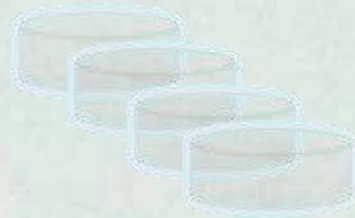




**COLLECTING MICROFOSSILS –  
DIATOMS AS Science AND Art**

*Janice L. Pappas*

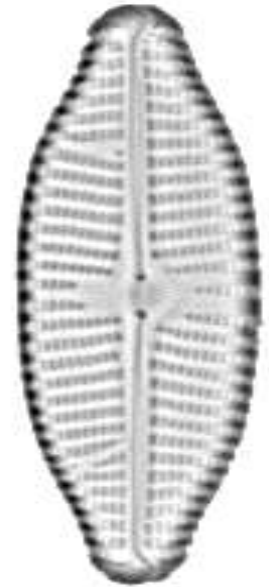


**APRIL 11, 2014**

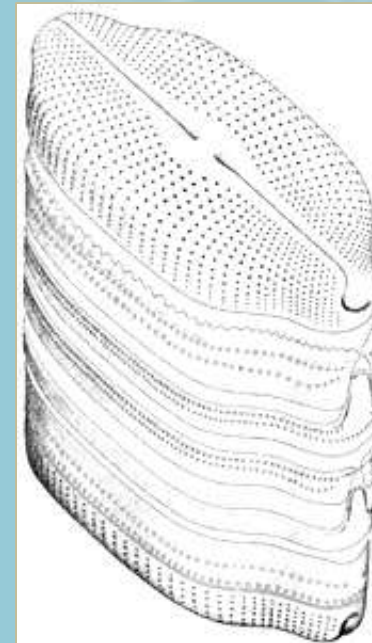
# What is a diatom?

- One-celled photosynthetic eukaryotic organisms (chlorophyll *a/c* and fucoxanthin)
- Derived by secondary endosymbiosis (a non-photosynthetic eukaryote engulfed a photosynthetic eukaryote (probably a red alga))
- Autotrophs (exceptions - *Nitzschia* spp. - heterotrophs in dystrophic conditions)
- Motile (polysaccharide mucilage) or dependent on floating ability (storage of fatty acids; colonial forms)
- Genomically, part animal and part plant
- 200,000 to 1,000,000 species worldwide
- Size range: ~3  $\mu\text{m}$  to 2 mm; usually ~10  $\mu\text{m}$  to 100  $\mu\text{m}$
- 25-50% contribution to global primary production
- Drivers of aquatic food webs and global carbon and silica cycles
- Indicators of environmental, climate, and sea level changes
- 85% of diatoms living during the Cretaceous are extant

*Navicula*

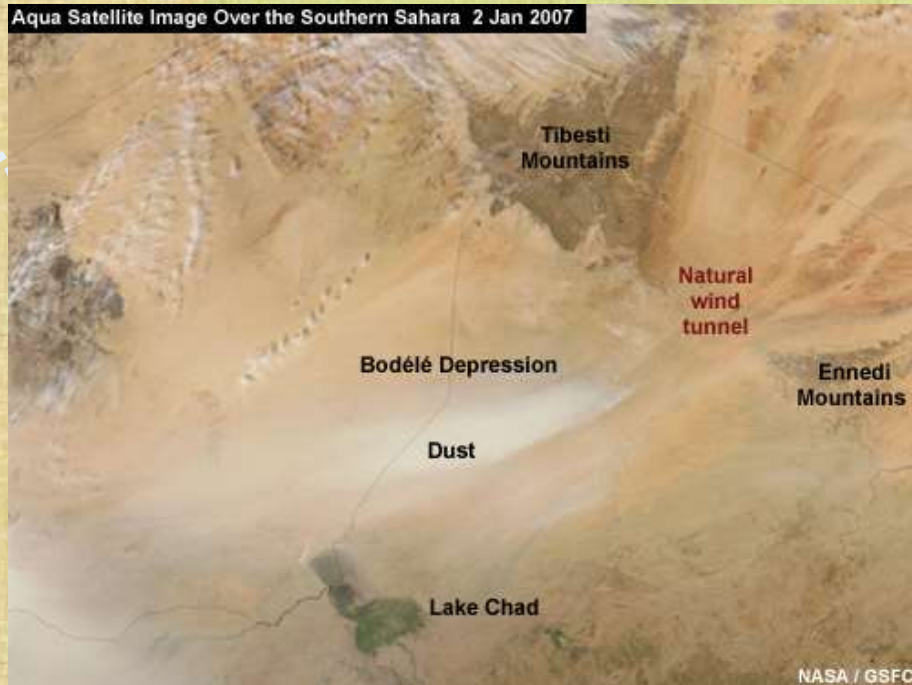


Royal Botanic Garden, Edinburgh



Round et al. 1990

← epivalve  
↑  
epicingula  
(4 bands)  
↓  
← hypocingulum  
← hypovalve



The Bodélé Depression—the source of diatomite.  
“The dustiest place on Earth.”

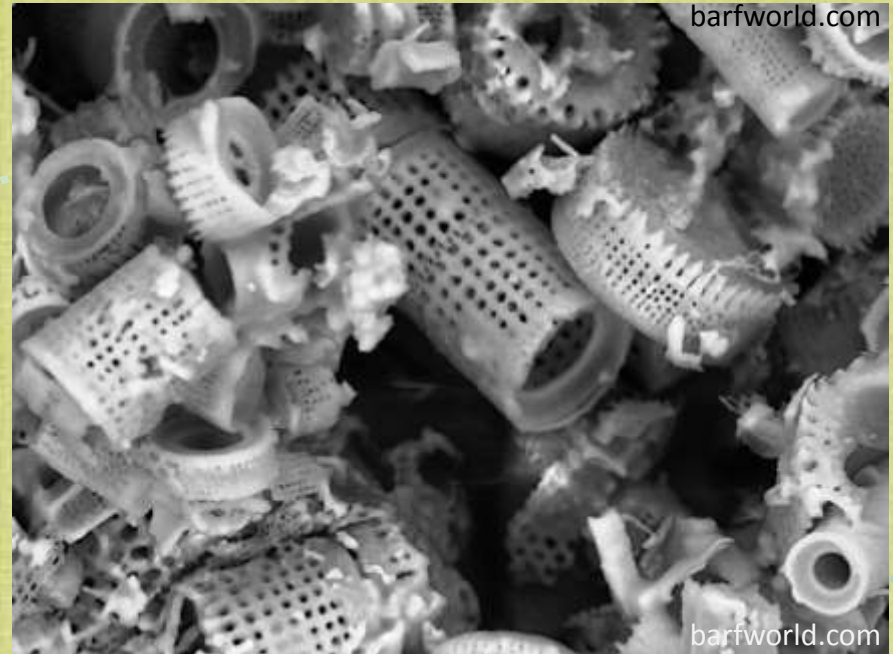
A diatomite dust cloud traveling across the Atlantic  
Ocean from Africa.

Charles Darwin, 1846, Quarterly Journal of the Geological Society (London), 2: 26-30

*‘On the 16th of January (1833), when the Beagle was ten miles off the N. W. end of St. Jago (Cape Verde Islands), some very fine dust was found adhering to the under side of the horizontal wind-vane at the mast-head; it appeared to have been filtered by the gauze from the air as the ship lay inclined to the wind. The wind had been for twenty-four hours previously E. N. E., and hence, from the position of the ship, the dust probably came from the coast of Africa’.*



Diatomite (kieselguhr), Bodélé Depression,  
Sahara Desert



Diatomaceous earth—*Aulacoseira granulata*

Darwin collected and sent some of the **dust** to C. G. Ehrenberg (1844)—  
The **dust** was found to be composed of **diatoms**.

# Cretaceous to Recent diatoms\*



*Neidium*

*Mastogloia*



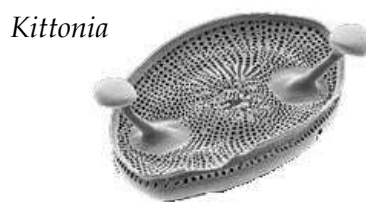
*Encyonema*



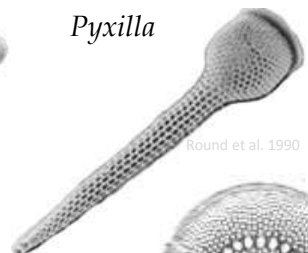
*Oxyneis*



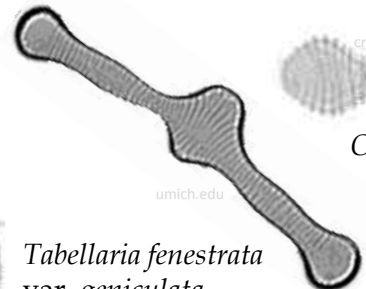
*Sceptroneis caduceus*



*Kittonia*



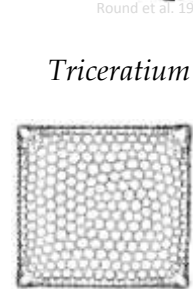
*Pyxilla*



*Tabellaria fenestrata*  
var. *geniculata*



*Diatoma tenue* var. *elongatum*



*Triceratium*



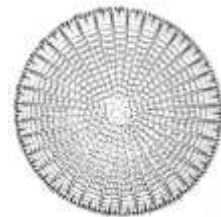
*Brightwellia*



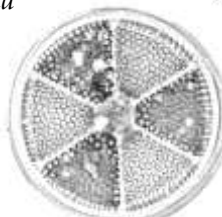
*Meridion circulare*



*Cylandrotheca fusiformis*



*Arachnoidiscus*



*Actinoptychus*



*Perissonöe cruciata*



*Asterionella formosa*



*Cocconeis*



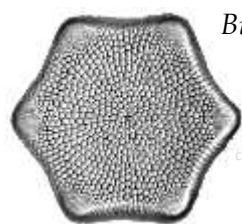
*Asterolampra*



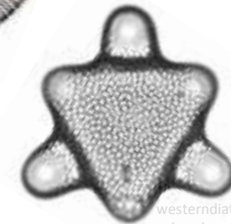
*Auliscus*



*Eunotia serra*



*Biddulphia*



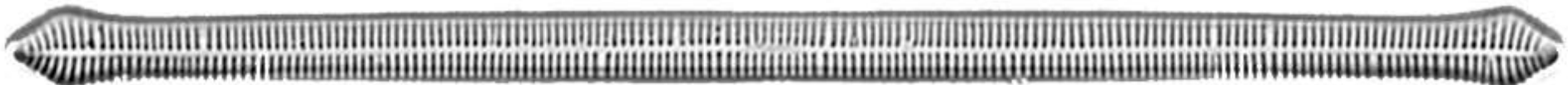
*Hydrosera*



*Campylodiscus*  
*noricus*



*Cymatopleura solea*



*Synedra capitata*

Dr. Ralf Wagner

# DIATOMS ARE EVERYWHERE...

In freshwater periphyton: epiphytic and epizooic



(Photos:  
E. F.  
Stoermer)

In geyser pools in Iceland



In acidic peat bogs



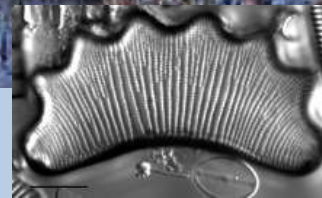
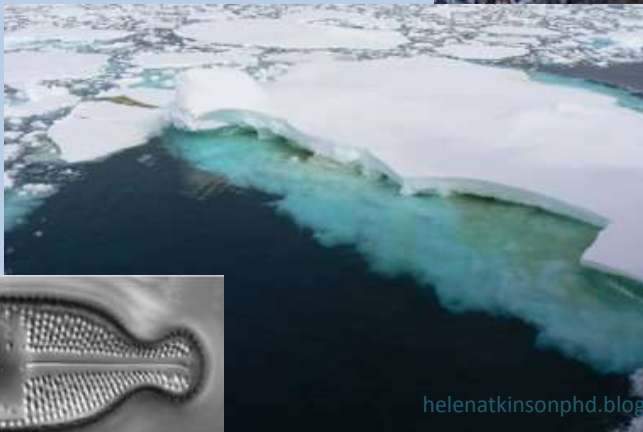
In oceanic subduction zones



In aerial habitats



(resting  
spores)



In East African soda lakes



# Diatoms hitching a ride...

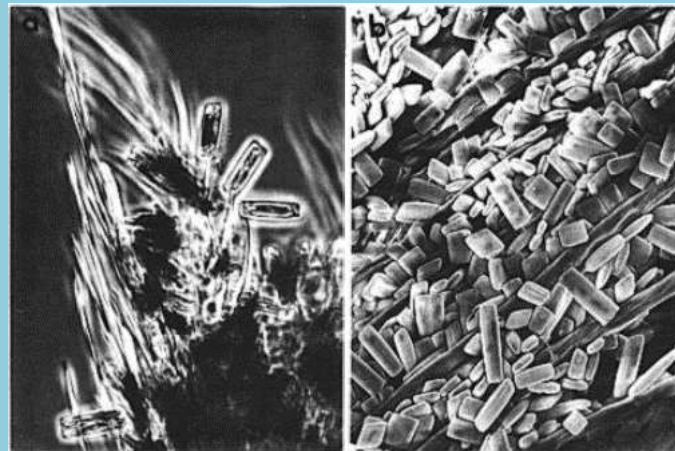


Yellowish coating on killer whale skin is diatoms.



[worldlandtrust.org](http://worldlandtrust.org)

The grooves or cracks in sloth hair carry diatoms.

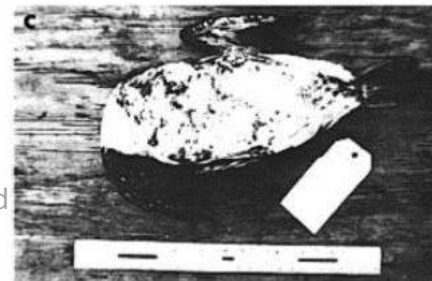


Common murre with diatoms on feathers.



[1000birds.com](http://1000birds.com)

Croll and Holmes 1982





# Diatoms – utilized in products and industry

earthslivingclay.com

**TOOTH POLISH**

INGREDIENTS: FOOD GRADE DIATOMACEOUS EARTH, PURE CALCIUM BENTONITE CLAY

USAGE: Sprinkle over toothpaste

All Natural Calcium Bentonite Clay

NET WT. 2.5 OZ (71.3g)

**THOMAS LABS**

**ORGANIC D/EARTH (DIATOMACEOUS EARTH)**  
Food Grade Fresh Water Quality

INGREDIENTS: earth (Diatomaceous Earth, Food grade), Fresh Water Quality

**SAFER**

ANT & CRAWLING INSECT KILLER  
MEDIUM AND HEAVY DUTY

**Diatomaceous Earth**  
Tierra Diatomacea

Kills Roaches, Ants, Earwigs, Silverfish and other Crawling Insects  
• Resists Run-Downing

**Celatom**

**Diatomite Filter Media for Swimming Pools**

poolsupplies.com



bedbugs.net

**Concern**

DIATOMACEOUS EARTH CRAWLING INSECT KILLER

KILLS COCKROACHES, ANTS, FLEAS, SILVERFISH & EARWIGS



**SAFER**

ANT & CRAWLING INSECT KILLER  
MEDIUM AND HEAVY DUTY

**Diatomaceous Earth**  
Tierra Diatomacea

Kills Roaches, Ants, Earwigs, Silverfish and other Crawling Insects  
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**Celatom**

**Diatomite Filter Media for Swimming Pools**

poolsupplies.com

**Mount Sylvia Diatomite**

**KLEANSORB**

Highly Diatomite Retains liquids up to 100% of its own weight

Specifically formulated for use in Oil and water treatment, Cellulose, Silo Lubrication, Clearing, and other applications.

25 LITERS

petsupersavers.com.au

**PERMA-GUARD**

**FOSSIL SHELL FLOUR**  
ANTI-CALCIFICATION AGENT

AMORPHOUS SILICA

**FOOD CHEMICAL CODEX GRADE**

**OMRI LISTED**

PERMA-GUARD, INC. ALBUQUERQUE, NM 87105

strombergsschickens.com

**FOSSIL SHELL FLOUR**

plantdoctor.com.au

**Beer Filter Aid**

**Diatomite**

humatechina.en.alibaba.com

**SILICA ALCHEMY**

Biological Transmutation

Human Body Nature's Internal Cosmetic

**SILICON MINERAL**

**Si**

diatomaceous.org

**Celatom**

MN-51

**DIATOMACEOUS EARTH**  
(Food Grade CODEX)

brownrecluse-spiderbite.com

**SilaPure**

adivaduavitamins.blogspot.com

voices.yahoo.com

saferbrand.com

thomaslabs.com



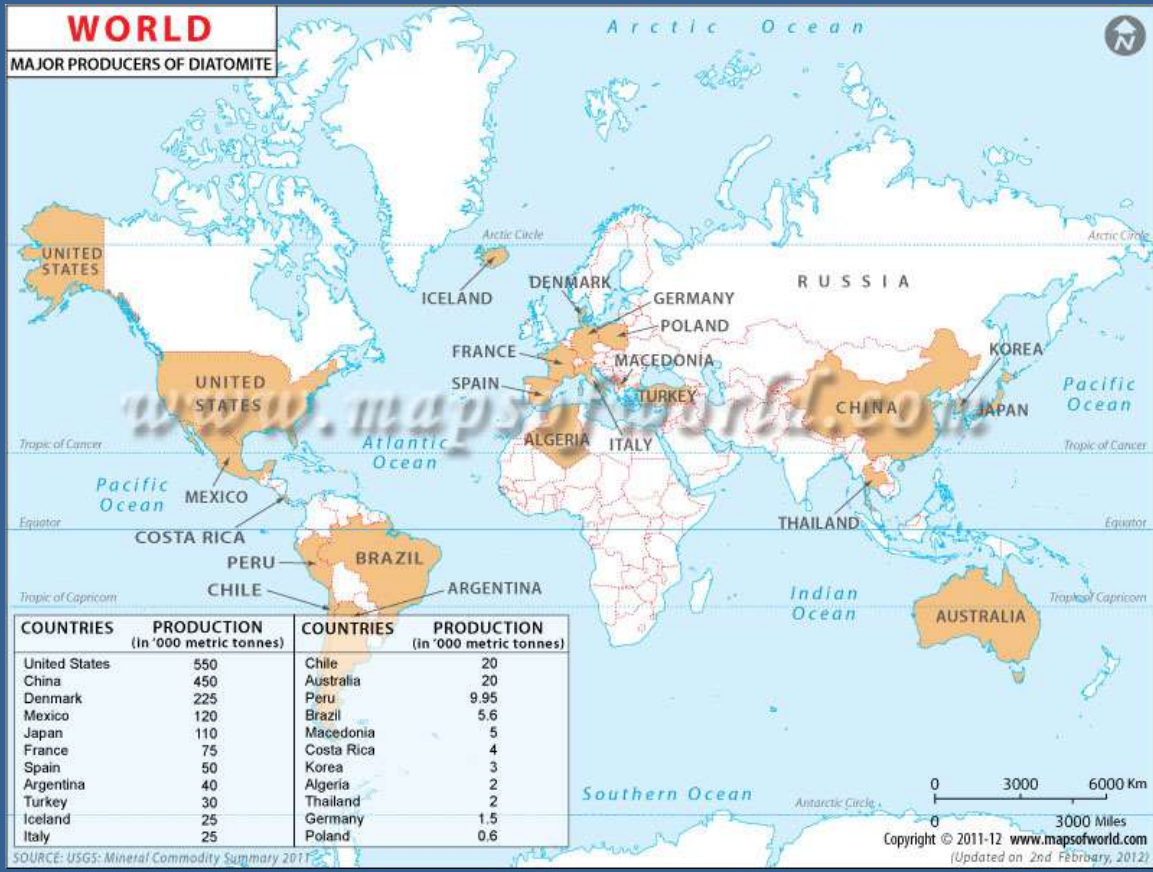
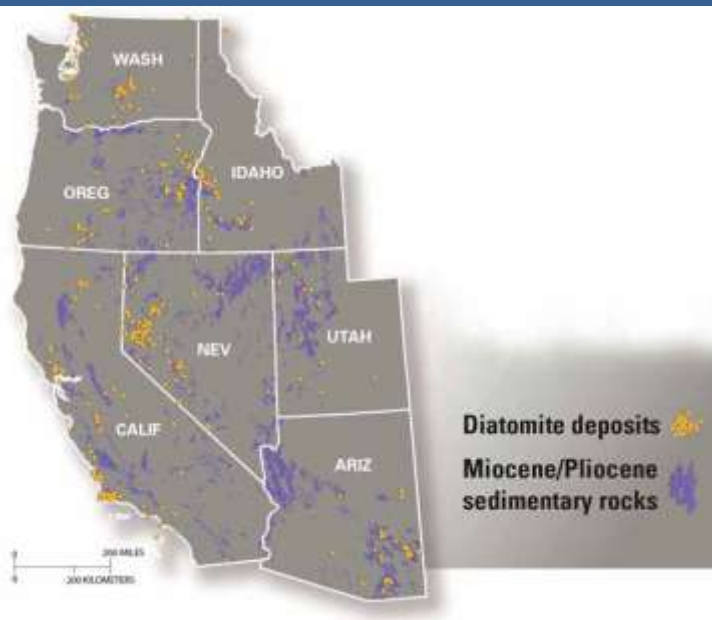
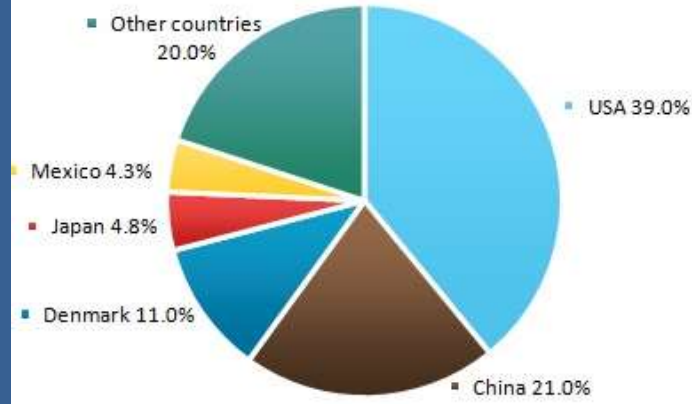


International Diatomite Producers Association

○ U. S. is the largest producer of diatomite — 813,000 metric tons produced in 2011

○ 2,060,000 metric tons produced worldwide in 2011

**Global Diatomite Production in 2012**



○ In 2009, 790,000 metric tons of diatomite had a value of \$179 million



Stephen P. Nagy

KLAMATH LAKE, OREGON  
FRESHWATER FOSSIL  
DIATOMITE DEPOSITS

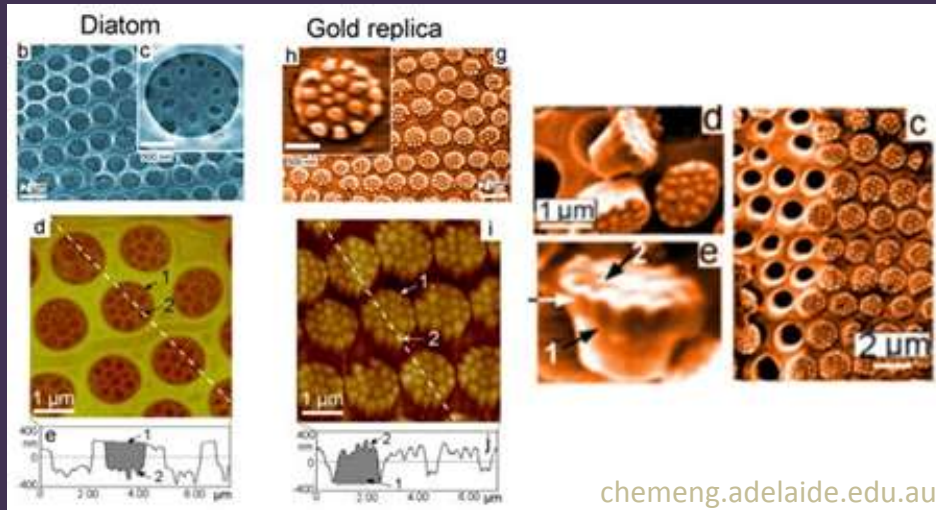
LOMPOC, CALIFORNIA  
MARINE FOSSIL  
DIATOMITE DEPOSITS



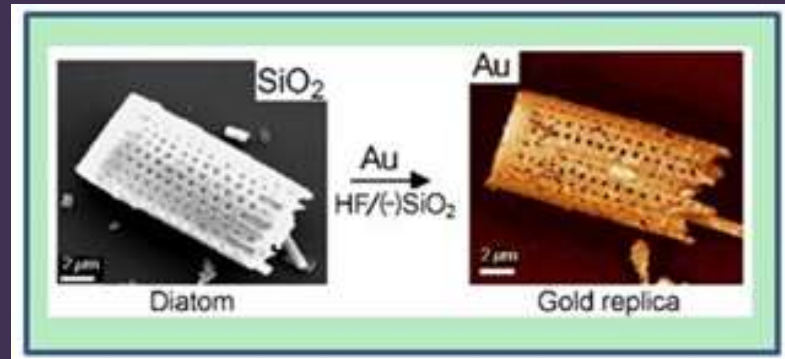
National Geographic 1979

# DIATOMS and **technology**

## Nanoscience and nanotechnology

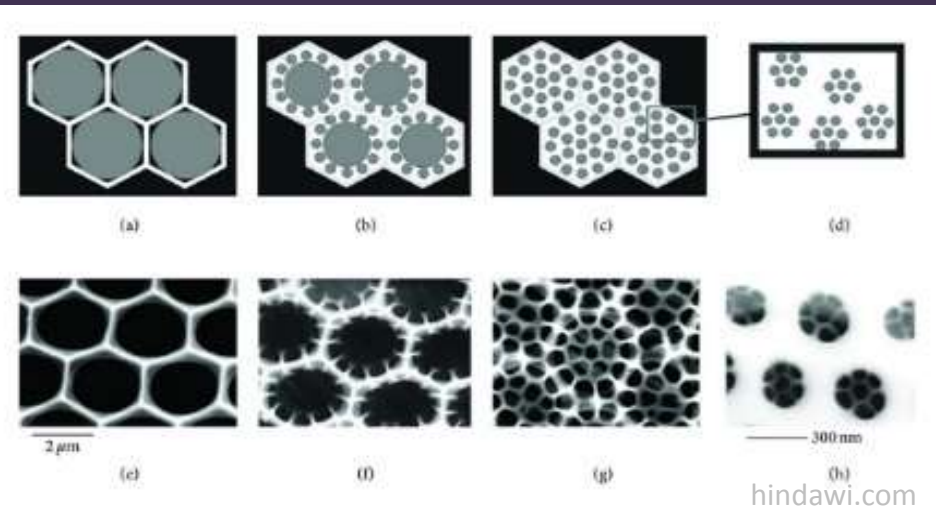


chemeng.adelaide.edu.au

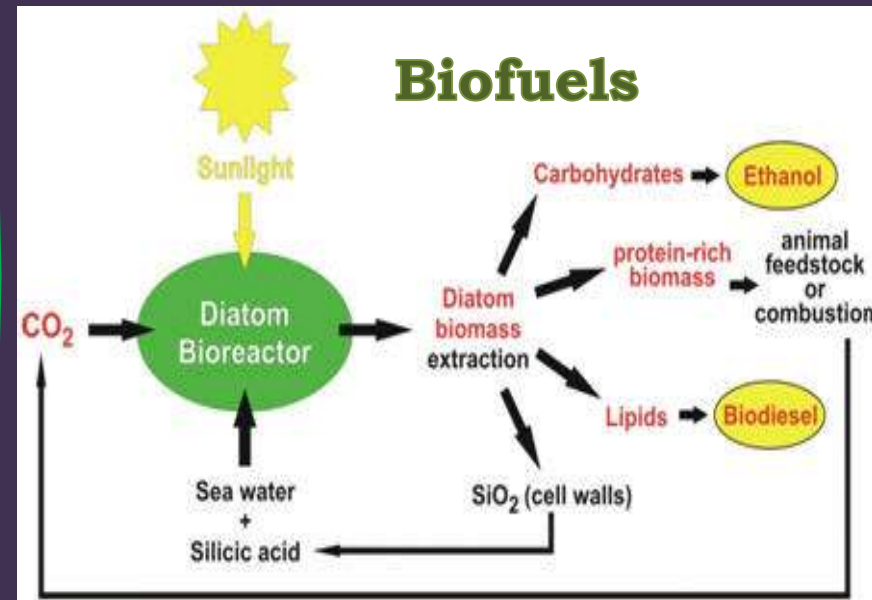


chemeng.adelaide.edu.au

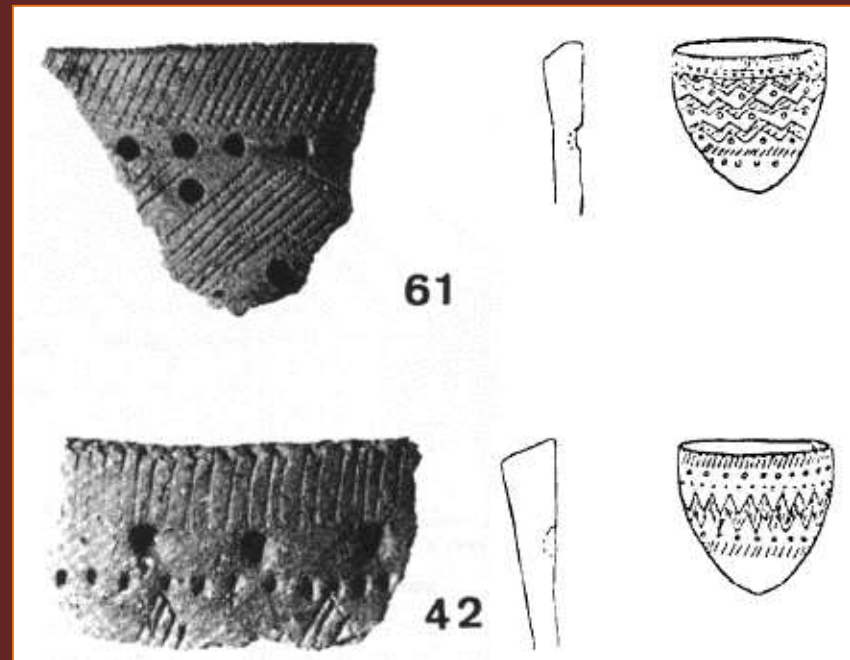
[www2.chemistry.gatech.edu/~kroeger/Kroeger/Biofuels.html](http://www2.chemistry.gatech.edu/~kroeger/Kroeger/Biofuels.html)



hindawi.com



# Diatoms in pottery, bricks and other archaeological finds



Stone Age pottery sherds from Kotka, Finland made of Ancyclus clays with *Melosira arenaria*. (Battarbee 1988)

Pottery clays with freshwater diatoms are thought to be from inland, then transported to coastal marine areas.

ORIGINAL ARTICLE

B. Ludes · S. Quantin · M. Coste · P. Mangin

**Application of a simple enzymatic digestion method for diatom detection in the diagnosis of drowning in putrified corpses by diatom analysis**

TECHNICAL NOTE

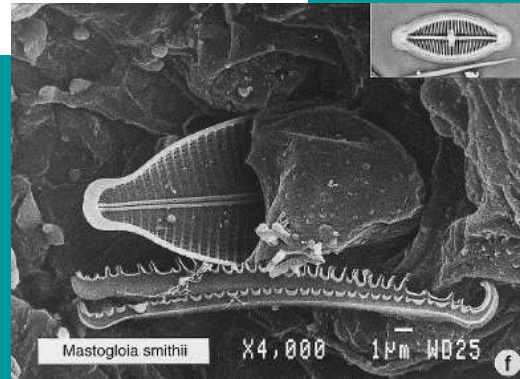
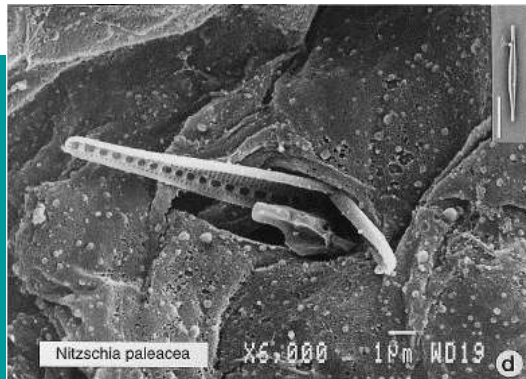
Stefan Günther · Jens Herold · Dieter Patzelt

**Extraction of high quality DNA from bloodstains using diatoms**

ORIGINAL ARTICLE

P. Lunetta · A. Penttilä · G. Hällfors

**Scanning and transmission electron microscopical evidence of the capacity of diatoms to penetrate the alveolo-capillary barrier in drowning<sup>1</sup>**



Diatoms penetrating alveolar lung tissue

# DIATOMS AND FORENSICS



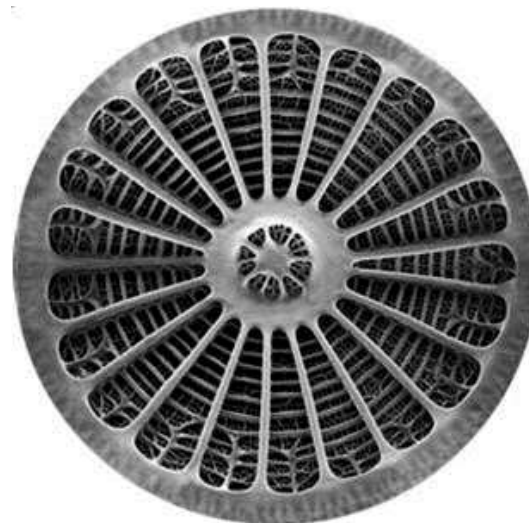
*Diatoms as Inspiration*

# DIATOM INSPIRATION...

*Arachnoidiscus*



Filip Knežić



Science Photo Library

Interior dome of the Hagia Sophia,  
Istanbul, Turkey

A knitted shawl





# DIATOM INSPIRED FIBER, GLASS WOOD AND CERAMIC ARTS



trilobiteglassworks on etsy



fionacampbellart.co.uk



orbytnz



breezyhillturning.com



bbusbyarts.com



jpolka.blogspot.com



antonveenstratextiles.com



Matthew Curtis

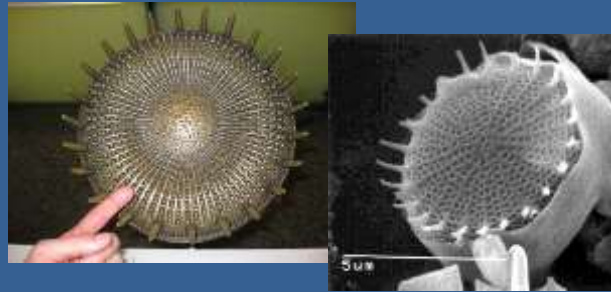
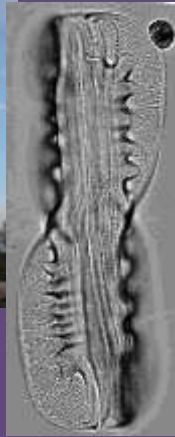


ceramicsnow.org

# Diatom inspired sculptures



*Entomoneis*



*Stephanodiscus*

Natural History Museum, NY



*Campylodiscus*

*Artist: Alan Ross*

## Portland, Oregon



*Artist: Fernanda D'agostino*

onlinegalleries.com



# DIATOMS & COLLECTING

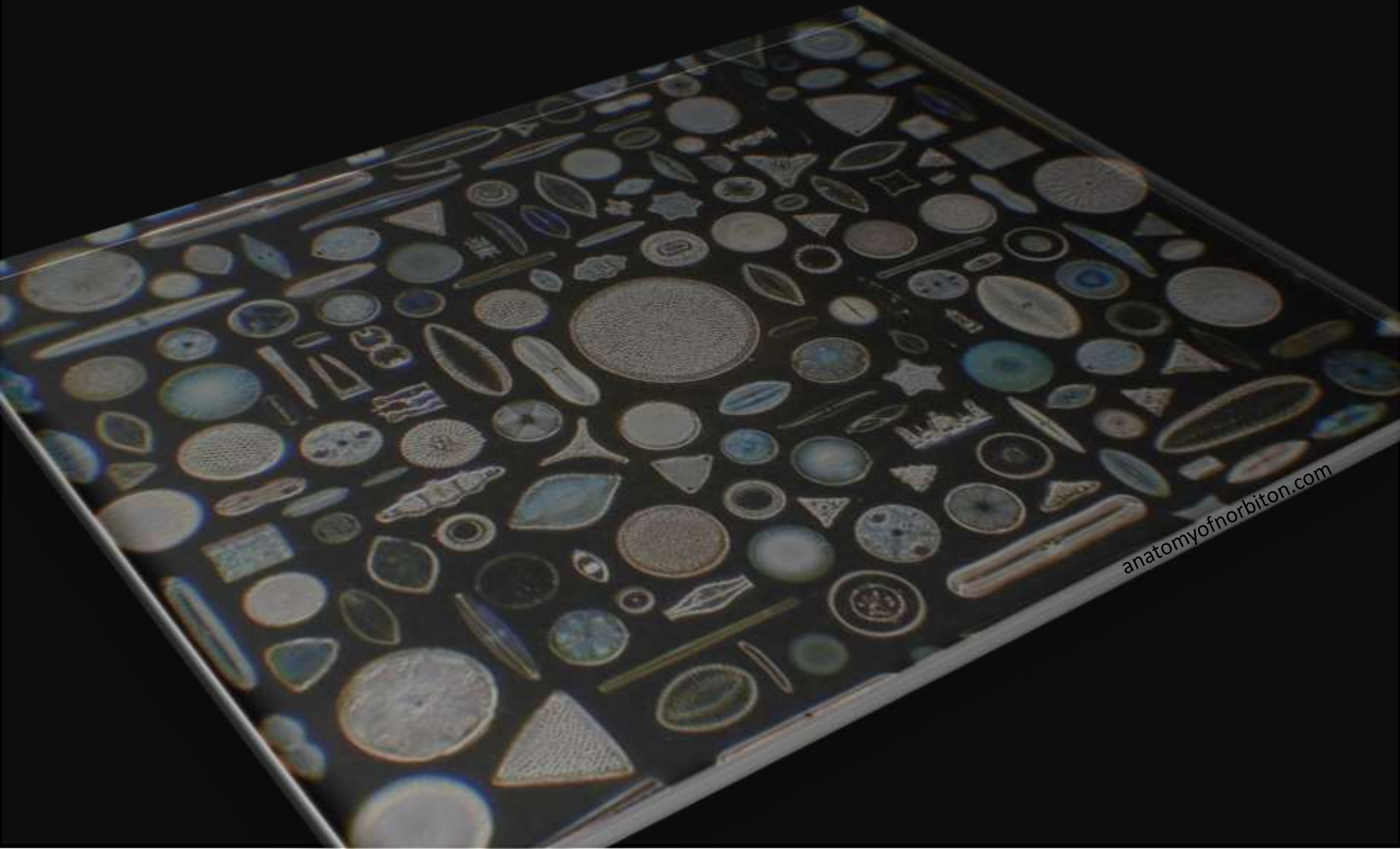


icollector.com



parcoscientific.com

# *Science, Diatoms, and Diatomists*

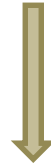


## Antoine van Leeuwenhoek (1632-1723)

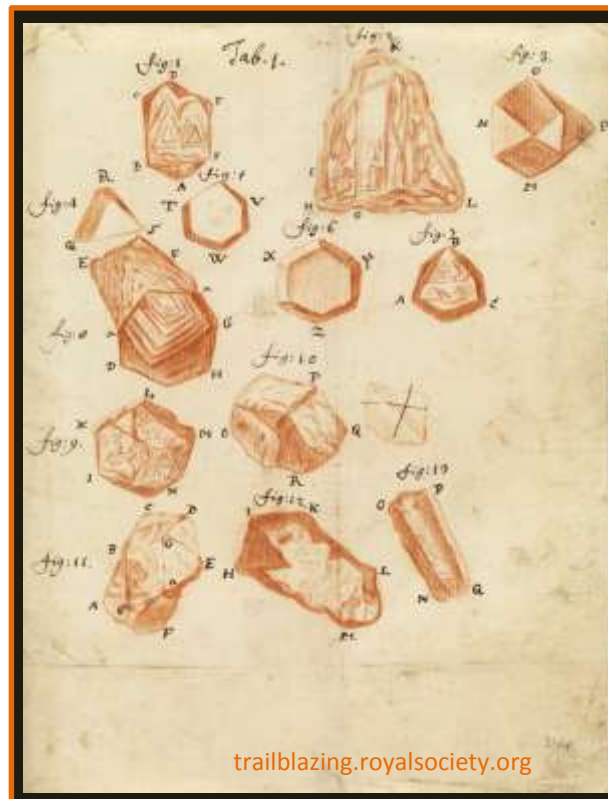


In **1702**, van Leeuwenhoek probably saw **diatoms** with his microscope and determined their size by his unit of measure—a sand grain. His measurements are equivalent to 20 – 120  $\mu\text{m}$ .

How to make a  
van Leeuwenhoek  
microscope:



<http://www.microscopy-uk.org.uk/mag/indexmag.html>  
<http://www.microscopy-uk.org.uk/mag/artjul07/hl-loncke2.html>



- van Leeuwenhoek's drawings of sand grains as viewed through the microscope
- his description and illustration of organisms thought to be diatoms are equivocal and unverifiable

1. Two Letters from a Gentleman in the Country, relating to Mr Leuwenhoeck's Letter in Tranfaction, No. 283. Communicated by Mr C.

July 5. 1703.

Dear Sir,

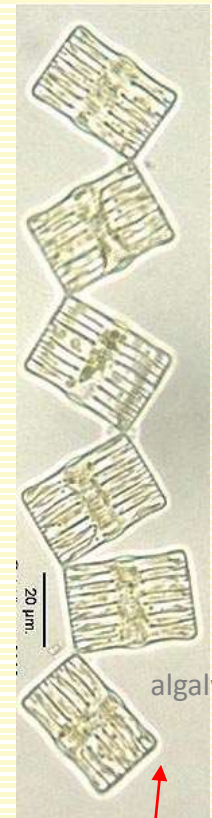
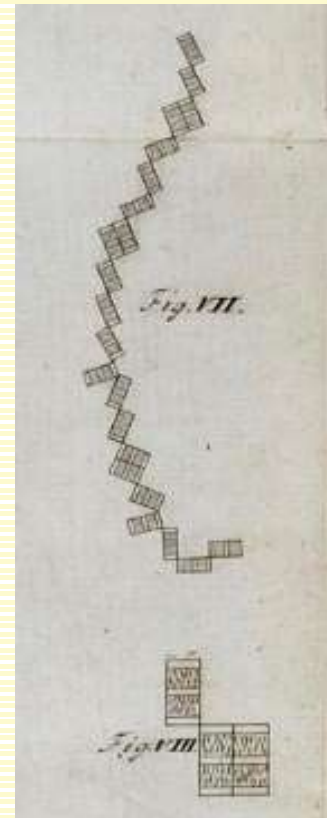
Since my last, I have farther observ'd the *Lens palustris*, and am fully satisfy'd of the truth of its first springing from the bottom. I lately took up some on the shallow side of a Pond, and found the ends of the Stalks (most of which were at least 5 inches long, and as thick as a strong Horse-hair) manifestly radicated in the bottom, so that I could not take them up without raising the Mud with them, which also adhered very visibly to them. These Stalks or Roots are of a curious texture, and almost transparent, and I have seen their outside very prettily cover'd with a regular sort of Net-work. The Draught in the *Transact.* No 283. is very stiff, and ill represents them.

( 1499 )

In my observation of these Stalks, I often saw adhering to them (and sometimes separate in the Water) many pretty branches, compos'd of rectangular oblongs and exact squares, which were joyn'd together, as you may see in Fig. VII which I drew as exactly as I could from one of them. There are often twenty or more of these Figures in one branch, which generally adheres at one end to the Stalks of the Plant, and I think it remarkable that these rectangular parallelograms are all of the same size, the longest side not exceeds  $\frac{1}{4}$  of an hairs breadth, and that the length is just double the breadth, the squares being visibly made up of two parallelograms joyn'd longwise. They seem very thin, and the texture of every one is nearly the same. To a very large Magnifier they appear as in Fig. VIII. I took these branches at first for Salts, but finding them always of the same size, and that there was no sensible encrease of their bulk while they continued in the Water, that after they had lain a day or two dry on a Glass Plate they alter'd not their Figure, and upon the addition of new Water (warm or cold) they had still the same appearance and cohesion, and that their adherence (tho touching only in the angular points) was so firm and rigid, that all mov'd together, and kept the same position in respect of one another, however, agitated by the Water; these considerations, I say, perswade me, that they may be rather Plants than Salts, but they being so very minute that no judgment can be made of 'em but by the Eye, I shall not determine any thing positively.

In **1703**, diatoms were first discovered and illustrated in a published account in the *Philosophical Transactions* of the Royal Society of London, but the author's name was not recorded.

The uncredited discoverer of diatoms, describes his response (as communicated by Mr. C.) to letters previously written by van Leeuwenhoek that were published in the *Transactions*.



His drawing resembles the freshwater taxon *Tabellaria*.

He was the premier diatom expert in the 1800s

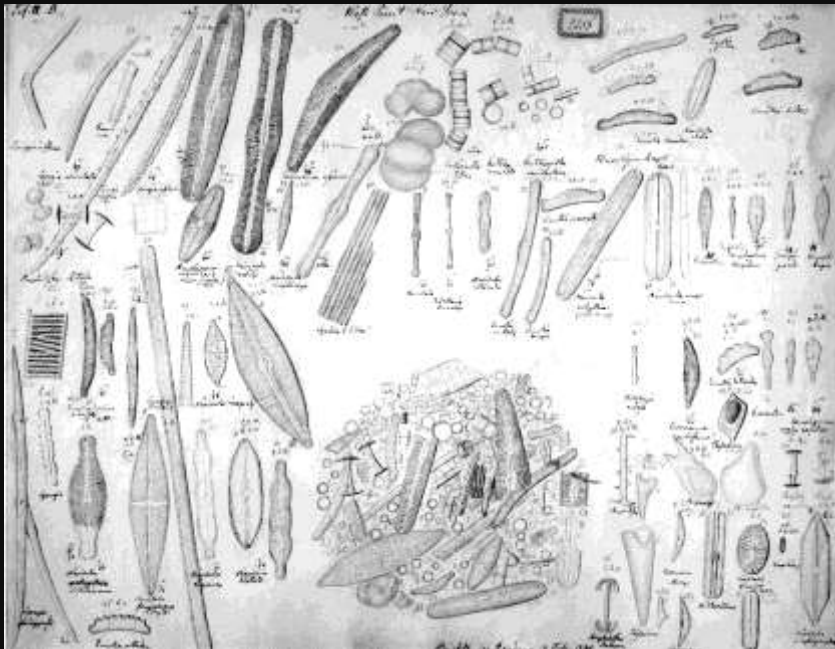


wikipedia.org

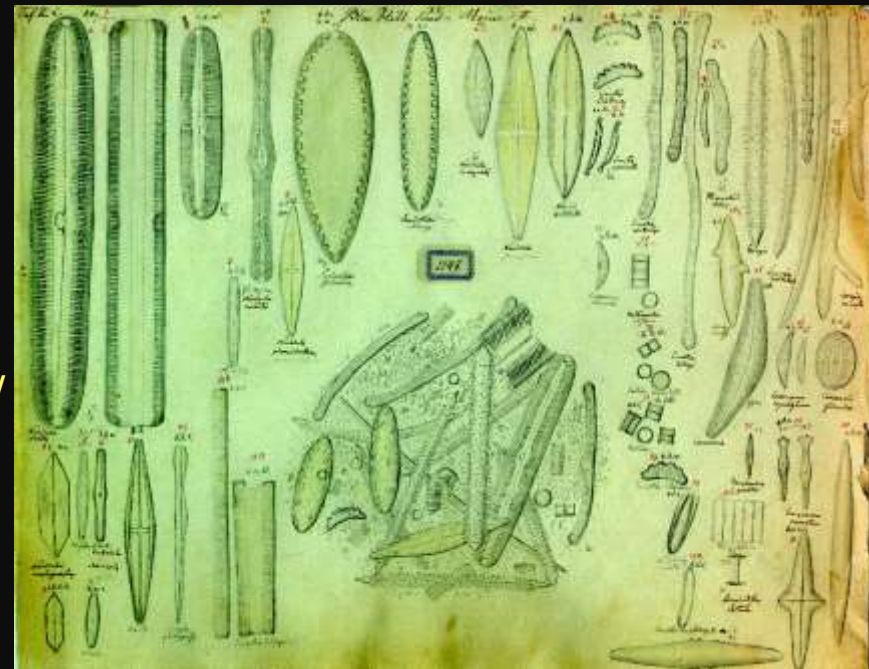
Christian Gottfried Ehrenberg  
(1795 – 1876) - zoologist



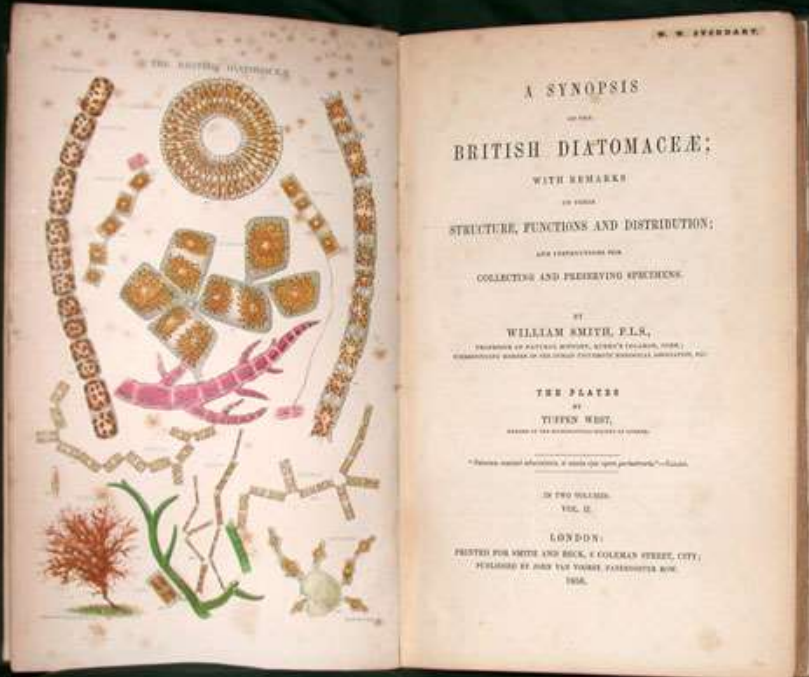
Some slides from his collections at University of Berlin



Some of his diatom drawings at University of Berlin



Reverend William Smith (1808-1857) – amateur turned professional - academic and diatomist



microscopy-uk.org.uk



1850



1851

He collected and mounted diatoms and had a lucrative business selling prepared slides and making mounts for people.



microscopy-uk.org.uk



earlytech.com



victorianmicroscopeslides.com



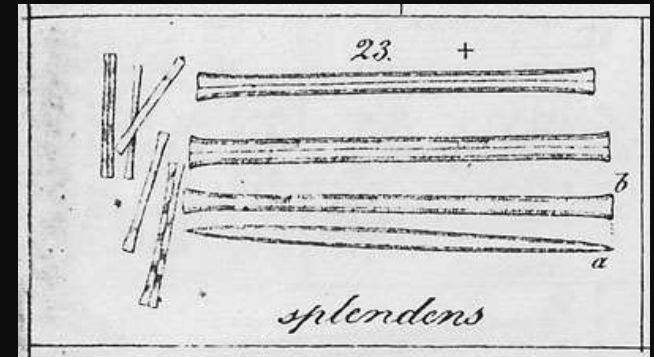
## Pharmacist, school teacher, turned diatomist



Friedrich Traugott Kützing  
(1809-1893)

- In 1833, he determined that diatom shells were composed of silica
- By 1835, his discovery that diatoms were composed of two parts to their shells was published and noted by Ehrenberg

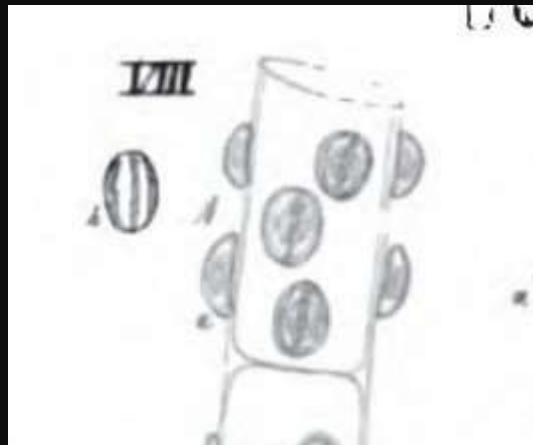
diatom.org



Kützing's drawing of *Frustulia splendens*  
(1833)

His original description  
and drawing of  
*Cymbella pediculus*

14. CYMBELLA? PEDICULUS. Taf. 3. Fig. VIII. Taf. 6. Fig. VII. (4"). C. parasitica laevissima, minutula, lunaris, dorso convexo, ventre parum concava, apice acutiusculo, latere altero elliptico truncato.



westerndiatoms.colorado.edu




gallica.bnf.fr

# Johann Diedrich Möller (1844 - 1907) – originated the art of diatom mounting

➤ In 1891, 4000 different diatoms were mounted on a 5 by 6 mm coverslip

TM12) Set of 6 Diatom Test Slides by J.D. Moller in Various Mounting Media - \$180



- Pleurosigma fasciola in Troken
- **Amphipleura pellucida in Troken**
- Grammatophora subuliforma in Troken
- Nitzschia lineavis in Monobrom Naphtalin
- Suriella gemma in Monobrom Naphtalin
- Frustulia saxonica in Jodkalium-Quecksilber Jodid.

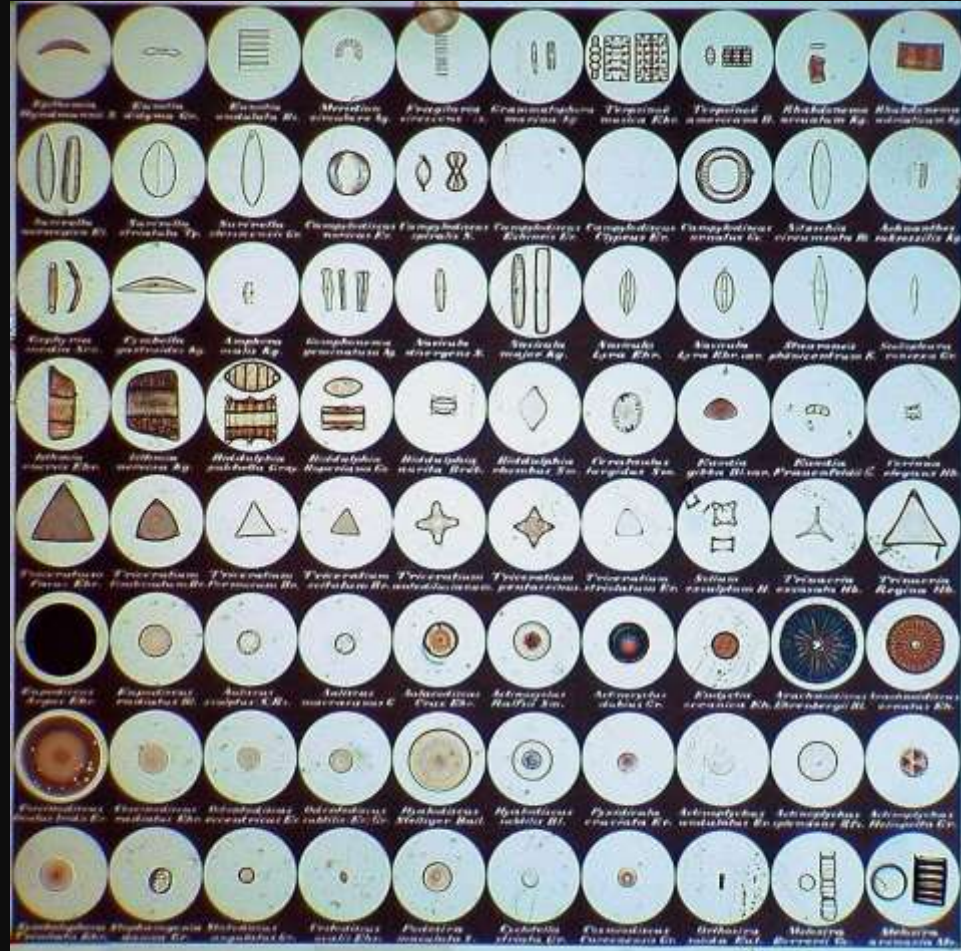
gemmary.com

National Geographic, 1979



Coverslip mount of 121 diatoms (1880)

80 diatom species (1880)



# Henri-Ferdinand Van Heurck (1839 – 1909) - botanist



users.tellenet.be

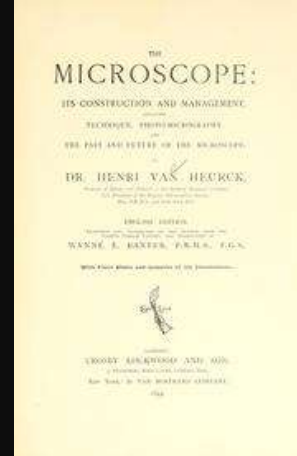
He proposed that the resin from *Styrax*, a deciduous bush, could be used as a stable diatom mountant with a high refractive index in slide preparations.



openlibrary.org



unz.org



bestor.be



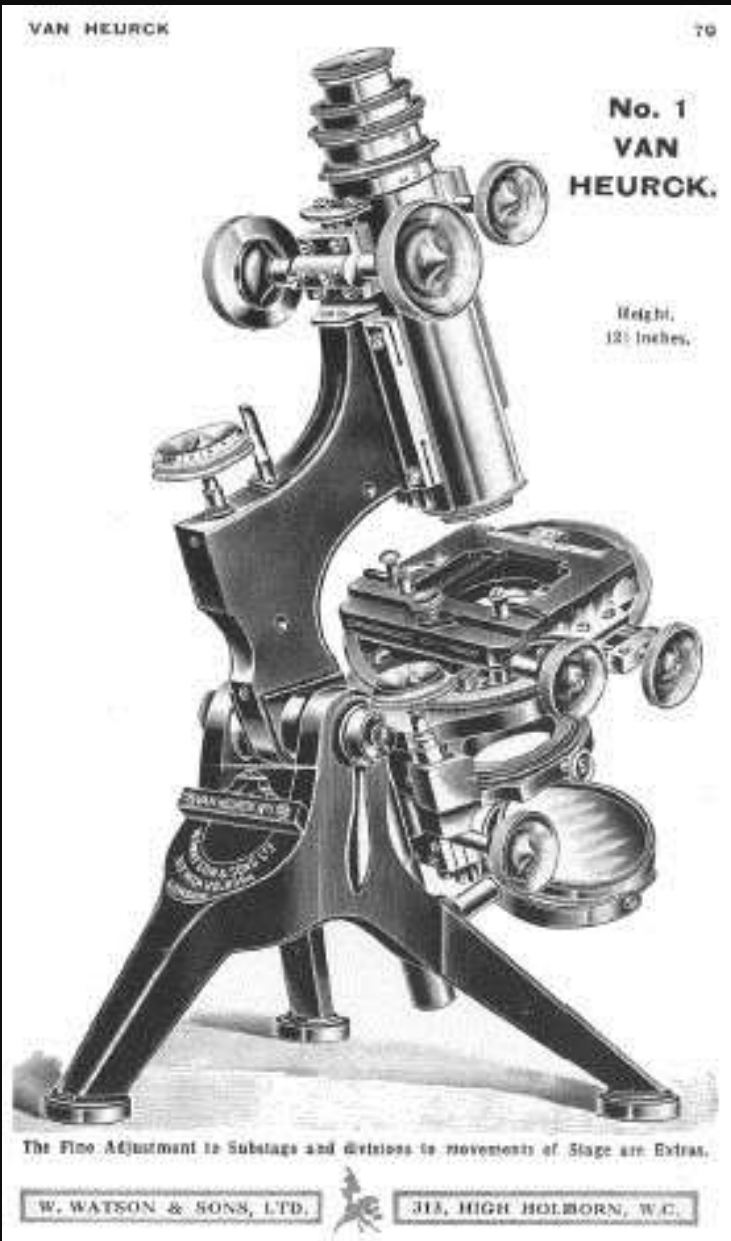
english.meeusen.com



victorianmicroscopeslides.com

Slides from 1885

# Henri-Ferdinand Van Heurck (1839 – 1909) - botanist



**Watson & Sons 1923 Catalog – Van Heurck originally designed this microscope in 1891.**

antique-  
microscopes.com

## THE VAN HEURCK MICROSCOPE.

For Research and General Purposes.

**Three Models—No. 1 and Circuit Stage.** Range of horizontal Mechanical Stage movement increased to 1 1/2 in.

**Grand Model.**—Reconstructed generally. Range of horizontal Mechanical Stage movement increased to 2 inches.

The Van Heurck is the most completely-fitted model which we make, and represents all that is most modern in microscope design and manufacture.

The aim in its construction has been to present, in the most efficient form possible, mechanical movements of complete and comprehensive description, in a design of maximum rigidity, and to maintain every feature in the most up-to-date manner, and we can assert unhesitatingly that the complete control which is afforded in working enables the finest results to be secured with a rapidity and comfort which is unique. It has brought the most gratifying testimony from many of the leading microscopists of the day, and this, coupled with the fact that the Van Heurck is now used by many of the foremost workers in every branch of research, is a sufficient guarantee of the perfection attained.

This Microscope was first made by us to the specification and order of the late Dr. Henri Van Heurck, the celebrated Microscopist, of the Botanical Gardens, Antwerp, for conducting the researches for which he gained such distinction, and for his high-power Photographic work.

Photo-Micrography, especially with high powers of large aperture, demands a working excellence and accuracy of the highest grade in every part—it is, in fact, the severest test to which a microscope can be put. In the construction of this Instrument the usual causes of failure have been eliminated. It will at once be recognised that the precision which is requisite for high-power photography and which is provided in this Instrument, is of immense value to the ordinary visual worker, for it enables him to secure the fullest and most effective means of conducting his researches. Especially does this apply to Laboratory work, in which reliance has to be placed on the results obtained; and to those who are doing original and accurate work, this microscope will be found to embody every convenience for rendering such work more easy and exact.

The Van Heurck is, in fact, the last word in modern microscope construction

W. WATSON & SONS, LTD.

311, HIGH HOLBORN, W.C.

## Astrid Cleve-Euler (1875 – 1968)



fof.se

- ⊙ In 1898 – First Ph.D awarded to a female scientist at Uppsala University, Sweden
- ⊙ Botanist, chemist, geologist, diatomist
- ⊙ Published many monographs on diatoms, papers in chemistry, and a text on biochemistry



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Although 1,540 slide preparations and some raw material are housed in Sweden, most of her collections, including slides, were lost.

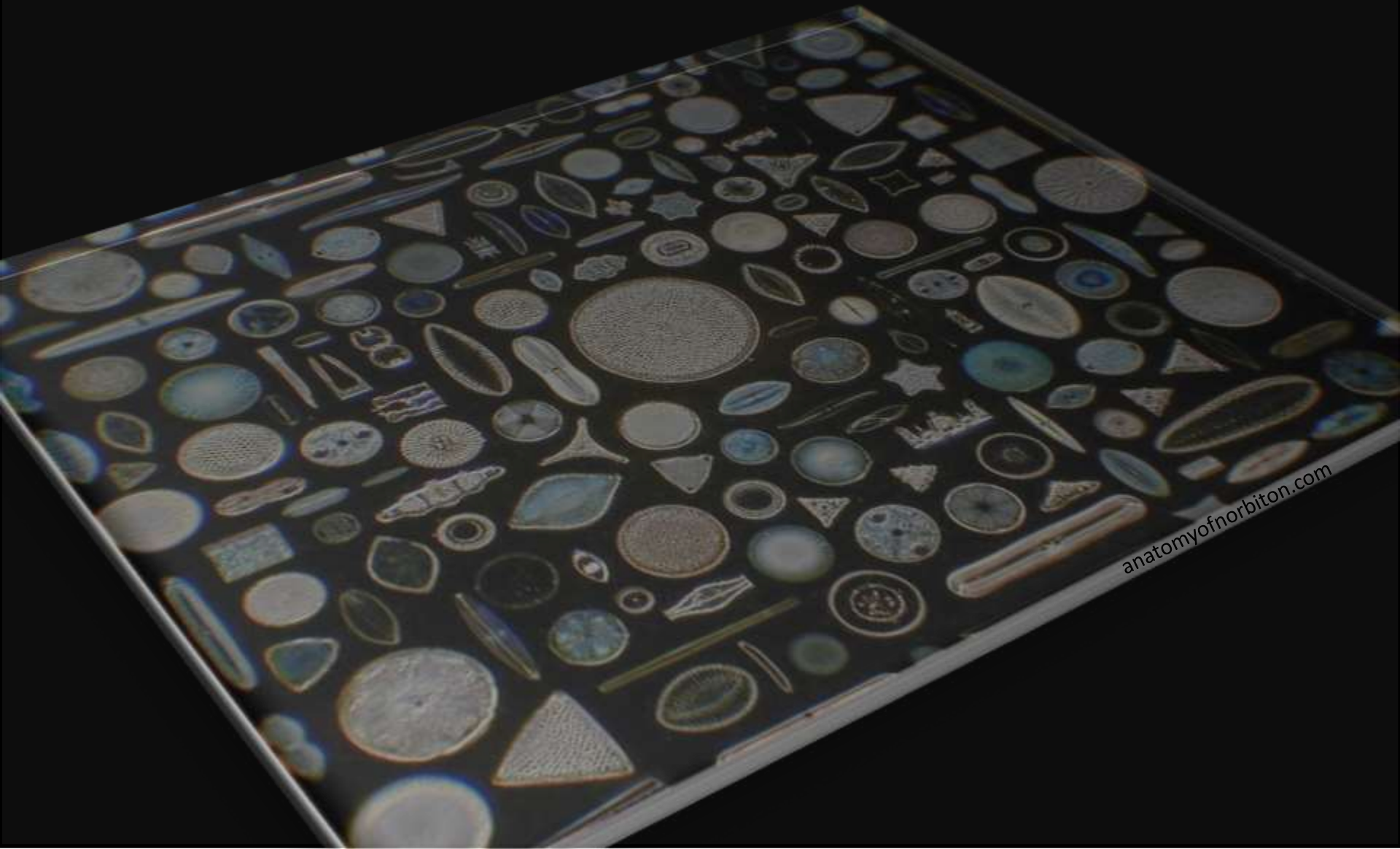
~ 1948

## Friedrich Hustedt (1886 – 1968)

- ⌈ A school teacher for 32 years, becoming head teacher in 1924 at Hauffstraße in Bremen, Germany
- ⌈ Gained increasing stature and standing in the scientific community and was encouraged and funded to study diatoms full time in 1939 when he decided to leave his teaching position
- ⌈ Described over 2000 taxa
- ⌈ Amassed the largest private diatom collection which was donated to the Alfred Wegener Institute, Bremerhaven, Germany with the stipulation that it be used for scientific research



# *The popularity of diatoms*



HARDWICKE'S

## Science-Gossip:

AN ILLUSTRATED MEDIUM OF INTERCHANGE AND GOSSIP

FOR STUDENTS AND

LOVERS OF NATURE.

EDITED BY

J. E. TAYLOR, PH.D., F.L.S., F.G.S., F.R.G.S.I.,

HON. MEMBER OF THE MANCHESTER LITERARY CLUB, OF THE NORWICH GEOLOGICAL SOCIETY, OF THE  
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J. W. BUCK, B.Sc., &c.

VOLUME XXI.

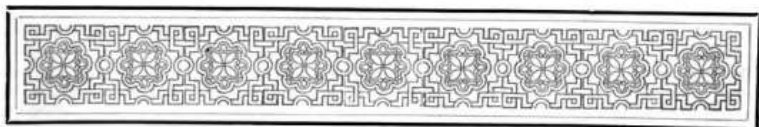


London:

CHATTO AND WINDUS, PICCADILLY.

1885.





## THE NATURAL HISTORY OF DIATOMS.



WITH the title of "The Diatoms of the Alps and the Jura," an important paper by Professor J. Brun, of Geneva, has just been published in the Proceedings of the Belgian Microscopical Society. We have great pleasure in laying the following translation (by Mr. W. B. Hardy) before our readers:—

*Diatoms; their place in Nature.*—

Diatoms are all microscopic and belong to the vegetable world. When first they were studied, they were thought to belong to the animal kingdom. Ehrenberg, in consequence of the curious movement with which they are endowed, classed them in 1842 amongst the Infusoria. But numerous investigations made since, by means of the spectroscope and polarised light, have made evident their affinities with certain filamentous Algae, the *Hyalotheca*, *Zygonema*, *Spirogyra*, &c. Their endochrome, their respiration, and their mode of reproduction, place them without doubt, in the great family of the Algae, where they form a separate and well-defined class.

**Their abundance.**—Diatoms are indeed amongst the most singular objects of the vegetable kingdom. The more one studies them, the more one is astonished to see with what abundance they are distributed in nature: we meet with them nearly everywhere where water is to be found, whether stagnant for running, limpid or troubled, hot or icy cold, even among the melting snow of the lofty Alps. Everywhere in the deposits of these waters, the eye, aided by the microscope, discovers diatoms, and nearly always in immense numbers.

Their invisible germs are so light (I do not call them spores) that they remain suspended in the air, thus passing from one region to another. Amongst the Alps, these germs are able to remain months without perishing, on the dry rocks exposed to the sun, or on the glaciers exposed to the bitterest cold; and when a ray of sun comes, and some drops of water, we see them appear by millions!

**Their dissemination on the Surface of the Globe.**—It is by the joint action of the air and water that diatoms are disseminated, and it is the winds and the rains which render their distribution constant. Once dried, their excessive tenuity permits the slightest eddy to sweep them up and spread them abroad over immense tracts of country, and even from one continent to another. When the air becomes calm they gradually settle down. The rains strew this organic dust everywhere on the surface of the soil, and even as far as the highest summits of the Alps, carrying it into the brooks, the marshes, the peat-bogs, and the lakes, and there, in every season, the diatomic dust soon commences to live. This diffusion distributes every species of freshwater Diatomaceæ all over the surface of the globe. Thus we have in Switzerland nearly all the species which have been found in Saxony, by Rabenhorst; in the environs of Paris, by P. Petit; in the south by M. Guinard; in Austria, by M. Grünow, and in the high Tatra of the Carpathians by Schühmann.

Nevertheless some species require special conditions. Some require salt water, or water containing lime or silica; others require water perfectly stagnant and warm; others again prefer water running and fresh; whilst a few live parasitically on certain species of aquatic plants. Hence, although the same country receives the germs of every species, they do not equally all develop; it is this which causes the Alps, with their varied conditions of altitude, of heat, of pressure, and of humidity, to support relatively many species. I have collected during eight years six hundred and eighty different species and varieties, and I do not pretend to have found them all, although I have been much aided by my friends of the Alpine Club. Among these species six are new. There are altogether in the known

world, about six hundred well-defined freshwater species of diatoms.

**Their smallness.**—Ehrenberg estimated that a cubic inch could contain forty-one millions of *Diatomaceæ carapaceæ*. I have found that one species averages eight thousand in a cubic millimètre. Other precise measurements show that a cubic millimètre can contain twenty-seven million specimens of *Navicula pediculus*, and forty millions of *Achnanthisium delicatulum*. These are our two smallest species.

**Their Endochrome.**—Diatomine, or endochrome, is the substance found within the silicious carapace, or frustule. It is translucent, of an oily appearance, strongly refracts the light, and its colour is brown, tawny, or golden; it corresponds to the chlorophyll of other green Algae. The endochrome, under the influence of heat, of alcohol, or acids, becomes a beautiful emerald-green. It is thick and viscid, like protoplasm, and its natural division in the frustule takes place sometimes in the form of plates amongst the placo-chromatic diatoms, and sometimes in the form of granulations amongst the cocco-chromatic diatoms.

The endochrome is ordinarily motionless, very rarely one sees it move under the form of granules which appear to be gifted with a slow Brownian movement. It contains a trace of iron, which is found in the form of a peroxide when living diatoms are calcined. It resists putrefaction for a long time. The species which I collected in the Sahara, in 1873, and preserved in the water in which I took them, had still, four years after, their endochrome in good condition. It remained translucent and yellow, but its primitive form had changed and become contracted. I have seen fossil diatoms, from a considerable deposit in Holland, and which, consequently, had been buried for ages, show here and there examples whose endochrome was still yellow and transparent, although it had become thicker and more plastic. Ehrenberg, in studying the "Kieselguhr" of Hanover, noticed the same fact. I am convinced that this only took place in those specimens which had arrived at perfect maturity, and whose two valves were still hermetically closed.

**Respiration.**—Diatoms, like all the Algae, respire by means of the carbonic acid gas which all waters exposed to the atmosphere contain in a dissolved state (gaseous nutrition). No carbonic acid, no diatoms. They assimilate the carbon of the gas, but the oxygen is set free and escapes, little by little, under the form of minute bubbles. The carbon is used in the formation and development of all the soft part of the vegetable called the Thallus. At the same time that they breathe it, they also take from the water a portion of the mineral substances which it contains in a dissolved state; as iron, alumina, lime, and, above all, much silica, which constitutes its hard and transparent glassy frustule.

If in a phial containing drinking-water and many

living diatoms we inject a very slow current of carbonic acid gas, and if the gas which escapes be collected under the influence of light, experience proves that the latter gas is richer in oxygen than atmospheric air.

**Calcareous Deposits due to Diatoms.**—Nearly all waters contain lime (*Calcic carbonate*). Lime, it is true, is completely insoluble in water chemically pure; but when the water contains carbonic acid gas, the gas renders the lime slightly soluble. In proportion as the diatoms decompose this gas, the dissolved lime is separated, and then it is either precipitated or else it incrusts the mucilaginous envelope, in the middle of which these Algae are developed. It is especially the gelatinous spheres where the Epithemia and some Synedra grow which afford the microscope the prettiest groups of calcareous crystals. Where the water is quiet, the lime that is set free settles to the bottom, and partially firms the mud of stagnant waters; but if the water is running, the calcareous particles are immediately swept on with the current. We must not forget that in proportion as the carbonic acid gas of the water is decomposed, the same water dissolves a new amount of gas that it borrows from the atmosphere, which gas serves in its turn to dissolve a new quantity of lime. These infinitely minute plants maintain, then, in the water a constant movement of mineral molecules and of the gas. This rôle is incessant, and takes place in winter as well as in summer, and the Count de Castracane was right when he proved that the diatoms not only cooperate directly by their silicious residuum, which they leave after death, to form geological strata, but also indirectly by the lime which they constantly set free from the midst of the water.

**Their Silicious Frustule.**—I do not believe that there ever has been in nature a more marvellous organic incrustation than the silicious envelope of the diatoms. It is only with the most powerful immersion lens, and giving a considerable linear magnifying power (+ 1000 or 1500) that we are enabled to resolve the finest striations of certain species. But for the determination of species a linear power of + 300 or 400 is nearly always sufficient, and especially in employing oblique light. However, all works treating on the microscope give the necessary instructions. This silicious envelope resists putrefaction for an indefinite length of time, and remains intact at the bottom of the water as each of the diatoms die, forming in this way in many countries considerable deposits (Kieselguhr), and which require thousands of years to form. This silica resists acids, and even a dull red heat; but at an intense reddish-white heat it softens and presents a half melted and vitreous mass.

The following three analyses give the exact chemical composition of the fixed frustule of the diatoms.

# Hardwicke's Science - Gossip

Advertisements  
to obtain  
diatoms in  
exchange for  
slide mounted  
organisms or  
other materials

1879

SMALL packet of diatomaceous earth (Stoneyford, Ireland) sent upon receipt of stamped envelope; any object of interest will be thankfully accepted. I have some very fine selected slides of diatoms, some arranged in pattern, that I will exchange for fragments of *Hyalonema mirabilis*, or other good spicula bearing sponges.—W. White, 18 Convent Street, Nottingham.

VERY fine slides of anchors, and plates of *Synapta Gallienica*, selected and arranged in various symmetrical patterns, likewise a few diatom slides arranged in different designs, in exchange for really good unmounted microscopic material. Would like to correspond with some microscopist in the locality of Torquay, with a view to mutual exchanges.—W. White, 18 Convent Street, Nottingham.

1881

MOUNTED slides of anchors and anchor plates of *Synapta Gallienica*, arranged in patterns—beautiful objects for the polariscope or spot lens, in exchange for good unmounted material. Wanted good forms of spicula, &c.—W. White, 7 Warden Place, York Street, Nottingham.

ANATOMICAL microscopic objects well finished, for good unmounted microscopic material. Fragments of sponge, gorgonias named *Holothuria chirodota*, and *synapta* most wanted.—W. White, 7 Warden Place, York Street, Nottingham.

TO MICROSCOPISTS.—Educational Series of Plant Structure, 80 varieties, embracing all the most beautiful forms of Plant-hairs, Scales, &c., prepared ready for mounting, 1s. per dozen: postage extra.—W. White, Warden Place, Nottingham.

1886

GOOD mounts of whole insects or selected and arranged Diatomaceæ offered in exchange for male cockchafers (*Melolontha vulgaris*), field crickets, etc., also wings of *Urania rhypeus* (Madagascar), insects fresh caught, not dried cabinet specimens.—W. White, 17 York Street, Nottingham.

1890

**Microscopic Objects**, mounted in enamel, thousands to select from at 6s. per dozen.—W. White, 17, York-street, Nottingham.

1880

PREPARATIONS of the large water beetle (*Dytiscus marginalis*), and house cricket (*Acheta domestica*), prepared ready for mounting, in exchange for good unmounted material brittle stars, Ophiocoma, and fragments of *Hyalonema mirabilis* required most. Will also exchange good mounted objects. English  $\frac{1}{4}$  in. objective.—W. White, 7 Warden Place, York Street, Nottingham.

WILL exchange good mounted microscopic objects for  $\frac{1}{4}$  or  $\frac{1}{8}$  inch objective; will also give liberal exchange of mounted objects for unmounted microscopic material. Fragments of gorgonia, sponges, &c.—W. White, 7 Warden Place, York Street, Nottingham.

1882

DIATOMS WANTED.—Mounted or unmounted microscopic objects for good gatherings of *Campylodiscus castalus*, *Meridian circularis*, *Achnanthes longipes*, &c. Liberal exchange given. W. White, 7, Warden-place, York-street, Nottingham.

1883

**Microscopic Objects**.—12 botanical sections, stained ready for mounting, 1s. 1d.—W. WHITE, Warden-place, Nottingham.

**Microscopic Objects**.—Twelve anatomical preparations in tube, with directions for mounting, 1s. 7d.—W. WHITE, Warden-place, Nottingham.

**Microscopic Objects**.—12 Botanical Preparations, ready for mounting, 1s. 1d.—W. WHITE, 17, York-street, Nottingham.

**Anatomical Preparations**.—12 in tube, with instructions for mounting, 1s. 7d.—W. WHITE, 17, York-street, Nottingham.

1898

Slides.—W. White, 2 Rick street, Nottingham, England, offers cabinet of 72 slides for 21 shillings.

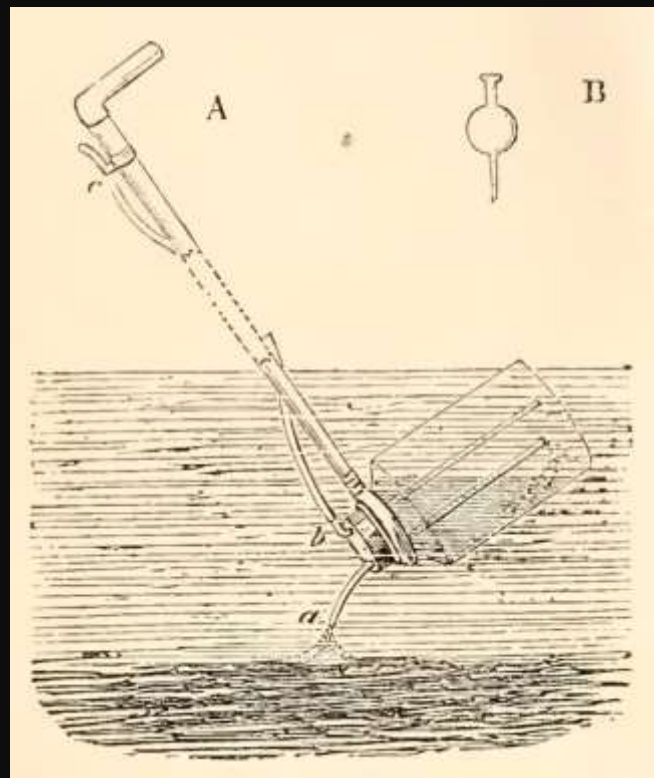
John Thomas Redmayne (1846 – 1880) – surgeon, physician, and amateur diatomist



Single taxon slides

Advertisement to exchange a self-published book of diatom micrographs for a microscope objective or slides

- 1874    *Good Slides of Eanolia sibirica and Coscinodiscus radiatus for other diatoms.*—Address, J. Redmayne, Astley Bank, Bolton.
- 1875    *Prize gatherings prepared of Fragilaria capricornis and Denticula elongatum, for other good Diatomaceous Material or Slides.*—John Redmayne, Surgeon, Bolton, Lancashire.
- 1878    *An Album of eighty Micro-photographs of nearly 200 of the Diatomacea, magnified 250 to 4000 diameters, in exchange for first-class 1-inch Objective, or first-class Micro Slides (ap proved).*—Address, Dr. Redmayne, Bolton, Lancashire.

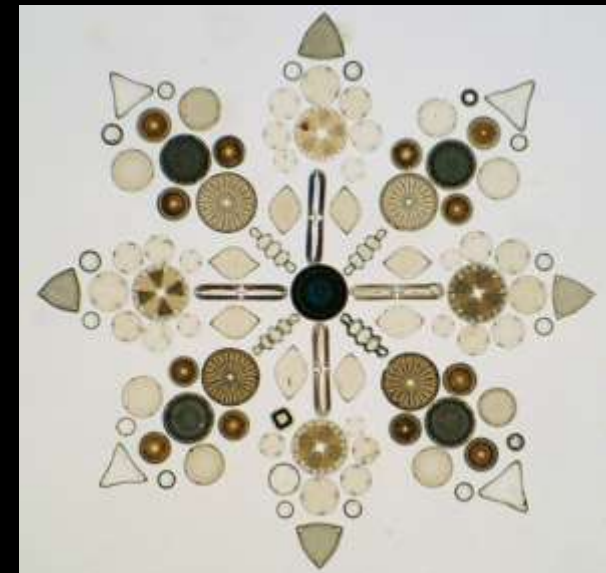
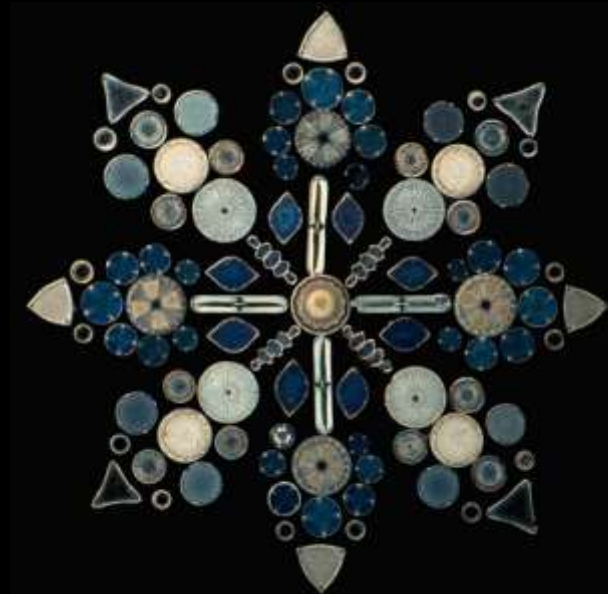


Diatom collecting device described in Hardwicke's - 1875

# John Albert Long (1863-1945) – amateur diatom mouter



Genus	Species	Location	Country	Row	No. in row
Caloneis	per magna	Connecticut	USA	1	1
Campylodiscus	clypeus	Loos	Bohemia	1	2
Campylodiscus	grevillei v. regalis	California	USA	1	3
Cerataulus	orbicularis	Abyssinia		1	4
Cerataoneis	arcus	Appleby	England	1	5
Cestodiscus	superbus	Newcastle	Barbados	1	6
Climacocira	mirifica		Rodriguez	1	7
Climacocira	mirifica		Rodriguez	1	8
Climacosphenica	australis	Port Philip	Australia	1	9
Climacosphenica	australis	Port Philip	Australia	1	10
Cocconeis	seticola	Whales	Antarctica	1	11
Cocconeis	seticola	Whales	Antarctica	1	12
Corunna	elegans	Jutland	Denmark	1	13
Corunna	elegans	Jutland	Denmark	1	14
Coscinodiscus	tumidus v. lineatus convexus		Russia	2	1
Craspedodiscus	elegans	Dunkirk, Indiana?	USA	2	2
Cyclotella	striata	Hanover	Germany?	2	3
Cymatopleura	solea	Hillingdon, Middlesex	England	2	4
Cymbella	mexicana	Laran Is? Oregon	USA	2	5
Dactyliosolen	antarctica	Surfate	Antarctica	2	6
Diatoma	anceps	Pyrenees	France?	2	7
Diatoma	anceps	Pyrenees	France?	2	8
Decladia	capreolus	Baltic Sea	Sweden?	2	9
Diploneis	giebellii	Palos Verdes, California	USA	2	10
Encyonema	prostratum	Yorkshire	England	2	11

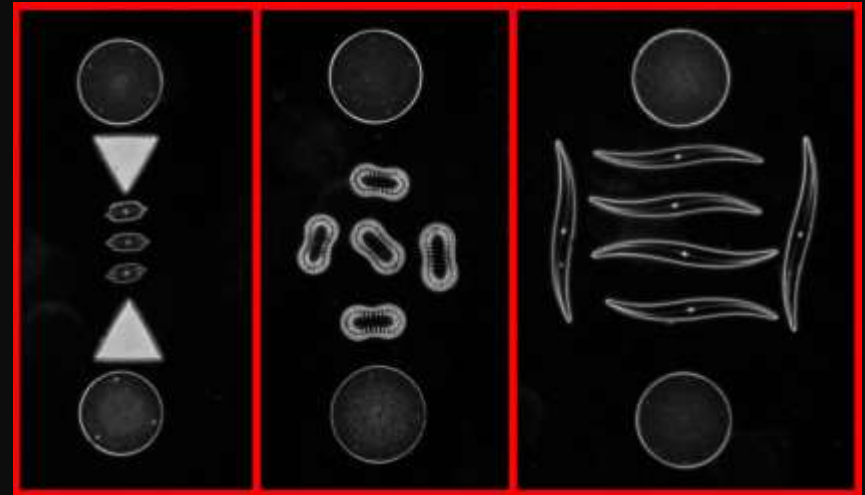


Map and species list

Darkfield

Brightfield

William Gatrell (1864 – 1902) – dentist; amateur turned commercial specimen mounter



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*From  
Victorian  
times  
to the  
present*

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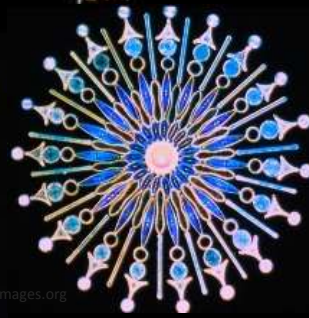


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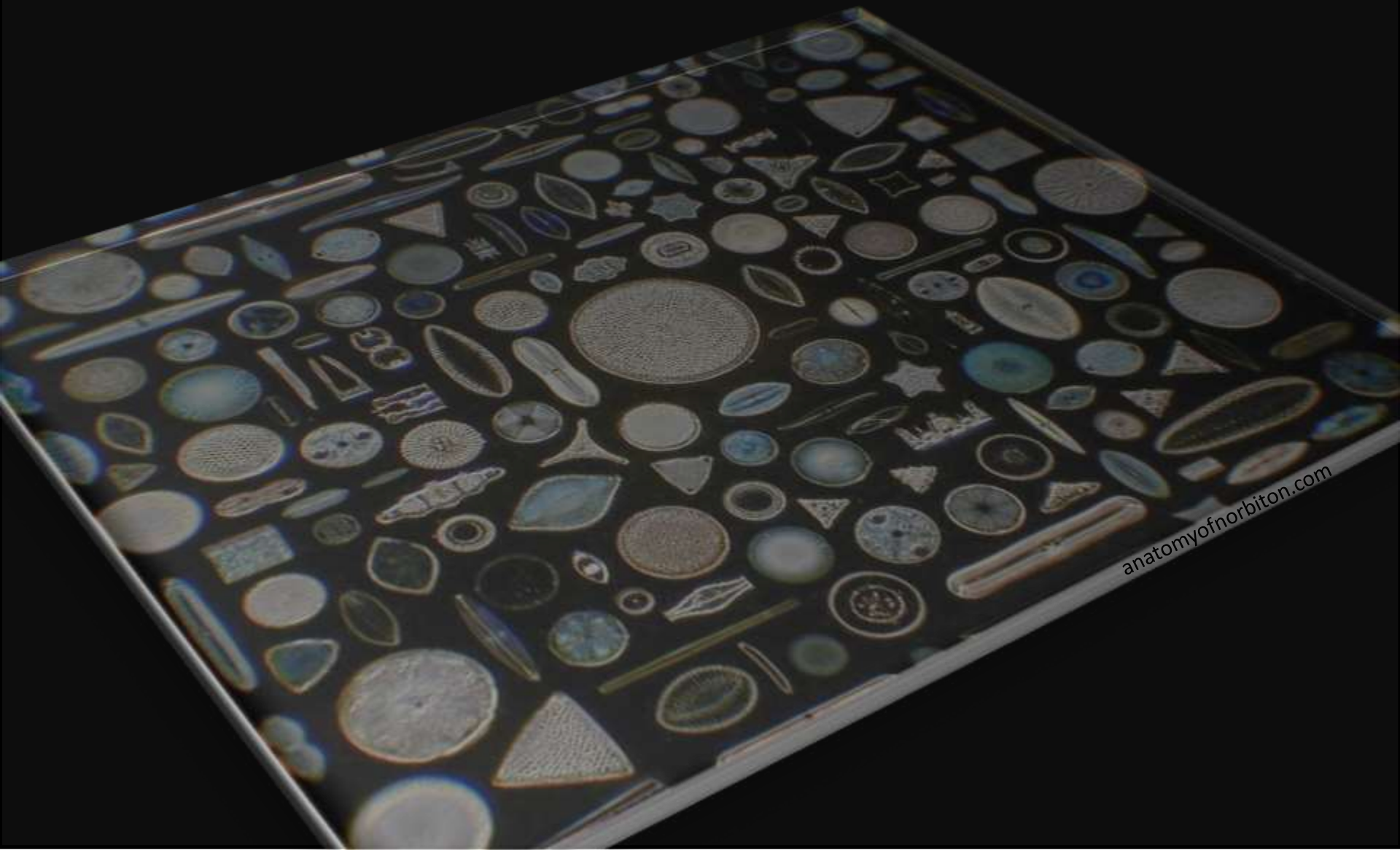
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# *Modern Amateur Diatomists*

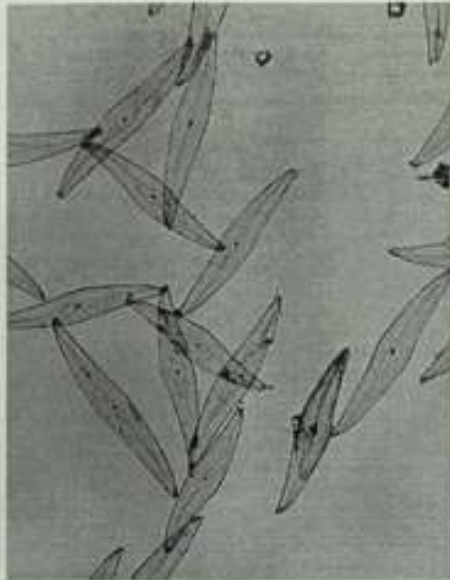


# The Amateur Diatomist

Vol. II. No. II.

December 2003

Little Imp Publications



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There is no strict editorial policy.

## Klaus-Dieter Kemp's Diatom Database

Access via a web browser (IE5.5 or above) - requires 1024x768 display minimum.

Includes:-  
over 15,000 species images  
over 2,350 species descriptions  
nearly 300 typical genus forms  
124 genus description  
from over 60 publications

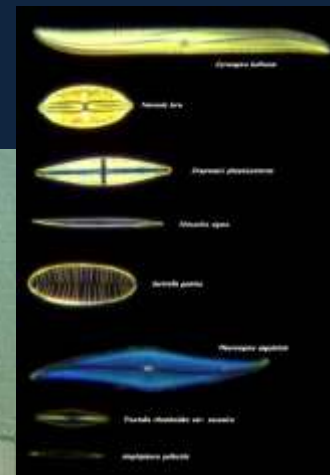
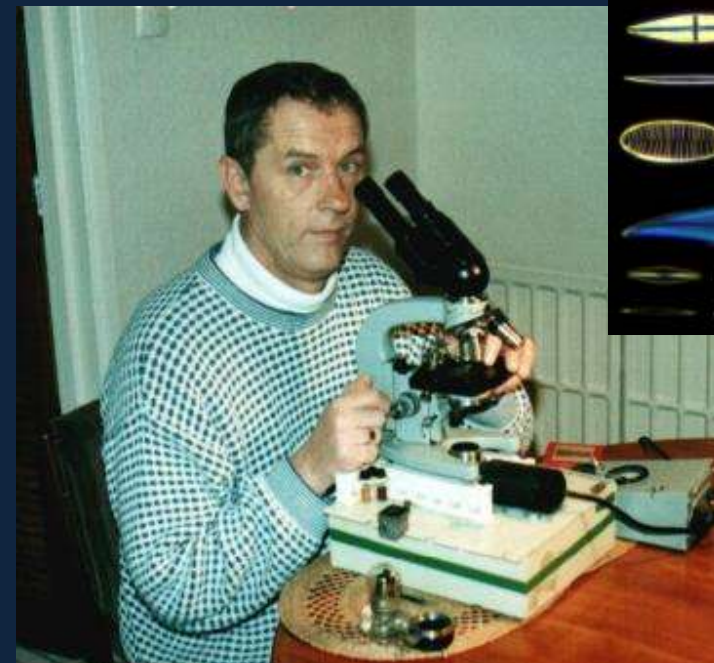
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- ◇ Specialist in diatom microslides and diatom arrangements
- ◇ Inspired by the mounts of J. D. Möller and R. I. Firth
- ◇ Provides identification strewn mounts and mounts to test microscope objectives

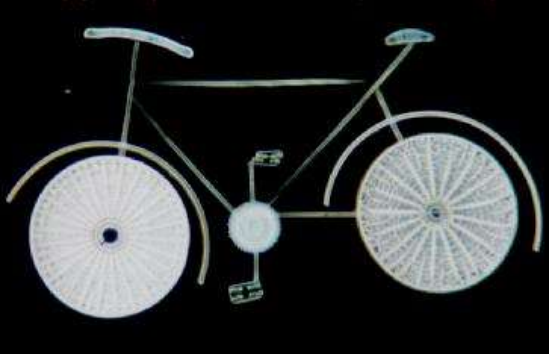
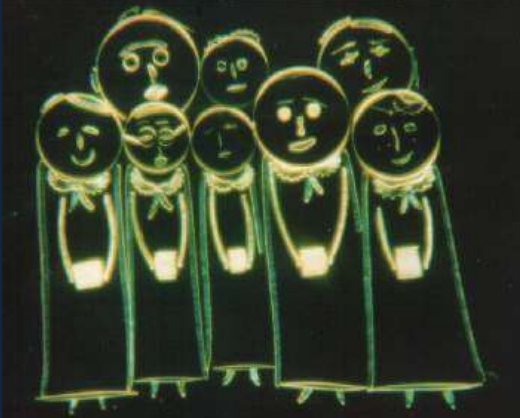
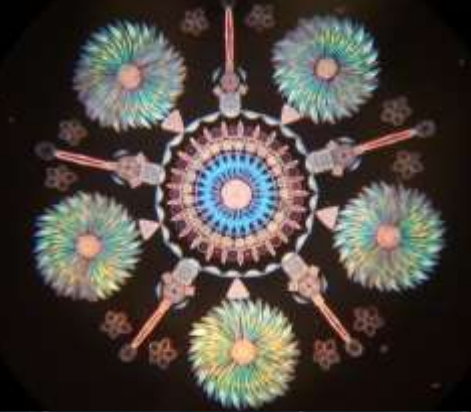
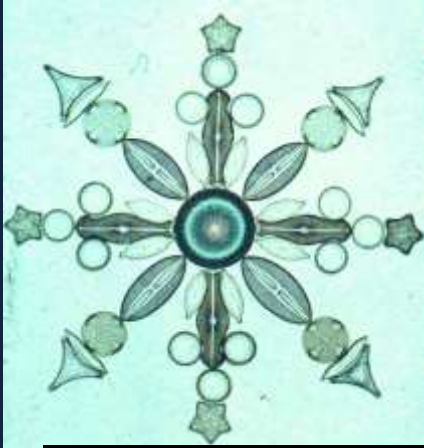
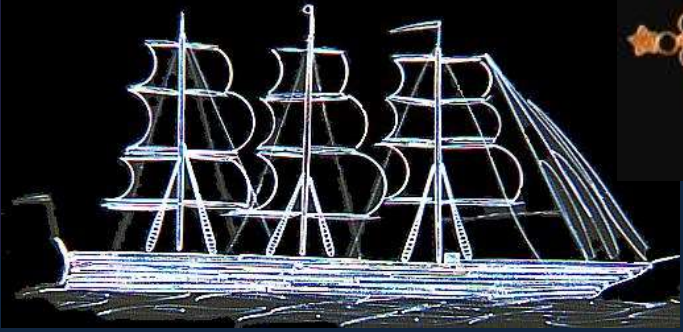
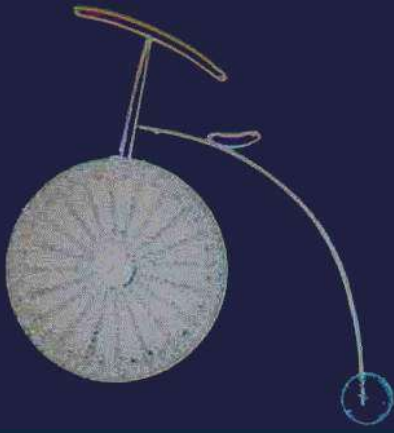
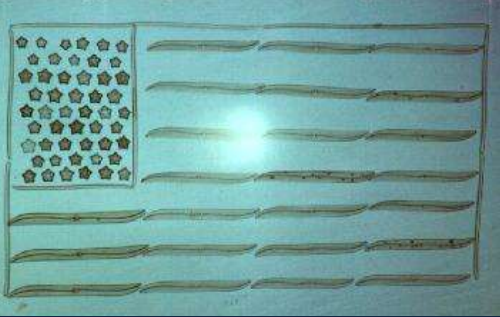


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Klaus D. Kemp (Microlife Services)



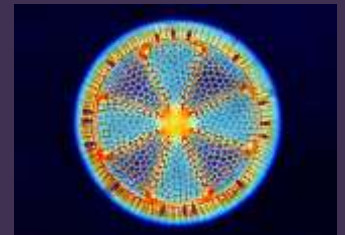
# Stephen S. Nagy, M.D. – Psychiatrist and amateur diatomist (Montana Diatoms)

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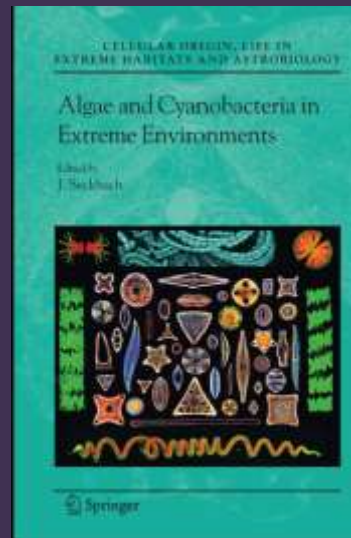


It is our mission to see, to image, to display, and to conserve diatoms from worldwide locations. To that end we work cooperatively and with integrity with individuals, organizations, and **Museums** to help achieve maximal beauty of diatoms, from whatever source, whether fossil or recent origin.

- make high refractive-index diatom mountants available to diatomists worldwide
- provide tools that are otherwise unavailable, such as the **Klaus Kemp** Micromanipulator
- exchange samples with other diatomists from obscure or hard-to-reach locations
- **work cooperatively with Museums to assist them in exhibiting their collections to maximum benefit**
- provide very limited numbers of arranged microscope slides of diatoms to assist in the display of collections, increase the individual enjoyment of microscopists, and to provide scientific artwork to publications and to businesses
- increase interest in, appreciation of, and knowledge of diatoms and their inherent beauty for every visitor to our website



# Stephen S. Nagy, M.D. – Psychiatrist and amateur diatomist (Montana Diatoms)



## DIATOMS:

*Living in a Constructal Environment*

FRITHJOF A.S. STERRENBURG<sup>1</sup>, RICHARD GORDON<sup>2</sup>,  
MARY ANN TIFFANY<sup>3</sup> AND STEPHEN S. NAGY<sup>4</sup>

<sup>1</sup>Stationsweg 158, 1852LN Helloo, The Netherlands. <sup>2</sup>University of  
Manitoba, HSC Room GA216, 820 Sherbrook Street, Winnipeg  
MB R3A 1R9 Canada. <sup>3</sup>Center for Inland Waters, San Diego State  
University, 5500 Campanile Drive, San Diego CA 92182 USA.  
<sup>4</sup>P.O. Box 5714, Helena, Montana 59604 USA



Starting in 1999, he learned how to mount diatoms with instructions from Klaus Kemp via e-mail and telephone!

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MT 59604-5714, USA

Cellular Origin, Life in Extreme Habitats and Astrobiology 11

Joseph Seckbach  
J. Patrick Kociolek Editors

## The Diatom World



Figure 5. Light-colored guide rings on the rear of the slide and dark India ink ring on the mounting glass to help locate the diatom arrangement. The guide rings are removed when the slide is finished. (Photo copyright retained by author).

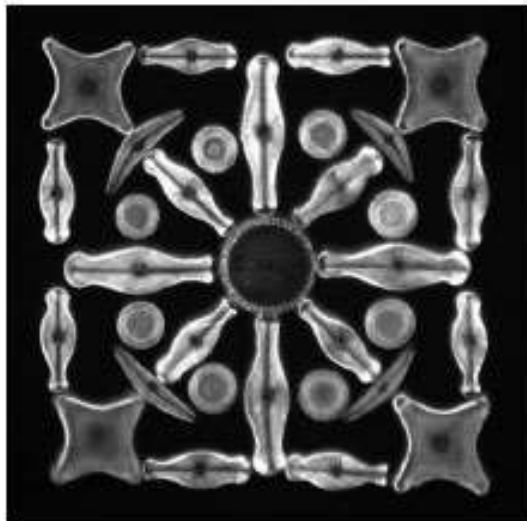


Figure 1. An ornate square of arranged diatoms by the author, which includes freshwater and marine diatoms. *Ditymosphepta* forms the main spokes of the arrangement and has a shape similar to a classic bottle of Coca-Cola. (Photo copyright retained by author).

#### 4. Collecting Fossil Diatoms

There are sites around the world where diatoms fell as sediment out of marine or freshwater bodies of water over time, and formed deep concretions on the bottom. Over time, the organic material decomposed and the diatom frustules were pressed together, resulting in diatomaceous earth, or diatomite. Perhaps, the most famous location to diatomists are the deposits at Oamaru, New Zealand, a marine deposit with extinct and exotically unique forms unlike those found anywhere else in the world. Additional sites of some notoriety include: the freshwater deposits at Terrebonne, Oregon, on the eastern slope of the Cascade Mountains north of Bend, Oregon on the banks of the Deschutes River. These deposits are quite loosely packed, appear as white layers in road cuts near the Deschutes River, and appear to be composed of about 97% unbroken frustules. There are freshwater fossil deposits in Klamath Falls, Oregon, well known to Victorian diatomists as the source of varied freshwater species which form brilliant white, hard chalky deposits throughout the Klamath basin, the site of an ancient lake which preceded the formation of the Cascade Mountains. This diatomite or diatomaceous earth is much more densely compressed and is actually used as chalk by children growing up there to draw hopscotch courts on the pavement of driveways.

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# What do you need to become an amateur diatomist and diatom mounter?

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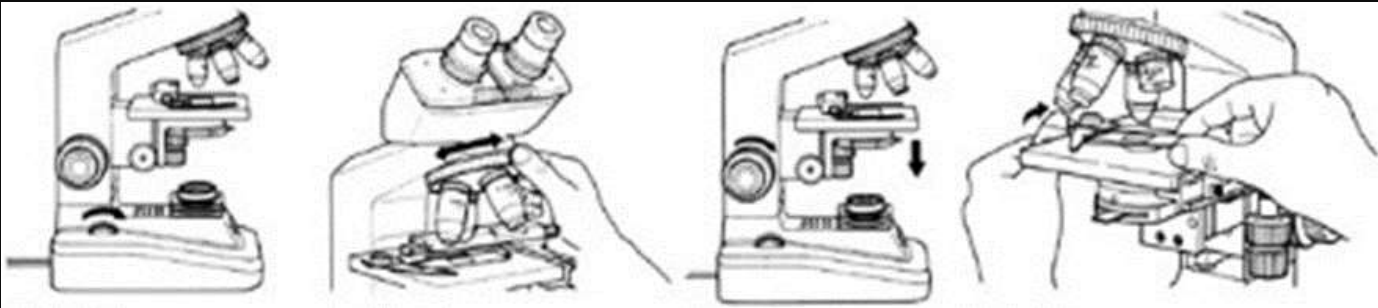
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- 1) A compound light microscope with appropriate optics
- 2) High quality immersion oil
- 3) Glass microscope slides and coverslips
- 4) Pasteur pipettes, fine insect pins mounted to handles, fine forceps
- 5) Mounting media with a high refractive index
- 6) Information about diatoms from books, the Internet, experts
- 7) A Kemp micromanipulator (optional)
- 8) Digital imaging capability (optional)

# Compound light microscope



wikipedia.org



nikon.org



© OnFocus Laboratories

**Brands:** Olympus, Nikon, Leica, Zeiss  
**Older brands:** Bauch & Lomb, American Optical  
**Cost:** Used/refurbished – \$ 500 - \$ 2000 +

# Compound light microscope: parts

Objectives: \$ 50 - \$1000 + →

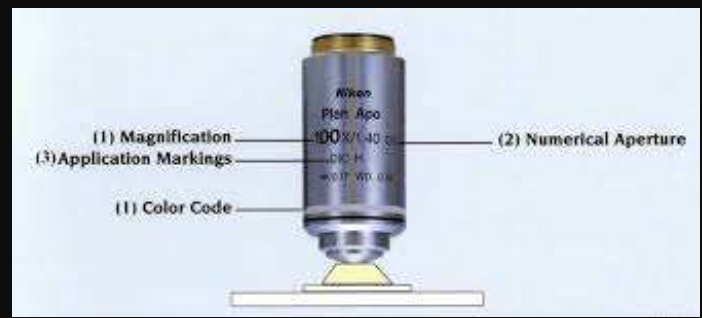
- α short barrel objectives greatest working distance to transfer diatoms to slides
- α numerical aperture of 1.25 – 1.4
- α oil immersion – 100X to 140X
- α plan apochromatic



earth2geologists.net



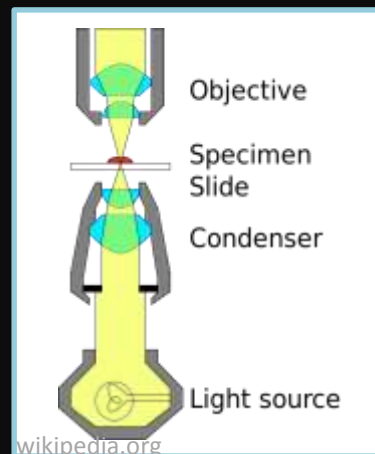
Can use a 3X or 4X objective to isolate diatoms initially



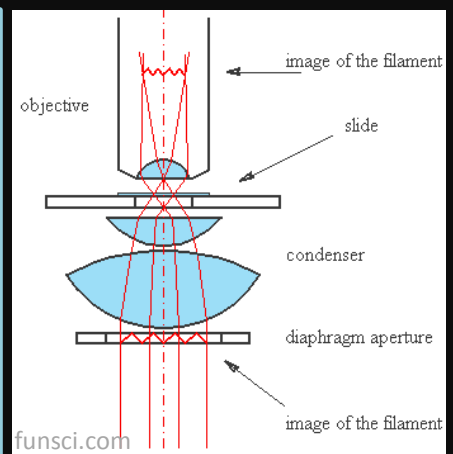
nikon.com

## Condenser:

- ✓ numerical aperture equal to objective
- ✓ Köhler illumination



wikipedia.org



funsci.com

# Supplies:

Immersion oil: Types A, B, and others -  
Different viscosities  
Increases resolution at high magnification



tedpella.com

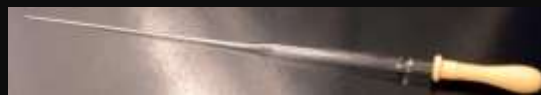
## To select individual diatoms:

☀ Kemp Micromanipulator



modernmicroscopy.com

☀ Glass pasteur pipettes – using a forceps, draw out the tips by heating



wikipedia.org



lifescience.kinesis.co.uk



Lepidoptera Breeding Association

☀ Insect needle (size 000) mounted to a thin wooden handle



lakis.com



# Supplies:

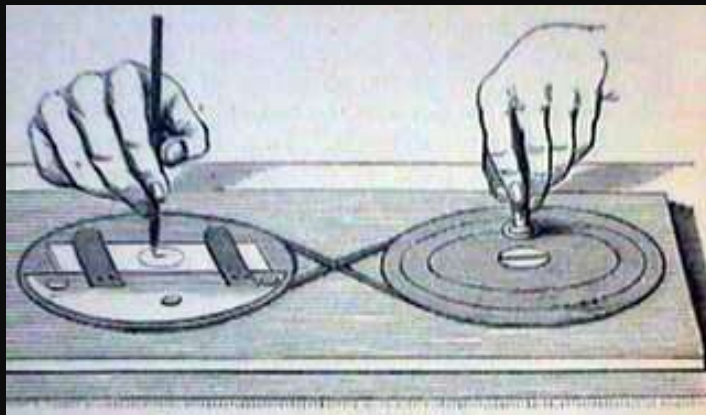
Mounting media: e.g., Styrax, Zrax, Naphrax, Pleurax, Canada Balsam, Taft's medium



Ringing the coverslip: Asphaltack



Roland Mortimer, Brazil



microscopy-uk.org.uk

Brunel  
Microscopes, UK:  
sells ringing tables

◆ OR ◆

Seal coverslips with  
clear nail polish



microscopy-uk.org.uk

An amateur diatomist's set up – R. H. Hummelink, The Netherlands -

<http://hummelrh.home.xs4all.nl/index.html>



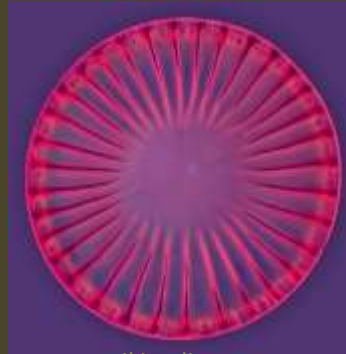
Fossil diatoms from Denmark

Diatom mounts – specimens from New Zealand and The Netherlands



# Photomicroscopy, digital imaging, and digital mounting

- Darkfield – Rheinberg illumination – colored filters are used to change the light rays entering the condenser

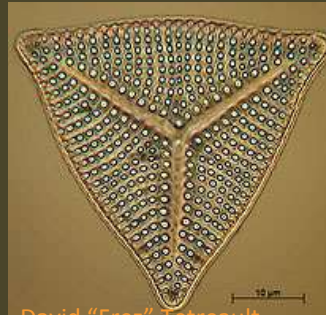


wikipedia.org



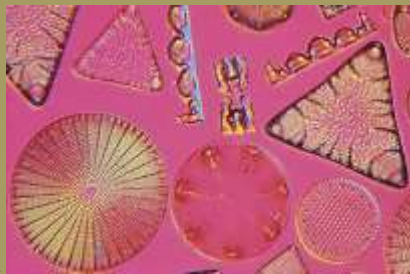
math.ualberta.ca

- \*Phase contrast (Zernike) – phase shifts in light are used to affect brightness variation

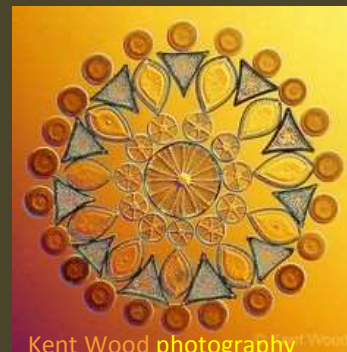


David "Frez" Terreault

- \*Differential interference contrast (Nomarski) – polarized light is used to create shadows



nhm.ac.uk



Kent Wood photography

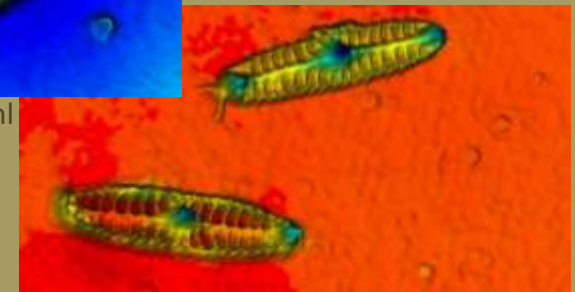
\*require different objectives and/or prisms

## Holographic microscopy

(requires a laser source and beam-splitter)



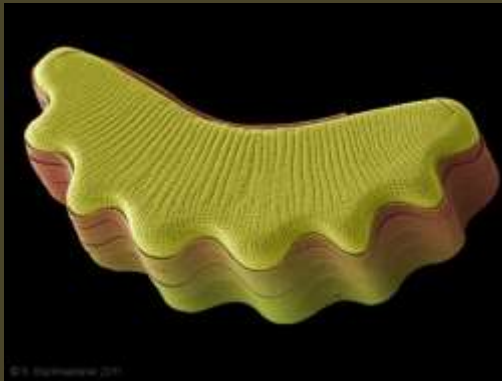
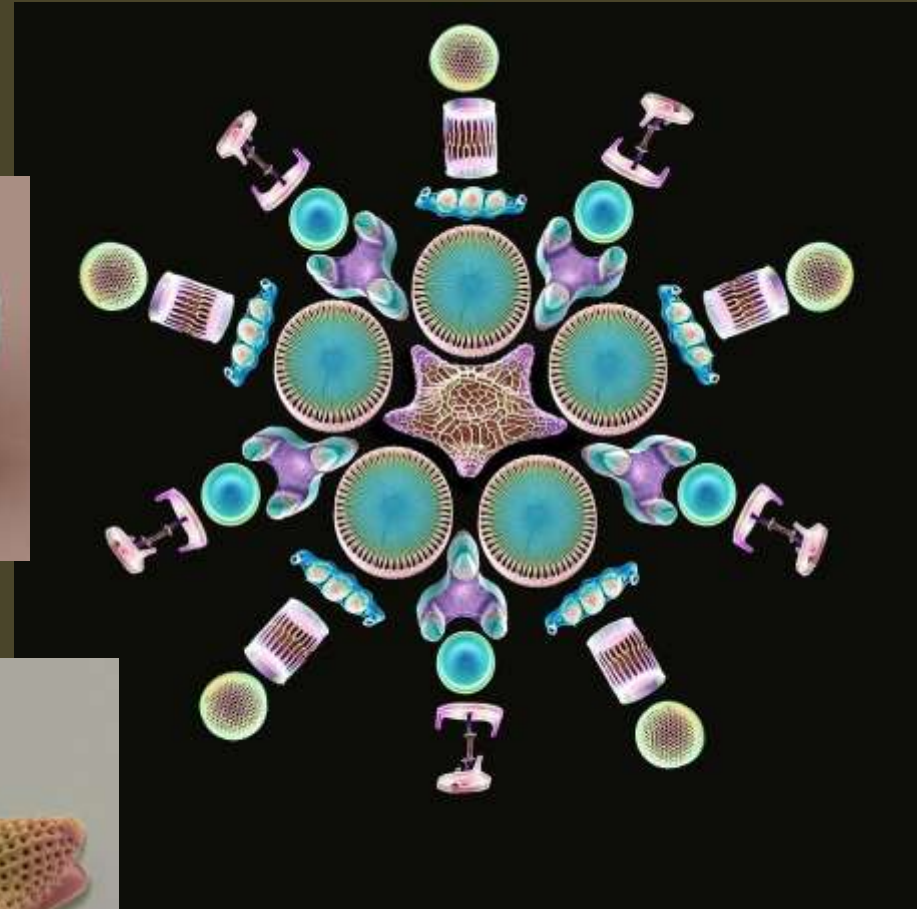
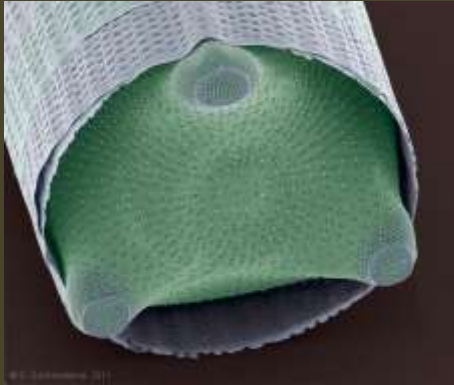
nioz.nl



# Photomicroscopy, digital imaging, and digital mounting

Steve Gschmeissner – scanning electron microscopy

<http://www.theworldcloseup.com>

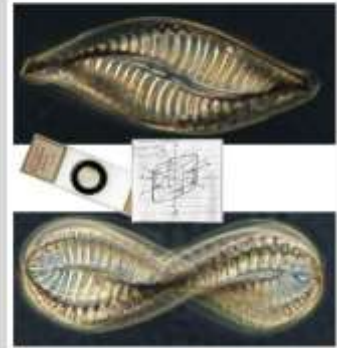


# Information and Expertise

**BOOKS** – for instance...



An Introduction to the  
Microscopical Study of  
Diatoms



Robert B. McLaughlin  
Edited by Julia Guerin-Delley & Steve Gill

modernmicroscopy.com

**WEBSITES** – for instance...

Zeiss: <http://zeiss-campus.magnet.fsu.edu/articles/basics/resolution.html>

Olympus: <http://www.olympusmicro.com/primer/index.html>

Leica: <http://www.leica-microsystems.com/products/light-microscopes/education/life-science/details/product/leica-dm500/>

Nikon: <http://www.microscopyu.com/articles/formulas/index.html>

and <http://www.microscopyu.com/smallworld/index.html>

Small Worlds: the art of the invisible: <https://www.mhs.ox.ac.uk/smallworlds/exhibition/>

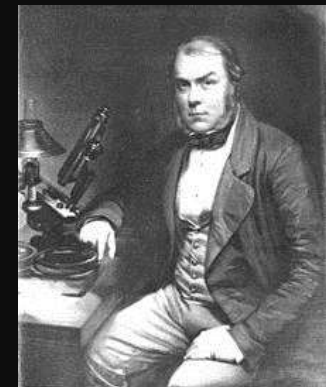
MICROSCOPY

The Quekett Microscopical Club: <http://www.quekett.org/why-amateur-microscopy>

John Thomas Quekett (1815 – 1861)

➤ Histologist and surgeon

➤ Founder of the Royal Microscopical Society in 1839



Microscopy for amateurs: <http://www.microscopy-uk.org.uk/index.html>

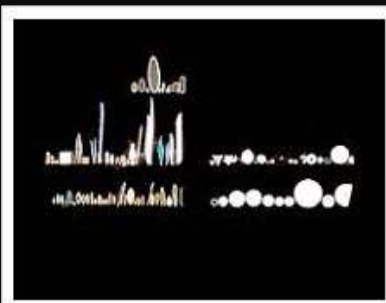
AMATEUR DIATOMISTS  
AND MICROSCOPISTS

# Buying Diatom Mounts and Supplies

ebay

- Diatom mounts
- Diatomite/diatomaceous earth
- Microscopes, slides, coverslips, drawers and storage boxes
- Glass Pasteur pipettes, fine forceps, size 000 insect pins
- Immersion oil

Locally, for example... In Ann Arbor:



Microscope slide 100 Diatom Test  
[View similar active items](#) | [Sell one like this](#)  
 Time left: Dec-08 16:42 **\$135.00**  
 1 bid  
 +\$10.00 shipping



Möller 335 Diatom Type-plate  
 Microscope Slide (Rare)  
[View similar active items](#) | [Sell one like this](#)  
 Time left: Feb-26 10:58 **\$1,000.00**  
 Buy It Now  
 +\$6.00 shipping



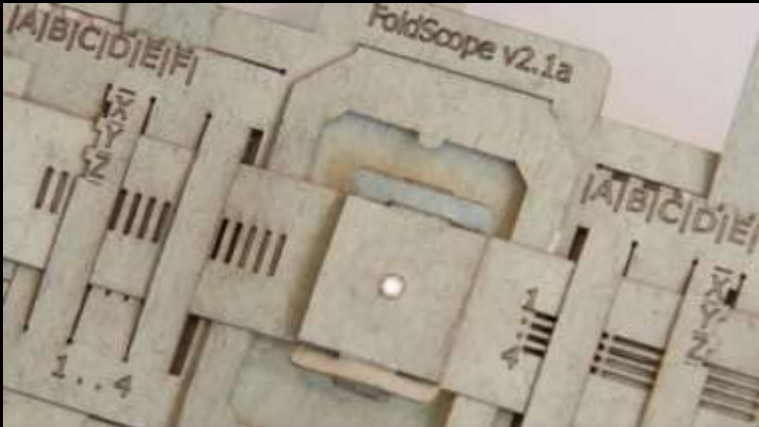
Microscope Slide by K. D. Kemp Diatom  
 Stew from Dogs Bay Roundstone  
 N. Ireland  
[View similar active items](#) | [Sell one like this](#)  
 Time left: Jan-11 05:19 **\$12.57**  
 5 bids  
 +\$8.38 shipping



Campylodiscus horologium Diatom  
 Microscope Slide by William G. Atrell  
[View similar active items](#) | [Sell one like this](#)  
 Time left: Mar-01 21:04 **\$20.00**  
 0 bids  
**\$26.00**  
 Buy It Now  
 +\$4.00 shipping

(Some listings I found in February and March, 2014)

If you just want to view diatoms...the Prakash folding microscope:

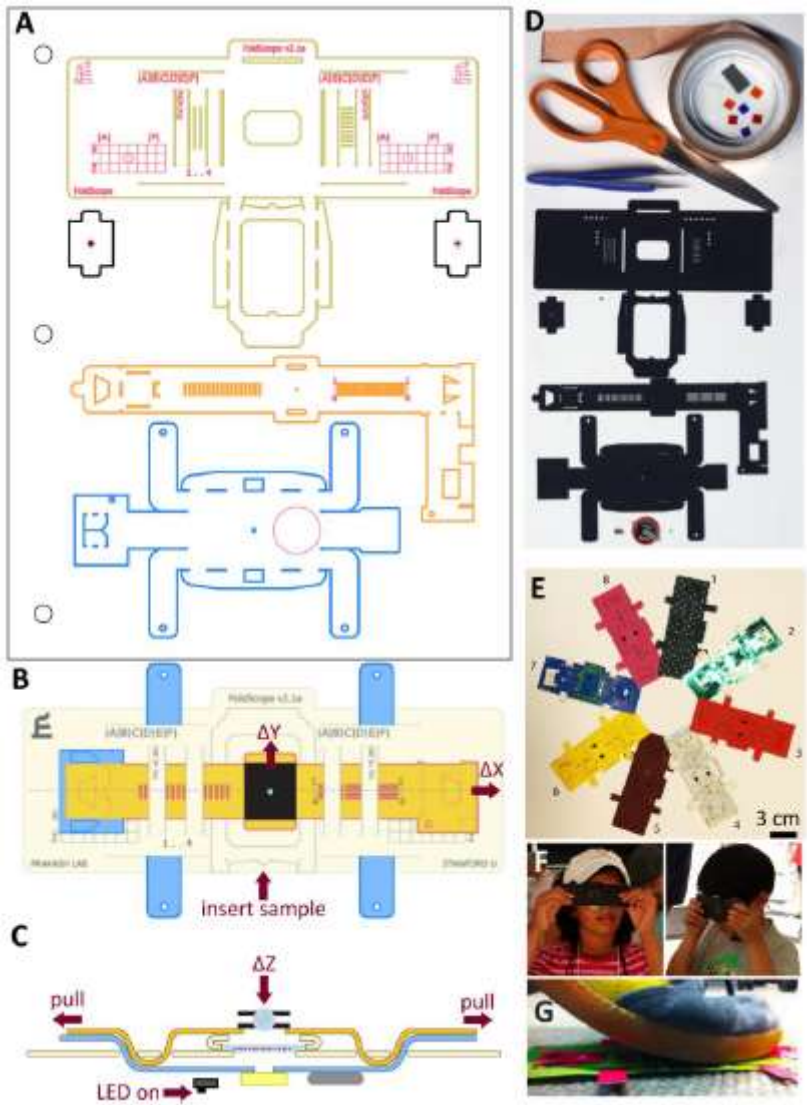


A video about an economical, foldable microscope - [Manu Prakash: A 50-cent microscope that folds like origami](http://www.youtube.com/watch?v=12Mub6htz3w)

<http://www.youtube.com/watch?v=12Mub6htz3w>

<http://www.wired.com/2014/03/paper-microscope/>

<http://www.technologyreview.com/view/525471/the-1-origami-microscope/>



<http://arxiv.org/abs/1403.1211>

# Special thanks to...

## Extant:

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*Dr. Daniel J. Miller – microscopist, 3D visualization/statistical surface analysis and invertebrate fossils expert – especially mollusks that eat diatoms*

*Friends of the Museum of Paleontology*

*Diatoms*

## Extirpated:

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*Some of the diatoms mentioned in this presentation (perhaps)*

## Extinct:

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*Some of the diatoms mentioned in this presentation (definitely)*



*The End*

THE END