing industry uses of the product. One such was the production of Murexide dye.

With guano as a source of uric acid the manufacture of Murexide was significantly made cheaper. The first cargo of Peruvian guano to reach these shores was consigned to a Liverpool merchant in 1835. This was destined for the agricultural market. It was relatively slow to be taken up as a general-purpose fertiliser such that by 1841 it was still so little appreciated that only 1700 tons were imported. Only 6 years later this figure was 220,000 tons. The price in England at that time was about £10 per ton.

Whilst the guano was good quality the uric acid content was about 20%, but as the years went by and the less rich deposits were mined the percentage dropped to such a degree that it became useless for manufacture. Whilst the stocks were good however, Guano was the key to the success of murexide as a dye.

The following description details the methods used in the preparation of uric acid from guano.

"The guano is boiled with aqueous potassium hydroxide solution (10%) until all the ammonia is removed. Carbon dioxide is bubbled through the remaining liquid to give a precipitate of potassium hydrogen urate. This precipitate is filtered, washed with water and dissolved in sodium carbonate solution. The addition of hydrochloric acid gives a precipitate of uric acid."

The first commercial manufacture of murexide in the started in 1853 at Mulhouse and later, within a year or two, Manchester. In Mulhouse Frédérick Sacc and Jules-Albert Schlumberger, 'colorists' from Alsace, advocated and promoted the use of Murexide as a dye which was soon being made by Depoully Frères and by Dolfus, Mieg et Cie. In Manchester, a major producer was Robert Rumney (1811-1872) of the Ardwick Chemical Works, Gorton. Between 1857 and 1859, it is estimated that he was processing 12 tons of guano a week and producing 12 hundredweights of murexide which he was selling for 30 shillings/lb. The guano would have cost approximately £6,000 per year and sales of Murexide brought in £100,000 for that period.


Peruvian Government Guano
Imported by the Peruvian Guano Company Limited
Norman & Pigott.
Joint Sole Contractors
in Liverpool.
37 The Albany, Old Hall Street
Liverpool. 11 Nov 1881
Mr J. F. Farmer

Peruvian Guano Company Ltd Letterhead

Text of the letter follows.

Mr. J. F. Farmer

Dear Sir,

As good cargoes of Government Peruvian Guano for the coming season are likely to be scarce we would recommend early purchases and would be glad to book your order now for delivery any time in the Spring.

By reference to our circular of 25 Oct you will find a list of the cargoes we are offering.

Samples and prices of any you may select we shall be happy to send on application.

It is not unlikely (before the season is over) an advance may take place.

Awaiting your reply,

Yours truly,

Norman & Pigott.

P.S. We should be glad if you could come over and inspect the bulk in the Birkenhead Dock Warehouse.

Why our interest in guano?

Our interest in guano is a consequence of the food chain and the indigestability of diatom frustules. Zooplankton eat diatoms, they in turn get eaten by larger predators, these predators get eaten by fish (fish also eat diatoms), the sea-birds eat the fish. The fish get digested, the frustules

don't. Guano provides us with a sort of snapshot of the sea conditions over a few thousand years. Though the guano diatoms are sometimes referred to as fossil diatoms their remains are mostly recent in geological terms. Guano is a useful source of diatom frustules and particularly of species that inhabit the open ocean.

Guano Diatoms.

Under this title there appeared, in Science Gossip of March 1st 1870, the following by Lewis G. Mills, LL.D.:-

After all that has been written of late against the very extensive, and too exclusive, study of the Diatomaceae prevalent among microscopists, and considering the prejudice which to some extent evidently exists against the study, on account of the supposed undue share of attention which it has received, it is not without some hesitation that I venture to contribute a paper on diatoms. And this hesitation is not lessened by the fact that I have to make some remarks on the so-called 'fossil-diatoms' and some of their unusual forms, of which, when no living examples of similar kinds have been found, doubts are entertained whether they should occupy any position whatever in the scientific classification of the Diatomaceae.

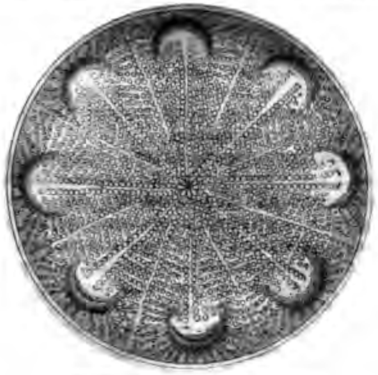


Fig. 52. *Aulacodiscus Kittoni*, × 350.

For some time past, during the leisure time at my disposal, I have made extended examinations of guano, and I have prepared many slides, by the method of selection, of which there is a description in Science Gossip, vol. i., and a further account in the second number of the Monthly Microscopical Journal. Perhaps an account of some of the results of my search may contribute to Microscopical Recreation, if not to 'Microscopical Research.'

In common Peruvian guano, besides the forms usually met with, I have found two specimens of Aulacodiscus Kittoni, a form, according to Pritchard, usual in New Zealand and Monterey Bay, and fossil Monterey stone. I notice that in my specimens the row of marginal dots given in the figure by Pritchard is entirely wanting (fig. 52)

I have also met with two very interesting and perfect specimens of an Auliscus, which I suppose to be new. The accompanying figure will give a clear idea of the form and markings of this diatom. The species to which it bears the closest resemblance is, I think, Auliscus racemosus (Microscopical Journal, vol. iv., new series); yet the difference of structure is greater than that usually required to mark a distinct species (fig. 53).

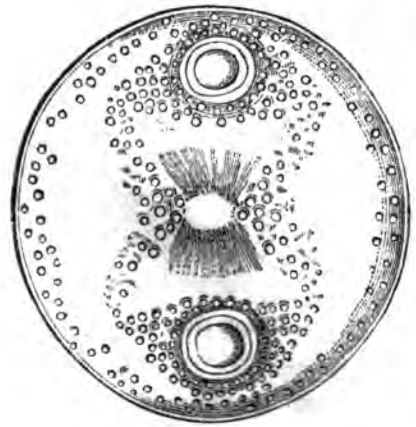


Fig. 53. ***Auliscus*****, × 350.**

Fig. 54. *Biddulphia*, sp., × 350.

Another form, which I take to be one of the valves of a large Biddulphia, is also worthy of notice (fig. 54.)

There is yet another example of singular form to which I would direct attention. It is a diatom, small, elliptical, very convex, and it has one large process nearly central. From this process to the margin it is marked by fine striae which cannot easily be explained by figure (fig. 55).

Fig. 55. Diatom from Guano, × 350.

Peruvian Guano.

Peruvian guano is still available today advertised as garden fertiliser. The samples we have came from the States.

Home-grown guano.

We are not sure how much work has been done on fresh guano, particularly in the United Kingdom. Fish eating birds that form colonies inland might offer opportunities to collect material. Cormorant roosts on inland lakes for instance. Swan guano might also prove to be a good source of material. After all they feed on submerged weed and that weed is almost certain to have its own communities of diatoms.

Should anyone be in a position to collect and clean material we would be very interested in the results. Indeed has someone already done work in this field?

Cleaning Guano

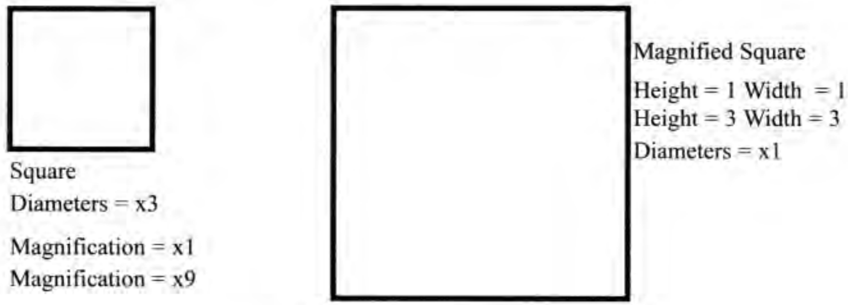
We can do no better than to quote from an article that appeared in the Journal of Microscopy as far back as 1884. This article on cleaning diatoms was written by Alfred W. Griffin.

The preparation of these substances so as to obtain the Diatoms mixed with them, is unquestionably tedious and dirty; but I would qualify this somewhat discouraging remark by stating that these ammoniacal guanos contain by far the most beautiful forms, and the result is therefore well worth the labour bestowed.

As a type of this we will take some Peruvian Guano, first sifting it to free it from stones, feathers and other debris. The finely-sifted material should be slowly dried in an oven, which causes the evaporation of a considerable portion of the ammonia, and most of the moisture with which it is so frequently charged. A tin pan or skillet is now to be half-filled with a string solution of commercial Carbonate of Sod, about three ounces of soda carb. to the pint of water, and placed over a gas stove, and on the liquid boiling the guano is gradually and slowly dropped in. It is necessary frequently to stir the solution to prevent its boiling over, owing to a considerable effervescence produced by the Soda on the Ammonia of the Guano. When the liquid ceases to effervesce. it is poured into a plentiful supply of clean water, and washed several times, taking, of course, every care that the frustules of the Diatoms are not washed away in the process. A red-looking mud is the result of this process, which, on boiling in Sulphuric Acid, treating with Bichromate of Potash, and finally washing, will yield some very clean and beautiful specimens.

The difference between Diameters and Magnification.

Most illustrations in most scientific publications are accompanied by 'linear magnifications', that is a measurement commonly called 'diameters', e.g. x100, x400 etc. Occasionally you come across what seem to be impossibly large magnifications e.g. x2000. These represent Magnification in its true sense and represents the squaring of the actual linear magnification. The following illustration may help to explain the difference.



The Value of Type Slides

Type slides, though more expensive than strews, are particularly valuable to any diatomists who want to be sure of their identification. Photographs are good, drawings are excellent but there is nothing quite like being able to compare what you are seeing down the microscope, on your own sample, with a view of a known species down the same microscope at the same magnification, with the same optics. Type slides tend to be have their subjects mounted in both valve and girdle view and sometimes end on.

A type slide should be labelled with the species name, the authority, recent or fossil, and whether it is marine, freshwater or brackish in origin.

A cabinet of single species type slides is not a substitute for literature but compliments it.

Safety Data for Diatomaceous Earth

General

Synonyms: infusorial earth, amorphous silica, kieselgur, celite, various trade names
Molecular formula: SiO_2
CAS No: 61790-53-2
EINECS No: 212-293-4

Physical data

Appearance: tan powder

Stability

Stable. Incompatible with strong acids

Toxicology

Harmful if inhaled; may be harmful if ingested in quantity. Eye, skin and respiratory irritant.

Risk phrases

R20 Harmful by inhalation.
R40 Possible risk of irreversible effects.

Transport information - Non-hazardous for air, sea and road freight.

Personal protection - Safety glasses, adequate ventilation.

Safety phrases

S24 Avoid contact with skin.
S25 Avoid contact with eyes.
S36 Wear suitable protective clothing.
S37 Wear suitable gloves.
S45 In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible.)

The Diatom Frustule

(continued). Photographs by Mike Samworth

This quarters article doesn't actually deal with the diatom frustule itself but is concerned with artefacts that may (or may not) occur in your samples. It is quite easy to get fooled by a number of artefacts you may come across when looking at strews. This is particularly true when viewing with relatively low powers. You can get all sorts of regular structures in your cleaned material. Time spent looking at these is not wasted unless, of course, you have convinced yourself, that you have discovered a new diatom species. Here are just a few examples of what you might see.

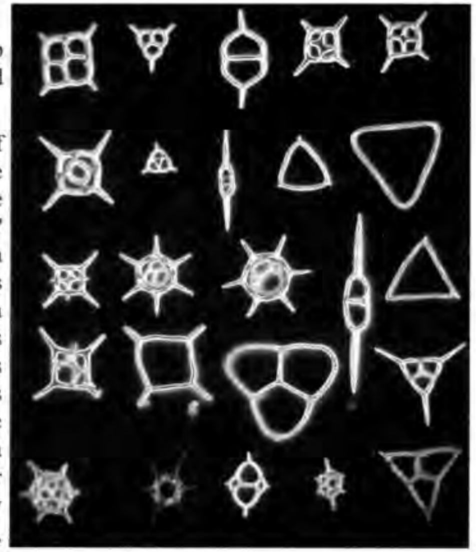
Sponge Spicules.

There are a plethora of forms to be found. The photographs to the left depict just a few of these. in the main spicules have sharp points but you may come across plates and coral like structures. There are also 'anchor' shapes and fiercom barbed needles. You are more likely to come

across sponge spicules in fossil deposits and in deep sea soundings.

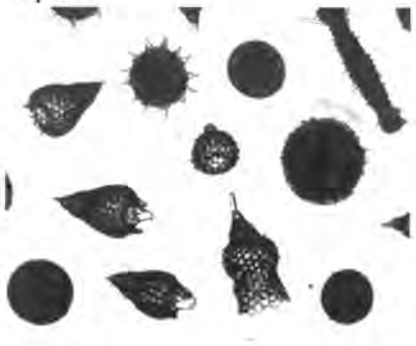
Spicules are the glassy structures that are formed, generally, at the base of a living sponge within its body structure.

Silico-flagellate plates.



This slide was mounted for us by K. D. Kemp (see advertisement inside front cover) and serves as an exteremely useful reference slide.

Silicoflagellates are planktonic marine algae of the same taxon as diatoms (Chromista) that are both photosynthetic and heterotrophic. Unlike diatoms which have an external 'frustule' silicoflagellates have an internal silica skeleton that is not nearly as complex or ornate as diatom silica and in general is composed of a framework of bars. Silicoflagellate skeletons may comprise as much as 1-2% of the siliceous component of marine sediments; and are thus much less abundant than the diatoms. In life silicoflagellates propel themselves with a single, long eukaryotic flagellum, or undulipodium. Silicoflagellate skeletons may vary considerably even within a single species, making it difficult to use the 'skeleton' to define a species.



Radiolaria.

Radiolaria are holoplanktonic protozoa which are widely distributed throughout the oceans. They are, in the main, nonmotile organisms, and they rely on buoyancy and currents to get around. The skeleton, if present, like the diatom frustule, is composed of amorphous silica (SiO_2). It is, again as in the diatomaceae, a major feature in identifying species and also distinguishes them from their close relatives, the Acantharia, which possess skeletons composed of Strontium Sulphate.

Holothurian plates.

The Holothuroidea or Sea Cucumbers, are echinoderms. Holothurians are generally long and wormlike; and don't look a great deal like starfish or sea-lilies. However, holothurians retain the pentameral (five-rayed) symmetry, with five rows of tube feet running from the mouth down the length of the body . Holothurians also have the skeleton of echinoderms, but in most species the skeletal structures have been reduced to microscopic plates as in the photographs above. The best way to envisage a sea

cucumber is to imagine a starfish whose legs have been tied back and then rolled out into a cylinder. The plates are ranged along the surface of the organism and are held in place by barbed 'anchors'.

Is it worth the Amateur being involved?

One need only 'surf the web' to appreciate how many academics are studying diatoms. Papers on all sorts of esoteric matters are constantly being published. Many of these, if not most, relate to matters that the amateur diatomist has no hope of duplicating, replicating or in some instances understanding. The techniques used are beyond the scope of the amateur. In the light of this fund of knowledge and wealth what can the amateur contribute?

One need only look at things like cleaning techniques to appreciate that the amateur can and does produce a finer preparation. Some of the light microscope micrographs are sufficient for the students purposes but wouldn't be acceptable to the dedicated amateur.

Distribution data - a single student on a project can collect samples from different areas but the distribution of amateurs, on their home ground, can provide a much more comprehensive analysis. We are not constrained by the desire to name species using the latest paper. If Van Heurck is the thing in our library then we can name a species based on his descriptions, as long as we cite the authority.

We can pose questions!

This latter statement is perhaps the most important. It may be that the question is so basic that the academic world throws up its hands in horror, but if the question is posed it should be answered in a manner understandable to us all. It is in everyone's interest to have these questions asked and answered. I remember when I was a young student, with all the technology available in the laboratories, I was told by an ageing laboratory technician who, I perceived, was struggling with the new technology that 'there is no substitute for experience'. At the time I dismissed this homily as an excuse, a smoke-screen to hide ineptitude. I am older now, I am struggling with the new technology and I now appreciate that 'experience' compliments progress.

Having an SEM, in itself is of no use unless you have cleaned material to work with. Being able to clean material is of no use if you cannot find it in the first place. We, as amateurs, have a wealth of experience in identification of specimens, at relatively low powers, most can determine to genera, many students cannot. We know where and when to collect, what we are likely to find, we can clean samples, we can select individual species onto a slide (well some can, I can't), we can do all of these things and we are prepared to share our knowledge and our material. Many of

those in academia are also prepared to share. We hope to have articles from 'the professionals' in these pages, we already have offers.

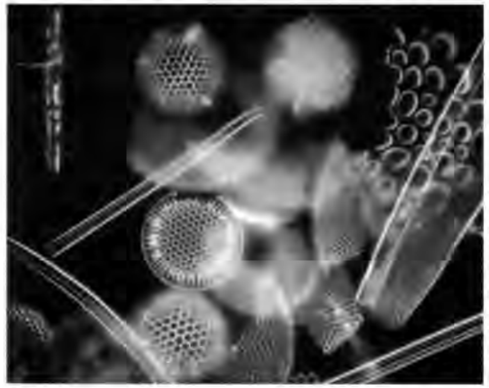
One of the problems, I think, has been the preponderance of expensive seminars attended by the academics. These effectively exclude the amateur on the grounds of cost. An academic institution is prepared to pay their representatives fees, we have to pay our own. The recent Marine Diatom Workshop run by Dr. Maurice O. Moss on behalf of the Quekett Microscopical Club at the University of Surrey is an example of a seminar/workshop which is within the budget of the Amateur and is to be applauded. We hope there will be more.

Geophagy. - Diatomaceous Earth eating!

In Java and Sweden, a special wetland clay filled with near microscopic invertebrates (infusoria) is a prized micro-food. Earth eating (usually of infusorial clays) is quite common amongst tribes in Central America and Africa, also in Japan where a soup is made from clay.

'Food grade' diatomaceous earth is often mixed with animal feed, to prevent insect infestation of food and also to clear intestinal parasites.

At the 1882 March 8th meeting of the Doncaster Microscopical Society Mr. J. Kirk remarked in his address to the meeting "A Diatomaceous deposit exists in Sweden and Norway under the name of 'Berg mehl' or mountain flour; and in times of scarcity the inhabitants mix this with their dough in making bread."



Diatoms by Dark-ground Illumination - with some historical musings. Part II

by Barry Ellam

Photographs by John Garrett

The Abbe Condenser

Most microscopes arrive equipped with an Abbe condenser. The reason is not too far to seek. As condensers go, it is comparatively cheap. For student use it is not too sensitive to being out of centre, or out of focus. Altogether a useful and robust device.

Many of the remarks which follow could also apply to a three lens aplanatic condenser. I am not sure about some of the modern 'flip-top' condensers. The top lenses seem just too small.

There is some variation in the details of design of the Abbe condenser. It must be said that some are better than others. Personally I like a condenser with a nice big top lens. This, however, is a subjective and possibly prejudicial opinion.

Most condensers are complete with an iris diaphragm and a filter tray. For dark ground work, the iris diaphragm should be fully open.

Now we are going to use patch stops. You may be lucky and have a purpose made set of metal or of glass. If you are very lucky you may have a Travis expanding stop. This, in effect, is an 'inside-out' iris diaphragm.

FIG. 253. REFRACTING CONDENSER WITH CENTRAL STOP (C-S) FOR DARK-FIELD ILLUMINATION.

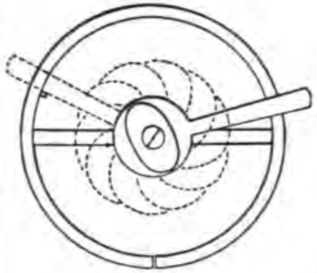


Fig. 53
TRAVISS' EXPANDING STOP

FIGURE 117. CONE OF STOPS FOR LOW POWER DARK FIELD ILLUMINATION

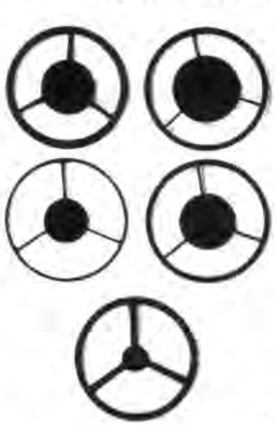
Fig. 253 from S.H. Gage 1925

Fig. 53 from Hind and Randles 1913

Fig. 117 from Needham 1977

If you do not have a set of patch stops, the only way forward is to make some. The easiest thing is to cut a series of discs from black paper. Using a tiny pinch of Blu-Tac, one of these may be secured in the middle of a 'daylight' filter.

The commonly repeated instructions go more or less as follows:-



Place a specimen on the stage of the microscope. Focus the microscope using, for example, a x10 objective. Now focus the condenser. Remove the eyepiece and look down the tube. Open or close the iris until the rear focal lens of the objective is just flooded with light. Then carefully measure the diameter of the aperture in the iris and make your stop to this diameter. Of course, this would have to be repeated for each objective.

Personally I am a fully paid up member of the 'Trial and Error' club. With care, it is possible to obtain good dark ground using patch stops over a much wider range of magnifications than most textbooks admit to. By putting a small stop immediately before the top lens I have obtained good dark ground with a three lens aplanatic condenser and a x60 N.A. 0.85 objective. For higher numerical aperture objectives it may help to have the condenser oiled to the slide.

Some workers have made much of the fact that the Abbe condenser is not corrected for spherical or chromatic aberration. The diatomist can quite easily overcome these technical niggles. Annular illumination has long been favoured by diatomists for the resolution of the most recalcitrant forms. First we need a suitable patch stop in the filter tray. The condenser must be oiled to the slide. Only marginal rays are now passing through the condenser and they may be brought to a sharp focus. With a good green filter in the system, it should leave little to be desired. The field, if the stop has been chosen correctly, will not be uniformly dark. The centre will be darker than the periphery. Remember, if you are using an oil immersion objective of N.A.

1.25 or 1.3 you will need a large stop. Please note - the objective is used at full aperture.

Oblique illumination is currently out of favour and has been for some time. At the risk, however, of being regarded as a heretic, I suggest you try it. It is not difficult to cut a series of stops from black card. For higher N.A. objectives, the condenser should be oiled to the slide. With care in focussing the condenser and the use of a green filter you may be surprised by the results.

If you have a condenser mounted in an Abbe substage, which allows the iris diaphragm to be moved laterally by a small rack and pinion you can experiment with a minimum of effort. The Russian aplanatic condenser was equipped with this fitting. Personally I prefer stops - prejudice again!

Of course, Rheinberg illumination is also possible. I have mentioned my method of making the discs. It is, though, quite possible to cheat. Simply use a blue or green filter for the transmitted light, and a contrasting colour, red or orange, for top lighting. If you get it right, it is quite impressive.

There is one method of oblique illumination which employs the full aperture of the objective and which seems to be accepted. This was devised by the late Dr. R. J. Baker of the Department of Zoology and comparative Anatomy at Oxford University.

This was originally described for use with a highly corrected oil immersion condenser such as the Watson 'Holos'. I see no reason why it should not be effective with the Abbe condenser. Dr. Baker also recommended a stainless steel or other suchlike mirror but admitted that this was not really necessary.

My version of the instructions assume that a high intensity lamp equipped with an iris diaphragm is in use. Dr. Baker's preferred object for demonstration was the diatom Amphipleura pellucida.

(1) Set up microscope as normal. Condenser in oil contact with slide. Oil immersion objective in use. Focus on specimen.

(2) Open the substage iris fully.

(3) Open the lamp iris to about 15mm diameter. Remove eyepiece. Use phase telescope to observe rear focal plane of objective.

(4) Hold pencil point in centre of lamp iris. Carefully focus condenser until pencil point is seen in sharp focus.

(5) Lay pencil aside. Close lamp diaphragm to about 5mm. Carefully tilt mirror so that the disc of light from the lamp is moved to the edge of the field and about half of it remains visible.

(6) Replace eyepiece.

Phase condensers

Those of you who work with a phase contrast condenser may have noticed that these can give quite good dark-ground illumination with low powers.

With the Russian outfit, good dark-ground can be obtained with a x10 objective and the x90 annulus in place.

Dry Dark-ground Condensers

Most of the major manufacturers have made a condenser of this type. Usually they are best with objectives of magnification 20 to 40x and N.A. 0.4 to 0.7. Not infrequently they are engraved with a numerical aperture range. Even with the products of highly regarded manufacturers these might seem a bit optimistic. This may be explained by the following table extracted from 'Optical Systems for the Microscope - Carl Zeiss, Oberkochen 1967'.

Designation	N.A. (mm)	Focal Length (mm)	Object Distance of N.A.	For Objectives
Ultracondensor,				
1.2...1.4 N.A., oil	1.2 - 1.4	5.9	1.1 - 1.3	0.75-1.0
Dry Darkfield Condensor,				
0.8...0.95 N.A.	0.8 - 0.95	8.2	6	0.6-0.75
Dry Darkfield Condensor,				
0.7...0.85 N.A.	0.7 - 0.85	8.5	6.5	0.4 - 0.6

Some of the older versions were made with the R.M.S. objective threads. Apart from fitting these to the substage they present few problems.

Many of the more modern versions require a stage with a very large hole. I have an old Watson 'Service' which allows me to use most such condensers. Before anyone asks - No, they don't fit the substage but it's amazing what may be achieved with insulating tape and Blue-Tac.

No. 3644. **Dark ground illuminator** for low and moderate powers £5 0 0

No. 3644.

This illuminator is for use with object glasses the numerical aperture of which is not greater than ·65 N.A. It is made somewhat on the principle of an ordinary substage condenser but has a specially long working distance. It is provided with an iris diaphragm for transmitted light in the usual manner. When the iris diaphragm is opened to its fullest extent and the tray is swung aside, a special stop can be folded in, which converts the apparatus into a dark ground illuminator. A neutral glass screen is supplied to fit into the tray, in order to reduce the necessarily strong light required for dark ground illumination to an amount suitable for ordinary transmitted light. With this illuminator, dark ground illumination can be used with all powers up to ⅙ inch (4 m/m) provided the object glass has not an aperture exceeding N.A. ·65.

My favourite is the oldest. The beautiful Beck dry paraboloid. I am able to use this on a number of microscopes - and it 'works like a charm'.

There is a Russian 'Brightfield/Darkfield condenser. This can be used only with the Biolam microscope with a circular rotating stage. It is rather a fiddle to fit and not altogether straightforward to use. Once correctly adjusted however, it is capable of giving good results.

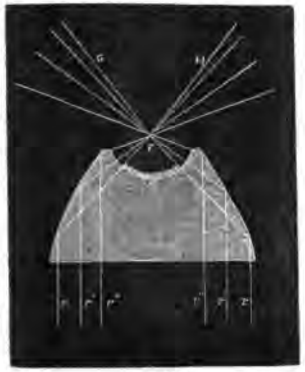


Fig. 259.

Fig. 260. Parabolic illuminator

Azimuthal Stops

For a time there was a fashion for the use of such stops with dark-ground illuminators.

In my hands these have provided only optical chaos.

D.I.Y.

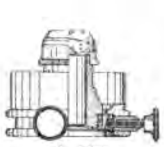
W. Burrells, in 'Microscope Technique' - (Fountain Press, 1977) gives descriptions of two possible do-it-yourself designs.

The first is the Cylinder Dark Ground Illuminator. This is intended to illuminate a large field for a low power objective. This design could perhaps be modified to use a L.E.D.

He also describes a high power version (W.G.Hartley, J.R.M.S. Series III Vol. LXXX p.282). At the lowest end of the cylinder, apex inserted towards the stage, is a polished perspex cone. It is claimed that with this, illumination to N.A. 0.85 is possible.

No. 3296. **High power dark ground immersion illuminator**, in plain substage fitting £2 10 0

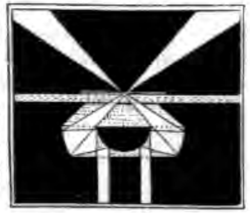
No. 3297. **Ditto**, in centring substage fitting 3 5 0



No. 3297.

This illuminator throws upon the object a hollow cone of light between 1 and 1.3 N.A. It must be used in immersion contact with the slide and the slide must be 1 m/m thick or the light will not be in focus.

It is specially intended for use with object glasses of high power, as it gives a very small but brilliantly illuminated spot of light. Oil immersion object glasses such as the 2 m/m. with an aperture of .95 can be used with it, but lenses with a greater aperture require to be stopped down by the insertion of a diaphragm behind the back lens.



From Beck Catalogue 1930s

High Power Dark-ground Condensers

This is one of those areas which has given the optical designer scope. Overwhelmingly they utilise reflecting systems.

Probably the oldest design is the paraboloid. This was followed early in the twentieth century by the cardioid and bispheric condensers. I can only think of one truly refracting system which was designed by the indefatigable E. M. Nelson.

Whilst the optical construction of these devices varies, they are all rather similar in use.

Firstly, the limitations. They must all be used in oil contact with the slide. Secondly, the numerical aperture of the objective should not exceed 1.0. Some makers have produced low N.A. oil immersion objectives specially with dark-ground work in mind. Otherwise there are two options. One is the use of a funnel stop. This fits into the back of the objective and reduces the N.A. to less than one. The other rather more elegant and certainly more expensive is to incorporate a small iris diaphragm into the objective. Even the Russian manufacturers have done this - at a price.

Perhaps it is in order to offer some basic instructions on 'setting-up'. Before proceeding, however, I should mention that all dark-ground condensers are corrected for use with slides of a certain thickness. There is a little latitude in this - and this varies from condenser to condenser. I use a micrometer to measure slide thickness.

Some workers have written of increasing slide thickness with cover-slips in oil contact with the slide. I have tried this. In my hands it is messy and not very satisfactory.

Annoyingly, diatomists have been given to using thin slides. Most dark-ground condensers are corrected for use with slides about 1.2mm thick.

Cardioid Condenser

What follows really is drawn from experience with the Russian cardiod condenser. This is a very good copy of the Zeiss condenser and comes in a neat wooden box complete with a funnel stop for the Russian x90 oil immersion objective.

Some makes of condenser have a small circle engraved in the centre of the top element to facilitate centration. Others do not.

Let us assume that the microscope is set up and a low power objective in position. The condenser should be in oil contact with the slide (actually water or glycerol could be used here if preferred).

By hook or by crook the low power objective should be in focus. All dark-ground condensers are sensitive to both focus and centration. For this reason, in years gone by, some microscopes had a fine adjustment fitted to the substage.

No matter. It is possible, with a delicate touch, to focus the condenser - even if it is housed in a simple tubular substage.

As you adjust the mirror (if in use) you may see an area of the slide illuminated. This will probably be in the form of an annulus (ring). Gently raise (or perhaps lower) the condenser. When it is in focus you will see a brightly lit spot in the centre of the field. There will be an annulus both above the focus and below it.

Now, the condenser should be centred, using the centring screws and the focus re-adjusted if necessary.

If you have a dark-ground condenser without centring mount, it is quite often possible to use it in a non-centring substage. Try rotating the condenser. Who knows? This may work.

Now you can begin to increase the magnification. It is instructive to do this step by step. With low N.A. objectives you may observe diffraction colours. Whilst very pretty, this is an indication that the numerical aperture is too low for resolution to be achieved. I have a slide of diatoms from Sumatra given to me many years ago by a friend in the Quekett Microscopical Club - there are a large number of beautiful circular forms on this slide which give an amazing display of diffraction colours. I also have a test slide with a range of diatoms prepared by Mr. Bernard Hartley. The range of colours is fascinating - the golden-brown of Pleurosigma angulatum to the beautiful deep electric blue of Amphipleura pellucida.

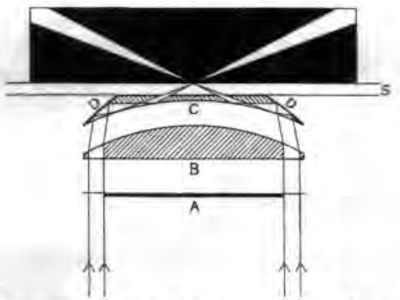


FIGURE 123. NELSON CASSEGRAIN (WATSON & SONS) BIREFLECTING DARK GROUND ILLUMINATOR **Numerical Aperture of the Hollow Cone of Rays Is 1.37 to 1.47, hence, the 1.30 N.A. Oil Immersion Objective Can Be Used at Full Aperture.**
A. Patch stop (interchangeable).
B. Lower plano-convex lens.
C. Upper modified concave meniscus lens with two reflecting surfaces, one silvered at D and one unsilvered.
D. Silvered concave reflecting ring.
S. Object slide.

From Practical Use of the Microscope - G. H. Needham 1977

By the time you are using the x40 objective (N.A. 0.65) you should be able to resolve Pleurosigma angulatum.

The next step, of course, is to use the oil immersion objective. This should be a revelation, many of the traditional test diatoms revealing their structure.

It is worth asking at this stage what happens if the N.A. of the oil immersion objective is not reduced to less than 1. Well, we now have an objective of N.A. 1.25 or 1.3. Dark-ground will not be achieved but a quite extreme form of annular illumination will be. This may bring some of the more recalcitrant diatoms to heel.

Some workers prefer to use a green filter in these techniques.

A more recently developed form of dark-ground condenser is the so-called torroidal dark-ground

condenser. This was introduced by Toyoda for use in transmitted light fluorescence microscopy. This was then taken up by other manufacturers, particularly Reichert and the American Optical Company. Loosely, a torroid is a 'doughnut'. In fact, the bottom optical element in these condensers is a cast lens with the following cross section -

This allows the condenser to make more efficient use of the available light. Highly recommended - if you can find one!

There are also condensers usable at all N.A.'s up to 1.4. Perhaps the most famous of these is attributable to Mr. E. M. Nelson. This was the Cassegranian condenser. Again - highly desirable.

A number of manufacturers also made focussing dark-ground illuminators. The Cooke, Troughton and Simms condenser has its own fitted metal cylinder. The top of the cylinder is engraved with the famous legend D. G. Illum.

Beck also made a focussing dark-ground condenser from which the top lens may be removed. This allows it to be used as a dry dark-ground condenser for medium power objectives.

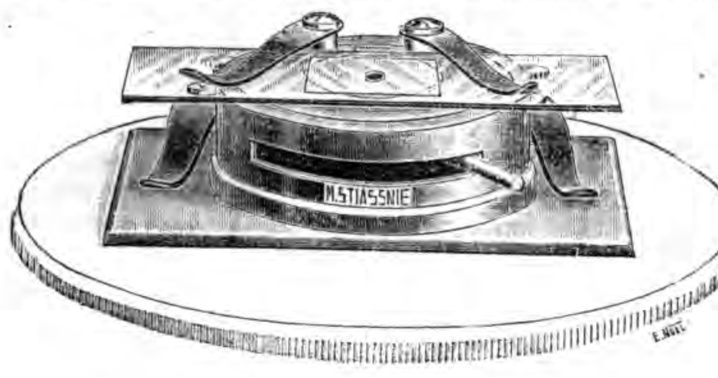
These condensers remove the problem of slide thickness and will focus through a wider range than most of us will encounter.

Under the right conditions all of these condensers (particularly the focussing type) open up the possibility of Reflex Illumination. This is dark-ground with a difference. Light is bounced back off the cover-slip on to the specimen.

The late Mr. L. V. Martin has written of Reflex illumination (Q.M.C. Journal, Vol.34,pp306-307 and 615-617).

If using a conventional dark-ground illuminator, choose the thinnest slide which you can find. Use a high power dry objective, not an immersion lens. The condenser should be centred and focussed. It should then be raised above its true focus. with a low power objective you should now see a small annulus of light surrounding your chosen specimen. If you have 'got it right' - on examination with the high power dry objective you should have achieved Reflex illumination. This is subtly different to normal dark-ground.

Of course, a focussing dark ground condenser makes the achievement of Reflex illumination easier. The thickness of the slide may be measured, and the condenser set for work with a much



Precis de Microscopie 1921

thicker slide.

There is one final category of dark-ground condenser which I have not mentioned. These are not substage condensers. They should perhaps be called superstage condensers. They fit on top of the stage.

I have been fortunate enough to be able to try three versions. There is a Leitz device, a form of bispheric condenser, which will focus through slides of different thickness. Personally, I did not find this easy to use.

There is a comparatively simple and limited version made by the Spencer Lens Company. This works quite well.

However, the best of these is the beautiful Reichert Spiegel Condenser.

This sits on the stage, held in place by pegs which fit into the holes intended for the stage clips. The upper surface is engraved with a small circle to facilitate centration. There is a range of stop sizes allowing the condenser to be matched to objectives of varying numerical aperture. It is corrected for slides between 1.2 and 1.4mm thick. Using very thin slides it gives beautiful Reflex Illumination with a high power dry objective.

Claude Marmasse in his book 'Microscopes and their Uses' (Gordon and Breach Science Publishers 1980) describes the use of the Cotton and Mouton Prism. I have never tried this.

They write that 'due to its simplicity, it deserves to be brought again to the attention of microscopists'.

This could provide an effective D.I.Y. 'on stage' condenser for dark ground illumination. I am not sure over what range of magnifications it would be useable.

The Use of Polarised Light

Here I quote from 'The Microscope' Part II by Conrad Beck (R. and J. Beck 1924).

"There is another method of illumination which was first employed by Sir Herbert Jackson in work on the examination and identification of small particles in various media, notably in glasses and glazes, and he also employed it for the study of a number of other objects including diatoms.

It gives somewhat the same appearance as dark-ground illumination, in that the object stands out more brightly illuminated than the background and has the same merit of showing no glare, giving good contrast and filling the whole aperture of the object glass with evenly distributed light and there is no restriction on the aperture that can be used.

It consists of the use of a polarising apparatus in combination with a wide-angle substage condenser. (It would be worth trying an Abbe condenser in immersion contact with the slide, possibly with a stop for annular illumination.). A polarising prism (today a piece of Polaroid) before the condenser illuminates the object with plane polarised light; that is to say the object is illuminated by light that is 'vibrating' in one plane at right angles to the optical axis of the instrument, and if an analyser be placed over the eyepiece of the microscope in a 'crossed' position, at right angles to the polarising prism, no light that is vibrating in this plane can pass through. But it is a property of reflection from most fine structures that some of the reflected plane polarised light is elliptically polarised, and if the object has the power of reflecting the light in all directions some of this reflected light will no longer be in the plane of polarisation and will pass through the analyser over the eyepiece, with the result that the small reflecting elements show up brightly on a relatively dark background. Each reflecting point in the object is illuminating the portions around it with this elliptically polarised light, and a completely

illuminated object is seen.

The light so reflected is somewhat faint, and a powerful source of illumination is essential. This method has the disadvantage that the field is not perfectly black, because no polarising apparatus is so perfect that it entirely stops all light. Nevertheless, the contrast between the illuminated object and the background is very considerable.

It is essential for the use of this polarised light method that the object should be under the most favourable conditions for reflecting light, and it might appear that such an object as a diatom must be mounted dry in order to possess a great difference in the refractive index between the object and the mounting medium, and thus to have sufficient power of reflection. The reflecting power is, however, so much increased by the angle at which the light impinges upon it that by the use of a wide angle condenser, preferably an immersion condenser of about 1.30N.A., beautiful resolution of diatoms mounted in Styrax, monobromide of napthalene or Realgar is obtained. It is far superior to the resolution obtained with ordinary transmitted light, and such a diatom as Amphipleura pellucida can be seen as if it consisted of dots with a 1/12inch achromatic object glass, 1.25N.A., and with an apochromatic of 1.4N.A. the dot resolution is quite convincing. The combination of a patch stop with the polariser and the condenser is useful, as it has a tendency to reduce light other than that reflected from small elements of the object. The combination of the dark-ground illuminator and the polarising apparatus also gives most striking results."

In addition to the above recommended use of polarised light in conjunction with dark-ground, some workers have found the use of an analyser (without polariser) useful.

A return to diffraction

It is instructive to examine a specimen of a known diatom by dark ground illumination. My choice would be Pleurosigma angulatum. With a low N.A. objective (e.g. x10, N.A.0.25) it will give a beautiful brown gold colour.

If the rear focal plane of the objective is examined at this stage, it will be seen to be brightly lit. A phase telescope is useful for this.

Now, if a higher N.A. objective is brought into use (e.g. x40, N.A.0.65), the diatom should be resolved and the diffraction colour lost. Now examination of the rear focal plane of the objective may be of interest. The bright central spot should be observed. This is the direct light (zero order). It will be surrounded by six small first order diffraction spectra. This very neatly demonstrates the requirement for resolution as laid down in the Abbe theory.

An exotic

Recently I acquired a Hungarian made 'Metrimpex' condenser.

This was advertised and sold in the U.K. in 1960. It was supplied in a wooden box, with three interchangeable top lenses, green and blue filters and a 'phase' telescope.

Perhaps this is a cheat. This is not really a dark-ground condenser. So far as I can see it provides highly directed oblique illumination from two diametrically opposite points. When correctly adjusted it provides an image with striking relief. Such images must of course be interpreted with extreme caution. It was advertised as a 3D condenser, but I am not sure to what extent this is an artefact.

Incident Light

With incident light, as with transmitted light we have the choice of using a bright field or dark field.

Normally, the objectives for use with such systems are metallurgical lenses, corrected for use on uncovered specimens.

The low-power objectives are tolerant and work quite well. Oil immersion objectives too, in the main, will perform quite well.

I have a Russian incident light outfit. For dark-ground illumination a central stop may be inserted into the system. Light is directed around the objective onto the specimen.

The Russian outfit is supplied with a cylindrical 'stage'. I have had this drilled in the centre and use a dark well beneath it. This was a marked improvement.

The images are pleasing and provide a different view of the specimen.

Metal-coated Slides

In microscopy, we have two basic problems, resolution and contrast.

Imagine a slide of Pleurosigma angulatum being used to set up the microscope for transmitted light, firstly with a x10 objective (N.A.0.25) and then a x40 (N.A.0.65). You will certainly be able to see the outline of the diatom and its major features. We know it ought to be resolved, but (perhaps this is a comment on my eyesight) may not be able, clearly, to see the fine structure.

Now try removing the eyepiece and. using a phase telescope, having a look at the rear focal plane of the objective. You should see the central zero order spot and six small circular spectra around it. Optically the conditions are right for resolution but the problem is one of contrast.

The use of aluminium coated slides, to a large extent, solves the problem. I really cannot comment on the matter of priority. It was, however, the late Horace Dall who brought this technique to the notice of Amateur Microscopists.

The aluminium film is applied in vacuum. This, of course, is a technique of preparation used in electron microscopy.

I have seen slides in which the film is too thick or too thin to be useful. When, however, it is the correct thickness, the slides are quite splendid.

They may be examined by transmitted light with the substage iris diaphragm fully open. Some workers favour the use of a green filter. For the resolution of difficult diatoms annular illumination may be used, or, indeed, any other trick of the trade.

Not normally available commercially, every now and then some reach the market. Not in the strict sense dark-ground illumination, but a form of negative staining.

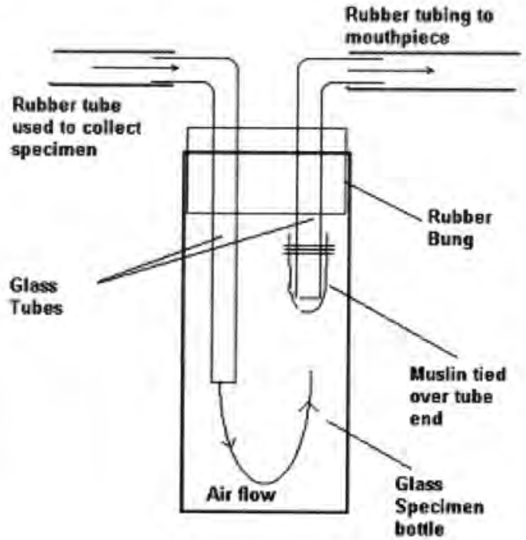
Conclusion

It would be dangerous to claim that this survey is comprehensive but I hope that it encourages you to try dark-ground, and, perhaps to try one of the D.I.Y. projects. In that case I would be interested to know how you get on.

Collecting Diatoms

In many cases it is possible to collect diatoms from relatively easily accessible spots but it is so often the case that a particularly rich bloom is just out of reach or in such a location as to be difficult to collect.

The Aquatic Pooter.



Entomologists and microscopists alike have for many years used a simple device for collecting small land invertebrates. This device is commonly called a 'Pooter'. Its simple construction has made it popular amongst amateurs and professionals. Its efficacy is limited only by the power of ones lungs as it operates using suction.

This is really useful, you can catch your specimen unawares and with a whoosh it is sucked up the tube and deposited in the specimen bottle (if you are to do this then always check that the muslin barrier is tied over the mouthpiece tube as failure to do so results in mouthfuls of vile tasting, but no doubt nutritious, little beasties.) But what, if anything, has this got to do with collecting diatoms? Well, the same general principle can be used to collect diatoms lying on the surface of sediments. What you want to create there is sufficient suction to lift the diatoms from the surface, get them into your specimen jar and not have them escape as you draw your receptacle from the water. You also don't want to get a mouthful of water!

Tie a weight to the pooter specimen bottle sufficient to sink it. Add a quick-release tubing clip to the mouthpiece tubing. You now have two pieces of tubing to hold - the collector tube and the clipped tube. Lower the pooter body into the water and let it sink below the surface. Target the diatom film you want to collect with the collector tube getting as close as possible without disturbing the sediment. Release the tubing clip. The pressure of the water will cause a current of water to enter the specimen bottle of sufficient strength to lift some of the diatoms and deposit them in suspension in the specimen bottle. Close the clip and lift the whole from the water.

Amazing Facts - III

Iceland - Mining

Iceland has few proven mineral resources, and profitable development has been difficult. Minerals of commercial value include shell sand, perlite, pumice and diatomite; the last is refined from diatomaceous earth mined from Lake M˝vatn.

Sales, Wants and Exchanges

Exchanges should be described accurately and fully. They should be FAIR.

U.S. A. Material Exchange - I am seeking to swap fossil material from any location worldwide, but would prefer Hungarian, Danish or Russian samples. Raw material preferred of 5 to 10 grams weight. In exchange I can trade excellent quality raw fossil material from the following locations: Klammath Falls, Oregon, U.S.A. (fossil freshwater, very diverse species represented), Terrebone, Oregon, U.S.A. (fossil freshwater about 97% whole frustules), Brady Hotsprings, Nevada, U.S.A. (fossil freshwater, primarily small Melosira with lots of carbonates present) and Dunkirk, Maryland (fossil marine, cleans easily, very diverse). Please reply in the first instance to Stephen Nagy, M.D. via email: snagymd@pol.net.

Diatomaceous Earth - from Oamaru. Small samples exchanged for fossil earths from other locations. Mike Samworth Tel. 01969 667119 or email apochrom@ukgateway.net with details before sending.

Peragallo et Peragallo etc. - Little Imp CDs exchanged for well mounted diatoms. See publications list for offerings. Contact the publishers to discuss exchange.

Material from exotic locations - wanted. Contact Klaus Kemp (see advertisement - inside front cover). Exchange for slides of material supplied.

Old diatom mountants wanted. - Particularly Hyrax and Styrax. Any condition. Contact Steve Gill. Tel. 024 76 327989. Diatom strew slides in exchange.

Policy Statement - Names, Synonyms and Taxonomy

The editors of this publication will not presume to alter names to 'conform to the current taxonomy'. Taxonomists maintain a state of flux and what might be correct today will be wrong tomorrow. Where a species name is given we (and authors) should where possible state the authority they are using when naming. This simply means that if someone else has subsequently renamed the species or re-categorised it in some fashion the basis for the identification will be clear.

Correspondence

Dear Editors,

I was delighted to receive your publication "The Amateur Diatomist" which has made me feel somewhat rejuvenated at the ripe old age of 82+ years!

I sincerely hope that you will be able to keep the publication going and enable us to once more exist as Diatomists.

Dr. Kenneth R. Green

East Yorkshire

UK Currency

Subsequent to the publishing of the R. I. Firth Price List a number of correspondents have enquired about the monetary system used. An explanation follows.

Prior to 1970 the monetary system in the UK was based on Pounds (£), Shillings (s.) and Pence (d.)

There were 12 pence (d.) to the shilling, 20 shillings to the pound. Two shillings were called a Florin. Each penny was equivalent to 2 ha'pennies (half penny). In older advertisements you may even see Farthing which was a quarter of a penny. A guinea was one pound and one shilling (or 21 shillings).

Values were written in a number of ways:-

6d = sixpence, 1/- = 1 shilling, 1/6 = one shilling and sixpence, 20/6 = twenty shillings and sixpence which may also have been written as 1-0-6 or 1/0/6 or £1.0s.6d.

2/6 denoted two shilling and sixpence and was known as half-a-crown, for which there was a single coin. A crown was thus 5 shillings, for which there was a coin, but it was issued as a commemorative rather than for general circulation.

Scottish Diatomite Deposits

There are a number of diatomite deposits in Scotland which have been commercially exploited in the past, and other minor ones which have been noted , and not being commercially viable for extraction have been studied by Diatomists.

Most of the deposits are to be found beside existing lochs and are of recent (Quaternary) origin. The lochs neighbouring the deposits were originally more extensive. When their boundaries receded they left diatomite deposits behind. Over hundreds of years these deposits become buried under layers of peat and extraction requires the removal of this layer.

The diatomite deposits in Scotland are of variable quality, this being determined by the amount or decayed organic matter, sand and gravel that is mixed in with the diatom frustules themselves. At most locations the centre of the deposit seems to provide the best material, with less adulteration than is found at the deposit margins.

Skye

Probably the most significant Scottish commercially exploited deposits of diatomite are those to be found on Skye and its environs. Eight of the Skye sites are in the Trotternish area and one is located on Waternish some distance to the West.

The table below gives an indication of the quality of the deposits, the quality figure being a percentage diatomaceous content. The 'worked' column indicates whether or not the deposits have been commercially 'mined'.

SITE	QUALITY	VOLUME	WORKED
Loch Cuithir	79%-88%	350 000m3	Yes
Loch Valerain	81%	Worked Out	Yes
Loch Mealt	Unknown>	10 000m3	Unknown
Eilean Callum Chille	57%-76%	Unknown	Unknown
Loch Sneosdal	78%	1 000 000m3	Unknown
Glen Uig	77%	Unknown	Unknown

Three other sites are known on Skye:- Loch Cleat (Trotternish), Staffin Bay (Trotternish) and Score Horan (Waternish).

The deposits at Loch Cuithir and Loch Valerain were worked between about 1883-and 1918. Between 1899 and 1914, it is recorded that in excess of 2000 Imperial tons of diatomite was removed from these two sites alone. This extensive commercial activity exhausted the deposit at Loch Valerain. In the late 1930s, the works at Loch Cuithir were reopened and exploited by the Skye Mineral Syndicate Company. This activity lasted for but a short period before it was realised that the whole recovery process was not commercially viable.

Diatomite from Loch Valerain was transported by aerial ropeway to Staffin bay, and from Loch Cuithir by tram to nearby Invertote. It was here that the diatomite was kiln dried, ground and then calcined (roasted to reduce the particle size and remove organic matter) (Haldane et al., 1940).

Aberdeenshire

Beneath the moorland close to the village of Dinnet. These deposits, like those in Skye are typically covered with a layer of peat.

The sites have evocative names and references to the sites appear on many a slide from the turn of the century. They are: Black Moss, Ordie Moss, Kinnord Moss, Drum Moss, Auchnerran and Presswhin.

These deposits are thought to have been exposed when a large body of water receded, leaving the accumulations to be covered, over an extended period of time, by accumulations of peat forming vegetation.

The deposits at Kinnord Moss, Black Moss and Ordie Moss are particularly close together and all were commercially worked during the period 1910-circa 1918, to provide diatomite for use in the production of dynamite, silicaceous paints and also an Ultramarine substitute (Ultramarine being a pigment derived from ground lapis lazuli). The diatomite works at Dinnet were dismantled at the termination of extraction around the end of the First World War. An extensive record of the works still exist in the form of photographs. (Haldane et al., 1940).

Other Sites

There are a number of other sites. These are of little or no commercial value but provide interesting material for Diatomists.

1. On the Isle of Lewis, some fifteen miles North of Stornoway, is a deposit called the North Tolsta deposit. This site was worked on a minor scale, yielding quite good quality diatomite and there is estimated to be around 2000 Imperial tons left.

2. At Kinross in Fife there is a thin layer of diatomite which is thought to have been deposited by Loch Leven as it changed its boundaries.

3. Near Balerno, Edinburgh, at a place called Dalmahoy, there is a diatomite deposit which was discovered by one J. W. Lunn in 1924, and the diatomite from it was extensively analysed by researchers in Dundee. Recent attempts to study the deposit further met with problems as there is rumoured to be an unexploded bomb from the Second World War lying somewhere in the diatomite! (Henderson, 1925; D. Mann, pers. comm.).

4. Near Golspie (Sutherland)

5. On Eigg and Mull (South Ebudes)

6. Uist (Shetland)

7. Three sites in Argyll (Glen Shira, South Cur and Campbeltown).

In the Press


Calling all Bacillario-phytaphiles

The Amateur Diatomist

The second issue of *The Amateur Diatomist* is now available. The June issue has articles on mounting diatoms, loca-

LABORATORY *news*

THE SCIENTISTS' NEWSPAPER www.labnews.co.uk OCTOBER/NOVEMBER 2002

We have been fortunate enough to have our efforts recognised in the scientific press.

The October/November 2002 issue of Laboratory News has included a small column noting the publication of Volume 1 No. 2 of The Amateur Diatomist.

Laboratory News, in the main, is targeted at Professional Laboratories and Education but has included a number of articles relating to Amateur Microscopy and has a Microscopy Section in its own right.

Enquiries concerning availability of the Laboratory News should be directed to:- Laboratory News, Quantum House, 19 Scarbrook Road, Croydon, CR9 1LX

The next issue of

The Amateur Diatomist

In the next Issue:-

Further notes on reproduction
Mounting techniques - V
The Haemocytometer
Cleaning Diatoms - V
Diatom Genera - V (P)
Famous Diatomists Eduard Thum
Pure Diatom Cultures
Holiday Diatoms
Watermills
- Devon,Dorset and Somerset
Useful Notes
Sales, Wants and Exchanges
The diatom frustule (cont.)
Simple Setups Suffice
WWW - Sites of Interest
Useful Formula
Notes on Aroclor
Diatom Visibility Index
Correspondence

Notes for contributors.

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If you wish to name anyone then get their permission first as seeing your name in print, and perhaps associated with something you would rather was forgotten, can come as something of a shock.

We hope that by adopting this relaxed approach to the submission of copy you will all break out the notepads and begin writing. What you have to say concerning Diatoms, mounting and Microscopy is of interest to us all.

"No one of us know all there is to know, and yet we do not know what we do not know." - Anon.