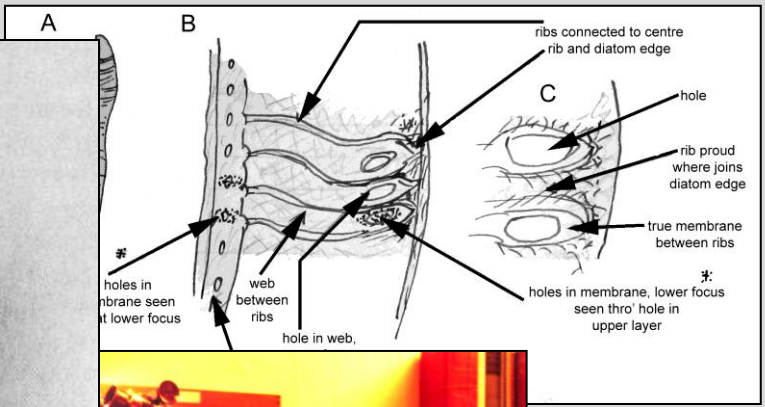
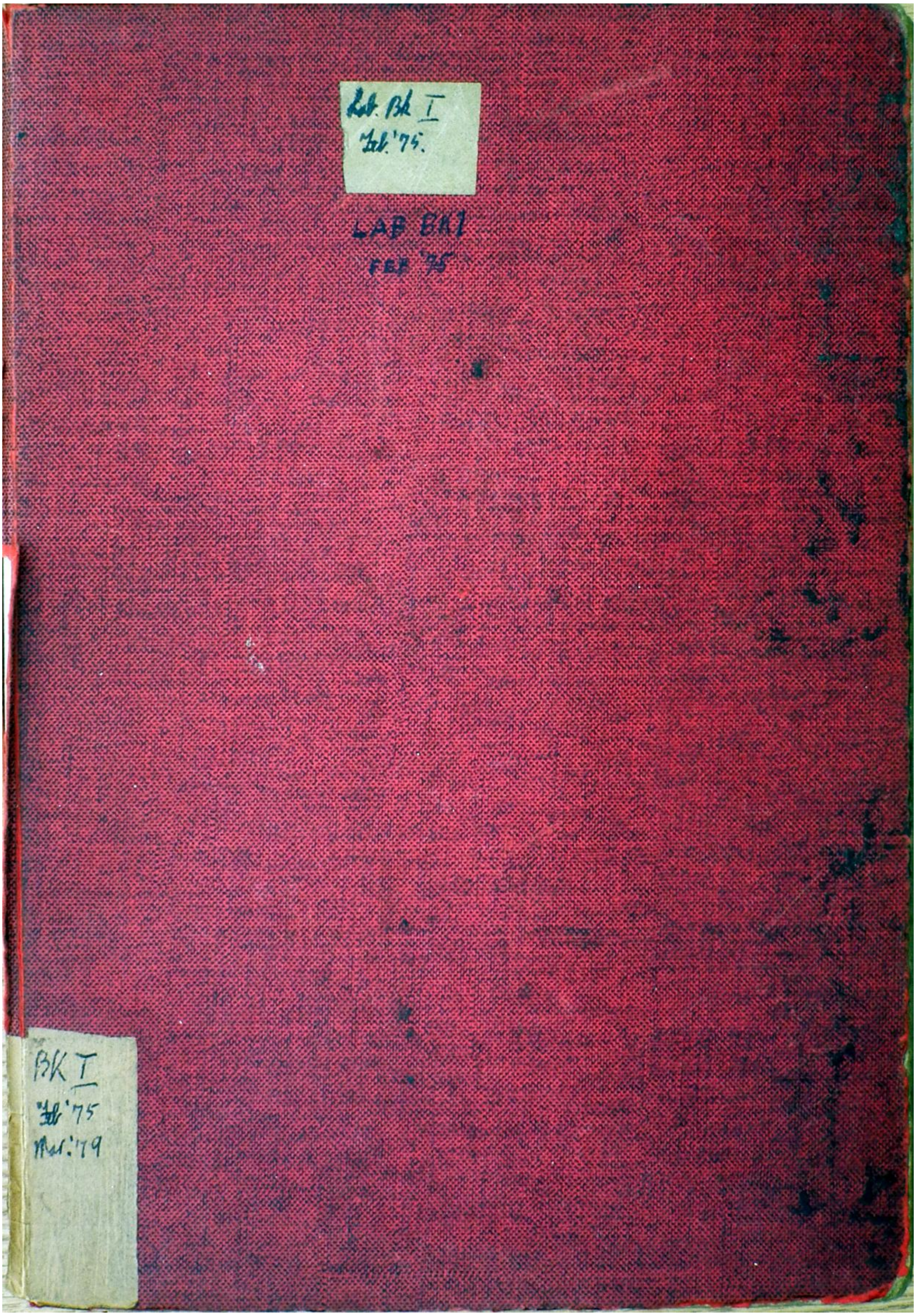
Laboratory Notebook Book I.



by

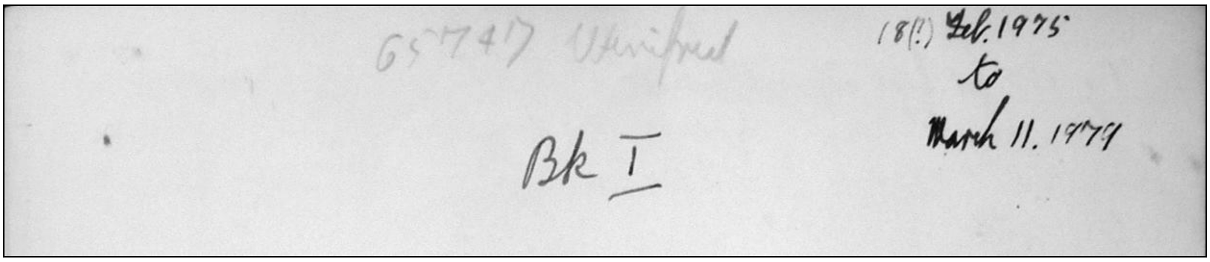
Walter "Bill" Burrells

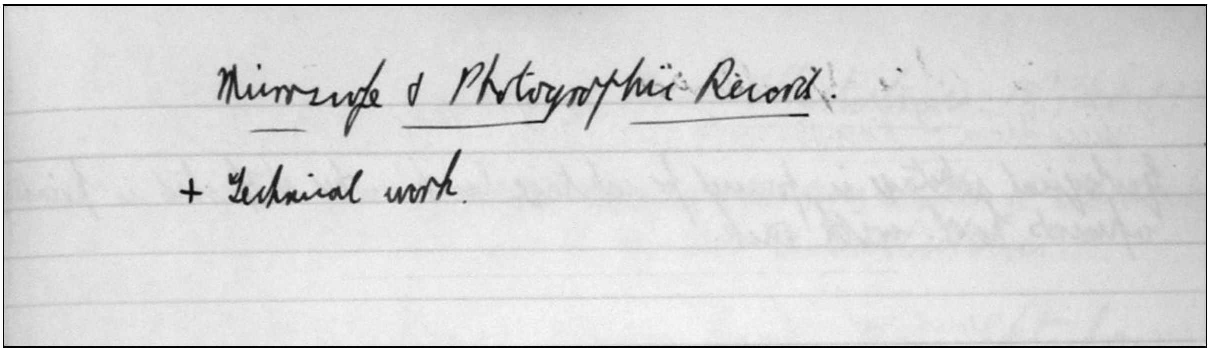
Transcribed by Steve Gill
Photographed by Mike Samworth



An A4 Laboratory Notebook (Hardbound) 8.5" x 12" (21cm x 30cm)

Introduction





Bill Burrells was fascinated by the construction of his optical instruments. The vast majority of the ‘experiments’ recorded in his lab. books reflect this. His diatom observations were recorded more to exercise his optics than to further the study of the diatomaceae. Nonetheless, they are an interesting record of one man’s obsession with getting the most out of his instruments –to the extent that he effectively built his own microscopes out of a mix of others and as a consequence had to make adjustments to the stands to accommodate his various optics, or indeed, modify the optics to accommodate the stands.

Many pages relate to experiments and exercises utilising his Rolleiflex camera. Whilst these now, in general, have little relevance to modern day digital photography they are interesting in that they illustrate the ‘experimental’ nature of his photography. This is more so the case as regards this particular instrument as he had ‘re-polished’ the lenses, and, like many of his other instruments, taken it apart and put it back together again – not always entirely successfully.

This volume is a transcription of Lab. Book I. It appears that there was a previous book of laboratory notes (a yellow book) but it is not known where this is. There is a Lab. Book II of a similar size and scope. At this juncture (mid-2014) it has been decided that this latter volume should not be started (i.e. transcribed) until the reception of this volume can be gauged.

The ‘back pages’ of the Lab book, as well as containing drawings of accessories and some construction details of the Ross-Burrells microscope also contain many miscellaneous and household notes, some dated. These, though they may not be of interest to the microscopist, have been inserted into the main text at their appropriate date locations. They catalogue many ‘ordinary’ aspects of Burrells’ home life and even though he made meticulous notes on his hobbies these additional entries contribute to the image of a well rounded post-war man, albeit somewhat obsessed by his microscopes. To make it clear some such notes are reproduced in purple text. Where these ‘back pages’ would suffer in an attempt to ‘clean them up’ the pages have been included as is and enclosed by a purple border. There are also in this ‘back section’ copious notes on ”Electricity usage”, “Meter readings”, “Replacement door designs” and “electric bells”, I have elected to omit most of these notes as being of no significant interest to the prospective reader (though I have included a few examples).

The two lab. books in my possession came from the estate of Michael Vaughn Salmon and until they were thoroughly examined were assumed to be his work and, indeed, the transcription work was begun under that mistaken attribution. It soon became clear that Bill Burrells was the author and that Dr. Salmon had acquired these, together with the Ross-Burrells microscope from the Burrells estate.

Material such as that contained herein is so easily lost and were it not for family and friends saving these fragments we would all be the poorer. Details of Bill Burrells and Michael Salmon are to be found in Appendix B and C respectively.

Page 1

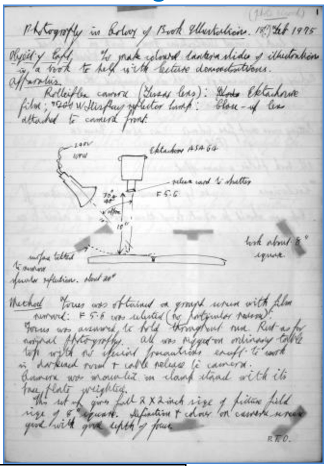


Photo record

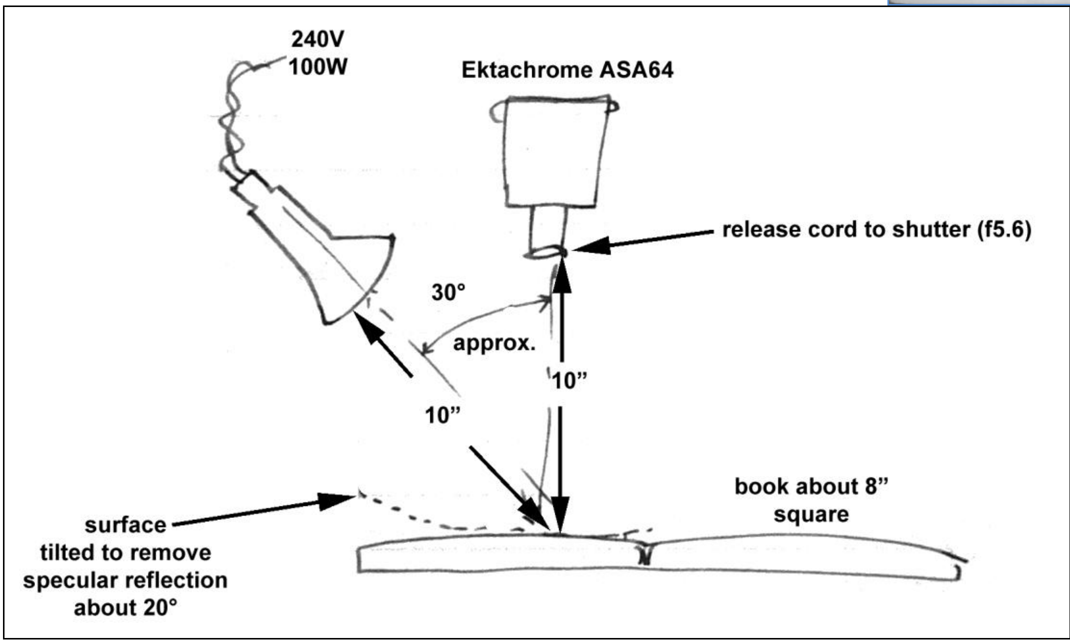
18th(?) February 1975

Photography in Colour of Book Illustrations.

Object of Experiment

To make coloured lantern slides of illustrations in a book to help with lecture demonstrations.

Apparatus. Rolleiflex camera (Tessar Lens): Ektachrome film: ~~100~~ 75W display reflector lamp: Close-up lens attached to camera front.

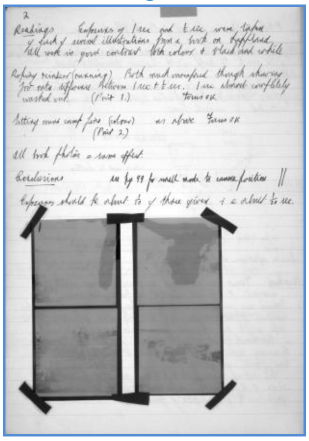


Method. Focus was obtained on a ground screen with film removed: F5.6 was selected (no particular reason): Focus was assumed to hold throughout run. Rest as for normal photography. All was rigged on ordinary table top with no special precautions except to work in darkened room and cable release to camera.

Camera was mounted in clamp stand with its base plate weighted.

This set up gives full 2x2 inch size of picture field size of 8" square. Definition and colour on camera screen good with good depth of focus. *(next page)*

Page 2



Readings:- Exposures of 1 second and ½ second were taken of each of several illustrations from a book on Lapland. All work is good contrast both colour and black and white

Roping reindeer (running). Both much overexposed though showing pro rata difference between 1 second and ½ second. 1 second almost completely washed out (Pair 1) Focus OK.

Sitting round camp fire (colour), as above, Focus OK. (Pair 2)

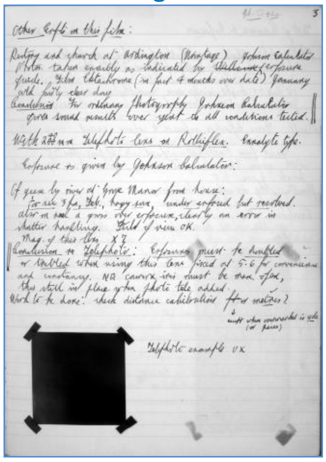
All book photos – same effect.

Conclusions. see page 99 for small modifications of camera position.

Exposure should be about $\frac{1}{10}$ of those given, i.e. about $\frac{1}{20}$th second.

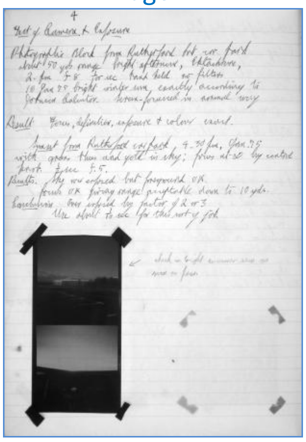



Page 3



Other experiments on this film:
Rectory and church at Ardington (Wantage). Johnson calculator. Photos taken exactly as indicated by exposure guide. Film Ektachrome (in fact 4 months over date). January, cold, fairly clear day.
Conclusion. For ordinary photography Johnson calculator gives sound results over year in all conditions tested.
With 40mm telephoto lens on Rolleiflex. Ennalyte type.
Exposure as given by Johnson Calculator.
Of geese by river at Grove Manor from house:
$\frac{1}{100}$ second, 3pm, February, hazy sun, under exposed but resolved.
Also on reel a gross over exposure, clearly an error in shutter handling. Field of view OK.
Magnification of this lens – x7.
Conclusion re. telephoto. Exposures must be doubled or trebled when using this lens fixed at f5.6 for convenience and constancy. NB. Camera iris must be maximum open, this still in place when photo tele added.
Work to be done: check distance calibration feet or metres (except where overmarked in yards (or paces)
Telephoto example underexposed.
Photograph entirely 'empty'.

Page 4

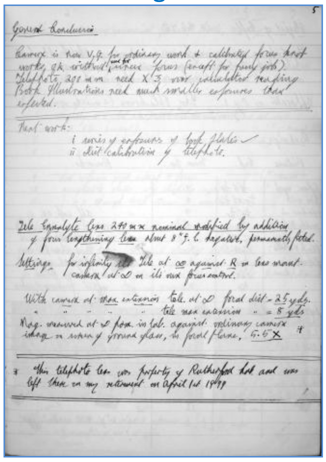


Test of Camera and Exposure.
Photographic Block from Rutherford Lab. car park, about 50yards range, bright afternoon, Ektachrome, 2pm, f8, $\frac{1}{100}$ second, hand held, no filters.
(6th January 1975, bright winter sun exactly according to Johnson Calculator. Screen focussed in normal way.
Result:- Focus, definition, exposure and colour exact.
Sunset from Rutherford car park, 4.30pm, January 1975, with green, blues and yellow in sky, focus at infinity by control knob, ½ second, f5.
Results:- Sky over exposed but foreground OK., focus OK giving range acceptable down to 10 yards.
Conclusion. Over exposed by factor of 2 or 3. Use about $\frac{1}{10}$ second for this sort of job.

3rd Photograph missing

General Conclusions
Camera is now very good for ordinary work and calibrated focus knob works OK without need for screw focus (except for funny jobs).
Telephoto 20mm need x3 over calculator reading.
Book illustrations need much smaller exposures than expected.

Page 5



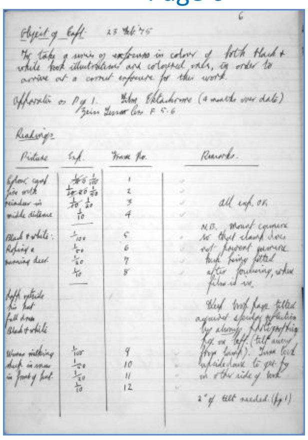
Next work:

1. Series of exposures of book plates
2. First calibration of telephoto

Tele Ennalyte lens 240mm nominal modified by addition of focus lengthening lens about 8" focal length negative, permanently fitted.
Settings. For infinity set Tele at infinity against R on lens mount.
Camera at infinity on its own focus control.
With camera at maximum extension tele at infinity focal distance = 25yds.
With camera at maximum extension tele maximum extension = 8 yards
Magnification measured at infinity position in lab. against ordinary camera image on screen of ground glass, in focal plane, 5.5x.*

*This telephoto lens was property of Rutherford Lab. and was left there on my retirement on April 1st 1979.

Page 6



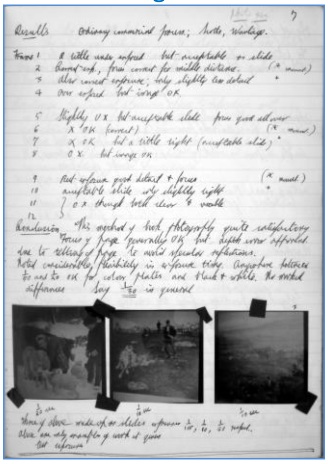
23rd February 1975
Object of Experiment
To take a series of exposures in colour of both black and white book illustrations and coloured ones, in order to arrive at a correct exposure for this work.
Apparatus as page 1. Film Ektachrome (4 months over date), Zeiss Tessar lens f5.6.
Readings:-

Picture	Exposure	Frame No.	Remarks
Colour: Camp fire with reindeer in middle distance	$1/100$ $1/50$ $1/20$ $1/10$	1 2 3 4	All exposures OK NB. Mount camera so that clamp does not prevent camera back being fitted after focusing, when film is in. Keep book page tilted against specular reflection by always photographing page on left (tilt away from lamp). Turn book upside down to get photograph of other side of book. 2" of tilt needed. Page 1)
Black and White: Roping a running reindeer	$1/100$ $1/50$ $1/20$ $1/10$	5 6 7 8	

Lapp outside his hut full dress. Black and white			
Woman milking sheep in snow in front of hut.	$\frac{1}{100}$ $\frac{1}{50}$ $\frac{1}{20}$ $\frac{1}{10}$	9 10 11 12	

(next page)

Page 7



Results: Ordinary commercial process, Scotts, Wantage.
Frame 1. A little under exposed, but acceptable as slide
Frame 2. Correct exposure, focus correct for middle distance (Mount)
Frame 3. Also correct exposure, only slightly less detail
Frame 4. Over exposed, but image OK
Frame 5. Slightly under exposed, but acceptable slide, focus good all over
Frame 6. Exposure OK (correct) (mount)
Frame 7. Exposure OK but a little light (acceptable slide)
Frame 8. Over exposed but image OK
Frame 9. Best exposure, good detail and focus (mount)
Frame 10. Acceptable slide, only slightly light
Frames 11 and 12. Over exposed though both clear and usable
Conclusion. This method of book photography quite satisfactory. Focus of page generally OK but depth error apparent due to tilting of page to avoid specular reflections.

Noted considerable flexibility in exposure time. Anywhere between $\frac{1}{50}$ and $\frac{1}{20}$ OK for colour plates and black and white. No marked differences. Say $\frac{1}{30}$ in general.

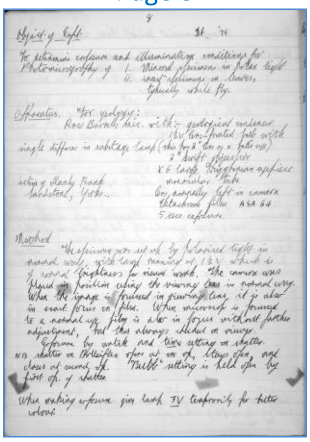
$\frac{1}{20}$ second

$\frac{1}{10}$ second

$\frac{1}{10}$ second

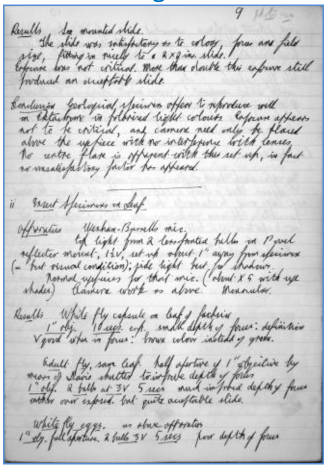
Three of above made up as slides, exposures $\frac{1}{100}$, $\frac{1}{50}$, $\frac{1}{50}$ respectively.
Above are only examples of work at given test exposures.

Page 8



February 1975
Object of Experiment
To determine exposure and illumination conditions for Photomicrography of i. Mineral specimens in polarised light, ii. Insect specimens on leaves, typically white fly.
Apparatus:- For Geology: Ross-Burrells microscope with:- geological condenser, 1½V lens-fronted bulb with single diffuser in substage lamp (this has 2” lens as a bull’s-eye), 2” Swift objective, x6 large Huyghenian eyepiece. Monocular tube, lens normally left in camera, Ektachrome film ASA64, 5 seconds exposure. Section of Hornly Bank Sandstone, Yorkshire.
Method:- The specimen was set up by polarised light in normal way, with lamp running at 1½V which is of normal brightness for visual work. The camera was placed in position using the viewing lens in normal way. When the image is focussed in viewing lens, it is also in exact focus on film. When microscope is focussed to a normal eye film is also in focus without further adjustment, but this always checked on viewer. Exposure by watch and time setting on shutter. NB. shutter on Rolleiflex opens one operation, and stays open, and closes at second operation. “”Bulb” setting is held open by first operation of shutter.
When making exposure give lamp 3V temporarily for filter colour.
(next page)

Page 9



Results. See mounted slide

The slide was satisfactory as to colour, focus and field size, fitting nicely to a 2x2ins slide.

Exposure was not critical. More than double this exposure still produced an acceptable slide.

Conclusion. Geological specimens appear to reproduce well on Ektachrome in polarised light colours. Exposure appears not to be critical, and camera need only be placed above the eyepiece with no interference with lenses. No centre flare is apparent with this set-up, in fact no unsatisfactory factor has appeared.

ii. Insect Specimens on Leaf

Apparatus:- Wenham-Burrells microscope, top light from 2 lens-fronted bulbs on Powell reflector mount, 1½V, set-up about 1" away from specimen (= best visual condition); side light best for shadows, normal eyepieces for that microscope (about x5 with eye shades). Camera work as above. Monocular.

Results. White fly capsule on leaf of fuchsia.

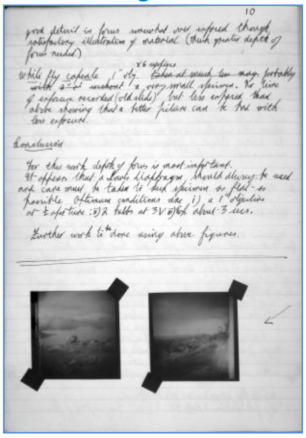
1" objective, 10 seconds exposure, small depth of focus, definition very good when in focus, brown colour instead of green.

Adult fly, same leaf, half aperture of 1" objective by means of Davis shutter to improve depth of focus. 1" objective. 2 bulbs at 3V, 5 seconds, much inferred depth of focus, rather over exposed but quite acceptable slide.

White fly eggs. As above apparatus

1" objective, full aperture, 2 bulbs, 3V, 5 seconds. Poor depth of focus…*(next page)*

Page 10



…good detail in focus somewhat over exposed though satisfactory illustration of material (much greater depth of focus needed).

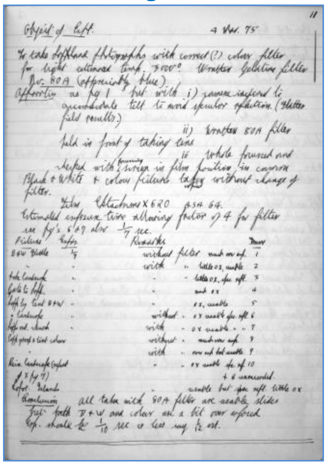
White fly capsule 1" objective, x6 eyepiece, ~~taken at much lens magnification probably with 2" objective without~~ a very small specimen. No time of exposure recorded (old slide) but less exposed than above showing that a better picture can be had with less exposure.

Conclusion. For this work depth of focus is most important. It appears that a Davis diaphragm should always be used and care must be taken to keep specimen as flat as possible. Optimum conditions are

i. A 1" objective at ½ aperture
ii. 2 bulbs at 3V
iii. Exposure for about 3 seconds

Further work to be done using above figures.

Page 11



4th March 1975

Object of Experiment

To take Lapland photographs with correct(?) colour filter for light estimated temperature 3000°. Wratten Gelatine filter No.80A (appreciably blue)

Apparatus:- as page 1 but with

i. Camera inclined to accommodate tilt to avoid specular reflection (flatter field results)
ii. Wratten 80A filter held in front of taking lens
iii. Whole focussed and checked with focussing screen in film position in camera.

Black and White and Colour pictures taken (copied) without change of filter.

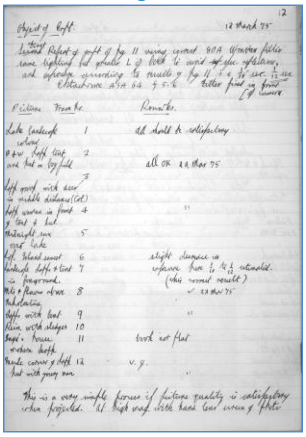
Film EktachromeX620 ASA64.

Estimated exposure time allowing factor of 4 for filter $\frac{1}{7}$ second. See pgs 6 and 7 also.

Picture	Exposure	Remarks	Frame
Black and White Kettle	$\frac{1}{7}$	Without filter, much over exposed	1
Black and White Kettle	$\frac{1}{7}$	With filter, little over exposed, usable	2
Lapland Landscape	$\frac{1}{7}$	With filter, little over exposed, specular reflection	3
Gate to Lapp.	$\frac{1}{7}$	With filter, much over exposed	4
Lapp by tent, Black and White	$\frac{1}{7}$	With filter, over exposed, usable	5
Lapland landscape	$\frac{1}{7}$	Without filter, over exposed, usable, specular reflection	6
Lapps outside church	$\frac{1}{7}$	With filter, over exposed usable, specular reflection	7
Lapp group and tent, Colour		Without filter, much over exposed	8
Lapp group with tent, colour		With filter, over exposed but usable	9
Reindeer landscape (repeat of 3 page 7)		With filter, over exposed usable, specular reflection	10
+ 2 unrecorded			
Lofot Islands		With filter, usable but specular reflection little, over exposed	

Conclusion. All taken with 80A filter are usable slides but both Black and White and Colour are a bit over exposed. Exposure should be $\frac{1}{10}$ second or less, say $\frac{1}{12}$ estimate.

Page 12



Object of Experiment

First report of experiment of page 11. using correct 80A Wratten filter, same lighting but greater angle of book to avoid surface reflection and exposure according to results of page 11 i.e. ~~$\frac{1}{10}$ second~~ $\frac{1}{12}$ second, Ektachrome ASA64, F5.6. Filter fixed in front of camera.

Picture	Frame No.	Remarks
Lake landscape colour	1	All should be satisfactory
Black and White. Lapp Tent and hut on bog field	2	All Ok. 22nd March 1975
Lapp group with deer in middle distance	3	
Lapp women in front of tent and hut	4	All Ok. 22nd March 1975
Midnight sun over lake	5	
Lof. Island sunset	6	Slight decrease in exposure here $\frac{1}{10}$ to $\frac{1}{10}$ estimated (this correct result) 22nd March 1975
Landscape. Lapps and Tent in foreground	7	
Plants and flowers above Nikolortnu	8	
Laps with boat	9	
Reindeer with sledges	10	
Ingu's House (modern Lapp)	11	Book not flat
Inside corner of Lapp hut with young men	12	Very good

This is a very simple process of picture quality is satisfactory when projected. At high magnification with hand lens screen of photo…*(next page)*

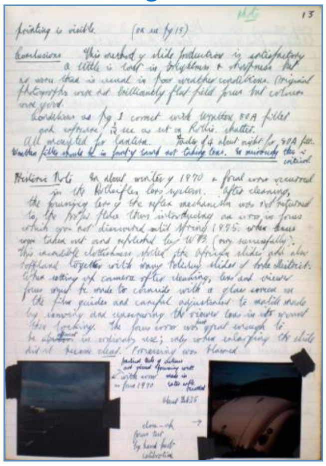
…printing is visible (Ok see page 15)

Conclusions. This method of slide production is satisfactory. A little is lost in brightness and sharpness but no worse than is usual in poor weather conditions. Original photographs were not brilliantly flat field focus but colours were good.

Conclusions as page 1 correct with Wratten 80A filter and exposure $\frac{1}{12}$ second as set on Rolleiflex shutter.

All mounted for lantern. Factor of 4 about right for Wratten 80A filter. Wratten filters should be in front of lamp not taking lens. In microscopy this is critical.

Page 13

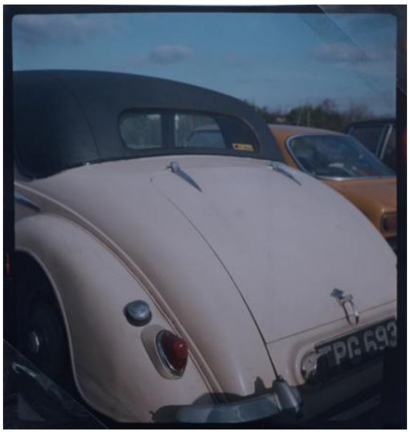


Historic Note: In about winter of 1970 a focal error occurred in the Rolleiflex lens system. After cleaning, the focussing lens of the reflex mechanism was not returned to the proper place thus introducing an error in focus which was not discovered until spring 1975 when lens was taken out and re-polished by WB (very successfully).

This incredible 'clottishness' spoiled the African slides and also Lapland together with many holiday slides of Lake District. When setting up camera after cleaning, lens and viewer focus must be made to coincide with a glass screen in the film guide and careful adjustment to match made by screwing and unscrewing the viewer lens in its mount then locking. The focus error was just great enough to be apparent in ordinary use; only when enlarging the slide did it become clear. Processing was blamed.

Practical tests of actinic and visual focussing were made in later experiments recorded.

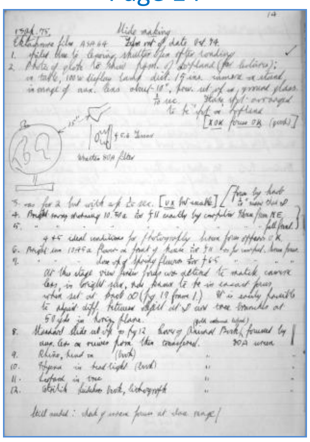
With error as from 1970



About February 1975

Close-up focus test by hand knob calibration

Page 14

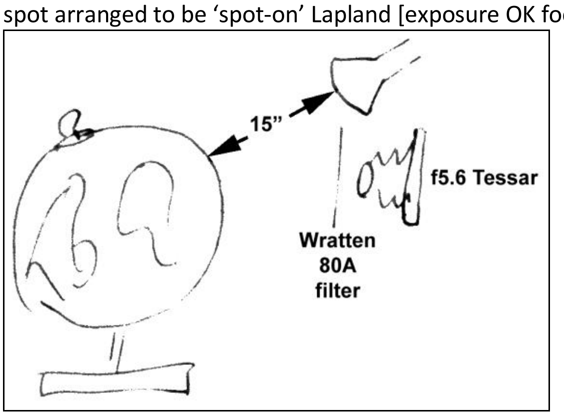


13th April 1975

Slide Making

Ektachrome film ASA64. Film out of date October 1974

1. Spoiled due to leaving shutter open after loading
2. Photograph of globe to sow position of Lapland (for lectures); on table, 100W display lamp, distance 15 inches, camera on stand in range of auxiliary lens about 10", previous set up on ground glass, $\frac{1}{10}$ second. Flare spot arranged to be 'spot-on' Lapland [exposure OK focus OK (good)]



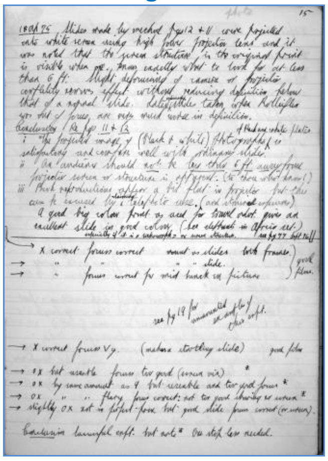
3. As for 2 but with exposure $\frac{1}{25}$ second (under exposed, but usable) (focus by knob $\frac{1}{10}$" nearer than infinity)

4. Bright sunny morning 10.30am $^1/_{100}$ f11 exactly by computor. House from NE
5. Bright sunny morning 10.30am $^1/_{100}$ f11 exactly by computor. House Full front
   4 and 5 ideal conditions for photography. Screen focus appears OK. Exposure correct, mount as slides (both frames) Good films.
6. Bright sun 10.45am. Flowers on front of house, $^1/_{100}$ f11 as per computor, screen focus. Exposure correct, mount as slide, good film
7. Bright sun 10.45am. Close up of spring flowers $^1/_{300}$ f6.5 as per computor, screen focus
   At this stage view finder focus was altered to match camera lens, in bright sun, now known to be in exact focus when set at knob infinity (page 17. Frame 1). It is easily possible to adjust difference between object at infinity and tree branches at 50 yards in horizontal plane. Exposure correct, focus correct for mid-bunch in picture, good film
8. Standard slide set up as page 12. Cover of Animal Book (gold embossed legend) focussed by auxiliary lens on viewer position then transferred. 80A screen. Exposure correct, focus very good (makes a startling slide) good film
9. Rhino, head on (book) 80A screen, over exposed but useable, focus too good (screen visible)*
10. Hyena in head light (book) 80A screen, over exposed by same amount as 9 but usable and too good focus*
11. Leopard in tree 80A screen, over exposed by same amount, flarey, focus correct. Not too good showing no screen*
12. Ostrich, Baedeker's book, lithograph, 80A screen, slightly over-exposed not in perfect position but good slide, focus correct (no screen) [Transcribers Note: - Karl Baedeker – Baedeker's Travel Guides – Baedeker's South Africa]

Conclusion. Successful experiment but note * one stop less needed.
Still needed: check of screen focus at close range. See page 19 for un-mounted examples of this experiment.

18th April 1975

Page 15



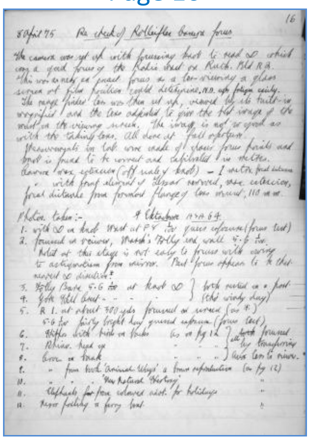
Slides made by method pages 12 and 11 were projected onto white screen using high power projector lens and it was that the screen structure in the original print is visible when one knows exactly what to look for at less than 6ft. Slight defocusing of camera or projector completely removes effect without reducing definition below that of a normal slide. Later ordinary slides taken when Rolleiflex was out of focus are very much worse in definition.

Conclusion. Re: pages 11 and 12

i. The projected image of (black and white) photographs of black and white plates is satisfactory and compares well with ordinary slides.
ii. An audience should not be less than 6ft away from projector screen or structure is apparent (to those who know!)
iii. Book reproductions appear a bit flat in projector but this can be excused by claiming telephoto use (and strained exposures)

A good big colour print as used for travel advertisements gives an excellent slide in good colour (see elephants in Africa set) especially if it is a lithograph = no screen structure.
See page 77. September 1976.

Page 16



8th April 1975

Re-check of Rolleiflex Camera Focus

The camera was set up with focussing knob to read infinity which was a good focus of the radio mast on Rutherford Building R2.

This was as near an exact focus as a lens viewing a glass screen at film position could determine. NB. eyes fatigue easily.

The range finder lens was then set up, viewed by its built-in magnifier and the lens adjusted to give the best image of the mast in the viewing screen. The image is not so good as with the taking lens. All done at full aperture.

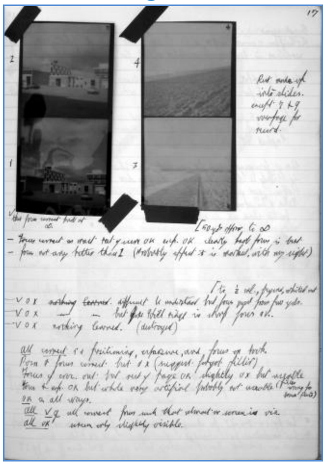
Measurements in lab. were made of closer focus points and knob is found to be correct and calibrated in metres. Camera maximum extension (off scale of knob) – 1 metre focal distance. Camera with front element of Tessar removed, maximum extension, focal distance from foremost flange of lens mount; 110mm.

Photos taken: (Ektachrome ASA64)

1. With infinity on knob. Mast at f8 $^1/_{100}$ guess exposure (focus test) - Focus correct on mast rectangle of scene OK. Exposure OK. Clearly knob focus is best
2. Focussed in viewer, Marsh's Folly end wall f5.6 $^1/_{100}$. Rolleiflex at this stage is not easy to focus with owing to astigmatism from mirror. Best focus appears to be that nearest infinity direction*. - Focus not any better than 1 (probably effect is marked with my sight)

3. Folly Barn f5.6 $^{1}/_{100}$ at knob infinity (both 3 and 4 rested on a post though windy day) – Very over exposed, difficult to understand but focus good from few yards to ¼ mile, beyond, 'whited' out
4. Gore Hill Crest f5.6 $^{1}/_{100}$ at knob infinity – Very over exposed but fore Hill ridge in sharp focus OK
5. R.L. at about 300 yards focussed on screen (as *)
   F5.6 $^{1}/_{100}$ fairly bright day guessed exposure (focus test) – Very over exposed, nothing learned (destroyed)
6. Hippos with birds on backs. As on page 12 (6,7,8 focussed by transferring auxiliary lens to viewer) - All correct i.e. positioning, exposure, and focus on book.
7. Rhino, head on, As on page 12 – Position and focus correct but over exposed (suggest forgot filter)
8. Crocodile on bank. As on page 12 – Focus of crocodile out but rest of page OK, slightly over exposed, but usable
9. Crocodile from book 'Animal Ways' a Crown reproduction (as page 12) – Focus and exposure OK but whole very artificial probably not usable (filter wring for this plate)
10. Crocodile from book 'New Natural History' (as page 12) – OK in all ways
11. Elephants from coloured advertisement for holidays (as page 12) – All very good, all correct focus such that almost no screen is visible
12. Negro pulling a ferry boat (as page 12) – All OK screen only slightly visible.

Page 17



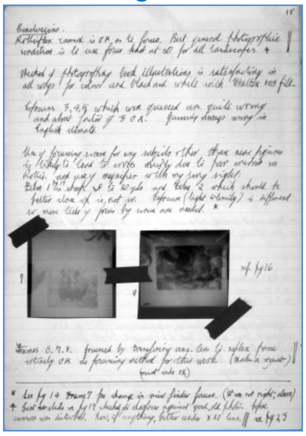
This focus correct. Probably at infinity

50 yards approximately to infinity

Rest made up into slides except 7 and 9 over page for record.

(next page)

Page 18



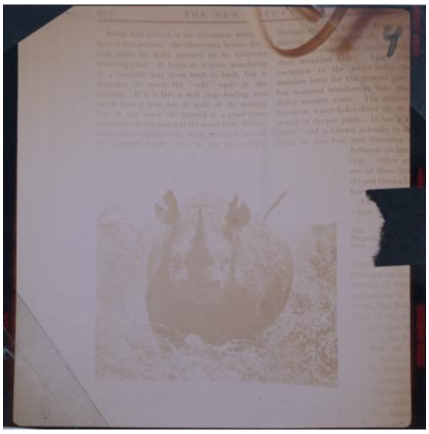
Conclusions. Rolleiflex camera is OK as to focus. But general photographic condition is to use focus knob at infinity for all landscapes. (see page 14 Frame 7 for change in view finder focus (it was not right: above).

Method of photographing book illustrations is satisfactory in all ways for colour and black and white with Wratten 80A filter.

Exposures 3, 4, 5 which were guessed are quite wrong and about factor of 30x. Guessing always wrong in English climate.

Use of focussing screen for any subjects other than near figures is likely to lead to errors mainly due to poor mirror in Rolleiflex, and use of magnifier with my long sight.

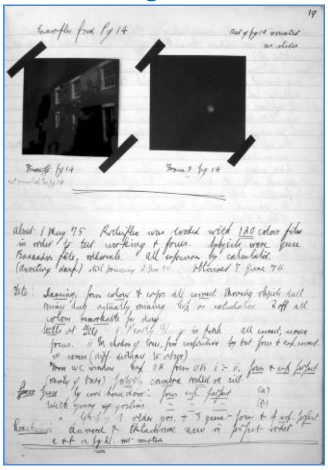
Film 1 (page 17) is sharp infinity to 20 yards and Film 2 which should be better close up is not so. Exposure (light intensity) is different so more tests of focus by screen are needed (best slide on pg 17 checked for sharpness against good old photo, before camera was disturbed. Now, if anything, better under x20 lens. See page 23.



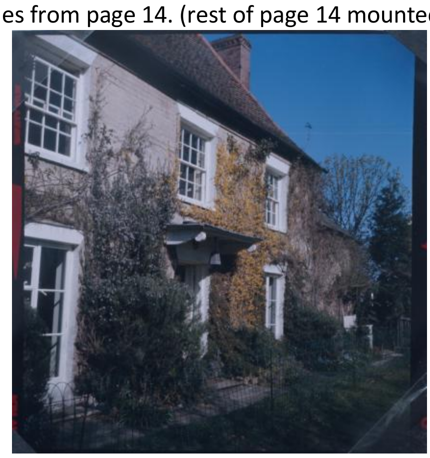
Ref. page 16.

Frames 6, 7, 8, focussed by transferring auxiliary lens to reflex form entirely OK as focussing method for this work. (Make a mount) (Mount made OK)

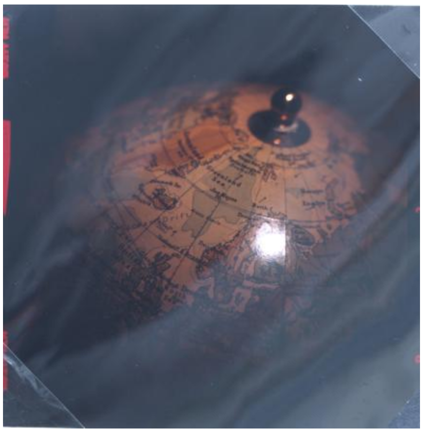
Page 19



Examples from page 14. (rest of page 14 mounted as slides)



Frame ? page 14 (not recorded on page 14!)



Frame 3 page 14.

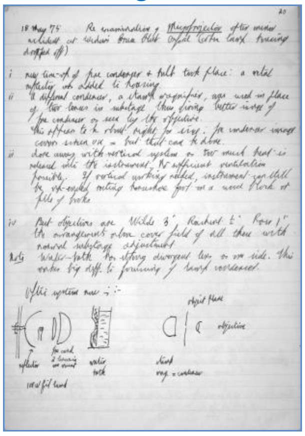
About 1st May 1975. Rolleiflex was loaded with 120 Colour film in order to test working and focus. Subjects were geese, Barnardos fete, oddments. All exposures by calculator. (Awaiting developing) Still waiting. 2nd June 1975. Obtained 7th June 1975.

Fete: Dancing. Focus, colour and exposures all correct. Moving objects. Dull rainy day, actually raining. Exposures as calculator. 2 off all colour remarkable for day. Stalls at fete.

1. Pearly King in porch. All correct, screen focus.
2. In shadow of trees, poor composition but focus and exposure correct on screen (different distance to above) From WC window. Exposure OK, focus OK. i. – ii. Focus and exposure perfect (mainly of barn) probably camera rested on sill.
   Geese by coal house door: focus, exposure perfect (A)
   With young goslings, focus and exposure perfect (b)
   With group of 4 older goslings and 3 geese – focus and exposure perfect.

Conclusion. Camera and Ektachrome now in perfect order. a and b page 21. not mounted.

Page 20

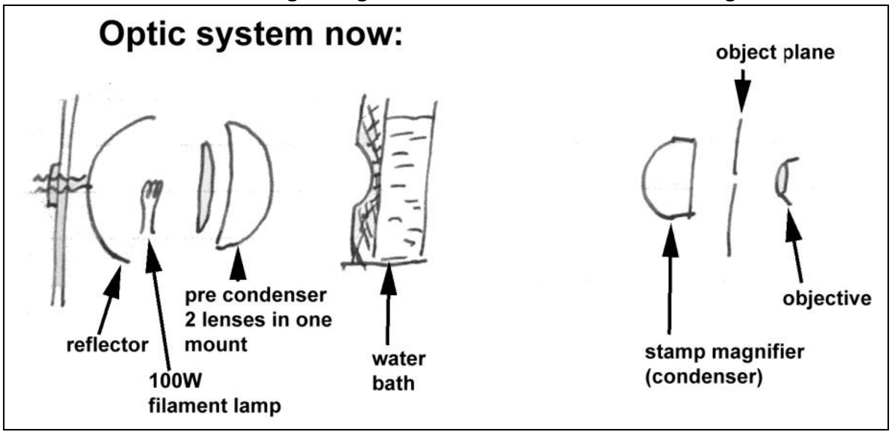


18th May 1975

Re-examination of Microprojector after minor accident at Widows Grace Club, Oxford (when lamp housing dropped off)

i. New line-up of pre-condenser and bulb took place: a metal reflector was added to housing.
ii. A different condenser, a stamp magnifier, was used in place of two lenses in substage thus giving better image of pre-condenser as seen by the objective.
   This appears to be about right for size: pre-condenser image covers screen OK = but that can be done.
iii. Done away with vertical system as too much heat is released into the instrument. No sufficient ventilation possible. If vertical working needed, instrument can still be up-ended resting horseshoe foot in a wood block or pile of books.
iv. Best objectives are Wild 3", Reichert ½", Ross 1". The arrangements as above cover field of all these with normal substage adjustment.

Note: Water-bath has strong divergent lens on one side. This makes big difference to focussing of lamp condenser.



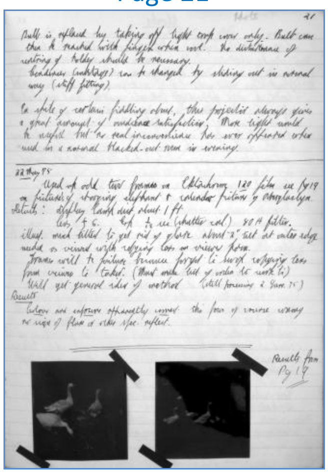
(next page)

Bulb is replaced by taking off light trap cover only. Bulb can then be reached with fingers when cool. No disturbance of centring of holder should be necessary.

Condenser (substage) can be changed by sliding out in normal way (stiff fitting).

In spite of certain fiddling about, this projector always gives a great amount of audience satisfaction. More light would be useful but no real inconvenience has ever appeared when used in a normal blacked-out room in evening.

Page 21



22nd May 1975

Used up odd two frames on Ektachrome 120 film, see page 19., on pictures of charging elephant and calendar picture of Aberglaslyn [Transcribers Note - near Beddgelert, North Wales on the edge of the Snowdonia National Park].

Details:-

Display lamp distance about 1ft. Lens f6. Exposure $\frac{1}{12}$ second (shutter cal.) 80A filter. Illustration much tilted to get rid of glare, about 2" tilt at outer edge needed as viewed with copying lens on viewer position.

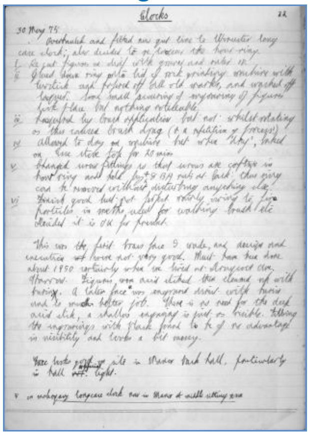
Frames will be failure because forgot to swap copying lens from viewer to taker.
(Must make list of orders to work to.)
Will get general idea of method. (Still focussing 2nd June 1975)

Results:-

Colour and exposure apparently correct. The focus of course wrong, no sign of flare or other spherical reflections.

Results from page 19

Page 22



30th May 1975

Clocks

Overhauled and fitted a new gut line to Worcester long-case clock; also decided to re-lacquer the hour ring.

i. Re-cut figures on dial with graver and ruler OK
ii. Glued down ring onto lid of rock grinding machine with Evostick and papered off all old marks, and washed off lacquer. Some small scouring of engraving of figures took place but nothing noticeable.
iii. Lacquered by brush application but not whilst rotating as this caused brush drag (and a repetition of process!)
iv. Allowed to dry on machine but when 'dry' baked on Esse stove top for 20 minutes.
v. Changed screw fittings so that screws are captive in hour ring and held by 4x8BA nuts at back; thus rind can be removed without disturbing anything else.
vi. Finish good but not perfect owing mainly to fine particles in methylated spirit used for washing brush etc. Decided it is OK for present.

This was the first brass face I made, and design and execution were not very good. Must have been done about 1950, certainly when we lived at Draycott Avenue, Harrow. Figures were acid etched, then cleaned up with burin. A later face* was engraved direct with burin and is much better job. There is no need for the deep acid etch, a shallow engraving is just as visible. Filling the engraving with black found to be of no advantage in visibility and looks a bit messy.

Face looks good in site in Manor back hall, particularly in hall artificial light.

*in mahogany longcase clock now in Manor middle sitting room.

2nd June 1975

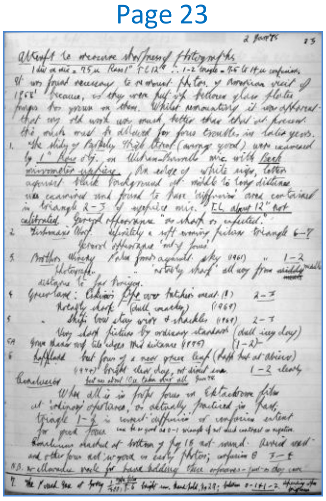
Attempt to measure sharpness of photographs

1 division on microscope = 75µ. Ross 1" tube length 12" therefore 1-2 triangle – 7.5 to 14µ confusion.

It was found necessary to re-mount photos of American visit of 1961 because, as they were put up between glass plates fungus has grown on them. Whilst re-mounting it was apparent that my old work was much better than that at present, though much must be allowed for focus troubles in later years.

1. The slides of Berkeley High Street (average good) were examined by 1" Ross objective on Wenham-Burrell microscope with Beck micrometer eyepiece. An edge of white sign, letters against black background at middle to long distance was examined and found to have 'diffusion' area contained in triangle 2-3 of eyepiece micrometer. Focal length about 12" not calibrated. General appearance as sharp as expected.
2. Fisherman's Wharf. Definitely a soft evening picture triangle 6-7 general appearance 'out of focus'.

Page 23



3. Brothers Winery. Palm fronds against sky (1961) triangle 1-2. Photograph palm fronds 'notably sharp' all way from middle distance to far horizon.
4. Greenland: Eskimos pipe over butcher's meat (!) 2-3. Notably sharp (dull weather (1969))
5. Greenland: Ship's bow stay wire and shackles (1969) 2-3. Very sharp picture by ordinary standard (dull icy day)

5A. Grove Manor roof tile edges mid-distance (1975) (1-2)

6. Lapland. Best form of a green leaf (Lapp but at Abisco) (1974) bright clear day, not direct sun. 1-2 clearly.
7. The Pound Inn at Goosey $\frac{1}{300}$ ASA film f6, bright sun, hand held, page 29; between 0-1 and 1-2 depending upon brightness.

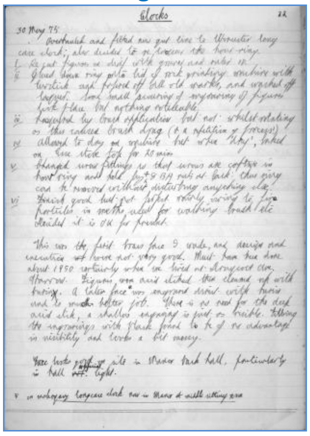
Conclusion. Best resolution about 10µ taken overall – June 1978

When all is in proper focus in Ektachrome film at 'ordinary' apertures, as actually practised in past; triangle 1-2 is correct 'diffusion' of comparison extent for good focus. Can be as good as 0-1 triangle if not much contrast on negative.

Conclusion reached at bottom of page 18 not sound. Aerial medium and other focus not so good as early photos; confusion circle 3-4.

NB. No allowance made for hand holding these exposures – just as they came.

Page 24



About 23rd May 1975

Rolleiflex loaded with Ektachrome 120 for continuing focus and performance tests.

Frames 1 and 2. Re-doing of the 2 frames of page 21, charging elephant taken without filter. Over exposed, colour poor, but useable.

Frame 3. Charging elephant 80A filter. Exposure, colour and focus correct. (Slide made.)

Frame 4. Aberglaslyn. All correct but not quite in position. Slide made.

Frames 5 and 6. Test landscape 7p.m. clear sun, computor exposure. Landscape from Hanney lay-by, but looking NE.

[Frame 5 rested on car radiator, 6 hand held, both $\frac{1}{100}$ f5. 5 and 6 taken at infinity on knob (=apparently correct by screen)

Frame 7. Car in Hanney lay-by by screen focus $\frac{1}{100}$ f5, little over exposed, focus not exact.

Frame 8. Challow Fete Band at infinity, focus and exposure right

Frame 9. Challow Fete Garden, correct at infinity

Frame 10. Grove balloon inflation, infinity

Frame 11. Grove balloon flight against sun (hand held) 5pm. Focus OK, glary as expected (for reference)

Also on this spool:

[Insert Photo]

Wenham-Burrells microscope, Wild objective, Davies shutter ⅓ open. 2 lens bulbs at 3V. Aphids on Abutilon leaf.

i. Exposure 3 seconds with no filter
ii. Exposure 10 seconds with Wratten 80A filter above specimen.

Both taken at best visible focus in microscope without change when camera placed in position (14th June).

Results:- i. and ii. Both exposures OK but filter position held in way of objective and destroyed image. Focus OK.

Infinity focus is now correct. Exposures slightly over exposed, so remember to come down a stop in open conditions.

Wratten 80A filter exposure correct 3x with microscope lights (2 lens bulbs on green material)

15th June 1975

Object of Experiment

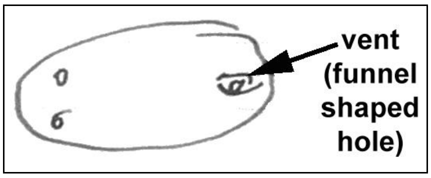
Use of Agfa 120

Loaded Rolleiflex with Agfa film 120, ASA50

i. Micrograph of White Fly insect on abutilon leaf, 2 capsules on at different degrees of development. Star leaf. 80A Wratten, 2" objective, Davis shutter ⅓ open, 2 x 3V bulbs 1" away, 95° angle, visual focus as in microscope, 10 seconds.
ii. Group of 4 insects just hatched, small capsule and 2 larger, condition as for i.

NB. there is a vent at rear top of developing capsule which about each ½ hour blows a bubble which instantly bursts.

Page 25



Both correct exposure and focus.
See page 26 for continuation of this run.
(next page)

Page24 results.


11


17

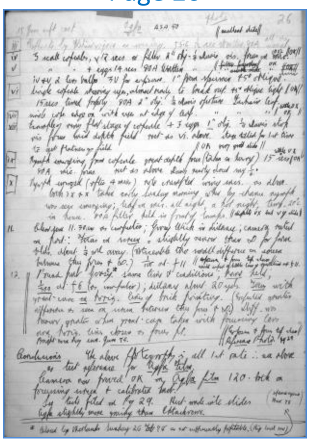

2


8


ii


5

Page 26



15th June 1975

Exposure continued (AGFA ASA50)

iii. Elephants by Kilimanjaro in evening. f5.6 $\frac{1}{12}$ second, Wratten 80A, all as usual.

iv. 3 scale insect capsules, 12 seconds, no filter, 2" objective, ¼ Davis, visual focus in microscope (Over exposed. OK)

v. Scale insect capsules and eggs, 14 seconds, 80A Wratten filter, ¼ Davis (OK)

[iv and v 2 lens bulbs 3V for exposure, 1" from specimen, 45° oblique]

vi. Single capsule showing eyes, almost ready to break out, 45° oblique light, 15 seconds timed properly, 80A, 2" objective, ¼ Davis aperture, Fuchsia leaf (OK)

vii. Single capsule edge on with eyes at edge of leaf (as above) (little over exposed, OK)

viii. Example of very flat stage of capsule and 3 eggs, 1" objective, $\frac{1}{5}$ Davis stop, visual focus, mid-depth field, rest as Vertical Illumination above. Stage tilted for first time to get flatness of field. (OK, very good slide)

ix. Nymph emerging from capsule, great depth focus (taken in hurry) 15 seconds, 80A, microscope focus, rest as above, Davis nearly closed, say $\frac{1}{6}$ (little over exposed, OK)

x. Nymph emerged (after 4 minutes) note crumpled wing sacs, as above, both ix and x taken early Sunday morning when by chance nymph was seen emerging; leaf on microscope all night, a hot night, temperature 20°C in house. 80A filter held in front of lamps (slightly under exposed but very good slide)

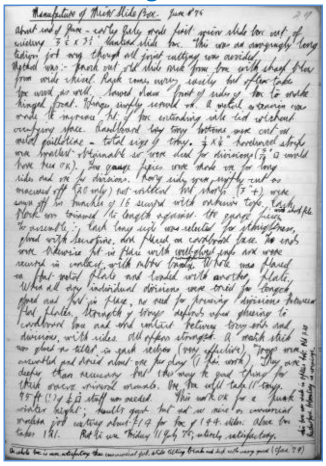
xi. Clear sun 11.30 am as computor; Goosey Wick in distance; camera rested on post, focus on screen = slightly nearer than infinity for farm buildings, about ¼ mile away (noticeable though small difference in screen between this focus and infinity) $^1/_{100}$ at f11 (Exposure and focus top class, would expect a little loss of resolution at f11)

xii. Pond Pub, Goosey (closed by Morlands Sunday 26th February 1978 as not sufficiently profitable – big local row – opened again March 1978), same time and conditions, hand held, $^1/_{300}$ at f6 (as computor), distance about 20 yards. Focus with great care on horizontal lines of brick pointing. (Expected greater difference as seen on screen between this focus and infinity) Difference was, however greater when great care taken with focussing lens and horizontal lines chosen as focus point. Bright noon day sun June 1975. (exposure and focus top class. Reference photo page 29)

Conclusions. The above photography is all 1st rate, therefore as above a test reference for Agfa film.
Camera now proved OK on Agfa film 120, both on focussing screen and calibrated knob.
See 'tests' filed on page 29. Rest made into slides. Agfa slightly more grainy than Ektachrome.

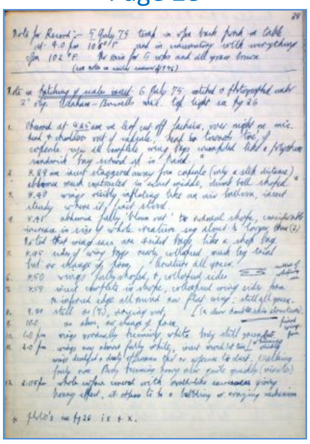
June 1975
Manufacture of Micro Slide Box
About end of June-early July made first micro slide box out of existing 3½x3½ lantern slide box. This was an amazingly long tedious job even though all joint cutting was avoided.
Method was:- knock out old slide rack from box with sharp blow from wide chisel. Rack comes away easily but often taken box wood as well. Sawed down front of sides of box to make hinged front. Hinges simple screwed on. A metal extension was made to increase height of box extending into lid without occupying space. Cardboard tray bottom were cut on metal guillotine = total size of tray. ¼" X ¼" hardwood strips were smallest obtainable so were used for divisions ($^3/_{16}$" square would have been OK). Two gauge pieces were made, one for long sides and one for divisions. Long sides were simply cut as measured off (20 only) not critical but shorts (3"+) were sawn off in bunches of 16 secured with adhesive tape. Each block was trimmed to length against gauge pieces with sharp file.

Page 27



To assemble:- Each long side was selected for straightness, glued with Secrotine, and placed on cardboard base. The ends were likewise put in place with well-glued ends and were secured in contact with rubber bands circumferentially. Whole was placed on flat metal plate and loaded with another plate. When all dry individual divisions were tried for length, glued and put in place, no need for pressing divisions between flat plates. Strength of trays depends upon gluing to cardboard base and end contact between tray-ends and divisions with sides. All appears strong. A match stick was glued as 'tilter' in each section (very effective). Trays were assembled and dried about one per day (1 hours work). They are deeper than necessary but this may be good thing for thick macro ringed mounts. One box will take 11 trays. 75ft(!) of ¼" square stuff was needed. This work OK for a junk winter night; results good but not so nice as commercial modern job costing about £14 for box of 144 slides. Above box takes 121. Put to use Friday 11th July 1975; entirely satisfactory.
This box was made in Optics Lab., Old R20, Rutherford Laboratory in evenings.
On whole box is more satisfactory than commercial job. Slide tilting block and deep cells very good (January 1979)

Page 28



Note for record:- 5th July 1975.
Temperature in open back porch on table at 4.00pm 106°F and in conservatory with everything open 102°F. No rain for 5 weeks and all grass brown.
(see notes on similar summer of 1976)

6th July 1975
Note on hatching of Scale Insect.
Watched and photographed under 2" objective on Wenham-Burrells microscope, top light (see page 26)

1. Observed at 8.25am, on leaf cut off fuchsia, over night on microscope, head and shoulders out of capsule, head towards toe of capsule eyes all complete, wing bags crumpled like a polythene sandwich bag screwed up in hand.*
2. 8.29am insect staggered away from capsule (only a step distance) abdomen much contracted in exact middle, dumb bell shaped**
3. 8.40 wings visibly inflating like an air balloon, insect steady when it first stood.
4. 8.41 abdomen fully 'blown out' to normal shape, considerable increase in size of whole creature say about ⅓ larger than (2). Noted that wing sacs are 4-sides bags like a shop bag.
5. 8.45 sides of wing bags nearly collapsed much leg trial but no change of form. Creature all green.
6. 8.50 wings fully shaped and collapsed sides


section of collapsing sac

7. 8.55 insect complete in shape, collapsed wing sides form reinforced edge all round now flat wings: still all green. A clear double skin structure.
8. 9.30 still as (7), drying out.
9. 10.00 as above, no change of form
10. 1.00pm wings gradually becoming white, body still green but whitening visibly.

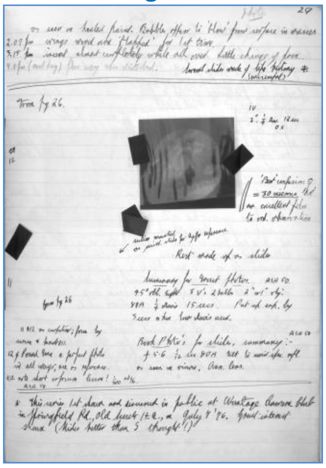

final wing form

11. 2.00pm wings now about fully white, insect moved 1st time, wings developed a dusty appearance though no exposure to dust. Walking freely now. Body becoming hoary also quite quickly (minutes)
12. 2.05pm whole surface covered with mould-like excrescences giving hoary effect, it appears to be a baffling or crazing mechanism.

*photos see page 26. ix and x.

…as seen on heated paint. Bubbles appear to ‘blow’ from surface in masses.
2.07pm Wings moved and ‘flapped’ for first time
3.15pm. Insect almost completely white all over. Little change of form.
9.00pm (next day) flew away when disturbed.
Several slides were made of life history (successful)*
*This series 1st shown and discussed in public at Wantage Camera Club in Springfield Road, old Scouts H.Q., on 7th July 1976. Great interest shown (slides better than I thought!)

Page 29



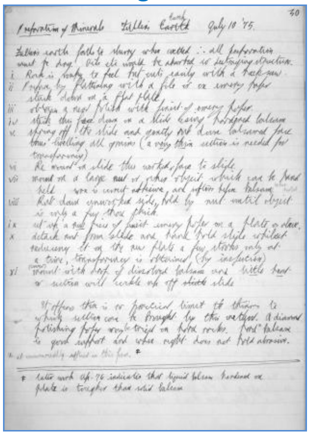
Frame 12. From pg26.
11 & 12 as computor; focus by screen and knob(11).
12. Pound Inn. A perfect photo in all ways; use as reference.
NB. short exposure lesson! $^1/_{200}$ at f6. ASA50.

From pg26.
IV. 2” ¼ Davis. 12 seconds. Over exposed
‘Best’ confusion circle = 30 microns though an excellent film to ordinary observation.

Section put up as microslide

Section mounted as microslide for Agfa reference. Rest made up as slides.
Summary of Insect photos. ASA50. 45° oblique light, 3V 2 bulbs, 2" or 1" objective.
80A, ¼ Davis 15 seconds – Put up exposure by 3 seconds when low Davis used.
Book photos for slides summary: ASA 50, f5.6, $^1/_{12}$ second 80A, tilt to avoid specific reflection as seen on viewer, Aux. lens.

Page 30



10th July 1975

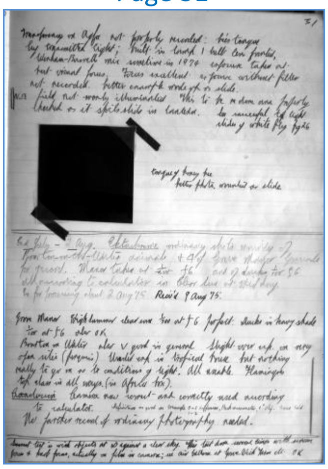
Preparation of Minerals
Fullers Earth
Fullers Earth falls to slurry when wetted, therefore all preparation must be dry. Oils etc. would be absorbed so destroying structure.

i. Rock is soapy to feel but cuts easily with a hacksaw.
ii. Prepare by flattening with a file or on emery paper stuck down on a flat plate.
iii. Obtain a near polish with finest of emery paper.
iv. Stick this face down on a slide using hardened balsam
v. Spring off the slide and gently rub down balsamed face thus levelling all grains (a very thin section is needed for transferring)
vi. Re-mount on slide this worked face to slide.
vii. Mount on a large nut or other object which can be hand held. Wax is correct adhesive and softens before Balsam when heated.
viii. Rub down un-worked side, hold by nut until object is only a few thou thick.
ix. Set up a new piece of finest emery paper on a plate as above.
x. Detach nut from slide and hand hold slide whilst reducing it on the new plate a few strokes only at a time, transparency is obtained (by inspection)
xi. Mount with drop of dissolved Balsam and little heat or suction will cockle up off slide.

It appears there is no practical limit to thinness to which section can be brought by this method. A diamond polishing paper may be tried on hard rocks. Hard Balsam is good support and when right does not hold abrasive.
Later work April 1976 indicates that liquid Balsam hardened on plate is tougher than solid balsam.

Transparency on Agfa not properly recorded: bee's tongue by transmitted light; built in lamp 1 bulb lens fronted, Wenham-Burrells microscope sometime in 1974, exposure taken at best visual focus. Better example made up as slide.
Field not evenly illuminated. This to re-done and properly checked as it spoils slide in lantern. See successful top light slides of white fly page 26.

Page 31



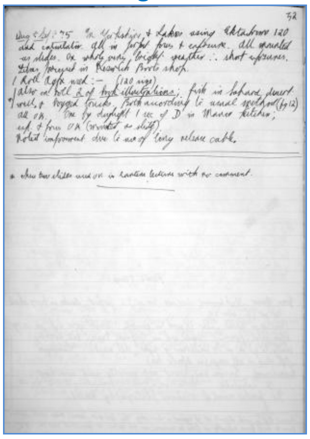
Tongue of honey bee (better photo mounted as slide)

End July – 2nd August 1975

Ektachrome ordinary shots mainly of Bourton-on-the-Water, animals and 4 Grove Manor grounds for record. Manor taken at 1/300 f6 and of ducks $^{1}/_{100}$ f6 all according to calculator in clear sun at midday.
In for processing about 2nd August 1975. Received 9the August 1975.
Grove Manor. High Summer clear sun $^{1}/_{100}$ at f6 perfect. Ducks in heavy shade $^{1}/_{100}$ at f6 also OK.
Bourton-on-the-Water also very good in general. Slight over exposure on very open sites (penguins). Under exposed in tropical house but nothing really to go on as to conditions of light. All usable. Flamingos top class in all ways (in Africa box).
Conclusion. Camera now correct and correctly used according to calculator. (Definition as good on triangle 0-1,1-2 diffusion, Beck Micrometer, 1" objective hand held.
No farther record of ordinary photography needed.

Severest test is with objects at infinity against a clear sky. This test done several times with screen focus and knob focus, actually on film in camera; see air balloon at Grove Wick Farm etc. OK

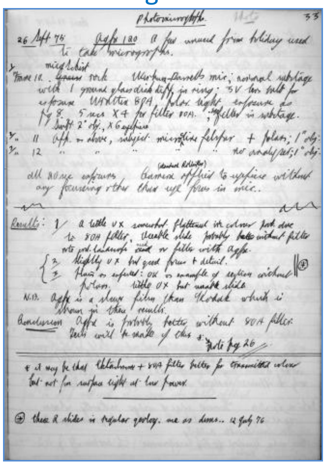
Page 32



August-September 1975

In Yorkshire & Lakes using Ektachrome 120 and calculator. All in perfect focus and exposure. All mounted as slides. On whole very bright weather, therefore short exposures. Films processed in Keswick Boots shop.
1 roll Agfa used: - (120 size)
*Also on roll 2 of book illustrations; fish in Sahara desert well & bogged trucks. Both according to usual method (page 12). All OK. One by daylight 1 second of D in Manor kitchen; exposure and focus OK (mounted on slide).
Noted improvement due to use of long release cable.
*these two slides used in lantern lectures with no comment.
Transcribers note: The 'D' mentioned above is his wife – Doris.

Page 33



Photomicrographs

26th September 1975

Agfa 120. A few unused from holiday used to take micrographs.

1. Frame 10. ~~Gneiss~~ Mica Schist rock. Wenham-Burrells microscope; normal substage with 1 ground glass disk diffuser in ring; 3V lens bulb for exposure; Wratten 80A, polarised light, exposure as page 8. 5 seconds x40 for filter 80A; 80A filter in substage; Swift 2" objective, x6 eyepiece.
2. Frame 11. Apparatus as above, subject microcline feldspar, crossed polars; 1" objective
3. Frame 12. Apparatus as above, subject microcline feldspar, no analyser; 1" objective

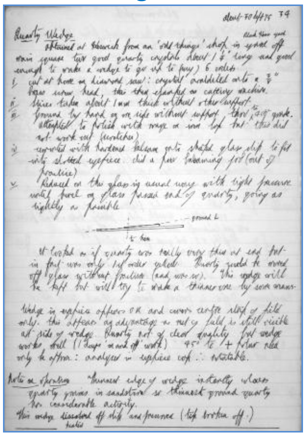
All 20 second exposures. Camera (standard Rolleiflex) applied to eyepiece without any focussing other than eye focus in microscope.

Results:

1. A little under exposed, somewhat flattened in colour probably due to 80A filter. Usable slide probably without filter. Note ordinary landscapes need UV filter with Agfa.
2. Slightly under exposed but good focus and detail
3. Plain as expected: Ok as example of section without polars. Little over exposed but usable slide.

NB. Agfa is a slower film than Kodak which is shown in these results.
Conclusion. Agfa is probably better without 80A filter. Test will be made of this. Note page 26. It may be that Ektachrome + 80A filter better for transmitted colour but not for surface light at low power.
2 and 3 in regular geological use as demonstrators 12th July 1976

Page 34

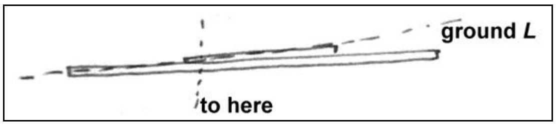


About 30th September 1975

Quartz Wedge

Obtained at Keswick from an 'odd things' shop in yard off main square two good quartz crystals about 1¼" long and good enough to make a wedge to go up to (say) 6 orders.

i. Cut at home on diamond saw: crystal Araldited into a 3.8" brass screw head, this then clamed on cutting machine.
ii. Slices taken about 1mm thick without other support.
iii. Ground by hand on one side without support. Thro to 400 grade. Attempted to polish with range on iron lap but this did not work out (scratches)
iv. Cemented with hardened Balsam onto shaped glass slip to fit into slotted eyepiece. Did a poor balsaming job (out of practice)
v. Reduced on this glass in usual way with light pressure until bevel on glass passed end of quartz, going as lightly as possible.



It looked as it quartz was really very thin at end but in fact was only 1st order yellow. Quartz could be moved off glass without fracture (and was so). This wedge will be kept but will try to make a thinner one by some means.

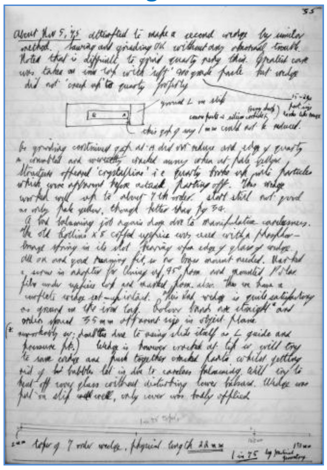
Wedge in eyepiece appears OK and covers centre stop of field only. This appears an advantage as rest of field is still visible at side of wedge. Quartz not of clear quality but wedge works well (1 day 'on and off' work) 45° to crossed polars need only be approximate: analyser in eyepiece cap there rotatable.

Notes on operation. Thinnest edge of wedge instantly colours quartz grains in sandstone so thinnest ground quartz had considerable activity.

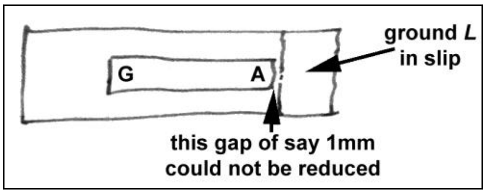
This wedge ~~dissolved~~ heated off slip and preserved (tip broken off).

About 5th November 1975

Page 35



Attempted to make a second wedge by similar method. Sawing and grinding OK without any abnormal trouble. Noted that it is difficult to grind quartz very thin. Greatest care was taken on iron lap with 'soft' 900 grade paste but wedge did not 'creep up' to quartz properly.

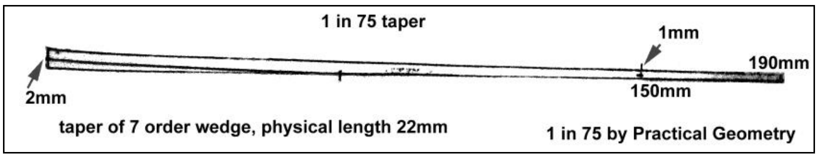


As grinding continued gap at 'A' did not reduce and edge of quartz A crumbled and virtually cracked away when at pale yellow. Structure offered 'crystalline', i.e. quartz broke up into particles which were apparent before actual parting off. This wedge worked well up to about 7th order start still not good as only pale yellow, though better that page 34.

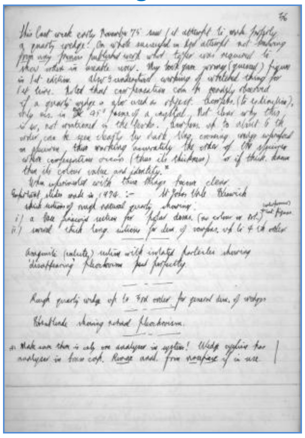
A bad balsaming job again done due to manipulative carelessness. The old Collins x8 capped eyepiece was used with a phosphor-bronze spring in its slot bearing upon the edge of glass of wedge. All OK and good running fit, so no brass mount needed. Marked a screw in adapter for lining up 45° position and mounted Polar film under eyepiece cap and marked position also. Thus we have a complete wedge set-up intact. This 2nd wedge is quite satisfactory as ground on the iron lap. Colour bands are straight* and orders spaced 35mm apparent size in object plane.

*remarkably so; doubtless due to using slide itself as angle guide and pressure point.)

Wedge is, however, cracked at tip so will try to save wedge and push together cracked parts whilst getting rid of bubbles let in die to careless balsaming. Will try to heat off cover glass without disturbing lower balsam. Wedge was put on slip well, only cover was badly affected.



Page 36



This last week, early November 1975, saw 1st attempt to make properly a quartz wedge. In whole successful on 2nd attempt, not knowing from any previous published work what taper was required to show order in useable way. My book gave wrong (guessed) figure In 1st edition. Also I understood working of wretched thing for 1st time. Noted that compensation can be readily observed if a quartz wedge is also used as object. Compensation (to extinction) only visible in two 45° forms of a crystal. Not clear why this is so, not mentioned in the books. Compensation up to about the 6th order can be seen clearly by dark line crossing wedge superimposed on specimen thus working accurately the order of the specimen where compensation occurs (thus its thickness) or if thickness known then its colour value and identity.*
When experimented with three things become clear.

Important slides made in 1974:- St. Johns Vale, Keswick thick sections of rough natural quartz showing:

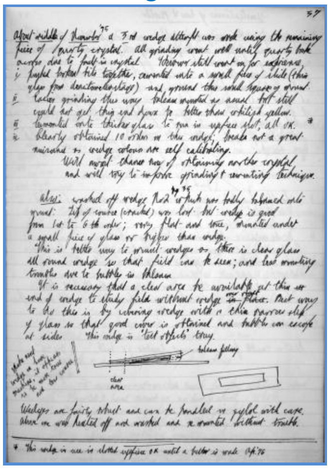
i) A full pinacoid section for polar demonstrations (no colour on rotation) (interference and interference figures)
ii) Several thick long sections for demonstration of compensation up to 4th order

Aragonite (calcite) section with isolated particles showing 'disappearing' pleochroism perfectly.
Rough Quartz wedge up to 3rd order for general demonstration of wedges.
Hornblende showing normal pleochroism.

*Make sure there is only one analyser in system! Wedge eyepiece has analyser in brass cap. Remove analyser from nosepiece if in use.

About middle of November 1975

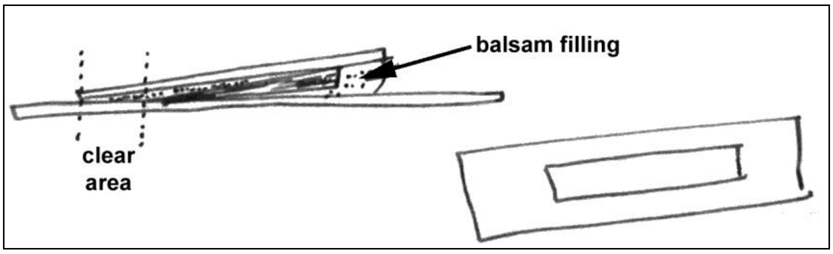
Page 37



A 3rd wedge attempt was made using the remaining piece of quartz crystal. All grinding went well until quartz broke across due to fault in crystal. However, still went on for experience.

i. Pushed broken bits together, cemented onto a small piece of slide (thin glass for densiometer stage) and ground this small square of mount.
ii. Easier grinding this way, Balsam mounted as usual but still could not get thin end down to better than whitish yellow.
iii. Cemented onto thicker glass to run in eyepiece slot, all OK.
iv. Clearly obtained 10 orders on this wedge; breaks not a great nuisance as wedge colours are self calibrating.

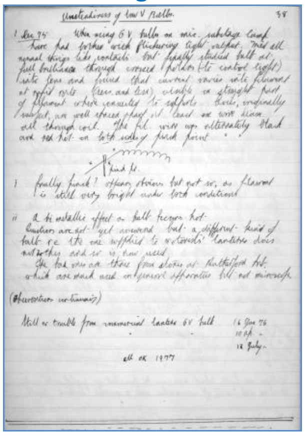
Will await chance now of obtaining another crystal and will try to improve grinding and cementing technique.
Also: washed off wedge No.2 (page 35) which was badly balsamed onto mount. Tip of course (cracked) was lost but wedge is good from 1st to 6th order; very flat and true, mounted under a small piece of glass no bigger than wedge.
This is better way to mount wedges as there is clear glass all round wedge so that field can be seen; and less mounting troubles due to bubbles in balsam.
It is necessary that a clear area be available at thin end of wedge to study field without wedge over object. Best way to do this is by covering wedge with a thin narrow slip of glass so that good cover is obtained and bubbles can escape at sides. This wedge in 'test objects' tray.



Wedges are fairly robust and can be handles in xylol with care. Above one was heated off and washed and re-mounted without trouble.

*This wedge in use in slotted eyepiece OK until a better is made – April 1976.

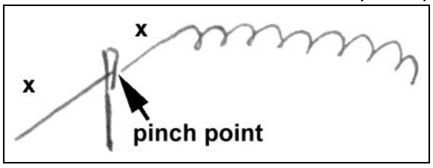
Page 38



1st December 1975

Unsteadiness of Low Voltage Bulbs

When using 6V bulbs on microscope substage lamp have had bother with flickering light output. Tried all normal things like contacts but finally studied bulb at full brilliance through crossed polars (to control light) into lens and found that current varies into filament at rapid rate (seconds and less), visible on straight part of filament where connected to supports. Coils, originally suspect, are well spaced apart at least one wire diameter all through coil. The filament wire was alternately black and red hot on both sides of pinch point.



i. Faulty pinch? Appears obvious but not so, as filament is still very bright under both conditions.
ii. A bi-metallic effect as half becomes hot.

Questions are not yet answered but a different kind of bulb i.e. the one supplied to motorists lanterns does not do this and so is now used.

The bad ones are those from stores at Rutherford Lab. which are much used in general apparatus but not microscopes.

(Observations continuing)

Still no trouble from commercial lantern 6V bulb – 16th January 1976

Still no trouble from commercial lantern 6V bulb – 10th April 1976

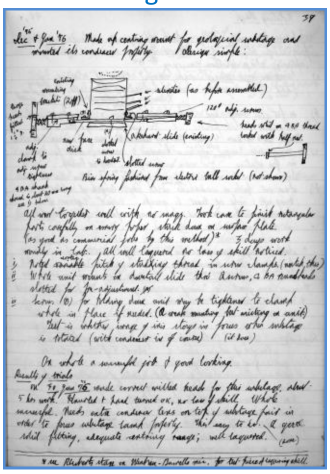
Still no trouble from commercial lantern 6V bulb – 12th July 1976

All OK 1977.

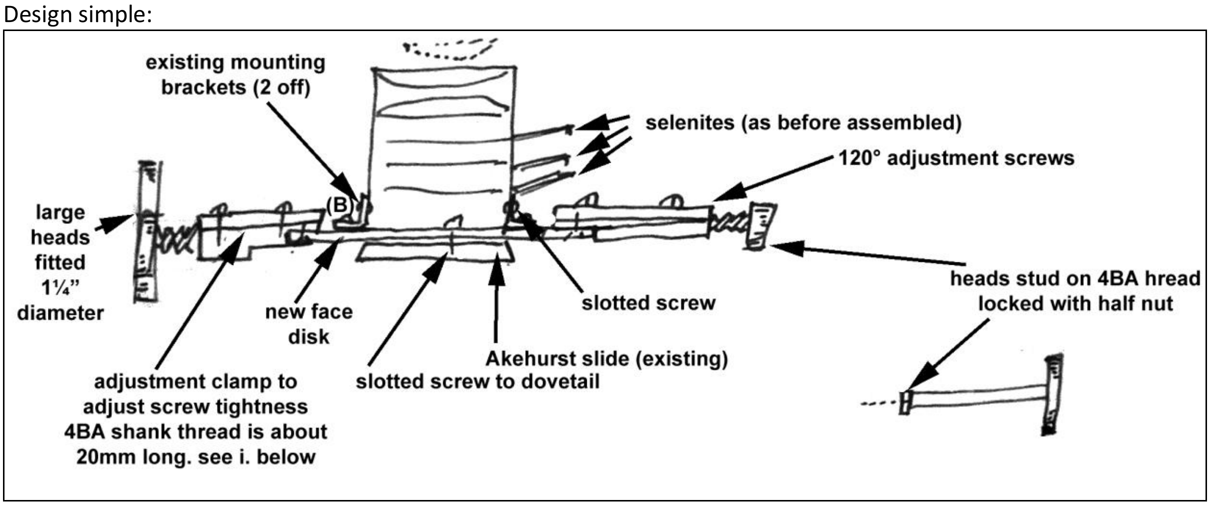
December 1975 and January 1976

Made up centring mount for geological substage and mounted its condenser properly.

Page 39



Design simple:

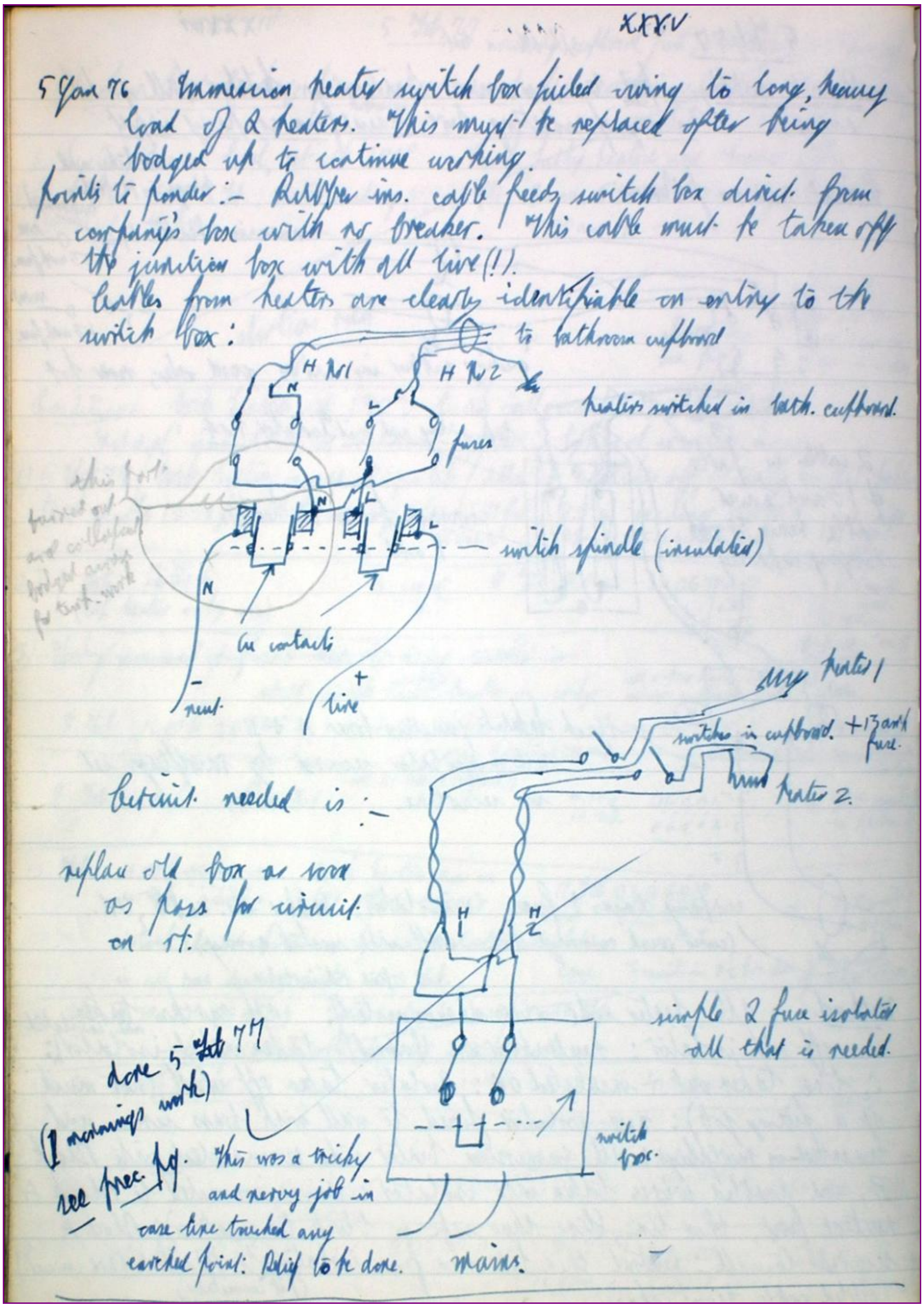


All went together with no snags. Took care to finish rectangular parts carefully on emery paper stuck down on surface plate (as good as commercial jobs by this method)*. 3 days work mainly in lab. All well lacquered. No loss of skill noticed.

i. Noted erratic pitch of studding thread in screw clamps (watch this)

ii. Whole unit mounts in dovetail slide through 2 screws, 4BA roundheads slotted for pre-adjustment.
iii. Screws (B) for holding down unit may be tightened to clamp whole in place if needed. (a Weak mounting but existing on unit)

Test is whether image of iris stays in focus when substage is rotated (with condenser in of course) – (it does).
On whole a successful job and good looking.
Results of trials.
On 30th January 1975 made correct milled heads for this substage, about 5 hours work. Knurled and hand turned OK, no loss of skill. Whole successful. Needs extra condenser lens on top of substage pair in order to focus substage lamp properly. This easy to do (done!). A good solid fitting, adequate centring range; well lacquered.
*see Reicherts stage on Wenham-Burrells microscope for test piece of lacquering skill.

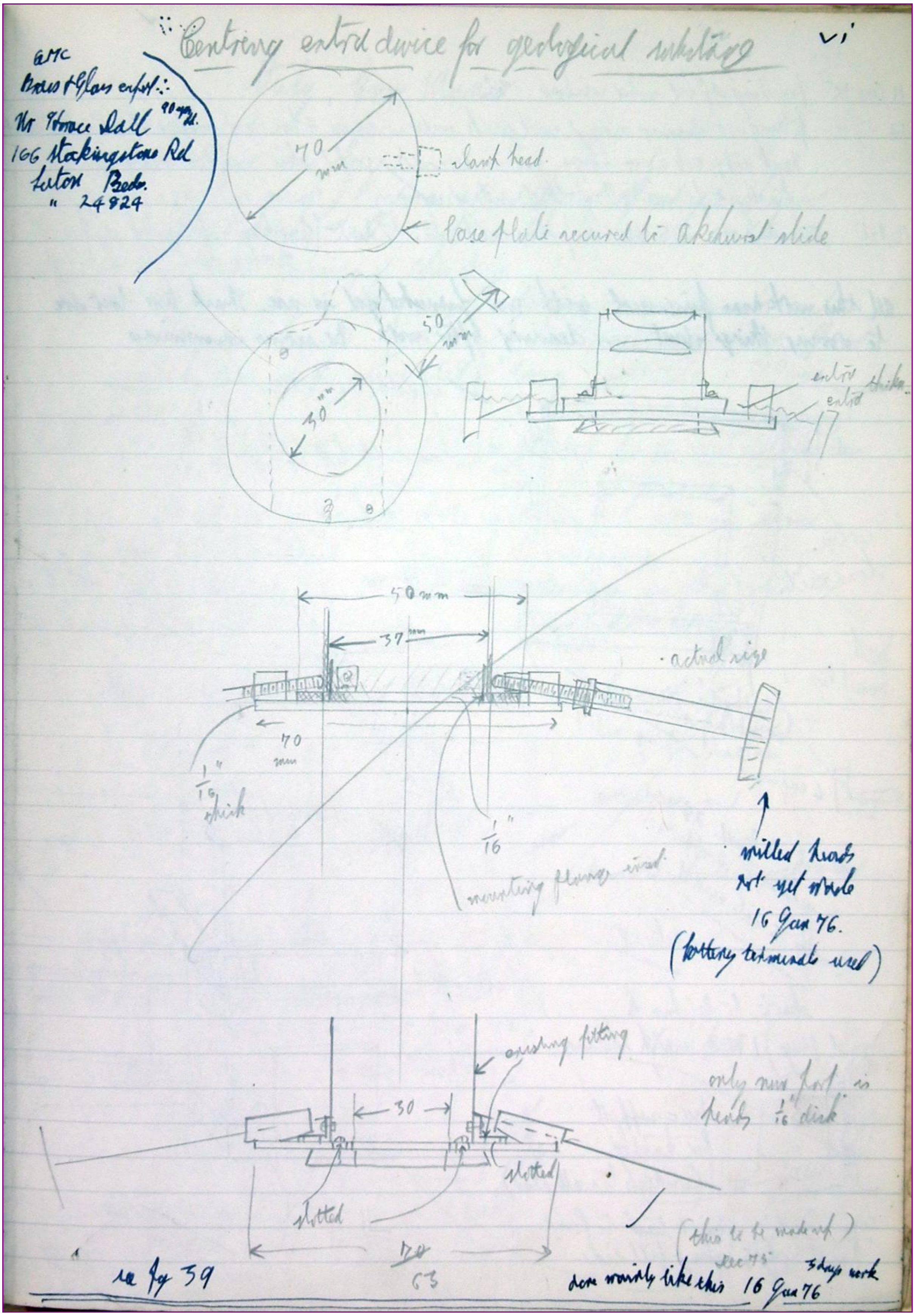

XXXV

5 Jan 76 Immersion heater switch box failed owing to long, heavy load of 2 heaters. This must be replaced after being bodged up to continue working.
Points to ponder:- Rubber ins. cable feeds switch box direct from company's box with no breaker. This cable must be taken off the junction box with all live(!).
Cables from heaters are clearly identifiable on entry to the switch box:

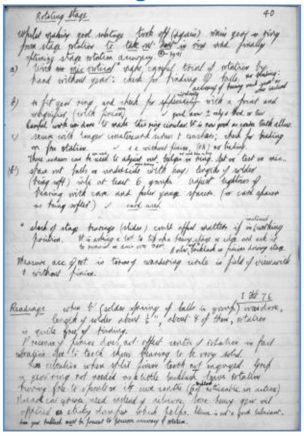
Circuit needed is:-

replace old box as soon as poss for circuit on rt.

done 5 Feb 77 (1 mornings work) see prev pg. This was a tricky and nervy job in case live touched any earthed point: Relief to be done.


Centring extra device for geological substage
vi
AMC
Brass & Glass expert
Mr Horace Dall
166 Stockingstone Rd
Luton Beds.
24824
70 mm
slot head
base plate secured to Akehurst slide
50 mm
30 mm
50 mm
37 mm
actual size
70 mm
1/16" thick
1/16"
mounting flange used
milled heads not yet made
16 Jan 76.
(battery terminals used)
existing fitting
only new part is brass 1/16" disk
30
slotted
slotted
(this to be made up)
see pg 39
70
63
done mainly like this 16 Jan 76
3 days work

Page 40



Rotating Stage

Whilst making Geological substage took off (again) main gear and ring from stage rotation to take out dent in rim and finally optimise stage rotation accuracy. (page 41)

a. With microscope vertical* make careful trial of rotation by hand without gear: check from finding of falls. No binding accuracy of bearing much same as when inclined.

b. Re-fit gear ring and check for irregularity with a point and magnifier (with pinion drive) (good now± only a thou or two). Careful work was done to make this ring circular. It is now good as coarse teeth allow.

b'. Space cut falls on underside – main bearing – with (say) lengths of solder (being soft) into at least 6 groups. Adjust tightness of bearing with care and feeler gauge spacers (or card spacers as being softer) – card used.

c. Secure with longer countersunk screws and washers; check for binding on free rotation i.e. without pinion (OK) no binding. These screws are used to adjust out bulges in ring (not much brass in ring). Set on test on microscope.

*slack of stage bearings (slides) could affect matters if inclined working position. It is asking a lot to tip up a heavy stage on edge and ask it to remain on axis over 360°. (Also must be backlash on pinions driving stage).

Measure acceptability of rotation in terms of wandering circle in field of view with and without prism.

Readings 1st February 1976. When b' (solder spring of falls in group) was done, length of solder about ½", about 8 of them, rotation is quite free of binding.

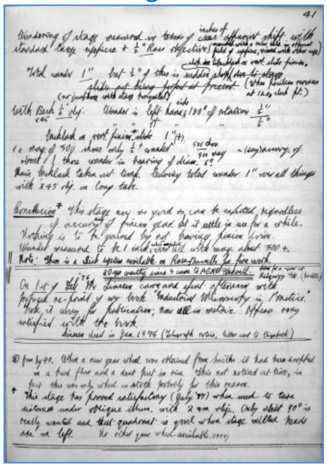
Presence of pinion does not affect centre of rotation in fact vibration due to its teeth show bearing to be very solid.

Less vibration when split pinion teeth not engaged. Grip on gear ring not needed as a little backlash leaves rotation bearing free to operate on its own centre (backlash not noticeable in action).

Normal car grease used instead of silicone. Some heavy gear oil applied as sticky damper which helps. Silicone is not a good lubricant. Some gear backlash must be present to preserve accuracy of rotation.

(next page)

Page 41



Wandering of stage measured in terms of inches of apparent shift with standard large eyepiece and ½" Ross objective (measured with a ruler held in apparent field of eyepiece, viewed with other eye)

Total under 1" but ½" of this is sudden stop due to backlash on vertical slide pinion (when position reverses at 12 o'clock point)

With Beck x45 ⅙" dry objective.

Wander in left hand side 180° of rotation ½"

Wander in right hand side 180° rotation ½"

i.e. magnification of 300 shows only ½" annular 500 though. 300 magnification = (say) accuracy of about 1 thou wander in bearing of diameter 6".

Main backlash taken out temporarily leaving total wander 1" over all things with x45 objective on long tube.

Conclusion. This stage now as good as can be expected regardless of accuracy of pinion gear. Let it settle in use for a while. Nothing is to be gained by not having pinion drive. Wander measured to be 1 inch over all with magnification about 300+.

Note: There is a Dick system available on Ross-Burrells for fine work.

This stage has proved satisfactory (July '77) when used to turn diatoms under oblique illumination, with 2mm objective. Only about 90° is really wanted and that quadrant is good when stage milled heads are on left.

1st February 1976

20 years exactly since I came to AERE Harwell [Transcribers Note – Atomic Energy Research Establishment]. And for a year at Ridgeway YH (Youth Hostel).

On 1st February 1976 Mr. Linssen came and spent afternoon with proposed re-print of my book "Industrial Microscopy in Practice".

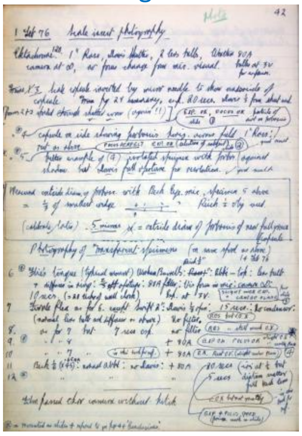
Took it away for publication, now all in metric. Appears very satisfied with the book.

Linssen died in January 1978 (Telegraph notice, letter sent to Elizabeth)

From page 40.

When a new gear wheel was obtained from Smiths it had been dropped on a hard floor and a dent put in rim. This not noticed at time, in fact this was only wheel in stock probably for this reason. No other gear wheel available. (1977)

Page 42



1st February 1976

Scale Insect Photography

Ektachrome 120, 1" Ross, Davis Shutter, 2 lens bulbs, Wratten 80A, camera at infinity, no focus change from microscope visual. Bulbs are 3V for exposure.

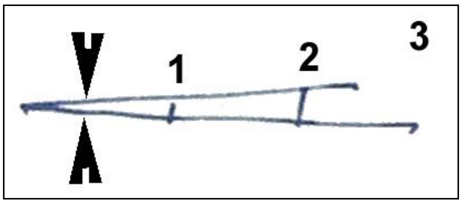
Frame 1. Scale capsule inverted by micro-needle to show underside of capsule. From page 28 summary, exposure 20 seconds, Davis ⅓ from shut end.

Frames 2 and 3. Spoiled through shutter error (again!!)

Frame 4. Capsule on side showing proboscis horizontal across field. 1" Ross, rest as above. [Exposure OK, Focus OK, Particle of dirt on proboscis (slide 1.)]

Frame 5. Better example of 4, isolated specimen with proboscis (against shadow, but Davis full aperture for resolution. Good result [Focus perfect, exposure OK. Selective of subject (slide 2.)]

Measured outside diameter of proboscis with Beck eyepiece micrometer, specimen 5 above - ⅓ of smallest wedge.



Reichert ½! Objective used. (Calibrate later). – 5 microns = outside diameter of proboscis of near full grown capsule.

Photography of transparent specimens (on same spool as above) 14th February 1976

Frame 6. Flies tongue (typical mount), Wenham-Burrells, Reichert ½", Abbe –top, lens bulb and diffuser in ring, ⅔ aperture, 80A filter, visual focus in microscope, camera infinity, 10 seconds (= 20 ticks of wall clock). Exposure at 3V. [Slight over exposure – Centre flare. (fair slide 3)]

Frame 7. Female flea as for 6, except Swift 2", Davis ⅓ open, 15 seconds, no condenser (normal lens bulb and diffuser as above), no filter. [Resolved but very over exposed]

Frame 8. As for 7 but 7 seconds exposure, no filter [Resolved but still much over exposed]

Frame 9. As for 8 + 80A [Exposure OK, Focus OK, slight over exposure, slight centre flare]

Frame 10. As for 7 (in this book for reference) + 80A [OK best overall, slight centre flare (slide 4)]

Frame 11. Beck ⅙ x45 0.65NA, normal Abbe, no Davis + 80A, 20 seconds, iris at ½ but diatom scatter filling back lens (Ok but nor great)

Frame 12. Beck ⅙ x45 0.65NA, normal Abbe, no Davis + 80A, 5 seconds, iris at ½ [exposure and focus good (prism mark on slide)]

Frames 4, 5, 6, 9 and 12 mounted as slides and referred to on page 44 Conclusions.

8th February 1976

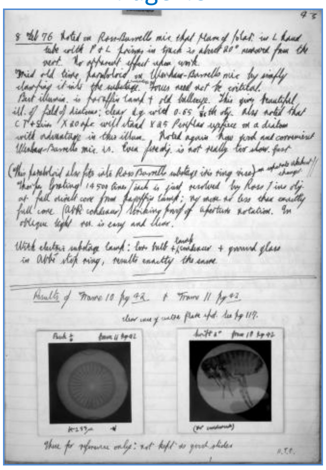
Noted on Ross-Burrells microscope that plane of polar in left hand tube with Powell and Lealand prisms in track is about 20° removed from the vertical. No apparent effect upon work.

Tried old time paraboloid on Wenham-Burrells microscope by simply clamping it into the ~~substage~~ understage. Focus need not be critical.

Best illumination is paraffin lamp and old bullseye. This gives beautiful illumination of field of diatoms; clear dark ground with o.65 ⅕th objective. Also notes that Cooke, Troughton and Simms x20 apochromat will stand x45 Periplan eyepiece on a diatom with advantage in this illumination. Noted again how good and convenient Wenham-Burrells microscope is. Even fine adjustment is not really too ~~slow~~ fast.

This paraboloid also fits into Ross-Burrells substage iris ring vice, on separate Akehurst changer.

Page 43



Thorp's [Transcribers Note - Thomas Thorp (1850-1915)] grating 14,500 lines/inch is just resolved by Ross 1" objective at fill direct cone from paraffin lamp; no more no less than exactly full core (Abbe condenser). Striking proof of aperture notation. In oblique light resolution is easy and clear.

With electric substage lamp: lens bulb and lamp condenser plus ground glass in Abbe stop ring, results exactly the same.

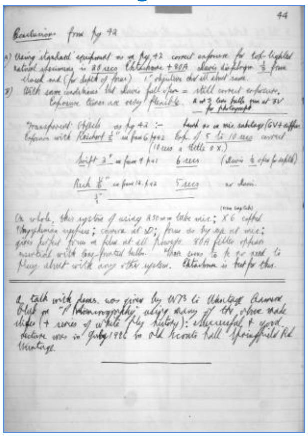
Results of Frame 10. Page 42. and Frame 11 Page 42.
Clear case of centre flare spot. See page 117.

Beck ⅙. Diatom width 233µ
Frame 10. Page 42

Swift 2" No condenser
Frame 11. page 42

These for reference only: not kept as good slides.

Page 44



Conclusions (from page 42)

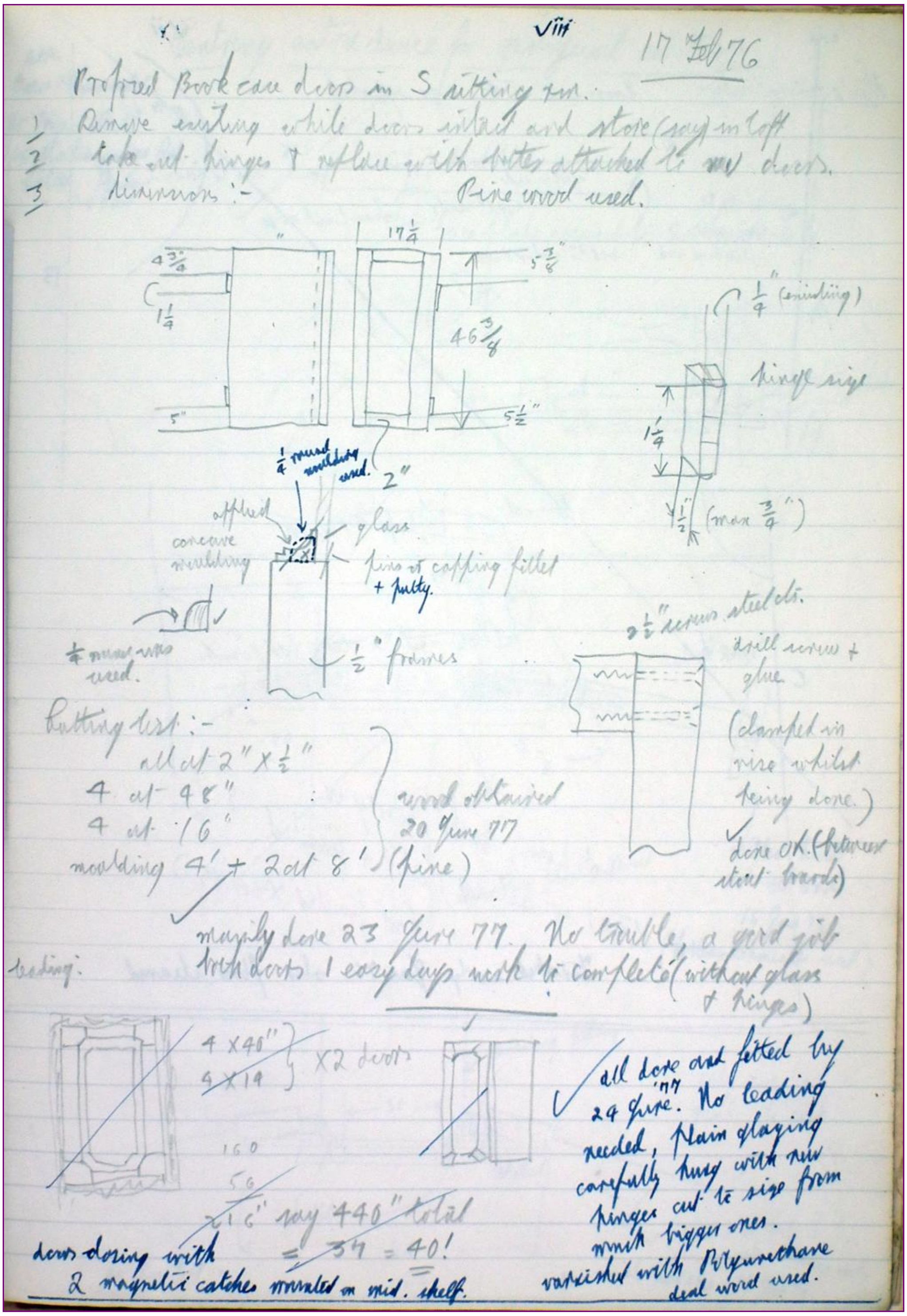
A. Using 'standard' equipment as on page 42 correct exposure for top-lighted natural specimens is 20 seconds. Ektachrome _+ 80A. David diaphragm ⅓ from closed end (for depth of focus) 1" objective though all about same.

B. With same conditions but Davis full open = still correct exposure.
Exposure times are very flexible. 2 or 3 lens bulbs run at 3V for photographs.
Transparent objects as page 42:- (lamp as a microscope substage [6V plus diffuser])
Exposures with Reichert ½" see frame 6 page 42. Exposure of 5 to 10 seconds correct (10 seconds a little over exposed)
Exposures with Swift 2" see frame 9 page 42. 6 Seconds (Davis ⅓ open for depth)
Exposures with Beck ~~⅙"~~ ⅕" see frame 12 page 42. 5 Seconds, no Davis shutter.

On whole this system of using 250mm tube microscope; x6 capped Huyghenian eyepiece (x10 OK long tube);

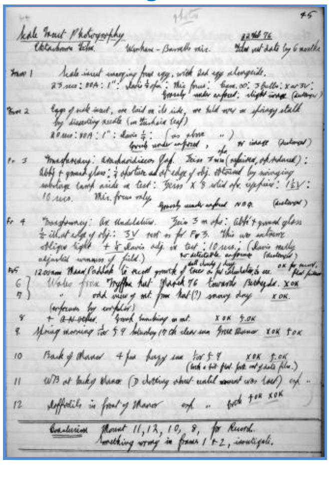
Camera at ∞ (infinity); focus as by eye at microscope; gives perfect focus on film at all powers. 80A filter appears essential with lens-fronted bulbs. There seems to be no need to play about with any other system. Ektachrome is best for this.

A talk with demonstration was given by WB to Wantage Camera Club on "Photomicrography" using many of the above made slides (+ series of white fly history); successful and good. Lecture was in July 1976 in old scouts hall, Springfield Road, Wantage.



22nd February 1976
Scale Insect Photography
Ektachrome Film, Wenham-Burrells Microscope, Film out date by 6 months

Page 45



Frame 1.	Scale insect emerging from egg, with 2nd egg alongside. 23 seconds: 80A: 1": Davis ⅛ open: Microscope focus: Camera ∞: 3 bulbs: Exposed at 3V: Grossly under exposed; slight image (destroyed)
Frame 2.	Eggs of scale insect, one laid on its side, one held over on springy stalk by dissecting needle (on Fuchsia leaf) 20 seconds: 80A: Davis ¼: as above Grossly under exposed, no image (destroyed)
Frame 3.	Transparency: *Arachnoidiscus Japonicus*. Zeiss 3mm apochromat (required, aperture reduced): Abbe and ground glass: ¼ aperture at ended of objective obtained by swinging substage lamp aside on test: Zeiss x8 solid apochromatic eyepiece: 1½V: 10 second. Microscope focus only. Grossly under exposed. NBG (No bloody good) (Destroyed)
Frame 4.	Transparency: *Arachnoidiscus undulatus*. Zeiss 3mm apochromat: Abbe plus ground glass: 1.5th illumination at ended of objective: 3V: rest as for Frame 3. This was extreme oblique light plus ¼ Davis adjustment. OK. Test. : 10 seconds: (Davis really adjust evenness of field). No detectable exposure (destroyed)
Frame 5.	12.00 noon. Manor Paddock to record growth of trees. Dull, cloudy day. As per calculator $\frac{1}{40}$th second. OK for record. Flat picture
Frame 6.	Wales from Tryffon hut. March 1976 towards Bethesda. Exposure OK
Frame 7.	Wales. Odd view of mountain from hut(?) Snowy day. Exposure OK.
Frame 8.	Group lunching on Mountain. Exposure OK. Focus OK.
Frame 9	Spring Morning $\frac{1}{100}$ f9. Saturday 17th. Clear sun. Grove Manor. Exposure OK. Focus OK.
Frame 10.	Back of Manor. 4pm. Hazy sun. $\frac{1}{100}$ f9. Exposure OK Focus OK. (Both a bit flat. Probably out of date film)
Frame 11	WB at back of Manor (D clotting about until moment was lost) Focus OK. Exposure OK.
Frame 12.	Daffodils in front of Manor. Focus OK. Exposure OK.

Conclusion.

Mount 11, 12, 10, 8, for record. Something wrong in frames 1 & 2, investigate.

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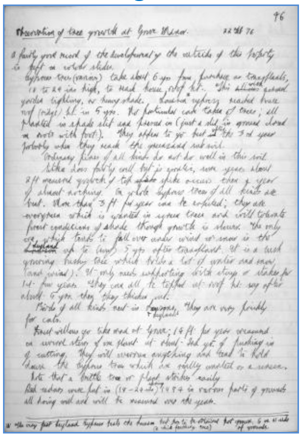


22nd February 1976

Observation of tree growth at Grove Manor

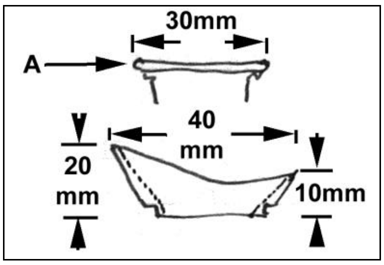
A fairly good record of the development of the outside of this property is kept on colour slides. Cypress trees (various) take about 6 years from purchase as transplants, 18-24 inches high, to reach house roof height. This with normal garden lighting, no heavy shade. Lawson* Cypress reached house roof (ridge) height in 5 years. No particular care taken of trees; all planted in spade slit and pressed in (just a slit in ground closed on roots with foot). They appear to go best after the 3rd year probably when they reach the greensand subsoil.

Ordinary pines of all kinds do not do well in this soil. Sitka does fairly well but is erratic, some years about 2ft measured growth of top spike occurs then a year of almost nothing. On whole Cypress trees of all kinds are evergreen which is wanted in screen trees and will tolerate forest conditions of shade though growth is slower. The only one which tends to fall over under wind or snow is the Leyland up to (say) 5 years after transplant. It is a lush growing bushy tree which holds a lot of water and snow (and wind). It only needs supporting with stays or stakes for 1st few years. They can all be topped at roof height say after almost 5 years, then they thicken out. Birds of all kinds nest in Lawsons and Leylands. They are very prickly for cats. Forest willows go like made at Grove; 14ft per year measured on several stems of one plant at about 2nd year of pushing in of cutting. They will overrun anything and tend to hold down the Cypress trees which are really wanted as a screen. Note that a brittle tree or plant strikes easily.Red cedars were first put in (18-24 inches) spring 1974 in various parts of grounds all doing well and will be measured over the years.

*The very fast Leyland Cypress beats the Lawson (a thick feathery tree) but has to be obtained pot grown. 6 on N side of grounds.

27th February 1976

Noted that shaded eyepiece caps fit larger eyepieces on Ross-Burrells microscope and are used with advantage there. The eye is a little close but if shaded caps were made to fit, with minimum of metal, all would be well.



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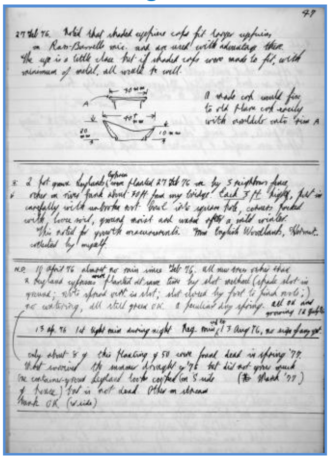

2 pot grown Leylandii Cypress were planted 27th February 1976, one by S neighbours fence, other on river bank about 30ft from my bridge. Each 3ft high, put in carefully with unbroken root bowl into square hole, corners packed with loose soil, ground moist and warm after a mild winter.
This noted for growth measurements. From English Woodlands, Hermit….. collected by myself.

NB. 10th April 1976. Almost no rain since February 1976. All new trees other than 2 Leyland cypresses were planted at same time by slot method (spade slot in found; roots spread vertically in slot; slot closed by foot to pinch roots; no watering, all still green OK. A peculiar dry spring. All OK and growing 12th July 1976.
Only about 8 of this planting of 50 were found dead in spring 1977. Most survived the summer drought of 1076 but did not grow much. One container-grown Leyland looks cooked (on S side of house) but is not dead. Other on stream bank OK (W side). (March 1977).

13th April 1976. 1st light rain during night. Negative rain up to 13th August 1976, no sign of any yet.

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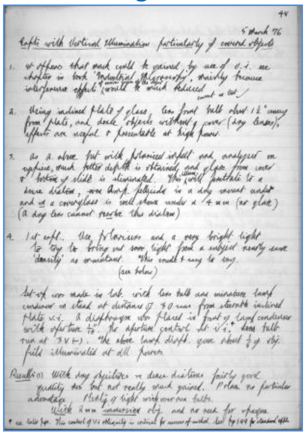

5th March 1976

Experiments with Vertical Illumination, particularly of covered objects.

1. It appears that much could be gained by use of Vertical Illumination. See chapter in book "Industrial Microscopy", mainly because interference effects of various layers of the subject, would be much reduced. (Correct in test)
2. Using inclined plate of glass, lens front bulb about 1½" away from plate, and dense objects without a cover (dry lenses), effects are useful and presentable at high power.
3. As 2. Above but with polarised input and analyser on eyepiece, much better depth is obtained and glare from cover and bottom of slide is eliminated. This illumination will penetrate a dense diatom, even *Amphipleura pellucida* in a dry mount under and on a coverglass is well shown under a 4mm (no glare) (A dry lens cannot resolve this diatom.)
4. 1st Experiment. Use polarisers and a very bright light to try to bring out some light from a subject nearly same 'density' as mountant. This crude and easy to try (See below)

Set up was made in laboratory with lens bulb and miniature lamp condenser on stand at distance of 30cms from steerable inclined plate Vertical Illumination. A diaphragm was placed in front of lamp condenser with aperture $^{1}/_{16}$". No aperture control at Vertical Illumination*. Lens bulb run at 3V(-). The above lamp diaphragm gave about ⅙ of objective field illuminated at all powers.

Results (i) With Dry objectives on dense diatoms fairly good quality resolution but not much gained. Polarised light – no particular advantage. Plenty of light with over-run bulbs.
With 2mm immersion objective and no need for opaque…*(next page)*

*see later pages This control of Vertical Illumination obliquity is critical for success of method. See page 149 for 'standard' apparatus.

…stop under slide, excellent results on covered diatoms obtained, no need for polars. This must certainly be developed.

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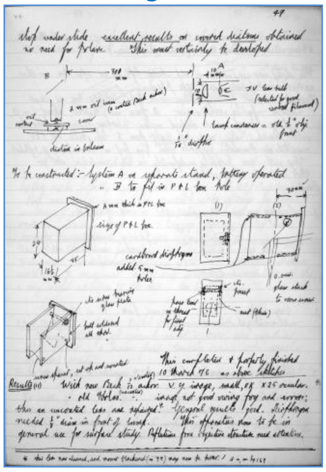
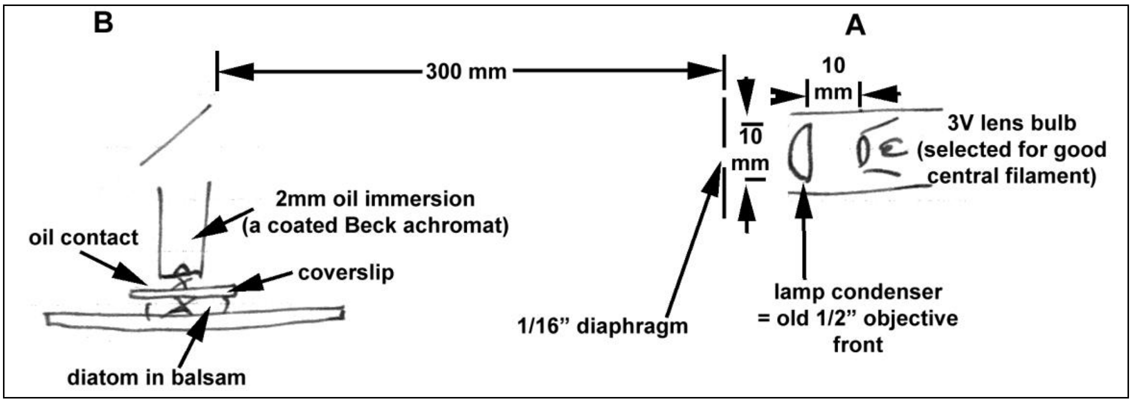
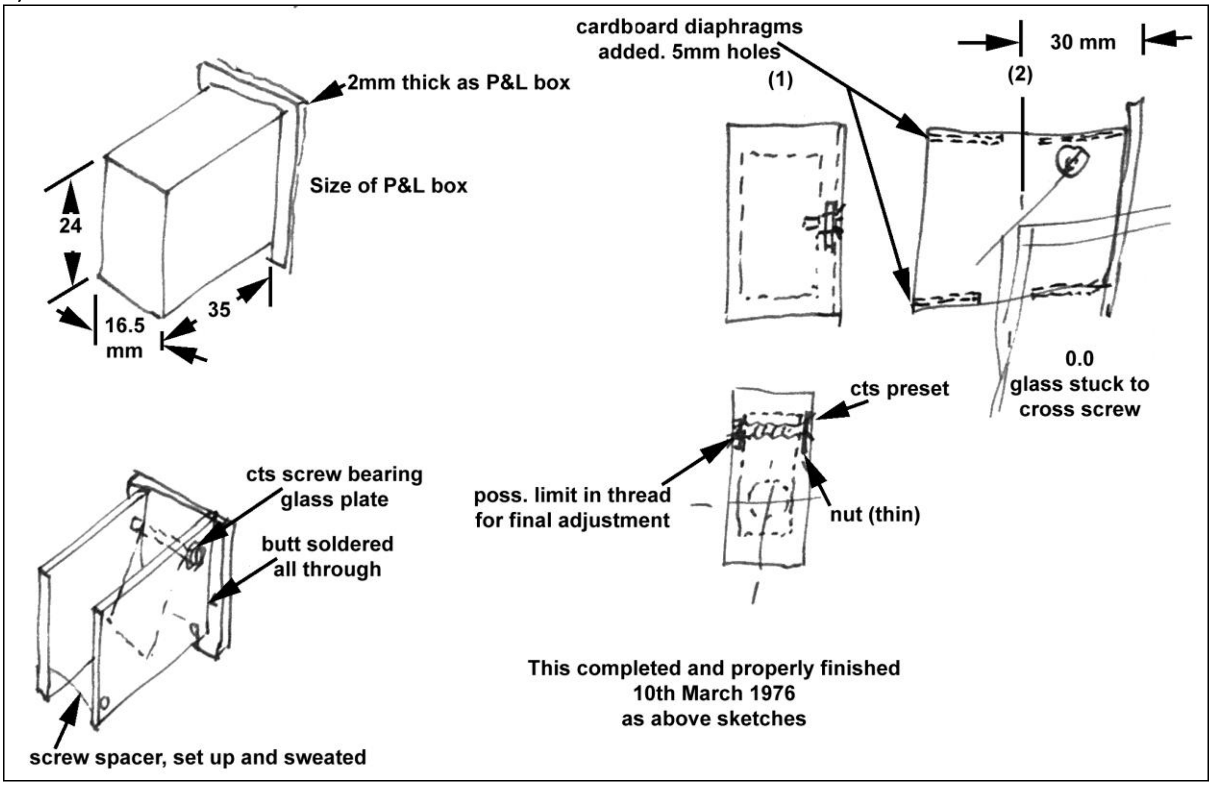




To be constructed:-
System A on separate stand, battery operated
System B to fit in Powell and Lealand box hole



Results (II).
With new Beck $\frac{1}{12}$” achromat (coated) very good image, small, OK, x25 ocular
With old Holos $\frac{1}{12}$” (uncoated) image not good owing to fog and errors; this is an uncoated lens and repaired*. General results good. Diaphragm needed ⅛” diameter in front of lamp. This apparatus now to be in general use for surface study. Reflections from objective structure need attention.
*this lens now cleaned, and mount blackened (in 1977) may now be better (it is, see page 169)

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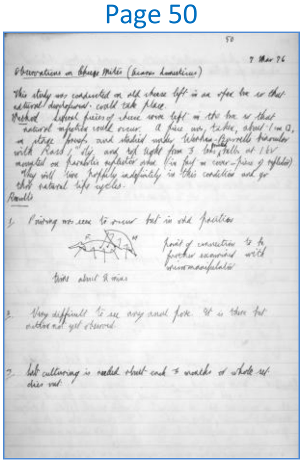


7th March 1976

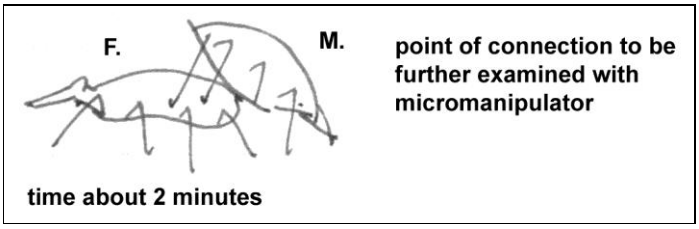
Observations on Cheese Mites (*Acarus domesticus*)

This study was conducted on old cheese left in an open box so that natural development could take place.

Methods. Several pieces of cheese were left in the box so that natural infection would occur. A piece was taken, about 1cm square, on stage forceps and studied under Wenham-Burrells binocular with Ross 1” objective and top light from 3 lens fronted bulbs at 1½V mounted on parabolic reflector arm (in fact on cover piece of reflector). They will live happily, indefinitely in this condition and go through natural life cycles.

Results.

1. Pairing was seen to occur but in odd position.



2. Very difficult to see any anal pore. It is there but action not yet observed.
3. Lab. culturing is needed about each 3 months or whole set dies out.

17th March 1976

Constructed a carrier for a condenser centre stop in Ross-Burrells microscope. This conveniently fitted slot below Akehurst slide.

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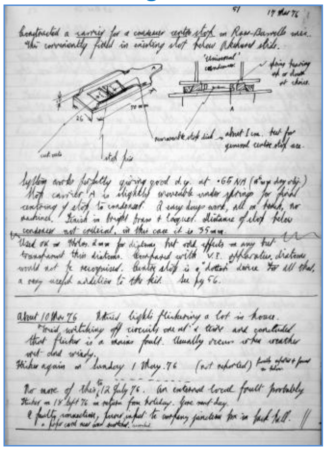

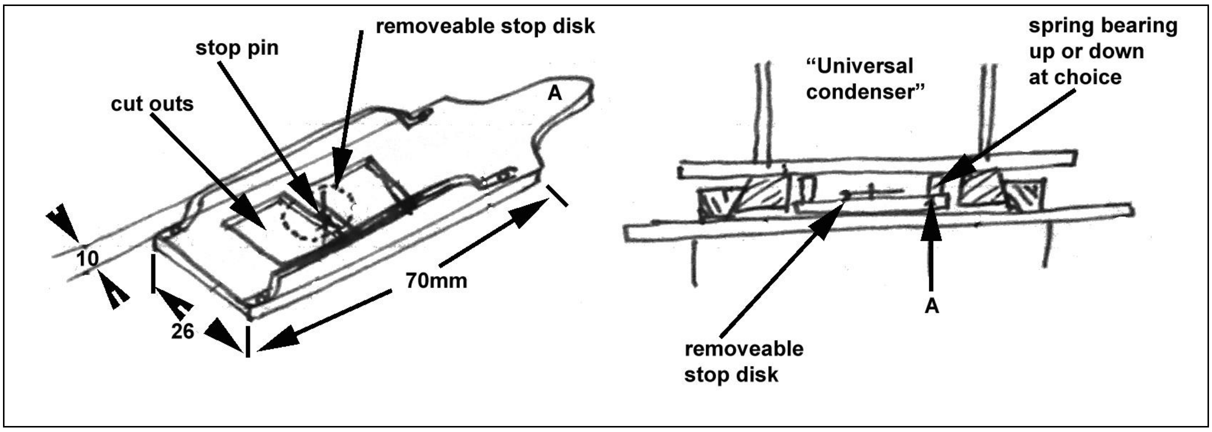

System works perfectly giving good dark ground at .65NA (6mm dry objective). Stop carrier A is slightly moveable under springs for final centring of stop to condenser. 2 easy days work, all on bench, no machines. Finish in bright brass and lacquer. Distance of stop below condenser not critical, in this case 35mm.

Used OK Holos 2mm for diatoms but odd effects on any but transparent thin diatoms. Compared with Vertical Illumination apparatus diatoms would not be recognised. Centre stop is a 'dotters' device. For all that, a very useful addition to the kit. See page 56.

About 10th March 1976

Noticed lights flickering a lot in house. Tried switching off circuits one at a time and concluded that flicker is a main fault. Usually occurs when weather wet and windy.

Flicker again on Sunday 1st May 1976 (not reported) Finally reported and found felon.

No more of this to 12th July 1976. An external local fault probably. Flicker on 18th September 1976 on return from holiday. Gone next day.

A faulty connection, power input to company junction box in back hall. A paper card near was scorched.

21st March 1976

Air Locks in Manor Hot Water System

1. This occurs about each 4 months when system has not been much used.
2. Only taps affected are No.1 bedroom, No.1 bathroom, and No.2 bedroom.

3. Downstairs toilet fed from connection pipes (hot tank to auxiliary hot tank) passing through landing W.C. usually OK when above (2) system is blocked.
4. Blockage therefore clearly around auxiliary tank and pipes
5. Much running off of hot water from main tank makes no difference to anything. Check where this tank gets its cold supply from.
6. (3) above could get hot water from main tank which means that at least one link circuit pipe is clear.
7. Connection of No.1 bathroom cold tap to hot tap clearly (sometimes!) makes some difference as hot circuit runs water after disconnection. This done after complete stoppage on 21st March 1976. Also (5) above was done first but with no obvious result. Noted that remaining lukewarm water in system after (5) was done came very quickly after (7) was done, therefore looks like a local pipe stoppage rather than a link pipe one.
8. It appears that action (7) is sufficient. Will test next time with this action alone. (No good 30th October 1976)
    a. Do nothing but (6) above
    b. Open all taps on this circuit in order to run them through with cold water.
    c. Shut them off one at a time.

Results (at any future stoppage) No good.

Results 30th October 1976. See later page for only solution i.e. connect front garden tap to bath hot tap in No.1 bathroom. Note: Reduce level of heating thus less vapour.

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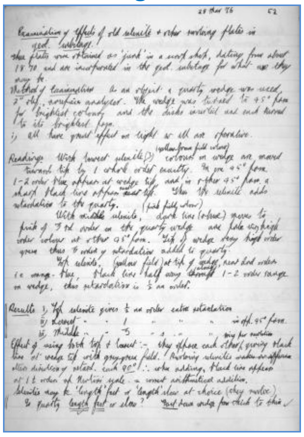


28th March 1976

Examination of effects of old selenite and other revolving plates in geological substage.

These plates were obtained as 'junk' in a scrap shop, dating from about 1870 and are incorporated in the geological substage for what use they may be.

Method of examination. As an object a quartz wedge was used, 2" objective, nosepiece analyser. The wedge was turned to 45° position for brightest colours and the disks inserted and each turned to its brightest position.

All have great effect on light so all are operative.

Readings. With lowest selenite (yellow brown field colour) colours on wedge are moved towards tip by 1 whole order exactly. In one 45° position 102 order blue appears at wedge tip and in other 45° position a sharp black line appears near tip. Thus the selenite adds retardation to the quartz. With middle selenite, dark line (above) moves to pink of 3rd order on the quartz wedge and pale very high order colour at other 45° position. Tip of wedge very high order green thus 3 orders of retardation added to quartz.

Top selenite, (yellow field) at tip of wedge, near 2nd orders i.e. orange-blue, black line half way along, 1-2 order range on wedge, this retardation is ½ and order.

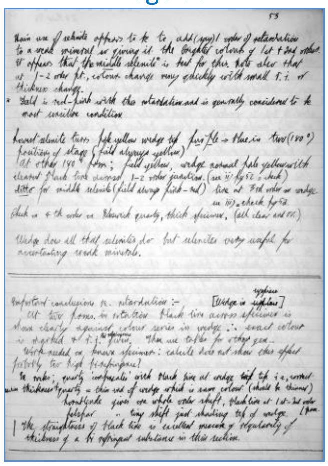
Results.

i. Top selenite give ½ an order extra retardation
ii. Lowest selenite give 1 order extra retardation in opposing 45° positions.
iii. Middle selenite gives 3 orders extra retardation

Effect of using both top and lowest:- they oppose each other twice per revolution giving black line at wedge tip with grey-green field. Revolving selenites alter direction of retard, each 90° therefore when adding, black line appears at 1½ orders of Newton's scale = correct arithmetical addition. Selenites may be 'length' fast of length 'slow' at choice (they revolve). Is quartz length fast or slow? Fast slow wedge from thick to thin.

(next page)

Page 53



Main use of selenite appears to be to add (say) 1 order of retardation to a weak mineral so giving it the brighter colours of 1st and 2nd order. It appears that the middle selenite* is best for this. Note also that at 1-2 order point, colour change vary quickly with small refractive index or thickness change.

*Field is red-pink with this retardation and is generally considered to be most sensitive condition.

Lowest selenite turns pale-yellow wedge tip purple-blue in two (180°) positions of stage (field always yellow)

At other 180° positions; field yellow, wedge normal pale yellowish with clearest black line across 102 order junction (see ii. Page 52 = check). Ditto for middle selenite (field always pink-red) line at 3rd order on wedge (see iii. page 52 = check)

Check on 4th order on Keswick quartz, thick specimen (all clear and OK)

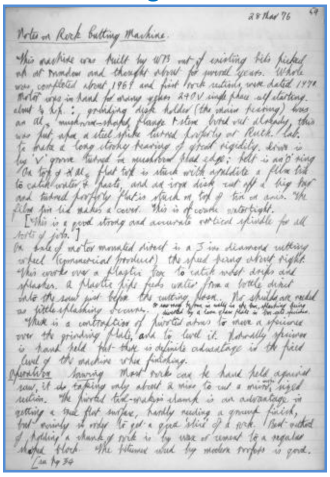
Wedge does all that selenites do but selenites very useful for ascertaining weak minerals.

Important conclusions re: retardation (Wedge in eyepiece):-

At two positions in rotation black line across specimen is shown clearly against colour series in wedge, therefore exact colour is marked and refractive index birefringence given. Then use tables for other gen…

Work needed on known specimens: calcite does not show this effect, probably too high birefringence?
In rocks: quartz 'components' with black line at wedge tip i.e. correct section thickness of quartz = thin end of wedge which is same colour (should be thinner). Hornblende gives one whole order shift, black line at 1st-2nd order position. Feldspar gives tiny shift just shading tip of wedge.
The straightness of black line is excellent measure of regularity of thickness of a bi-refringent substance in thin section.

Page 54



Notes on Rock Cutting Machine
This machine was built by WB out of existing bits picked up at random and thought about for several years. Whole was completed about 1969 and first rock sections were dated 1970. Motor was in hand for many years 240V single phase, self-starting, about ¼h.p: grinding disk holder (the main bearing) was an Al3 (aluminium) mushroom-shaped flange and stem bored out already, this was put upon a steel spike turned properly at Ruth. Lab., to make a long strong bearing of great rigidity. Drive is by "V" groove turned in mushroom head edge; belt is an "O" ring. On top of Al3 flat top is stuck with araldite a film tin to catch water and paste, and an iron disk cut off a big bar and turned properly flat is stuck on top of tin in axis. The film tin lid makes a cover. This is, of course, watertight.
[This is a good strong and accurate vertical spindle for all sorts of jobs.]
On axle of motor mounted direct is a 3ins diameter cutting wheel (commercial product) the speed being about right. This works over a plastic box to catch most drips and splashes. A plastic pipe feeds water from a bottle direct onto the saw just before the cutting position. No shields are needed as little splashing occurs. (Or saw may be run in water in the box, splashing being diverted by a loose glass plate in box onto specimen.)
There is a contraption of pivoted arms to move a specimen over the grinding plate, and to level it. Normally specimen is hand held but there is a definite advantage in the fixed level of the machine when finished.
Operation. Sawing. Most rocks can be hand held against saw, it taking only about two minutes to cut a microscope sized section. The pivoted tool-makes clamp is an advantage in getting a true flat surface, hardly needing a ground finish, but mainly in order to get a good 'slice' of a rock. Best method of holding a chunk of rock is by wax or cement to a regular shaped block. The bitumen used by modern roofers is good.
[see page 34] *(next page)*

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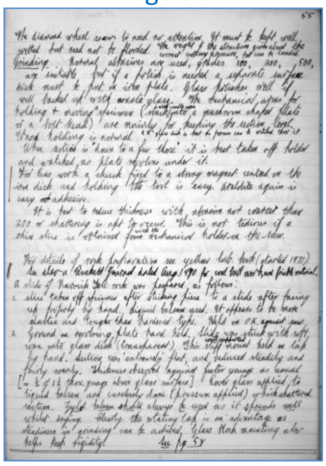
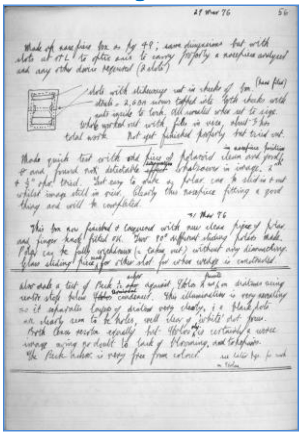


The diamond wheel seems to need no attention. It must be kept well wetted but need not be flooded. The weight and the structure gives about the correct cutting pressure, but can be loaded.
Grinding. Normal abrasives are used, grades 100, 200, 500, are suitable but if a polish is needed a separate surface disk must be put on iron plate. Glass polishes well if well backed up with waster glass. The mechanical arms for holding and moving specimens (stuck with candle wax onto a mushroom shaped plate of a bolt head) are mainly for keeping the section level. Had holding is normal. A 2" glass disk is best as process can be watched through it.
When section is 'down to a few thou' it is best taken off holder and watched as plate revolves under it.
For lens work a chuck fixed to a strong magnet centred in the iron disk and holding the tool is easy. Araldite again is easy adhesive.
It is best to reduce thickness with abrasive not coarser than 200 or shattering is apt to occur. This is not tedious if a thin slice is obtained with no mechanical holder on the saw.
For details of rock preparation see yellow lab. book (started 1971) [Transcribers Note: The whereabouts of the yellow lab. book is unknown.]
A slide of Hawick Fell rock was prepared as follows:

1. Slice taken off specimen after sticking piece to a slide after facing up properly by hand. Liquid Balsam used. It appears to be more elastic and tougher than hardened type. Held on OK against saw.
2. Ground on revolving plate hand held. Slide was stuck with soft wax onto glass disk (transparent). This well supported, stiff mount held on lap by hand. Section was 'extremely' flat, and reduced steadily and fairly evenly. Thickness observed against feeler gauge as usual (=½ of 1½ thou gauge above glass surface). Cover glass applied to liquid Balsam and carelessly done (pressure applied) which shattered section. Xylol Balsam should always be used as it spreads well whilst drying. Clearly the rotating lap is an advantage as steadiness in grinding can be achieved. Glass block mounting also helps keep rigidity.

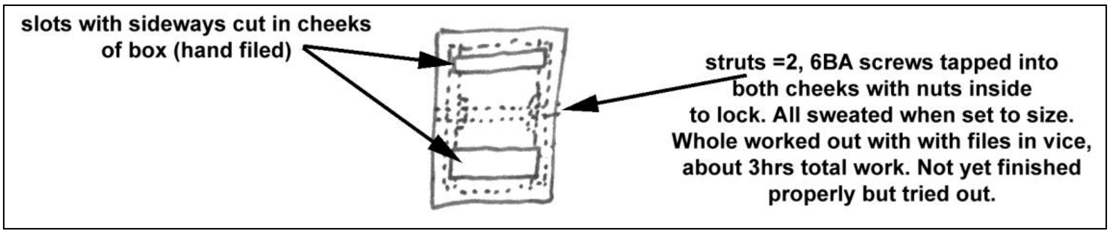
(see page 58)

Page 56



29th March 1976

Made up nosepiece box as page 49; same dimensions but with slots at right angle to optic axis to carry properly a nosepiece analyser and any other device required (2 slots).



Made quick test with old piece of Polaroid clean and good in nosepiece position and found no detectable detriment whatsoever in image. 2" and ⅓" apochromat tried. Test easy to make as Polaroid can be slid in and out whilst image still in view. Clearly this nosepiece fitting a good thing and will be completed.

31st March 1976

This box now finished and lacquered with new clean piece of Polaroid and finger knob fitted OK. Two 90° different sliding polars made.

Polar can be fully withdrawn (=taken out) without any dismantling. Glass sliding piece made for other slot for when wedge is constructed.

Also made a test of 1.12 ~~apochromat~~ achromat against Holos 2mm fluorite on diatoms using centre stop below ~~Holos~~ Universal condenser. This illumination is very revealing as it separates layers of diatom very clearly, i.e. black dots are clearly seen to be holes, well clear of 'white' dot focus.

Both lenses resolve equally but Holos objective is certainly a worse image owing, no doubt, to lack of blooming, and to repairs. The Beck achromat is very free from colour. See later pages for work on Holos.

8th April 1976

Thoughts on Quartz Wedge Use

It is necessary to have a wedge at 45° position to crossed polars and specimen rotated independent of all to its brightest position. This normally means that wedge is in body tube at 45° to polar planes. This difficult to arrange in Ross-Burrells microscope owing to nosepiece arrangement.

i. Propose to effectively turn polar system around specimen by 45°, therefore of Polaroid cut at 45° and insert in normal position.
ii. Make polar disk also 45° and mount in 2nd carrier: mark periphery so that this one may be easily removed and returned.
iii. Mark substage rotation if found necessary.

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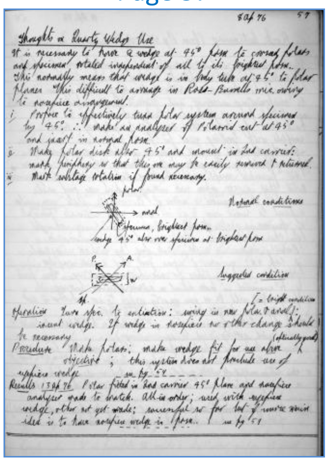

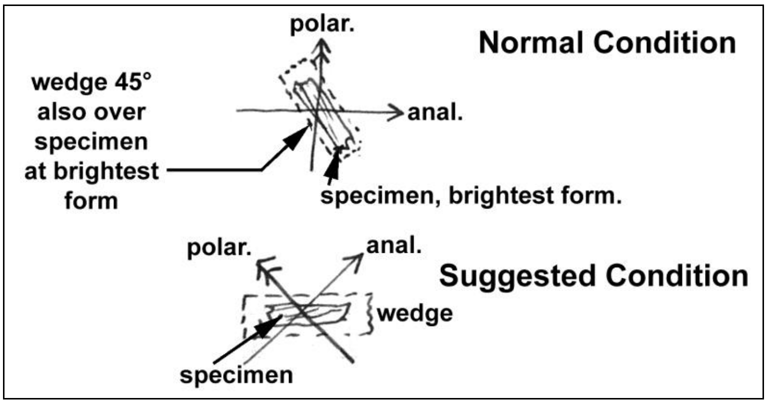

Operation. Turn specimen to extinction: swing in new polariser and analyser: insert wedge. If wedge in nosepiece no further change should be necessary.

Procedure. Make polars; make wedge fit for use above (optically good) objective; this system does not preclude use of eyepiece wedge. See page 59.

Results. 13th April 1976.

Polar fitted in 2nd carrier 45° plane and nosepiece analyser made to match. All in order; used with eyepiece wedge, other not yet made; successful so far but of course main idea is to have nosepiece wedge in position. See page 59.

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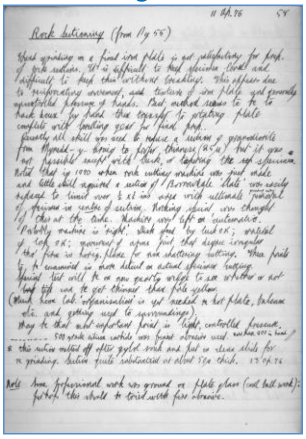


Rock Sectioning (from page 55)

Hand grinding on a fixed iron plate is not satisfactory for preparation of rock sections. It is difficult to keep specimen level and difficult to keep thin without breaking. This appears due to reciprocating movement, texture of iron plate and generally uncontrolled pressure of hands. Best method seems to be to hack down by hand then transfer to rotating plate complete with levelling gear for final preparation.

Recently all skill was used to reduce a section of granodiorite from Mynedd-y-Graig to proper thinness (25µ) but it was not possible except with luck, or tapering the specimen.*

Noted that in 1970 when rock cutting machine was just made and little skill acquired a section of Borrowdale 'slate' was easily reduced to limit over ½x½ins area with ultimate grinding away (removal) of specimen in centre of section. Nothing special was thought of this at the time. Machine was left on 'automatic'. Probably machine is 'right'. Disk feed by luck OK; material of lap OK; movement of arms just that degree irregular though firm in horizontal plane for non-shattering cutting. These points to be examined in more detail on actual specimen cutting.

Special test will be on new quartz wedge to see whether or not tip can be got thinner than pale yellow.

(Much home laboratory 'organisation' is yet needed i.e. hot plate, Balsam etc. and getting used to surroundings.)

May be that most important point is light, controlled pressure.

500 grade silicon carbide was finest abrasive used (now have 800 in hand).

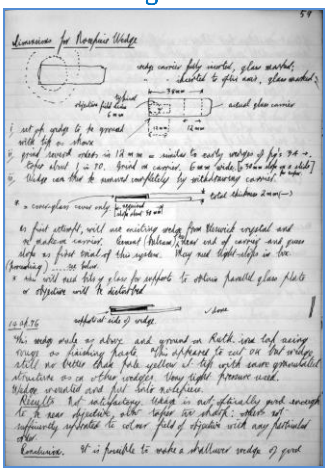
*this section melted off after xylol soak and put on clean slide for re-grinding. Section quite substantial at about 50µ thick. 13th April 1976

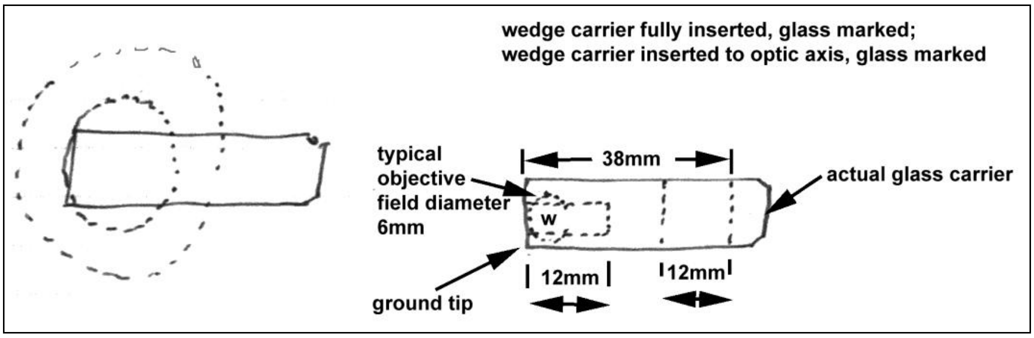
Note. Some professional work was ground on plate glass (coal ball work): perhaps this should be tried with fine abrasive.

(next page)

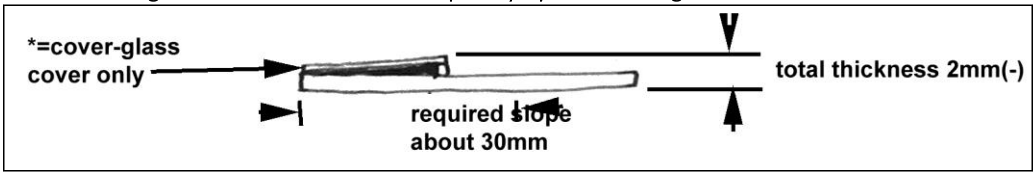
Dimensions for Nosepiece Wedge

Page 59





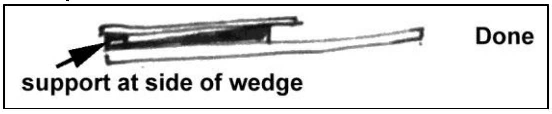
i. Set up wedge to be ground with tip as shown
ii. Grind several orders in 12mm = similar to early wedges of pgs 34 onward, taper about 1 in 70. Grind on carrier. 6mm wide [=30,, stops on a slide for taper]
iii. Wedge can then be removed completely by withdrawing carrier.



*this will need bits of glass for supports to obtain parallel glass plate or objective will be disturbed.

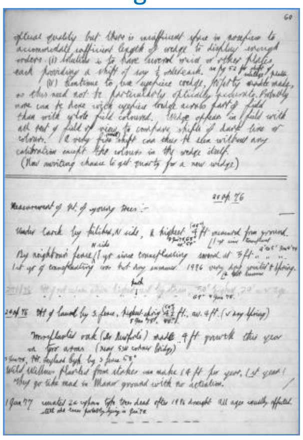
As first attempt, will use existing wedge from Keswick crystal and re-make on carrier. Cement (balsam) to near end of carrier and guess slop as first trial of this system. May need light-stops in box.
Proceeding….see below.

14th April 1976



This wedge made as above and ground on Ruth. iron lap using rouge as finishing paste. This appeared to cut OK but wedge still no better than pale yellow at tip with same granulated structure as on other wedges. Very light pressure used. Wedge mounted and put into nosepiece.
Results. Not satisfactory. Wedge is not optically good enough to be near objective, also taper too sharp: orders not sufficiently separated to colour field of objective with any particular order.
Conclusion. It is possible to make a shallower wedge of good…*(next page)*

Page 60



…optical quality but there is insufficient space in nosepiece to accommodate sufficient length of wedge to display enough orders.

(i) Solution is to have several mica or other plates, each providing a shift of say ½ order each. See page 52 for shift of substage plates.
(ii) Continue to use eyepiece wedge, properly made, as this need not be particularly optically accurate. Probably more can be done with eyepiece wedge across part of field than with whole field coloured. Wedge appears in field with all rest of field of view to compare shifts of dark line or colours. A very fine (small) shift can thus be seen without any calibration except the colours in the wedge itself.

(Now awaiting chance to get quartz for a new wedge.)

20th April 1976
Measurement of height of young trees:-
Under larch by pitches, N. side, 2 highest 4ft (48") measured from ground.
N. side 8th January 1978 – 68" (average 54") [1st year since transplant]
By neighbour's fence, N. side, 1 year since transplanting. Several at 3ft (4' to 5' 8th June 1978)
1st year of transplanting was hot, dry summer. 1976 very dry winter and spring (& hot summer)
24th April 1976. Height of red cedars above highest park rail by stream, 30" highest, 24' average. (69" 8th January 1978)
24th April 1976. Height of laurel by S. fence, highest sprig 4½ft (54"), average 4ft (very dry spring) [80" 8th January 1978]
Transplanted oak (Dr. Newport's) made 4ft growth this year on two arms (rear S.W. corner bridge)

3rd January 1978. Height of Leyland Cypress by S. fence 58".
Wild Willows planted from stakes can make 14ft per year, 1st year!
They go like mad in Manor ground with no attention.
1st January 1977. Counted 24 cypress type trees dead after 1976 drought. All ages equally affected. Still old trees dying in January 1978.
(next page)

[Transcribers Note: The following actually appears at the middle and bottom of page 61]

Photo of record of tree growth by river; early Spring 1976 (Red Cedars) Mid March 1976 photograph Viewed from drive corner of conservatory 8th January 1978. Up to 1st floor sill level of opposite houses. Cypress at West corner of barn, over roof ridge height of opposite houses.

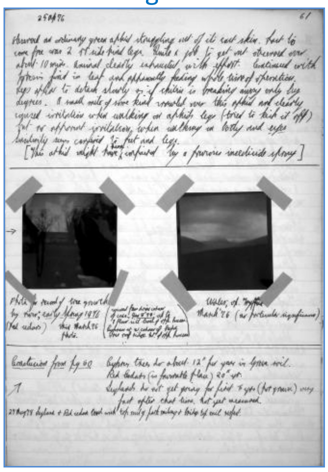
Wales: opposite Tryffan. March 1976 (no particular significance)

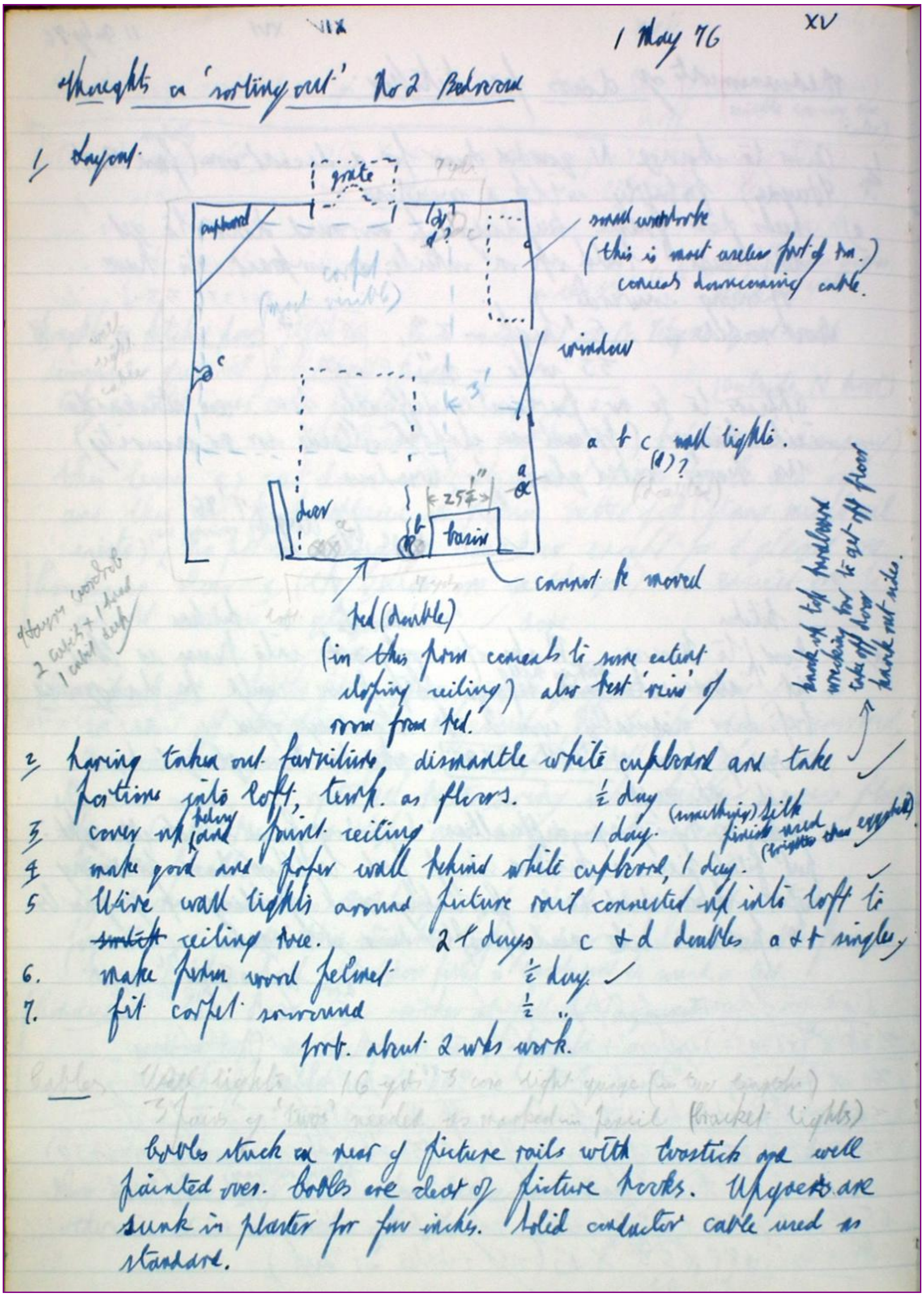
Conclusion from page 60.:
Cypress trees do about 12" per year in Grove soil.
Red Cedars (in favourable place) 20" per year
Leylands do not get going for first 3 years (pot grown), very fast after that time. Not yet recorded.
27th May 1978
Leyland and Red Cedars level with top rail of park railing and bridge top rail respectively.

25th April 1976
Observed an ordinary green aphid struggling out of its cast skin. Last to come free was 2 right side hind legs. Quite a job to get out observed over about 10 minutes. Animal clearly exhausted with effort. Continued with proboscis fixed in leaf and apparently feeding whole time of operation. Legs appear to detach slowly as if chitin is breaking away only by degrees. A small mite of some kind crawled over this aphid and clearly caused irritation when walking on aphids legs (tried to kick it off) but no apparent irritation when walking on body and eyes. Sensitivity seems confined to feet and legs.
[This aphid might have been impaired by a previous insecticide spray.]

(see page 60 for remainder of this page)

Page 61





XIV 1 May 76 XV

thoughts on 'sorting out' No 2 Bedroom

1/ Layout

grate
cupboard
d? d?
small wardrobe (this is most useless part of rm.) conceals downcoming cable.
window
a + c wall lights. (d)?
door
basin
25½"
cannot be moved
bed (double) (in this form conceals to some extent sloping ceiling) also best 'view' of room from bed.

2 having taken out furniture, dismantle white cupboard and take portions into loft, temp. as floors. ½ day

3 cover up [hairy] paint ceiling 1 day (emulsion) silk finish used (brighter than eggshell)

4 make good and paper wall behind white cupboard, 1 day.

5 Wire wall lights around picture rail connected up into loft to switch ceiling rose. 2+ days c + d doubles a + b singles

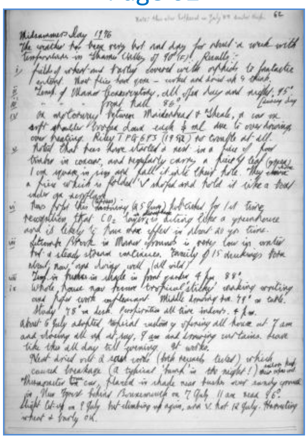
6. make pelmet wood pelmet ½ day ✓

7. fit carpet surround ½ "

prob. about 2 wks work.

Cables stuck on rear of picture rails with Evostick are well painted over. Cables are clear of picture hooks. Upgoers are sunk in plaster for few inches. Solid conductor cable used as standard.

Page 62



Midsummers Day 1976 (Note: this also happened in July 1983. Similar Temperatures)

The weather has been very hot and dry for about a week with temperatures in Thames Valley of 90°F.

Results:-

i. Fields of wheat and barley covered with aphids to fantastic extent. Most flies have gone – cooked and dried up I think.

ii. Temperature of Manor Conservatory, all open day and night; 95°

iii. Temperature of Manor front Hall 86° (during day)

iv. On motorway between Maidenhead and Theale, a car on soft shoulder broken down each ¼ mile due to over driving, overheating. Riley TPG 693 (1952) no trouble at all.

v. Noted that bees have started a nest in a piece of poor timber in conservatory and regularly carry a piece of leaf (green) 1cm square in size and pull it into their hole. They choose a piece which is folded 'V' shaped and hold it like a boat under an aeroplane.

vi. Newspaper this morning (Express) (25th June) published for 1st time that CO_2 layer in atmosphere is acting like a greenhouse and is likely to have maximum effect in about 20 years time.

vii. Letcombe Brook in Manor grounds is very low in water but a steady stream continues. Family of 15 ducklings born about now and doing well (all wild)

viii. Temperature in bushes in shade in front garden 4pm. 88°

ix. Whole house now became tropical 'sticky' making writing and paper work unpleasant. Middle drawing room 79° on table. Study 78° in desk. Perspiration all time indoors. 4pm.

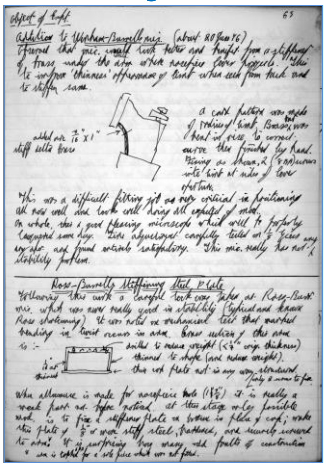
About 6th July adopted tropical custom of opening all house at 7am and closing all up at say 9am and drawing curtains. Leave like this all day till evening. It works.

Heat dried out 2 sash cords (both recently tested) which caused breakage (a typical bump in the night!) [sailors keep their ropes wet)

Thermometer from car, placed in shade near bushes over sandy ground in New forest behind Bournemouth on 7th July 11am read 96°.

Slight let up on 9th July but climbing up again, and very hot 12th July. Harvesting wheat and barley OK.

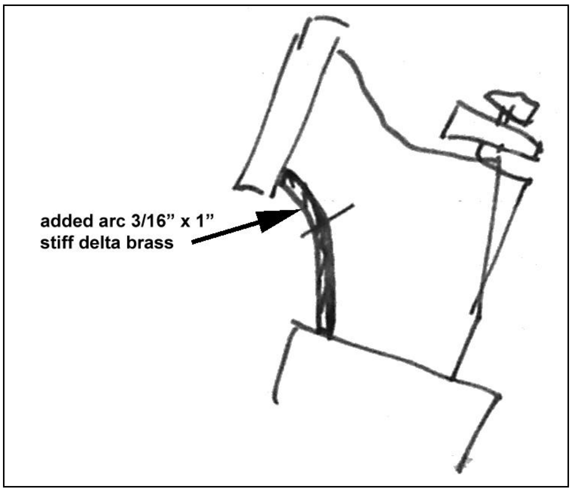
Page 63



Object of Experiment.

Addition to Wenham-Burrells microscope (about 20th June 1976)

Observed that microscope could look better and benefit from a stiffener of brass under the arm where nosepiece lever projects. This to improve 'thinness' appearance of limb when seen from back and stiffen same.



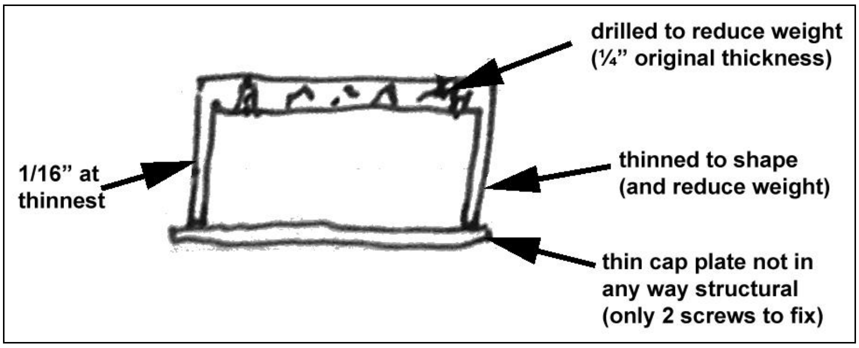
A card pattern was made of radius of limb. Brass bar was bent in vice to correct curve then finished by hand. Fitting as shown, 2 (8BA) screws into limb at sides of lever aperture.

This was a difficult fitting as very critical in positioning. All now well and looks well doing all expected of modification.

On whole, this a good pleasing microscope which will be properly lacquered some day. Fine adjustment carefully tested on ⅛" Zeiss dry apochromat and found entirely satisfactory. This microscope really has not any stability problem.

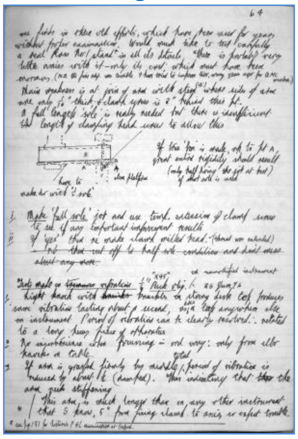
Ross-Burrells Stiffening Steel Plate

Following this work a careful look was taken at Ross-Burrell microscope which was never really good in stability (typical and known Ross shortcoming). It was noted on mechanical test that marked bending in twist occurs in arm. Cross section of this arm is:



When allowance is made for nosepiece hole (1 $^7/_8$") it is really a weak part not before noticed. At this stage only possible modification is to fix a stiffener plate on bottom in place of cap; make this plate of ⅛" or more stiff steel, hardened, and securely screwed to arm (arm is tapped [6BA] for a sole piece which was not fitted). It is surprising how many old faults of construction…*(next page)*

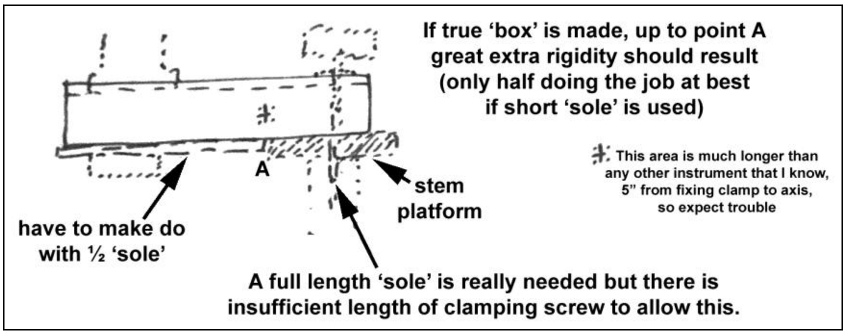
Page 64



…one finds in these old efforts; which have been used for years without proper examination. Would much like to test carefully a real Ross No.1 stand* in all its details. There is probably very little amiss with it – only its cost; which must have been enormous. (NB. Its fine adjustment was terrible. I have tried to improve this, many years ago for QMC members)

Main weakness is at join of arm with stem (see marked point in diagram) where sides of arm are only $\frac{1}{16}$” thick and clamp screw is 2” behind this point.

A full length ‘sole’ is really needed but there is insufficient length of clamping head screw to allow this.



i. Make “full sole” job and use temporary extension of clamp screw to see if any important improvement results.
ii. If ‘yes’ then re-make clamp milled head. (thread was extended)
~~If ‘no’ then cut off to half sole condition and don’t mess about any more.~~

26th June 1976

Tests made on ~~tremors~~ vibration.

$\frac{1}{8}$” x45 Beck objective in unmodified instrument

1. Light knock with knuckles on strong desk top produces some vibration lasting about a second, as does a tap anywhere else on instrument. Period of vibration can be clearly resolved therefore related to a long heavy piece of apparatus.
2. No inconvenience when focussing in ordinary way: only from elbow knocks on the table.
3. If arm is grasped firmly by middle, total period of vibration is reduced by about ½ (damped). This indicating that the arm nuts stiffening.

See page 191 for historic Powell and Lealand examination at Oxford.

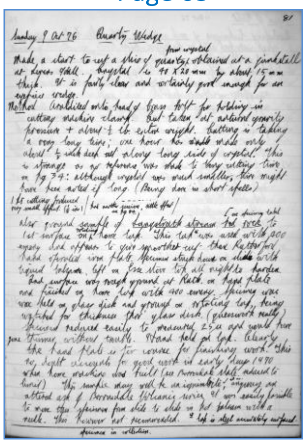
27th June 1976

A very hot day. Took samples from river surface mud by bridge. Contained many navicular, ach, diatoms in healthy state. Noted also that minnows are now back in river in Manor. There is still a fair flow of water but level very low.

11th July 1976

Little let-up in heat; fuchsias burnt off at level 1foot below roof of conservatory. Abutilon stood for it. All grass brown completely.
(They never recovered properly; 4 died by March 1979)

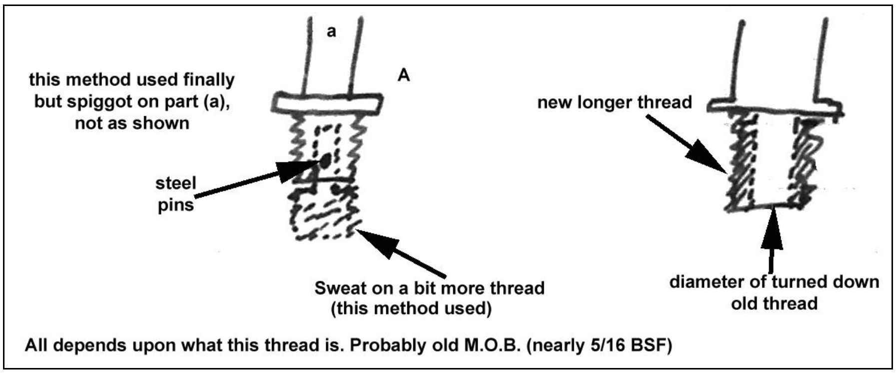
Page 65



About 9th July 1976

Ross-Burrells Microscope (continued)

Obtained a piece of surface ground steel ⅛" thick to make 'full sole' stiffener plate for Ross-Burrells microscope arm. Nosepiece hole drilled 10th July*, and shaping will take place around this hole, being the critical position. Ross clamp head may have to be extended (Sweat on a bit more thread.)



*this job balled up by workshop at Rutherford, drilled 1¾" (couldn't read) although mm dimensions given as well. Must now get new piece of ground steel.

12th July 1976

Thoughts on Outside W.C.

A thoroughly rough job which started life soon after 1898 (date on outside kitchen North wall) as a dry privy; see arch for unloading under North wall. Plaster on walls has decayed; woodwork around doors is eaten badly but now treated.

1. Deal with door posts. Inside of posts full height 74"x4" 2-off, top 25" adjust on site. This needs arch trimming when in place.
2. Inside posts 2½" wide on right, 4" with making-up blocks on left
3. Wall panel 76" x17", may be planking on door wall (East side)
4. North wall panel can be existing larder shutter as it stands. No point in doing any other work here except painting. Keep old Norfolk latch and door as example of work, 1890 time.
5. W.C. pan was changed by WB in about 1973 (no trouble). Pan front was cracked from pre-1963 days. Cistern operated without any attention after about 12 years+, standing idle.

Collect wood:-
74 x 4 (2 off)
25 x 4 (1 off) [inside of door opening]
76 x 4 (1 off)
76 x 2½ (1 off) [inside of door posts]
76 x 17 total area of planking East side
Oddments for skirting on site.

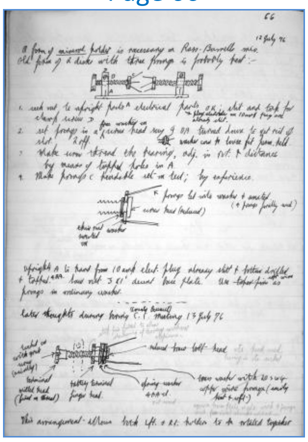
13th July 1976.

Rainfall took place. A drizzly evening but nothing much in actual fall. (Warm to hot temperature)

New piece of ground steel drilled properly 15th July and marked out for construction. When microscope arm dismantled, noted particularly weakness of this bar due to shaping and drilling for reduction of weight. Hard to see how this design fault was allowed in an instrument known to have this instability fault already.

(When made I remember it appeared very crude. (page 68) & heavy. I was not used to the scale of size of this instrument at that time)

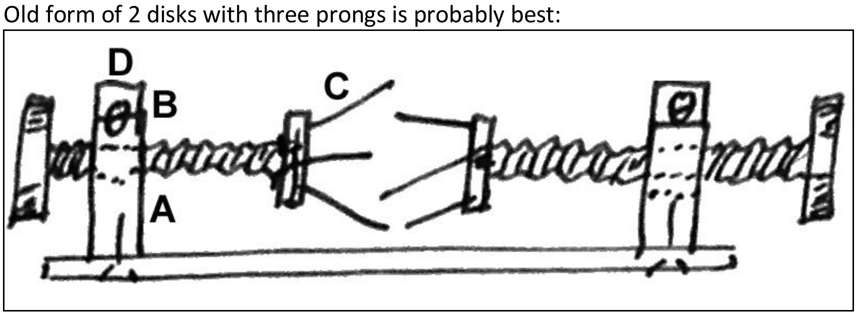
Page 66



12th July 1976

A form of mineral holder is necessary on Ross-Burrells microscope.

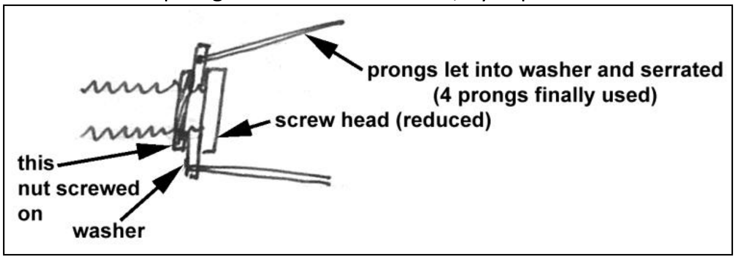
Old form of 2 disks with three prongs is probably best:



1. Seek out for upright posts A, electrical parts, plug electrodes on 10 amp plug are already slit. OK. Slit and tap for clamp screw D.
2. Set prongs in a free washer on screw head say 9 BA turned down to get rid of slot. 2 off.

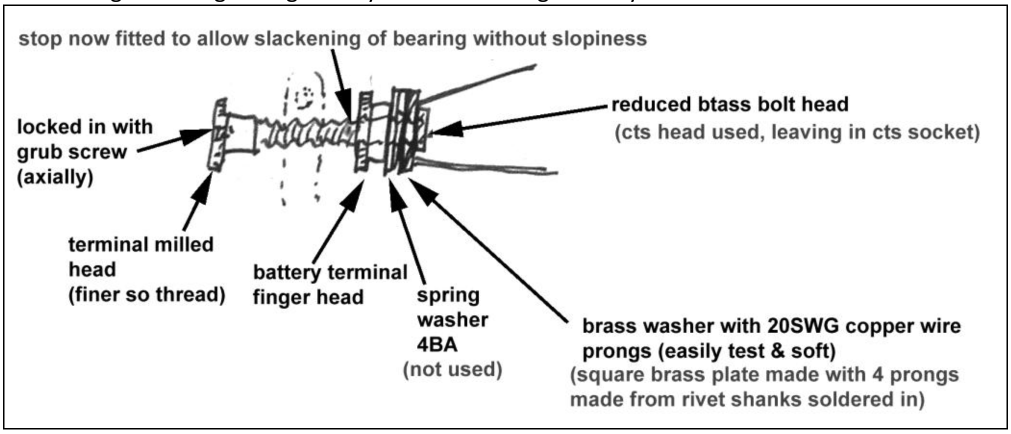
Washer can be loose fit, firmly held.

3. Make screw thread the bearing, adjustment is rotation and distance by means of tapped holes in A.
4. Make prongs C bendable as in test; by experience.



Upright A to hand from 10 amp electrical plug, already slit and bottom drilled and tapped (4BA). Saw out 3"x1" decent face plate. Use ~~taper pin~~ soft wire as prongs in ordinary washer.

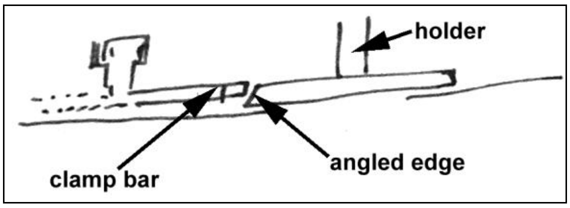
Later thoughts during boring County Council meeting 13th July 1976



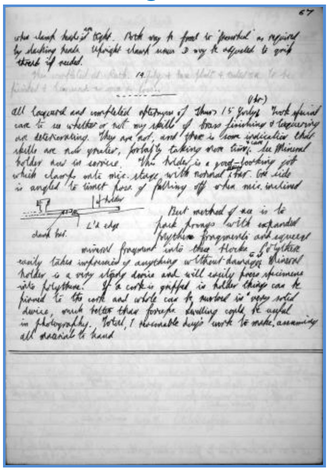
This arrangement allows both left and right holders to be rotated together…*(next page)*

…when clamp heads are tight. Both may be freed to 'freewheel' as required by slackening heads. Upright clamp screws D may be adjusted to grip there if needed. This completed at Ruth. 14th July + base plate + tested OK. To be finished and lacquered as soon as possible.

All lacquered and completed afternoon of Thursday 15th July (1 hour). Took special care to see whether or not my skills of brass finishing and lacquering are deteriorating. They are not, and there is some indication that skills are now greater, probably taking more time and care. See Mineral Holder now in service. This holder is a good-looking job which clamps onto microscope stage with normal sliding bar. One side in angled to limit possibility of falling off when microscope inclined.

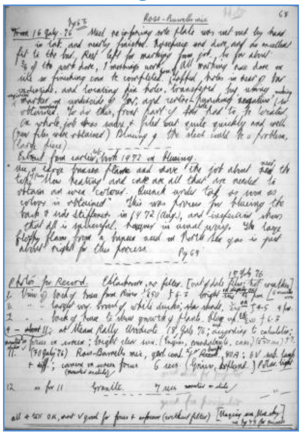


Page 67



Best method of use is to pack prongs with expanded polythene fragments and squeeze mineral fragment into these blocks. Polythene easily takes impression of anything without damage to it. Mineral holder is a very strong device and will easily press specimens into polythene. If a cork is gripped in holder things can be pinned to the cork and whole can be revolved in very solid device, much better than forceps. Levelling could be useful in photography. Total, 1 reasonable days work to make, assuming all materials to hand.

Page 68



From 16th July 1976 (page 63)
Ross-Burrells Microscope
Steel reinforcing sole plate was cut out by hand in lab. and nearly finished. Nosepiece end done, and an excellent fit to the bar. Rest left for marking from job. So far about ⅔ of the work done, 1 mornings work. All marking now done on site so finishing can be completed. Position of tapped holes in rear of bar underside, and locating pin holes, transferred by using engineers marker on underside of bar, and centre punching 'negative', so marking obtained. To do this, front part of sole had to be located. On whole, job was sawn and filed out quite quickly and well (new files were obtained). Blueing of the steel could be a problem (large piece).
Extract from earlier lab book 1972 on blueing.
"Use a large bunsen flame and move the job about near the top of the flame. Slow heating and care are all that are needed to obtain an even colour. Quench under tap as soon as colour obtained". This was process for blueing the back and side stiffeners in 1972 (August), and inspection shows that all is successful. Lacquer in usual way. The large floppy flame from a bunsen used on North Sea gas is just about right for this process. (page 69)

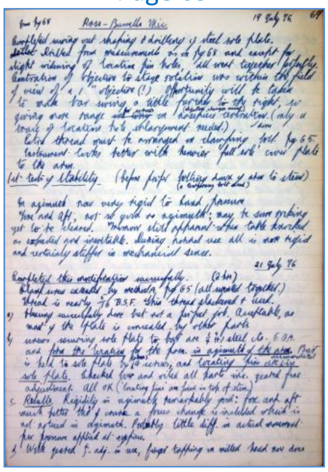
Photos for record.
Ektachrome, no filter [out of date film: 17th July 1976: six months over: hot weather]
1. View of back of house from river $^1/_{250}$ f6.3 bright sun 4pm. OK. Slight over exposed
2. View of largest ever brood of white ducks; shade, $^1/_{250}$, f4.5, 4pm. OK
3. View of back of house to show growth of plants. Close up. $^1/_{250}$, f6.3. OK

4–11. at Steam Rally, Woodcote 18th July 1976; according to calculator, focus on screen, bright clear sun (engine, roundabout, cars) $^1/_{250}$ second, f7. Mounted on slides

11. (30th July 1976) Ross-Burrells microscope, geological condenser, 2" Swift, 80A, 6V substage lamp and diffuser, camera on screen focus, 6 seconds (Gneiss, Lapland), polarised light (mounted as slide) Good slide for projector
12. as for 11, Granite, 7 seconds, mounted as slide. Good for projector

All 4 to 11 OK, most very good for focus and exposure (without filter) [blazing sun, clear blue sky]
See page 73 for records.

Page 69



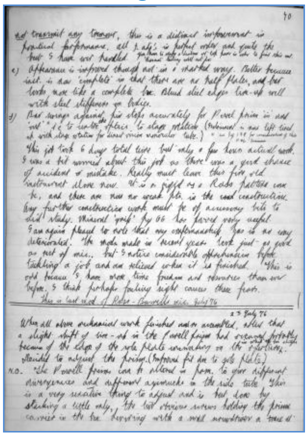
From Page 68
Ross-Burrells Microscope
Completed sawing out, shaping and drilling of steel sole plate. Drilled from measurements as on page 68 and except for slight widening of location pin holes, all went together perfectly. Centration of objective to stage rotation was within the field of view of a 1" objective (!) Opportunity will be taken to make bar swing a little further to the right, so giving more range for screws on nosepiece (objective changers mount) centration. (Only a trace of location hole enlargement needed.) (Done)
Extra thread must be arranged on clamping bolt. Page 65. Instrument looks better with heavier 'full sole' cover plate to the arm.
1st tests of stability. (before proper bolting down of arm to stand) (a temporary bolt used)
In azimuth now very rigid to hand pressure. Fore and aft; not so good as azimuth; may be some rocking yet to be cleared. Tremor still apparent when table knocked as expected and inevitable. During normal use all is more rigid and certainly stiffer in mechanical sense.

21st July 1976

Completed this modification successfully (2hrs)
Clamp screw extended by method A page 65 (all sweated together)
Thread is nearly $^5/_{16}$ BSF. This thread slackened and used.

a. Blueing successfully done but not a perfect job. Acceptable, as most of the plate is concealed by other parts.
b. Screws securing sole plate to bar are ¼" (+) steel cts. 6BA. And form the location for the position in azimuth of the arm. Bar is held to sole plate. Checked over and oiled all parts including geared fine adjustment. All OK ('locating pins' are fixed in top of stem)
c. Results. Rigidity in azimuth remarkable good: fore and aft much better though of course a focus change is included which is not noticed in azimuth. Probably little difference in actual movement per pressure applied at eyepiece.
d. With feared fine adjustment in use, finger tapping on milled head now does…*(next page)*

Page 70



…not transmit any tremor, this is a distinct improvement in practical performance. All focus adjustments in perfect order and quite the best I have ever handled. You have to study a diatom at top power in order to find this out. 'Casual' testing will not do.

e. Appearance is improved though not in a marked way. Better because instrument is now 'complete' in that there are no half plates, and bar looks more like a complete box. Blued steel edges line-up well with steel stiffeners on bodies.

f. Bar swings against pin stops accurately for Powell prism 'in' and 'out'* i.e. to centre the optics to stage rotation (Instrument is now left lines up with stage rotation for direct vision monocular tube.)

*see page 139 for considerations of this Powell and Lealand business.

This job took 6 days total time but only a few hours actual work. I was a bit worried about this job as there was a good chance of accident or mistake. Really must leave this fine old instrument alone now. It is as rigid as a Ross pattern can be, and there are now no weak points in the construction. Any further construction work must be of accessory bits to aid study. Mineral 'grip; page 66 has proved very useful. I am again pleased to note that any craftsmanship has in no way deteriorated. The modifications made in recent years look just as good as rest of microscope, but I notice considerable apprehension before tackling a job and am relieved when it is finished. This is odd because I have more time, freedom and resources than ever before. I think perhaps failing sight causes these fears.

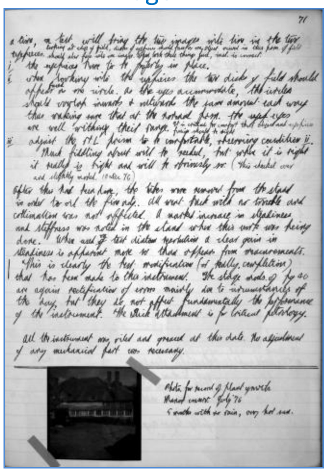
This is last modification of Ross-Burrells microscope. July 1976.

23rd July 1976

When all above mechanical work finished and re-assembled, noted that a slight shift of line-up in the Powell prism had occurred probably because of the edge of the sole plate encroaching on the aperture in which the box slides. Decided to adjust the prism. (Improved fit due to sole plate.)

NB. The Powell prisms can be altered in form to give different divergences and different azimuths in the side tube. This is a very sensitive thing to adjust and is not done by slacking a little only, the two obvious screws holding the prism carrier in the box, Levering with a small screw driver a trace at…*(next page)*

Page 71



…a time, on test, will bring the two images into line in the two eyepieces. Looking at edge of field, disks of eyepieces should fall as one object, viewed in this position of field. Should also fuse into one image. When both these things fuse, instrument is correct.

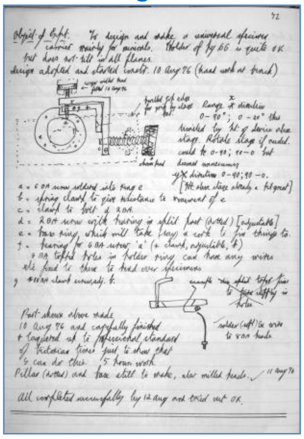
i. The eyepieces have to be properly in place
ii. When looking into the eyepieces the two disks of field should appear fused on one circle. As the eye accommodate, the circles should overlap inwards and outwards the same amount each way thus making sure that at the normal position the eyes are well within their range. It is critical for comfort that object and eyepiece fusion should be right.
iii. Adjust the Powell and Lealand prism to be comfortable, observing condition ii. Much fiddling about will be needed, but when it is right it really is right and will be obviously so. (This checked over and slightly modified 10th December 1976)

After this had been done, the tubes were removed from the stand in order to oil the fine adjustment. All went back with no trouble and collimation was not affected. A marked increase in steadiness and stiffness was noted in the stand when this work was being done. When used on test diatom resolution a clear gain in steadiness is apparent more so than appears from measurements. This is clearly the best modification (or really, completion) that has been made to this instrument. The stage modifications of page 40 are again rectification of errors mainly due to circumstances of the day, but they do not affect fundamentally the performance of the instrument. The Dick attachment is for critical petrology.

All the instrument was oiled and greased at this date. No adjustment of any mechanical part was necessary.

Photo of record of plant growth
Manor conservatory July 1976
5 months with no rain, very hot sun.

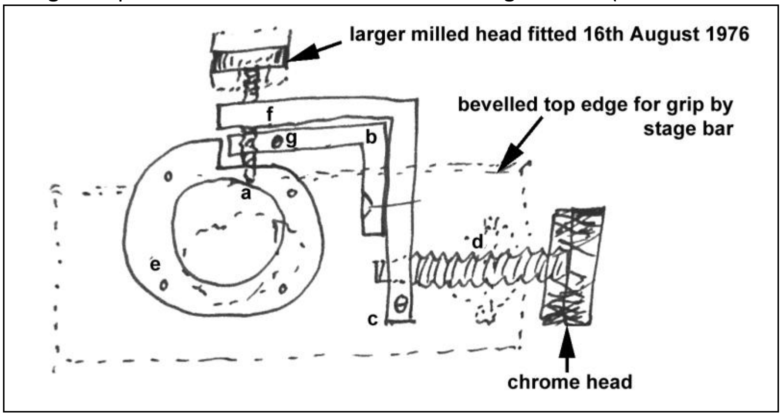
Page 72



Object of Experiment

To design and make a universal specimen carrier mainly for minerals. Holder of page 66 is quite OK but does not tilt in all planes.

Design adopted and started construction 10th August 1976 (hand work at bench)



Range x direction

0-90°; 0-20° this limited by height of device above stage. Rotate stage if needed. Could be 0-90°; 90-0. [Height above stage already a bit great.]

a = 6BA screw soldered into ring e

b = spring clamp to give resistance to movement of e

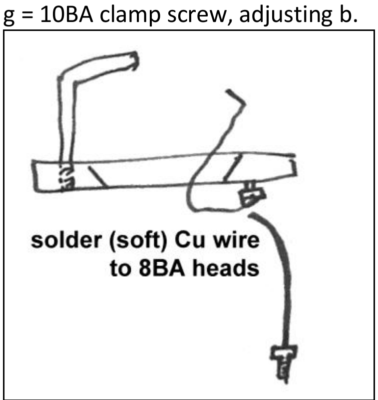
c = clamp to bolt a 2BA

d = 2BA screw with bearing in split part (dotted) [adjustable]

e = brass ring which will take (say) a cork to fix things to

f = nearing for 6BA screw 'a' (+ clamp, adjustable, b) 8BA tapped holes in holder ring can have any wires etc., fixed to it these to bend over specimens

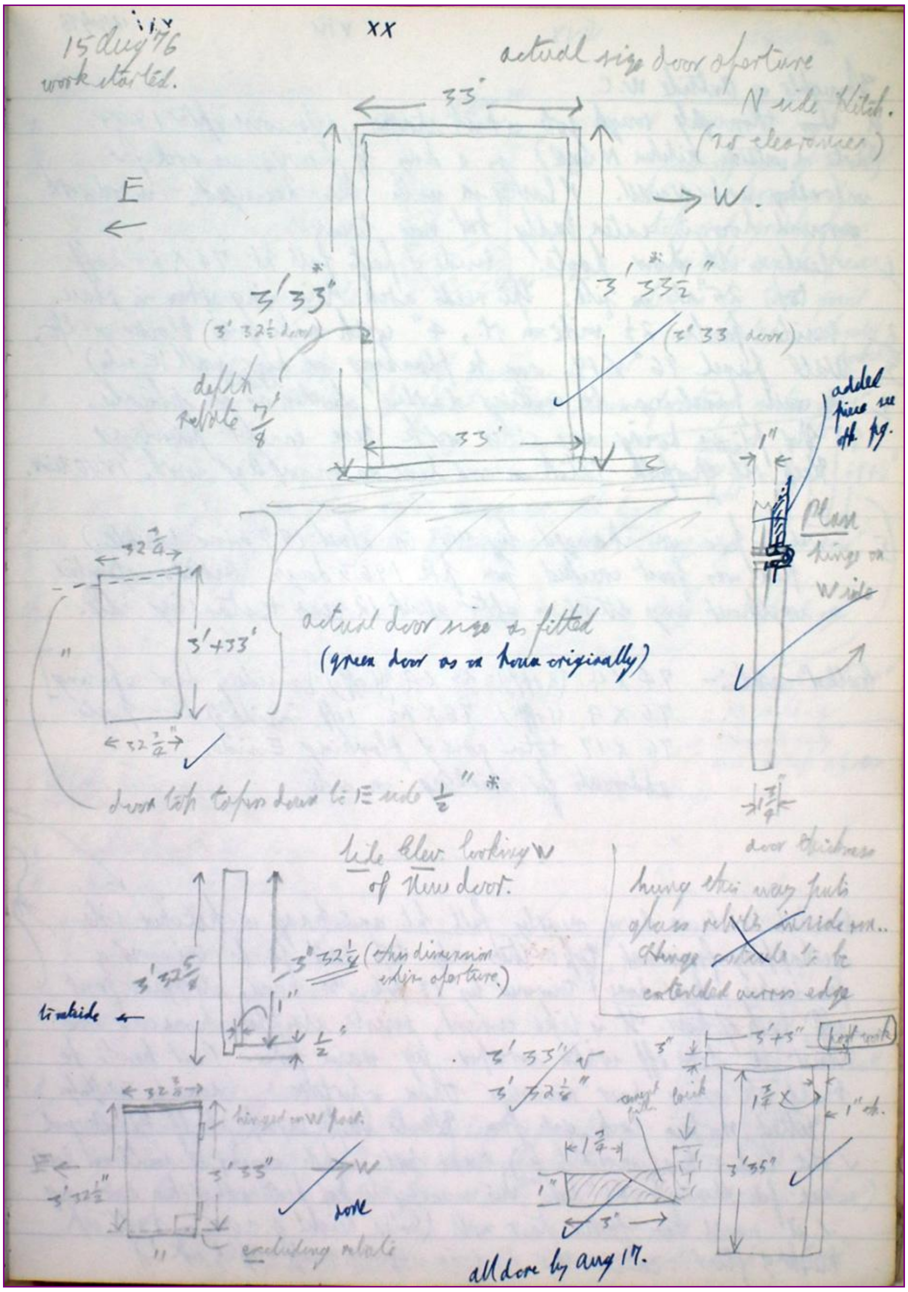
g = 10BA clamp screw, adjusting b.



Part shown above made 10th August 1976 and carefully finished and lacquered up to professional standard of Victorian times just to show that I can do this. 5 hours work.

Pillar (dotted) and base still to make, also milled heads. 11th August 1976.

All completed successfully by 12th August and tried out OK.

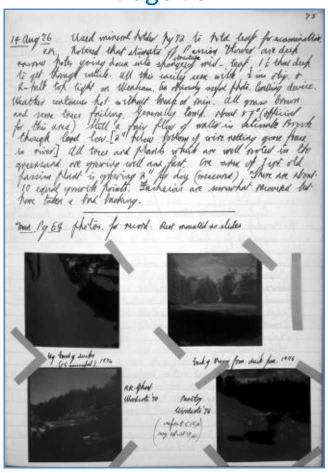


14th August 1976

Used mineral holder (page 72) to hold leaf for examination. OK. Noticed that stomata of Passion Flower are deep narrow holes going down into sponge structure of mid-leaf, 1½ thou deep to get through cuticle. All this easily seen with ½" objective and 2-bulb top light on Wenham. An obviously useful photo levelling device.

Weather continues hot without break or rain. All grass brown and some trees failing. Generally temperature about 87° (official for this area). Still a fair flow of water in Letcombe Brook though level low [2" below bottom of wire netting gorse fence in river]. All trees and plants which are well rooted in the greensand are growing well and fast. One arm of 1 year old passion plant is growing 2" per day (measured). There are about 10 equal growth points. Fuchsias are somewhat recovered but have taken a bad bashing.

Page 73



From page 68. Photos for record. Rest mounted as slides.

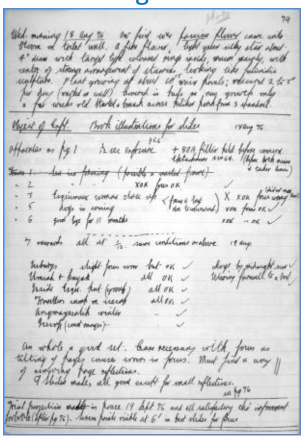
Big brood of ducks (15 successful) 1976

Back of Manor from duck pen 1976

Rolls Royce Ghost - Woodcote 1976

Bentley - Woodcote 1976
(Confusion circle < 15μ say estimated at 10μ.)

Page 74



Wednesday Morning 18th August 1976

Our first ever Passion Flower came into bloom on toilet wall. A fine flower, bright green silky star about 4" diameter with target type coloured rings inside, mauve mainly, with centre of strange arrangement of stamens, looking like futuristic sculpture. Plant growing at about 15 main points; measured 2 to 3" per day (marked on wall). Covered in buds on new growth only a few weeks old. Started a branch across kitchen porch from S. spandrel.

18th August 1976
Object of Experiment
Book Illustrations for Slides
Apparatus as page 1. $1/_{12}$th second exposure at f5.6 plus 80A filter held before camera (before both main and taker lenses), Ektachrome ASA64

~~Frame 1. Sea ice forming (possibly a wasted frame)~~
Frame 2. Sea Ice forming x10 focus OK
Frame 3. Esquimaux (Eskimo) woman close up Exposure OK, focus wrong (did not move lens)
Frame 4. Lost due to overwind
Frame 5. Dogs in evening. Exposure OK, focus OK
Frame 6. Good bye for 11 months. Exposure Ok, focus OK
Frame 7 onwards. All at $1/_{12}$th. Same conditions as above. 19th August.
Icebergs – slight focus error but OK
Uniak and Kayak, all OK
Inside Esquimaux (Eskimo) hut (group), all OK
Travellers camp on icecap, all OK
Engmayssalik winter, all OK
Icecap (coast ranges), all OK
Dogs by midnight sun

Waving farewell to a boat

On whole a good set. Care necessary with focus as tilting of pages causes errors in focus. Must find a way of removing page reflections.

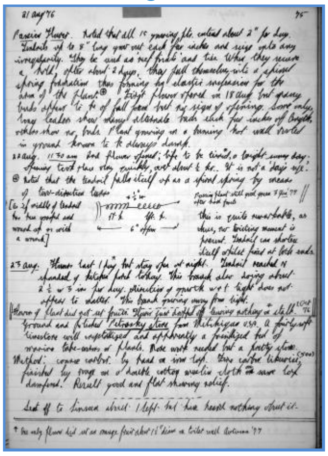
9 slides made, all good except for small reflections.

See page 76.

Trial projection in house 19th September 1976 and all satisfactory though improvement probable (after page 76). Screen points visible at 6' in best slides for focus.

21st August 1976

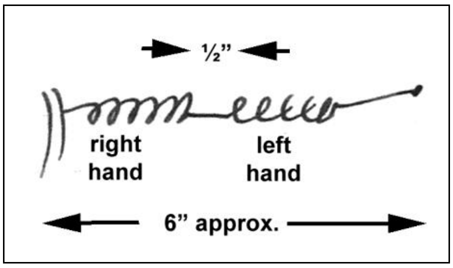
Page 75



Passion Flower. Noted that all 15 growing points extend about 2" per day. Tendrils up to 8" long grow out each few inches and seize onto any irregularity. They can be used as 'reef joints' and ties. When they secure a hold, often about 2 days, they pull themselves into a spiral spring formation thus forming an elastic suspension for the arm of the plant*. First slower opened on 18th August but many buds appear to be full form but no sign of opening. Some only, long show many alternate buds each few inches of length, others show no buds. Plant growing on a burning hot wall rooted in ground known to be always damp.

22nd August, 10.30am. 2nd flower opened; life to be timed, a bright sunny day; Opening took place very quickly, over about ½ hour. It is not a 'day's eye'.

*Noted that the tendril pulls itself up as a spiral spring by means of two-direction turns.



As if middle of tendril has been grasped and wound up as with a wrench.

This is quite remarkable, as thus, no twisting movement is present. Tendril can shorted itself whilst fized at both ends.

[Passion plant still good green 3rd January 1977 after hard frosts]

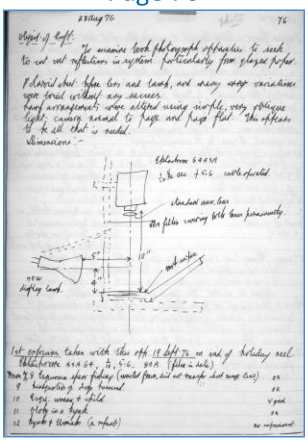
23rd August. **Flowers last 1 day but stay open at night. Tendril reached N. spandrel of porch today. This branch also doing about 2½ to 3 ins per day. Directions of growth – light does not appear to matter. This branch growing away from light. Flowers of plant did not set fruits. Flower just dropped off leaving nothing on stalk. 1st October 1976. An early flower did set an orange fruit about 1½" diameter on toilet wall, Autumn 1977.

Ground and polished Petoskey stone from Michigan, U.S.A. A fairly soft limestone well crystallised and apparently a fossilized bed of marine tube-worms or plants. More work needed but a pretty stone.

Method: coarse carborundum by hand on iron lap. Fine carborundum likewise, (500), finished by rouge on a double cotton muslin cloth on same lap dampened. Result good and flat showing relief.

Sent off to Linssen Abbott 1st September but have heard nothing about it.

Page 76



28th August 1976

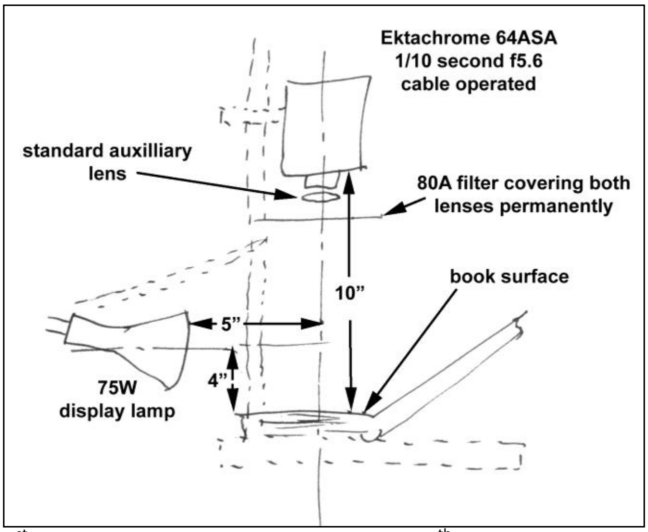
Object of Experiment

To examine book photograph apparatus to seek to cut out reflections in system particularly from glazed paper.

Polaroid sheet before lens and lamp, and many variations were tried without any success.

Lamp arrangements were altered using simple, very oblique light; camera normal to page and page flat. This appears to be all that is needed.

Dimensions:



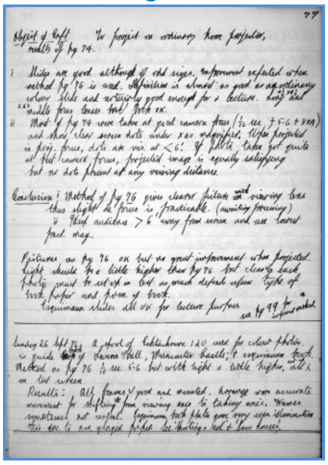
1st exposures taken with this apparatus 19th September 1976 in end of holiday reel.
Ektachrome ASA64, $\frac{1}{10}$, f5.6. 80A (film in date)
8. Esquimaux (Eskimo) spear fishing (wasted frame, did not transfer short range lens)
9. Hindquarters of dogs harnessed
10. Esquimaux (Eskimo) Woman & child
11. Bloke in Kayak
12. Kayaks and Uniaks (a repeat)

Object of Experiment
To project on ordinary home projector
Results of page 74.

i. Slides are good although of odd sizes. Improvement expected when method page 76 is used. Definition is almost as good as an ordinary colour slide and certainly good enough for a lecture. Long 4½x4½ and 2 x 2 middle focus lenses both OK.
ii. Most of pg74 were taken at good camera focus ($\frac{1}{12}$ sec f5.6 + 80A) and show clear screen dots under x20 magnifier. When projected in projector focus, dots are visible at < 6’. If photos taken not quite at best camera focus, projected image is equally satisfying but no dots present at any viewing distance.

Conclusion. i. method of page 76 gives clearer picture with viewing lens thus slight de-focus is practicable (awaiting processing). Ii. Keep audience > 6’ away from screen and use lowest projector magnification.

Page 77



Pictures as page 76 OK but no great improvement when projected. Light should be a little higher than page 76 but clearly each photo must be set up and position of book.
Esquimaux (Eskimo) slides all OK for lecture purposes.
See page 99 for improved method.

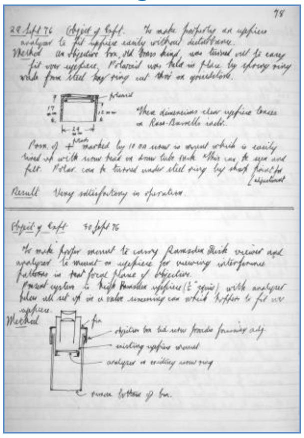
For record, costs of a typical middle class holiday in English Lake District 1976 September (2 weeks)

1. Travel by ordinary private car Riley 2½litre (24 years old). About 20mpg (at most pessimistic, estimate for mountains). Distance to and from Keswick Hotel 280 miles, needs 14 gallons petrol (say) total £22.
2. Actual petrol bought on holiday (all by Barclaycard) all 3 star.
   £4.20 Kendal
   £4.74 Galley A5
   £4.80 Windermere
   £3.20 Crossthwaite, Keswick
   £3.20 Crossthwaite, Keswick
   £4.86 Crossthwaite, Keswick
   £3.00 Holmbrook
   £20.15 Crossthwaite (new tyre)
   £3.24 Crossthwaite
   £6.76 Corley (Motorway)
   £3.00 cash purchase, odd journey
   £4.00 approximately before start of holiday
   Total petrol £45
   A normal months fill is about this much at home (including County Council running)

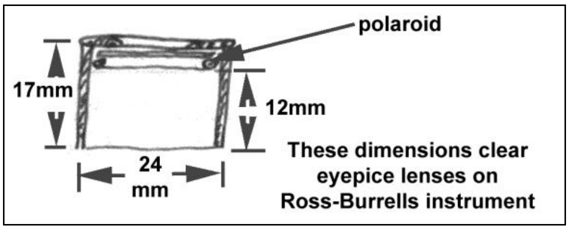
Hotel. A decent country house type hotel, 2Star AA, total £220 for two people for 2 weeks (approximate amount, including 10% tips). Of this total £20 was for table wine.
No private bathroom or toilet but all sufficient. Good drying sun (every evening) for wet clothing.
Costs at this time for lunches out, typically pie and pint in pubs £1.20 each *beer 30p pint) should need £3 for two.
Typical steam fare Paterdale to Howetown £1 each single journey. Keswick to Brandlehowe 50p each single.
In general if one ‘goes anywhere’ in modest way £5 per day is needed. Hence £60 spent on two people ex. Hotel.
Stately home typical 60p each.
WB would need 10 and 10 food & travel at Ruth.
DEB would need 30 approximately at home therefore fortnights’ entertainment exclusive of hotel only about £10 more than at home.
Total holiday bill (say) £265
Payments saved by being away say £90 (food, travel, electricity, etc.)
Cost of holiday (say) £175.
NB. 1 week similar holiday, 2 people, same hotel, end August 1978 Total £227 actual bills.

Sunday 26th September 1976.
A spool of Ektachrome 20 used for colour photos in guide book of Levens Hall, Muncaster Castle; & Esquimaux (Eskimo) book. Method as page 76 $\frac{1}{10}$ sec f5.6 but with light a little higher, set up all on test screen.
Results: All frames very good and mounted. Arrange more accurate movement for shifting from viewing axis. Frames sometimes not central. Esquimaux (Eskimo) book plates gave very even illumination, this due to non-glare paper. See ‘Shooting a Seal’ & ‘Snow houses’.

Page 78

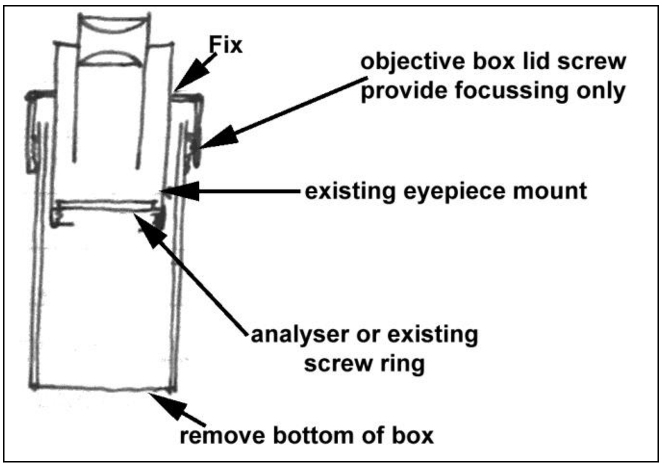


29th September 1976
Object of experiment
To make properly an eyepiece analyser to fit eyepiece easily without disturbance.
Method. An objective box, old brass kind, was turned out to easy fit over eyepiece. Polaroid was held in place by spring ring made from metal key ring cut through on grindstone.

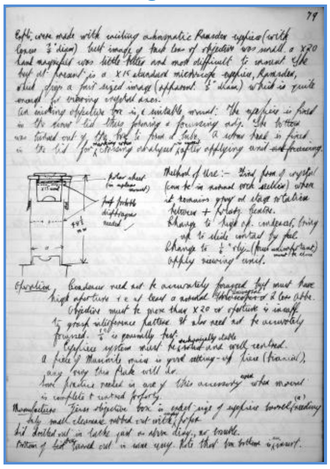


Position of polars marked by 10BA screw in mount which is easily lined up with screw head on draw tube rack. This can be seen and felt. Polar can be turned under steel ring by sharp point for adjustment.
Result. Very satisfactory in operation.

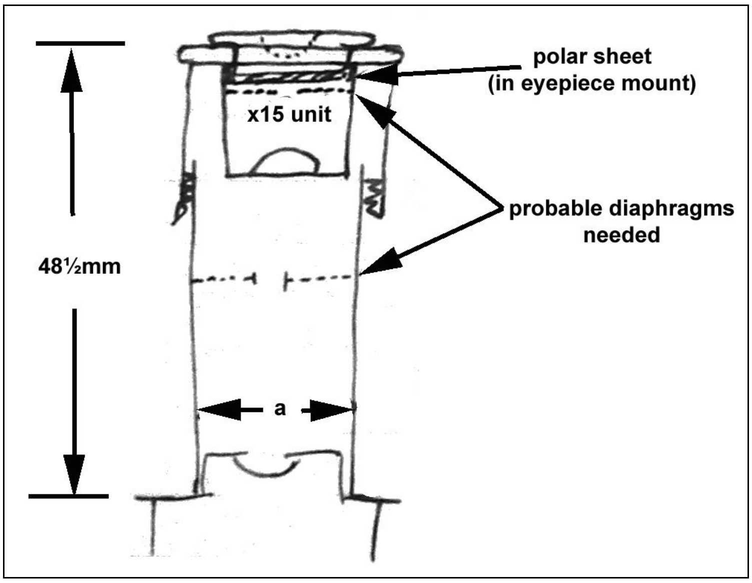
30th September 1976
Object of Experiment.
To make proper mount to carry Ramsden Disk viewer and analyser to mount on eyepiece for viewing interference patterns in rear focal plane of objective.
Present system is high Ramsden eyepiece (½” equivalent) with analyser below all set up in a valve screening can which happens to fit over eyepiece.
Method:



Page 79

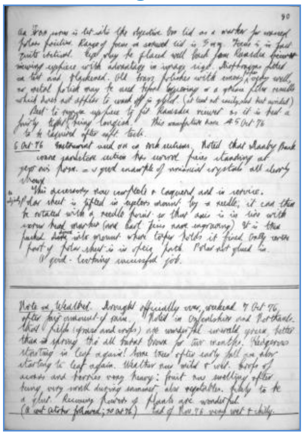


Experiments were made with existing achromatic Ramsden eyepiece (with lenses ¾" diameter) but image of back lens of objective was small. A x20 hand magnifier was little better and more difficult to mount. The best at present is a x15 standard microscope eyepiece, Ramsden, which gives a fair sized image (apparent ½" diameter) which is quite enough for viewing crystal axes.
An existing objective box is a suitable mount. The eyepiece is fixed in the screw lid thus forming a focussing adjustment. The bottom was turned out of the box to form a tube. A screw head is fixed in the lid for marking where crossing analyser is correct after applying unit ~~and focussing~~.



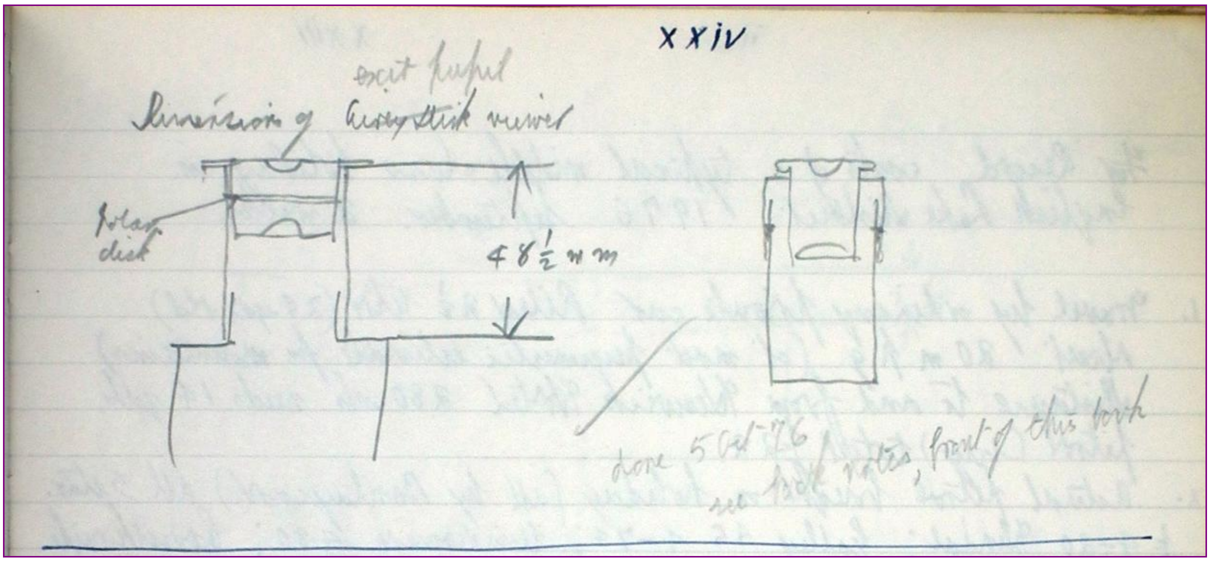
Method of use:- Find form of crystal (can be in normal rock section) where it remains grey on stage rotation between cross polars. Centre. Change to high aperture condenser, bring up to slide contact by feel. Change to ⅙" objective (focus unimportant – but must be close). Apply viewing unit.
Operation. Condenser need not be accurately focussed but must have high aperture i.e. at least a normal ~~Holoscopic~~ Universal 2 lens Abbe. Objective must be more than x20 or aperture is insufficient to grasp interference pattern. It also need not be accurately focussed. ⅙" is generally best.
Eyepiece system must be ~~solid~~ mechanically stable and well centred.
A piece of Muscovite mica is good setting-up piece (biaxial), any very thin flake will do.
Some practice needed in use of this accessory even when mount is complete and turned properly.
Manufacture. Zeiss objective box is exact size of eyepiece barrel (a) needing only small clearance rubbed out with emery paper.
Lid drilled out in lathe just as above diagram, no trouble.
Bottom of ~~lid~~ box turned out in same way. Note than box bottom is an insert. *(next page)*

Page 80



A ~~8~~ 10BA screw is let into the objective box lid as a marker crossed polars position. Range of focus on screwed lid is 3mm. Focus is in fact quite critical. Eye may be placed well back from Ramsden ~~viewer~~ viewing eyepiece with advantage in image size. Diaphragms fitted on test and blackened. All brass polishes with emery paper very well, no metal polish may be used before lacquering or a grease film results which does not appear to wash off in xylol. (At least not easily, and best avoided.)
Best to remove eyepiece to fit Ramsden viewer as it is but a fairly tight fit being longish. This manufacture done ~~4th~~ 5th October 1976. To be lacquered after experimental tests.
6th October 1976
Instrument used on rock sections. Noted that Danby Bank coarse sandstone section has several pieces standing at zero axis position = v. good example of uniaxial crystals all clearly shown.
This accessory now complete and lacquered and in service.

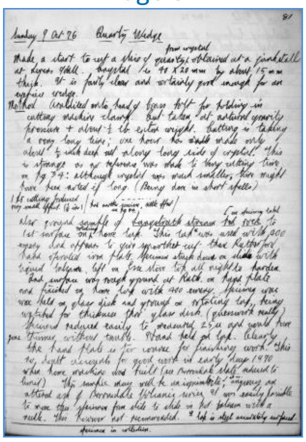
To adjust. Polaroid sheet is fitted in eyelets. Mount by a needle, it can then be rotated with a needle point so that axis is in line with screw head marker (and Carl Zeiss name engraving). It is then pushed down into mount where taper holds it fixed. Only centre part of polar sheet is in optic path. Polar not glued in.
A good looking successful job.



Note on Weather. Drought officially over, weekend 7th October 1976 after fair amount of rain. Noted in Oxfordshire and Northamptonshire that fields (grass and crops) are wonderful emerald green, better than in Spring though all burnt brown for two months. Hedgerows starting in leaf again! Some tree after early fall are also starting to leaf again. Weather now mild and wet. Crops of acorns and berries very heavy: fruit now swelling after being very small during summer, also vegetables. Likely to be a glut. Recovery powers of plants are wonderful.
(A wet October followed; 30th October 1976)
End of November very wet and chilly.

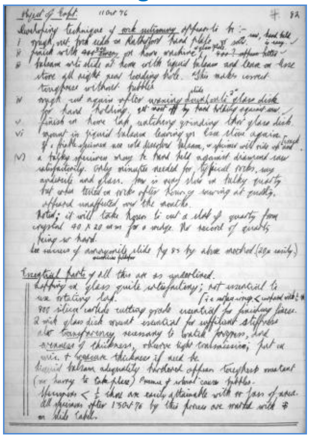
Sunday 9th October 1976

Page 81



Quartz Wedge
Made a start to cut a slice of quartz from crystal obtained at a junk stall at Levers Hall. Crystal is 20x20mm by about 15mm thick. It is fairly clear and certainly good enough for an eyepiece wedge.
Method. Araldited onto head of brass bolt for holding in cutting machine clamp. Cut taken at natural gravity pressure and about ½lb. extra weight. Cutting is taking a very long time; one hour has made only about ⅛ inch deep cut along long side of crystal. This is strange as no reference was made to long cutting time on page 34: although crystal was much smaller, time might have been noted if long. (Being done in short spells.)
1 hour cutting produced very small effect (⅛in) – had another session, little effect/see page 84.
Also ground sample of Langstrath stream bed rock [see specimen label] to 1st surface on rotating home lap.
This lap* was used with 400 emery and appears to give smoother cut than Rutherford hand operated iron plate. Specimen stuck down on slide with liquid balsam, left on Esse stove top all night to harden. 2nd surface was rough ground at Ruth. On hand plate and finished on home lap with 400 emery. Specimen was wax held on glass disk and ground on rotating lap, being watch for thickness through glass disk (guesswork really). Specimen reduced easily to measured 25µ and would have gone thinner without trouble. Hand held on lap. Clearly the hand plate is for coarse finishing work. This no doubt accounts for good work in early days 1970 when home machine was built (see Borrowdale slate reduced to limit). This sample may well be an Ignimbrite, it is anyway an altered ash of Borrowdale Volcanic series. It was easily possible to move this specimen from slide to slide in hot Balsam with a needle. This however not recommended.
*lap is steel accurately surfaced.
Specimen in collection.

Page 82



11th October 1976

Object of Experiment

Developing technique of rock sectioning appears to be:

i. Rough cut slides on Rutherford hand held plate or saw, hand held is easy.
ii. Finish with ~~400~~ 800 emery on home machine or glass plate.
iii. Balsam onto slide at home with liquid Balsam and leave on Esse stove all night near loading hole. This makes correct toughness without bubbles.
iv. Rough cut again after waxing down slide onto 2” glass disk for hand holding. Get most off by hand holding against saw.
v. Finish in home lap watching grinding through glass disk.
A bulky specimen may be hand held against diamond saw satisfactorily. Only minutes needed for typical rocks, say Andesite and glass. Saw is very slow on bulky quartz but when tested on rocks after hours of sawing at quartz, appeared unaffected over the months.
vi. Mount in liquid Balsam leaving on Esse stove again. If a friable specimen use cold dissolved Balsam or specimen will ride up and crack.

Noted: It will take hours to cut a slab of quartz from crystal 40x20mm for a wedge. No record of quartz being so hard.

See success of arrogonite (microline feldspar) slide page 83 by above method (20µ easily).

Essential parts of all this are as under:

Lapping on glass quite satisfactory; not essential to use rotating lap.

800 silica carbide cutting grade essential for finishing fineness i.e. surface irregularities less compared with ½ thickness.

2 inch glass disk mount essential for sufficient stiffness also transparency necessary to watch progress, and evenness of thickness, observe light transmission; put on microscope and measure thickness if need be.

Liquid Balsam adequately hardened appears toughest mountant (no hurry to take place). Presence of solvent causes bubbles.

Specimens < ½ thou are easily attainable with no loss of area.

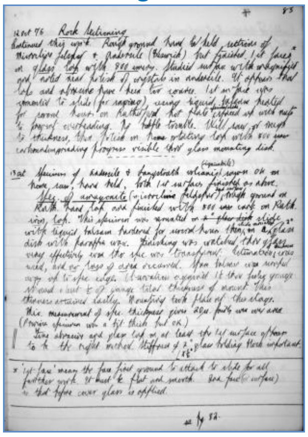
All specimens after 13th October 1976 by this process are marked with * on slide label.

12th October 1976

Rock Sectioning

Continued this work. Rough ground hand held sections of Microcline feldspar & Andesite (Keswick) but finished 1st faces* on glass lap with 800 emery. Studied surface with magnifier and noted near polish to crystals on Andesite. It appears that laps and abrasive have been too coarse. 1st surface was cemented to slide (for sawing) using liquid Balsam heated for several hours on Rutherford hot plate, specimen slide spaced up with nuts to prevent overheating. No bubble trouble. Will saw or rough to thickness, then polish on home rotating lap with 800 carborundum, grinding progress visible through glass mounting disk.

Page 83



13th October 1976

Specimens of Andesite & Langstrath volcanic (ignimbrite) sawn OK on home saw, hand held, both 1st surfaces finished as above.

Specimen of Aragonite (microline feldspar) 2nd surface rough ground on Rutherford hand lap and finished with 800 carborundum on Rutherford iron lap. This specimen was mounted on ~~2” glass disk~~ slide with liquid Balsam hardened for several hours then slide mounted on a 2” glass disk with paraffin wax. Finishing was watched thru glass very effectively even though specimen was transparent. Estimation of thickness was used, and no loss of area occurred. Spare Balsam was scraped away up to specimen edge. Observation against 1½ thou feeler gauge showed about ½ of gauge total thickness of mount. This thinness attained easily. Mounting took place at this stage.

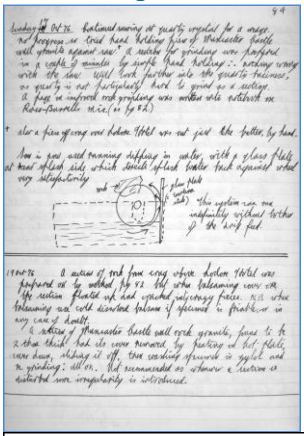
Microscopic measurement of specimen thickness gives 20µ fairly even over area. (Previous specimen was a bit thick but OK.)

Fine abrasive and glass lap on at least the 1st surface appears to be the right method. Stiffness of 2”x½” glass folding block important.

*’1st face’ means the face first ground to attack to slide for all further work. It must be flat and smooth. 2nd face (or surface) is that before cover glass is applied.

See page 82.

Page 84



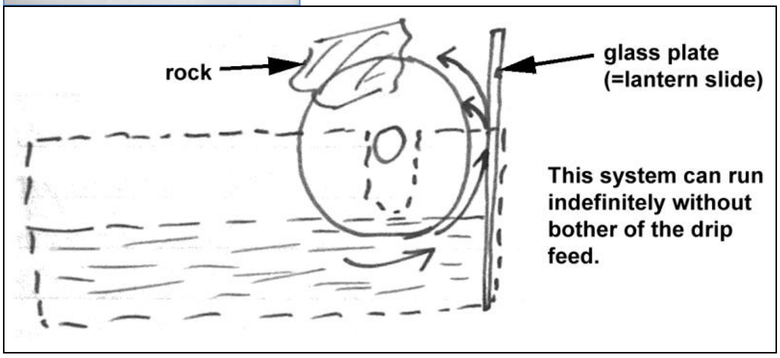
Sunday 17th October 1976

Continued sawing at quartz crystal for a wedge. No progress so tried holding piece of Muncaster Castle wall granite against saw*. A section for grinding was prepared in a couple of minutes by simple hand holding, therefore nothing wrong with the saw. Will look further into the quartz business, as quartz is not particularly hard to grind as a section.

A page on improved rock grinding was written into notebook on Ross-Burrells Microscope (page 82)

*also a piece off crag over Lodore Hotel was cut just like butter, by hand.

Saw is now used running dipping in water, with a glass plate at near splash side which directs splash water back against wheel very satisfactorily.



19th October 1976

A section of rock from crag above Lodore Hotel was prepared OK by method page 82., but when balsaming cover on the section floated up and cracked into craggy pieces. NB. when balsaming use cold dissolved Balsam if specimen is friable, or in any case of doubt.

A section of Muncaster Castle wall rock granite. Found to be 2 thou thick had its covers removed by heating on hot plate, cover down, sliding it off, then washing specimen in xylol and re-grinding: all OK. Not recommended as whenever a section is disturbed some irregularity is introduced.

During week following Sunday 17th, a proper eyepiece analyser for left hand tube was made*. No trouble. Also a brass cover for the nosepiece hole for use when no prisms in path, was completed.

(No loss of skill found if attention is paid to the job.)

* As page 78.

Riley speedometer returned from Lunderguard, and fitted 22nd October 1976.
Not recording properly on mileometer, Broken preset control.
They had replaced brass worm and fibre wheels.
Sent back 25th October 1976.
OK. Returned 8th November 1976.

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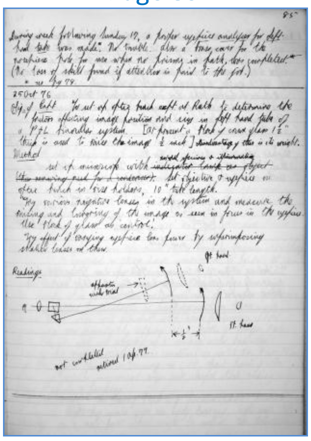


25th October 1976

Object of Experiment. To set up optic bench experiment at Rutherford to determine the factors affecting image position and size in left hand tube of a Powell and Lealand binocular system. [At present a block of crown glass 1½" thick is used to raise the image ½ inch]. Disadvantage of this is its weight.

Method.

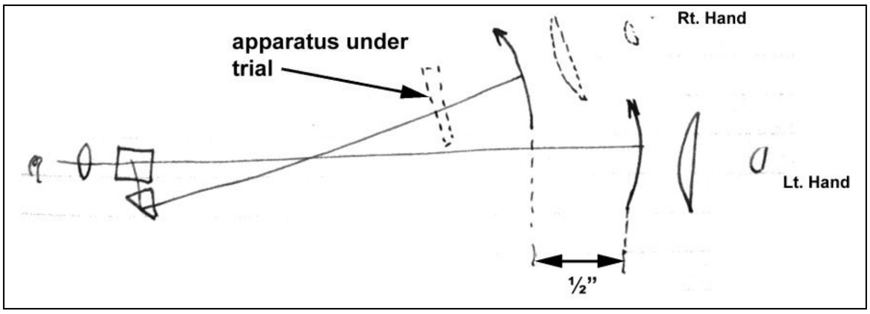
Set up microscope with specimen and illumination. Set objective and eyepiece on optic bench in vice holders, 10" tube length.

Try various negative lenses in the system and measure the raising and lowering of the image as seen in focus in the eyepiece.

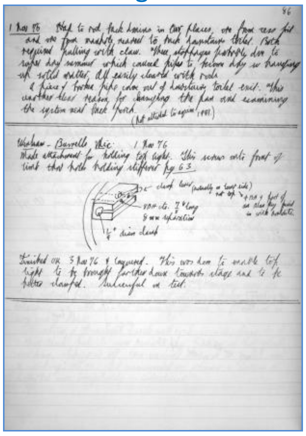
Use block of glass as 'control'.

Try effect of varying eyepiece lens power by superimposing shallow lenses on them.

Readings:-



Page 86



1st November 1976

Had to rod back drains in two places, one from cess pit and one from manhole nearest to back downstairs toilet. Both required pulling with claw. Three stoppages probably due to super dry summer which caused pipes to become dry with hanging up solid matter. All easily cleared with rods.

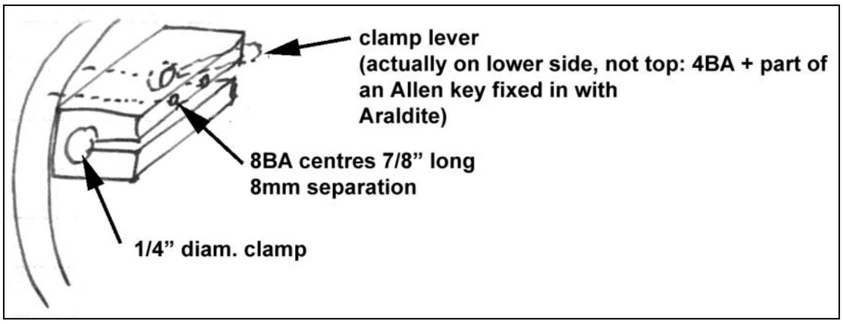
A piece of broken pipe came out of downstairs toilet exit. This another clear reason for changing the plan and examining the system near back porch.

(Not attended to again 1981)

1st November 1976

Wenham-Burrells Microscope

Made attachment for holding top light. This screws onto front of limb thru holes holding stiffener. Page 63.



Finished OK 3rd November 1976 & lacquered. This was done to enable top light to be brought further down towards stage and to be better clamped. Successful on test.

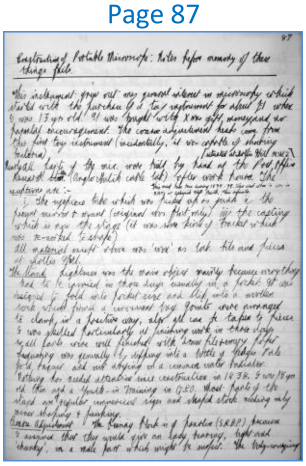
<u>Construction of Portable Microscope: Notes before memory of these things fails.</u>

This instrument grew out of my general interest in microscopy which started with the purchase of a toy instrument for about £1 when I was 13 years old. It was bought with Xmas gift money, and no parental encouragement. The coarse adjustment heads come from this first toy instrument (incidentally, it was capable of showing bacteria)

Nearly all parts of the microscope were built by hand at the Post Office Research Station (Anglo Hutch? Cable lab.) after work hours. This must have been during 1938-39. Was used often. I was in R.A.F. at Ashwick Hall, Bath. This definite. The exceptions are:-

i. The eyepiece tube which was picked up as junk
ii. The present mirror & mount (original was flat only)
iii. The casting which is now the stage (it was some kind of bracket which was re-worked to shape)

Page 87



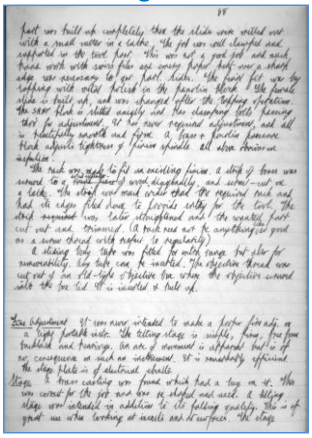
All material except above was 'iron' as lab bits and pieces at Dollis Hill.

<u>The Stand</u>. Lightness was the main object mainly because everything had to be carried in those days usually in a pocket. It was designed to fold into pocket size and slip into a woollen sock which formed a convenient bag. Joints were arranged to clamp in a positive way, also all can be taken to pieces. I was skilled particularly at finishing work in those days so all parts were well finished with draw file and emery paper. Lacquering was generally by dipping into a bottle of Gedyes? Pale Gold Lacquer and air drying on a common water radiator.

Nothing has needed attention since construction in 1938. I was 18 years old then and a Youth-in-Training in G.P.O. Most parts of the stand are of regular commercial sizes and shaped stock needing only minor shaping and finishing.

<u>Coarse Adjustment</u>. The bearing block is of Paxolin (S.R.B.P. [Transcribers Note – Synthetic Resin Bonded Paper]) because I assumed that this would give an easy bearing, light and 'chunky', in a male part which might be suspect. The body-carrying…*(next page)*

Page 88



…part was built up completely then the slides were milled out with a small cutter in a lathe. The job was well clamped and supported in the tool post. This was not a good job and much hand work with Swiss files and emery paper bent over a sharp edge was necessary to get parallel sides. The final fit was by lapping with metal polish in the Paxolin block. The female slide is built up, and was changed after the lapping operation. The SRBP block is slitted axially and has clamping bolts passing through for adjustment. It has never required adjustment, and all is beautifully smooth and firm. A brass and Paxolin pressure block adjusts tightness of pinion spindle. All above obvious on inspection.

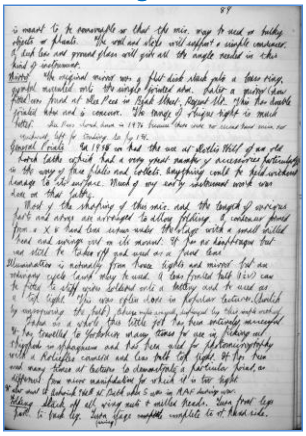
The rack was made to fir an existing pinion. A strip of brass was screwed to a ~~round piece~~ solid cylinder of wood, diagonally, and screw-cut on a lathe. The strip was much wider than the required rack and had its edges filed down to provide entry for the tool. The strip was later straightened and the wanted part cut and trimmed. (A rack need not be anything like so good as a screw thread with respect to regularity.)

A sliding body tube was fitted for extra range but also for removability. Any tube can be inserted. The objective thread was cut from an old-type objective box where the objective screwed into the box lid. It is inserted and built up.

<u>Fine Adjustment.</u> It was never intended to make a proper fine adjustment on a light portable instrument. The tilting stage is simple, firm, free from backlash and bearings. An arc of movement is apparent but is of no consequence on such an instrument. It is remarkably efficient. The stage plate is of electrical ebonite.

<u>Stage.</u> A brass casting was found which had a lug on it. This was correct for the job and was re-shaped and used. A tilting stage was intended in addition to its folding quality. This is of great use when looking at insects and at surfaces. The stage…*(next page)*

Page 89



…is meant to be removable so that the microscope may be used on bulky objects or plants. The Well and stops will support a simple condenser. A deep lens and ground glass will give all the angle needed in this kind of instrument.

Mirror. The original mirror was a flat dick stuck into a brass ring, gimbal mounted onto the single jointed arm. Later a mirror (now fitted) was found at Deepees in Beak Street, Regent Street. This has double jointed arm and is concave. The range of oblique light is much better. Deepees closed down in 1976 because there were no second hand microscopes nor equipment left for trading. See page 131.

General Points. In 1938 we had the use at Dollis Hill of an old Lorch Lathe which had a very great number of accessories particularly in the way of face plates and collets. Anything could be held without damage to its surface. Much of my early instrument work was done on that lathe.

Most of the shaping of this microscope and the length of various parts and arms are arranged to allow folding. A condenser formed from a x8 hand lens screws under the stage with a small milled head and swings out on its mount. It has no diaphragm but can still be used as a hand lens.

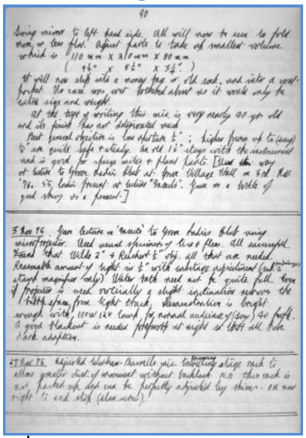
Illumination is normally from house lights and mirror but an ordinary cycle lamp may be used. A lens fronted bulb (1½V) can be fitted to stiff wires soldered onto a battery and be used as a top light. This was often done in popular lectures (Switch by unscrewing the bulb). Cheese mites are well displayed by this simple method.

Taken as a whole this little job has been entirely successful. It has travelled to Yorkshire many times for use in picking out rhizopods in sphagnum and has been used for photomicrography with a Rolleiflex camera and lens bulb top light, It has been used many times at lectures to demonstrate a particular point, as different from micro manipulation for which it is too light.

It also went to Ashwick Hall, nr. Bath when I was in R.A.F. during war.

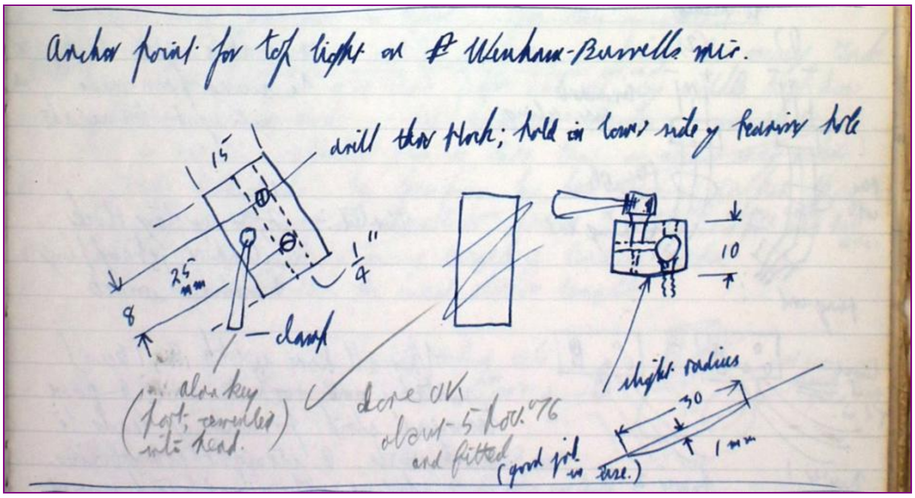
Folding. Slack off all wing nuts and milled heads. Turn front legs parallel to back leg. Turn (swing) stage complete to right hand side. *(next page)*

Page 90



Swing mirror to left hand side. All will now be seen to fold more or less flat. Adjust parts to take up smaller volume which is 110mmx210mmx80mm (4½"x8½"x3¼")
It will now slip into a money bag or old sock, and into a coat pocket. No case was ever bothered about as it would only be extra size and weight.
At the time of writing this microscope is very nearly 40 years old and its finish has not deteriorated much.
Best general objective is low aperture ½"; higher powers up to (say) ⅛" are quite safe and steady. An old 1½" stays with the instrument and is good for cheese mites and plant parts. [Used this way at lecture to Grove Ladies Club at Grove Village Hall on 3rd November 1976. 55 ladies present at lecture "Insects". Gave me a bottle of good sherry as a present.]

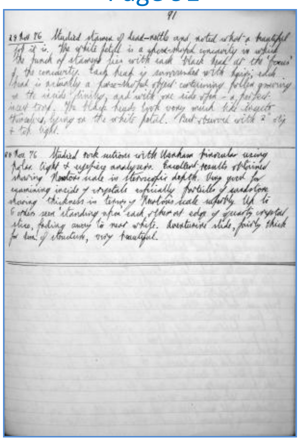
3rd November 1976
Gave lecture on "Insects" to Grove Ladies Club using microprojector. Used usual specimens of lice and fleas. All successful. Found that Wild 2" and Reichert ½" objectives all that are needed.
Reasonable amount of light in ½" with substage adjustment (sub. [Substage] = stamp magnifier only). Water bath need not be quite full. Even if projector is used vertically a slight inclination removes the bubble space from light track. Demonstration is bright enough with 100W 12V lamp for normal audience of (say) 40 people. A good blackout is needed, preferably at night so that all have dark adaption.



27th November 1976
Adjusted Wenham-Burrells microscope travelling, focussing stage rack to allow greater distance of movement without backlash. NB. this rack is not packed up and can be perfectly adjusted by shims. OK now right to end stop (Allen screw).

28th November 1976
Studied stamen of dead-nettle and noted what a beautiful job it is. The white petal is a spoon-shaped concavity in which the bunch of stamens lies with each black head at the 'focus' of the concavity. Each head is surrounded with hairs; each head is actually a purse-shaped object containing pollen growing in the inside lining, and with one side open – a perfect insect trap. The black heads look very much like insects themselves lying on the white petal. Best observed with 2" objective & top light.

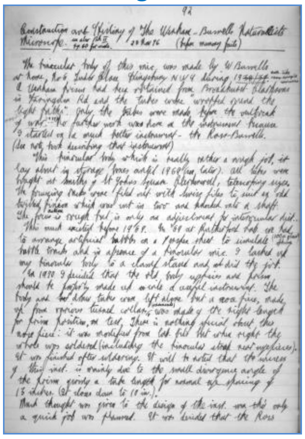
Page 91



28th November 1976
Studied rock sections with Wenham binocular using polarised light and eyepiece analysers. Excellent results obtained showing Newton's scale in stereoscopic depth. Very good for examining inside of crystals especially particles of sandstone showing thickness in terms of Newton's scale superbly. Up to 6 orders seen 'standing upon'

each other at edge of quartz crystal slice, fading away to near white. Aventurine slide, fairly thick for dimension of structure, very beautiful.

Page 92



28th November 1976

Construction and History of the Wenham-Burrells Naturalists Microscope

See also Bk.II page 60 for modifications.

(before memory fails)

The binocular body of this microscope was made by W. Burrells at home, No.6 Tudor Place, Kingsbury, N.W.9 during ~~1938/39~~ more like 1944 owing to war service.

A Wenham prism had been obtained from Broadhurst Clarkson in Farringdon Road and the tubes were 'wrapped round the light paths'. Only the tubes were made before the outbreak of war (1939). No further work was done on the instrument because I started on a much better instrument – the Ross-Burrells. (See note book describing that instrument).

This binocular body which is really rather a rough job, lay about in storage boxes until 1969 (see later). All tubes were bought at Smiths of St. John's Square, Clerkenwell, telescoping sizes. The focussing racks were filed out with Swiss files to suit an odd twisted pinion which was cut into two and knocked onto a shaft.

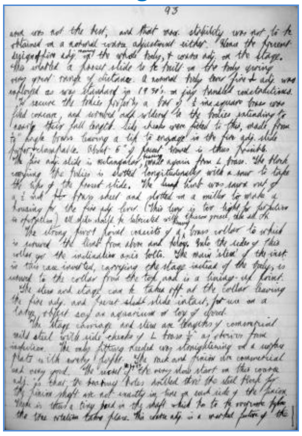
The focus action is rough but is only an adjustment for inter-ocular distance.

This much existed before 1969. In 1969 at Rutherford Laboratory We had to arrange artificial baffles on a perspex sheet to simulate (100µ glass spheres) baffle tracks and in absence of a binocular microscope I lashed up my binocular body to a clamp stand and did the job. In 1970 I decided that the old body eyepieces and prism should be properly made up into a useful instrument. The body and draw tubes were left alone but a nose piece, made up from various turned collars (oddments), was made of the right length for prism position, on test. There is nothing special about this nosepiece: it was modified from lab. Bits but when right the whole was soldered (including the binocular strap neat eyepieces).

It was finished after soldering. It will be noted that the success of this instrument is mainly due to the small divergence angle of the prism giving a tube length for normal eye spacing if 13 inches. (It closes down to 10 inches.)

Much thought was given to the design of the instrument even though only a quick job was planned. It was decided that the Ross…*(next page)*

Page 93



…arm was not the best, and that maximum stability was not to be obtained on a normal coarse adjustment either. Hence the present design of find adjustment moving on the whole body, & coarse adjustment on the stage.

This enabled a preset slide to be built in the body giving very great range of distance.

A normal body lever fine adjustment was employed as was standard in 1930s on jug handled constructions.

To secure the bodies properly a bar of ½inch square brass was filed concave, and screwed and soldered to the bodies extending to nearly their full length. Side cheeks were fitted to this, made from 1⁄16" angle brass leaving a lip to engage in the fine adjustment slide proper, clampable. About 6" of preset travel is thus possible.

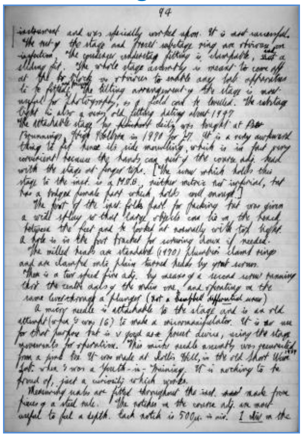
The fine adjustment slide is rectangular, bearing made again from *L* brass. The block carrying the bodies is slotted longitudinally with a saw to take the tips of the preset slide. The limb was sawn out of a ½inch brass sheet and slotted on a miller to make a housing for the fine adjustment lever. (This lever is too light for perfection in operation.) All slides should be lubricated with Apiezon Grease, then all OK.

The strong pivot point consists of a heavy brass collar to which is screwed the limb from above and below. Into the sides of this collar go the inclination axis bolts. The main 'stem' of the instrument in this case inverted, carrying the stage instead of the body, is screwed to the collar from the top and is a lining-up point.

The stem and stage can be taken off at the collar leaving the fine adjustment and preset slide intact, for use on a large object, say an aquarium or log of wood.

The stage carriage and stem are length of commercial mild steel with side-cheeks of *L* brass ⅛" as obvious from inspection. The only fitting needed was straightening on a surface plate with emery paper. The rack and pinion are commercial and very good. The secret (page 97) of the very slow start on this coarse adjustment is that the bearing holes drilled through the steel block for the pinion shaft are not exactly in line on each side of the pinion. There is thus a tiny bend in the shaft which has to be overcome before the true rotation takes place. This coarse adjustment is a marked feature of the…*(next page)*

Page 94



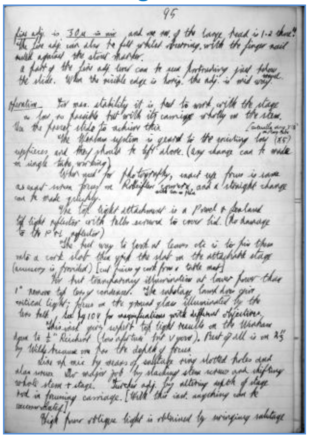
…instrument and was specifically worked upon. It is most successful. The rest of the stage and preset substage ring are obvious on inspection. The condenser understage fitting is clampable, and a sliding fit. The whole stage assembly is meant to come off at the block as obvious, to enable any lab. Apparatus to be fitted and focussed. The tilting arrangement of the stage is most useful for photography, as a field can be levelled. The substage light is also a very old fitting dating about 1947.

The attachable stage by ~~Reichert~~ Leitz was bought at Brunnings, High Holborn in 1970 for £7. It is a very awkward thing to fit hence its side mounting, which is in fact very convenient because the hands can rest on the coarse adjustment head with the stage at finger tips. [The screw which holds this stage to the instrument is a M.O.B., neither metric nor imperial, but has a bodged female part which holds well enough.]

The foot of the instrument folds parallel for packing but was given a wide splay so that large objects can be on the bench between the feet and be looked at normally with top light. A hole is in the foot bracket for screwing down if needed. The milled heads are standard (1970) plumber's clamp rings and are clamped onto plain turned heads by grab screws.

There is a two speed fine adjustment by means of a second screw running through the centre axis of the main one, and operating on the lever through a plunger (Not a Campbell differential screw.) A micro-needle is attachable to the stage and is an old attempt (when I was 16) to make a micromanipulator. It is no use for that purpose but is very good as a preset device, using the stage movements for operation. This micro-needle assembly was resurrected from a junk box. It was made at Dollis Hill, in the old Short Wave Lab. when I was a Youth-in-Training. It is nothing to be proud of, just a curiosity which works. Measuring scales are fitted throughout the instrument made from pieces of a steel rule. The notches in the coarse adjustment are most useful to feel a depth. Each notch is 500µ in division. 1 division in the…*(next page)*

Page 95



Fine adjustment is 30µ in div. and one revolution of the large head is 1.2 though. The fine adjustment can also be felt, whilst observing, with the finger nail rested against the stout marker.

A part of the fine adjustment lever can be seen protruding just below the slide. When the visible edge is horizontal the adjustment is mid way travel.

Operation. For maximum stability it is best to work with the stage as low as possible but with its carriage wholly on the stem. Use the preset slide to achieve this.

The Wenham system is geared to the existing low (x5) eyepieces and they should be left alone. (Any change can be made on single tube working.)

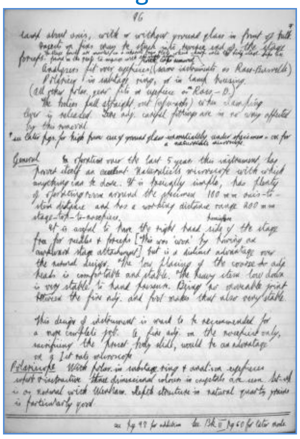
When used for photography, exact eye focus is same as exact screen focus on Rolleiflex camera with lens in place and a straight change can be made quickly.

The top light attachment is a Powell & Lealand top light reflector with bulbs screwed to cover lid. (No damage to the Powell and Lealand reflector.)

The best way to look at leaves etc. is to pin them onto a cork slab on the attachable stage then grip the slot on the attachable stage (accessory is provided) [cut pieces of cork from a table mat]

For best transparency illumination at lower power than 1" remove top lens of condenser. The substage lamp does give critical light; focus on the ground glass illuminated by the lens bulb. See page 104 for magnifications with different objectives. This instrument gives superb top light results on the Wenham down to ½" Reichert (low aperture but very good). Best of all is on 3" by Wild because one has the depth of focus. Line up microscope by means of substage ring slotted holes and also screws, No major job by slacking stem screws and shifting whole stem and stage. Further adjustment by altering depth of stage rod in focussing carriage. [With this instrument anything can be accommodated.] High power oblique light is obtained by swinging substage…*(next page)*

Page 96



…lamp about axis, with or without ground glass in front of bulb.*

Insects on pins may be stuck into reverse end of the stage forceps. The stage forceps are mounted in a separate brass plate which clamps onto the Leitz stage clips are formed on the plate to engage with the stage arms.

Analysers fit over eyepieces with caps removed (same instruments as Ross-Burrells)

Polariser in substage ring, or in lamp housing.

(All other polarising gear fits in eyepiece as on Ross-Burrells)

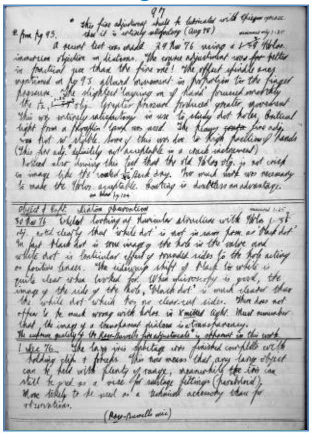
The bodies full straight out (upwards) when clamping lever is released. Fine adjustment careful fittings are in no way affected by this removal.

*see later figures for high power use of ground glass – intermediate under specimens = OK for a naturalists microscope.

General. In operation over the last 5 years this instrument has proved itself an excellent Naturalists microscope with which anything can be done. It is basically simple, has plenty of operating room around the specimen 10mm axis-to-stem distance and has a working distance range 200mm stage-top-to-nosepiece.

It is useful to have the right hand side of the stage free for needles and forceps [This was ‘won’ by having an awkward stage attachment] but is a distinct advantage over the normal design. The low placing of the coarse adjustment heads in comfortable and stable. The heavy stem low down is very stable to hand pressure. Being no moveable joint between the fine adjustment and foot makes that also very stable.
This design of instrument is much to be recommended for a more complete job. A fine adjustment on the nosepiece only, sacrificing the preset body slide, would be an advantage in a 1st rate microscope.
Polariscope. With polar in substage ring and analysers in eyepieces superb and instructive three dimensional colours in crystals are seen. Set-up is as normal with Wenham. Depth structure in natural quartz grains is particularly good.
See page 97 for addition. See Bk.II page 60. for later modifications.

Page 97



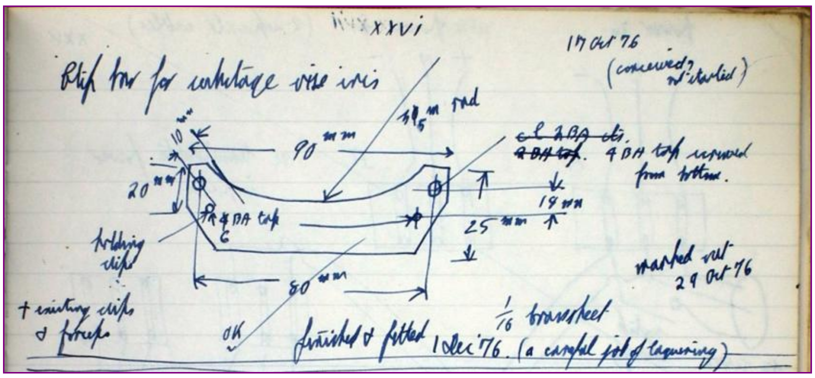
* from page 93.
A recent test was made 29th November 1976 using a measured only 1.25 Holos immersion objective on diatoms. The coarse adjustment was better in practical use than the fine one (fine adjustment should be lubricated with Apiezon Grease then it is entirely satisfactory (August 1978)) The offset spindle mentioned on page 93 allowed movement in proportion to the finger pressure. The slightest ‘laying on of hand’ focussed smoothly the ⅟12, 1.25 objective. Greater pressure produced greater movement. This was entirely satisfactory in use to study dot holes. Critical light from a paraffin lamp was used. The heavy fine adjustment was not so stable. Some of this was due to high position of hands (This fine adjustment definitely not acceptable in a crack instrument)
Noticed also during this test that the old Holos objective is not crisp in image like the coated ⅙” Beck dry. Too much work was necessary to make the Holos acceptable. Coating is doubtless an advantage.
See below page 104.

29th November 1976

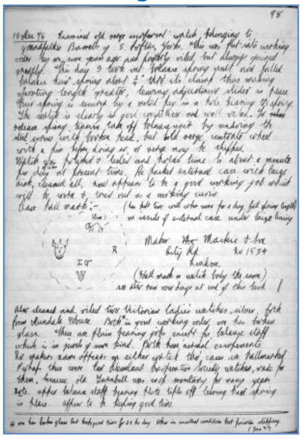
When making a repair to a clothing belt belonging to Jennifer Coates at Ruth. noticed that standard brazing rod (⅛” diameter) takes and holds a high polish. Also it can be bent easily without loss of strength later, in a bunsen flame long before red heat is reached. A small belt hook was so made involving tight bends, and all polished later with metal polish OK. The material is hard when cold, harder than most brasses. Colour is pale brass.

30th November 1976.
Object of Experiment.
Diatom Observation.
Whilst looking at Navicular structure with Holos (measured 1.25) objective noted clearly that ‘white dot’ is not in same form as ‘black dot’. In fact black dot is true image of the hole in the valve and white dot is lenticular effect of rounded sides to the hole acting as positive lenses. The sideways shift of black to white is quite clear when looked for. When microscopy is good, the image of the side of the hole, ‘black dot’ is much clearer than the white dot which has no clear-cut sides. There does not appear to be much wrong with the holes in transmitted light. Must remember that the image of a transparent diatom is a transparency.
The supreme quality of the Ross-Burrells fine adjustments is apparent in this work.

1st December 1976. The large iris substage was finished complete with holding clips and forceps. This now means that any large object can be held with plenty of range, meanwhile the iris can still be used as a vice for substage fittings (paraboloid). More likely to be used as a technical accessory than for observations.
(Ross-Burrells Microscope)



Page 98



10th December 1976

Examined old verge escapement watch belonging to grandfather Burrells of S. Loftus, Yorkshire. This was put into working order by me some years ago and properly oiled but always gained greatly. This day I took out balance spring unit and pulled balance hair spring about ¼" through its clamp thus making operating length greater, leaving adjustment slider in place. Hair spring is secured by a metal peg in a hole bearing the spring. The watch is clearly in good condition and well oiled. To release spring tension take off balance unit by undoing the steel screw with broken head, but hold verge control wheel with a pin before doing so, or verge may be chipped.

Watch was polished and tested and holds time to about a minute per day of 12 hours, at present time. Re-packed external case with baize disk, cleaned all, now appears to be a good working job which will be worn and tried out as a working curio. (has kept time well when worn for a day, full spring length)

(has kept time well when wound for a day, full spring length)
On inside of external case under baize lining

Maker:
Mackie & Fox
City Road
London
No. 1534

(Hall mark on watch body the same)
See also run over days at end of this book.

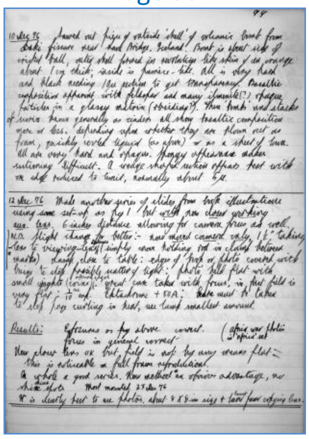
Also cleaned and oiled two Victorian ladies watches, silver, both from Dundale House. Both* in good working order, one has cracked glass. These are plain bearing jobs except for balance staff, which is in jewels of some kind. Both have 'normal' escapements. No makers name appears on either watch though cases are hallmarked. Perhaps these were East Cleveland Co-operative Society watches, made for them, because old Turnbull was co-op secretary for many years. Note. Upper balance staff bearing plate lifts off leaving hair spring in place. Appear to be keeping good time.

* one has broken glass but keeps good time for 24hr day. Other in excellent condition but pointers slipping – 1st January 1977

10th December 1976

Sawed out piece of outside 'shell' of volcanic bomb from Laki fissure near lava Bridge, Iceland. Bomb is about size of cricket ball, outer shell formed in revolution like skin of an orange about 1cm thick, inside is pumice-like. All is very hard and black needing 10µ section to get transparency. Basaltic composition apparent with feldspar and many Ilmenite(?) opaque particles in a glassy matrix (Obsidian?). These 'bombs' and stacks of scoria known generally as cinders all show basaltic composition more or less, depending upon whether they are blown out as foam, quickly cooled liquid (as above) or as a sheet of lava. All are very hard and opaque. Spongy appearance makes sectioning difficult. A wedge shaped section appears best with one edge reduced to limit, normally about 5µ.

Page 99



10th December 1976

Wired an extra outside lantern to North wall of coal house. Took lead from distribution box at kitchen near back door, through outside W.C. and along outside of North wall of kitchen to distribution box hidden in ivy at end of kitchen wall. Lantern hangs from wood rod knocked into gap in wall between coal house and house. Thus both kitchen porch and North coal house lanterns come on in parallel. 15W each. 2hrs work. A good looking job in the dark, in the ivy and trees. A loop tail is left above WC door for a parallel light in WC if needed. Switch in cupboard by kitchen North door (inside house) (twin flex without earth). Switch points for other outside lanterns:-

South garden gate in parallel with gate lanterns and series at West back of house, i.e. conservatory South west corner, conservatory night light, middle back porch, kitchen South west porch (switch by conservatory back door on skirting).

Front door lantern separate switch at top right of front door.

North arch lantern on front path and study. North wall lantern on game larder (power point by door to house.

Coal house door and inside bulb from witch at top right of outside porch of kitchen South West porch

All in operation OK. 1st January 1977.

Kitchen North porch and coal house North Wall outside lanterns; from switch in top right of cupboard by kitchen North door.

12th December 1976

Made another series of slides from book illustrations using same set-up as page 1. but with now closer working auxiliary lens. 6 inches distance allowing for camera focus as well.

NB. Slight change for the better:- Now moved camera only, 1½", taking lens to viewing-lens distance (simply move holding rd in clamp between marks). Lamp close to table: edges of book or photo covered with baize to stop possible scatter of light: photo' held flat with small weights (coins) around edges: great care taken with focus, in fact field is very flat: $1/10$ second exposure. Ektachrome +80A: Care must be taken to stop page curling in heat, use lamp smallest amount.

Results: Exposures as above correct. (Africa war photos in 'Africa' set). Focus in general correct

New closer lens OK but field in nor by any means flat.

This is noticeable on full frame reproductions. On whole a good series. New method* an obvious advantage, no shine spots. Most mounted 23rd December 1976.

It is clearly best to use photos about 8x8ins in size and lower power copying lens.

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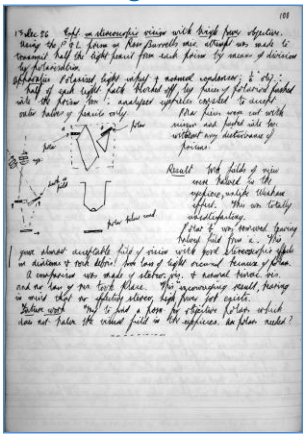
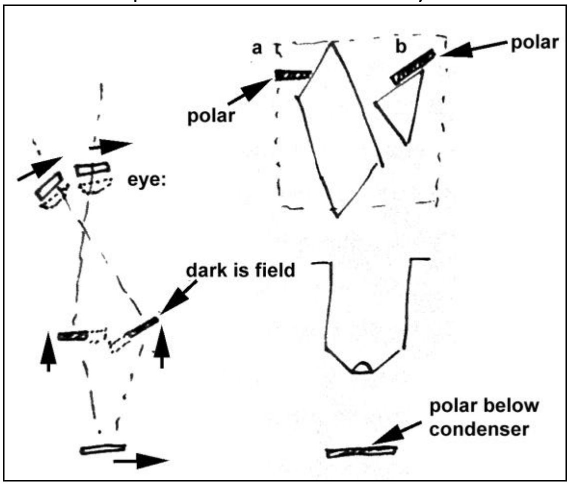


13th December 1976

Experiment on stereoscopic vision with high power objective.

Using the Powell and Lealand prism on Ross-Burrells microscope attempt was made to transmit half the light pencil from each prism by means of division by polarisation.

Apparatus. Polarised light input and normal condenser: ⅛" Objective: half of each light path blocked off by pieces of Polaroid pushed into the prism box: analyser eyepieces crossed to accept out halves of pencils only. Polar pieces were cut with scissors and pushed into box without any disturbance of prism.



Result. Both fields of view were halved in the eyepiece, unlike Wenham effect. This was totally unsatisfactory.

Polar 'b' was removed leaving halved field from 'a'. This gave almost acceptable field of vision with good stereoscopic effects on diatoms and rock debris. Some loss of light occurred because of polars.

A comparison was made of stereo visibility and normal binocular vision and no loss of resolution took place. This is an encouraging result, bearing in mind that no effective stereo high power job exists.

Future work. Try to find a form for objective polars which does not have the visual field in the eyepieces. Are polars needed?

28th December 1976

Examined water in Grove Manor grounds (Letcombe Brook) for micro life. Normal surface mud taken up with pipette and rested for 3hrs. Examination in normal live box. Weather cool and wet for some weeks. No green algae to be seen in river.

Results (per live box charge):

1st box – 6 active naviculoid diatoms: 1 testaceous rhizopod: odd small ciliates

2nd box - 3 active naviculoid diatoms: no testaceous rhizopods: no small ciliates

3rd box - 2 active naviculoid diatoms: no testaceous rhizopod: 2 small ciliates

After standing 1 day of 24hrs:- liquid now quite clear

2 active naviculoid diatoms: no testaceous rhizopods: 1 small ciliate

Life died out after 5 days.

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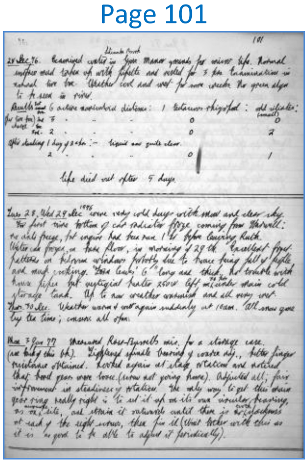
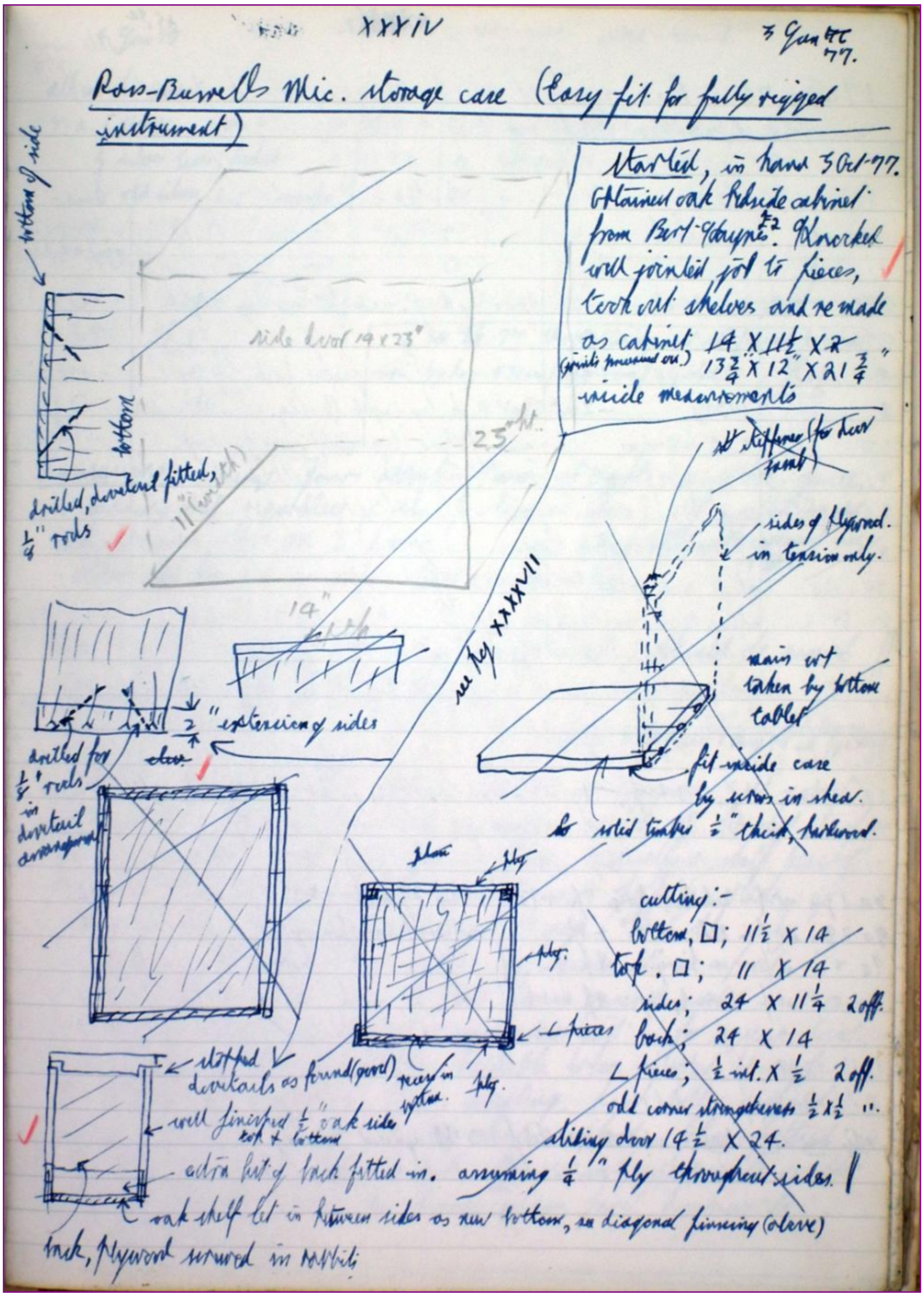


Tuesday 28th and Wednesday 29th December 1976 were very cold days with snow and clear sky. For first time bottom of car radiator froze coming from Harwell: no anti-freeze, but engine had been run 1hr before leaving Ruth.. Water can frozen, on Larder floor, in morning of 29th. Excellent patterns on bedroom window probably due to house being full of people and much cooking. "Fern leaves" 6" long and thick. No trouble with house pipes but vestigial heater 250W left on 38 hours under main cold storage tank. Up to now weather warmish and all very wet.

Thursday 30th December. Weather warm and wet again suddenly at 10am. All snow gone by tea time; conservatory all open.

Monday 3rd January 1977

Measured Ross-Burrells microscope for a storage case. (see back of this book). Tightened spindle bearing of coarse adjustment, better finger resistance obtained. Looked again at stage rotation and noticed that bevel gears were loose (screw not going home). Adjusted all; fair improvement in steadiness of rotation. The only way to get this main gear ring really right is to set it up on its own circular bearing, as on microscope site, and strain it outwards until there is no tooth slackness at each of the eight screws, then pin it. (won't bother with this as it is as good to be able to adjust it periodically).



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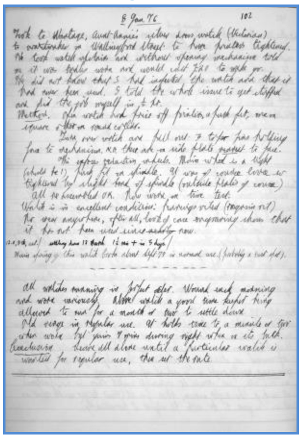

8th January 1977

Took to Wantage, Aunt Annie's silver dress watch (Victorian) to watchmaker in Wallingford Street to have pointers tightened. He took watch upstairs and without opening mechanism told me it was badly worn and would cost £20 to make good.
He did not know that I had inspected the watch and that it had never been used. I told the whole issue to get stuffed and did the job myself in ½ hour.
Method. Open watch and prise off pointers, a push fit, one on square, other on round collar.
Turn over watch and pull out 3 taper pins holding face to mechanism NB. these are on side plate nearest to face.
This exposes reduction wheels. Main wheel is a tight (should be!) push fit on spindle. It was of course loose so tightened by slight bend of spindle (outside plates of course).
All reassembled OK. Now work on time test:
Watch is in excellent condition: bearings oiled (Ragosin Oil)
No wear anywhere, after all, look of case engraving shows that it has not been used since new.
12.00 6th Set.
Settling down 12th March 1½ minutes + in 3 days.
Main spring of this watch broke about September 1977 in normal use (probably a rust spot)
All watches running in perfect order. Wound each this morning and work variously. Above watch a good time keeper being allowed to run for a month or two to settle down.
Old verge in regular use. It holds time to a minute or two when worn but gains 7 minutes during night when on its back.
Conclusion. Leave all alone until a particular watch is wanted for regular use, then set the rate.

19th January 1977
Other things on Wenham-Burrells:-
Sink stage clamp heads into block, flush.
Turn down back foot pad to match front.
Put indented head screws into most parts (6, 8, 4 BA needed)
19th January obtained OK, in scullery cupboard.

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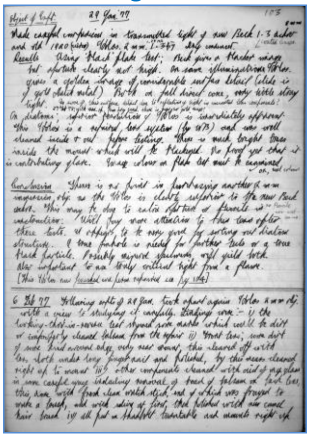
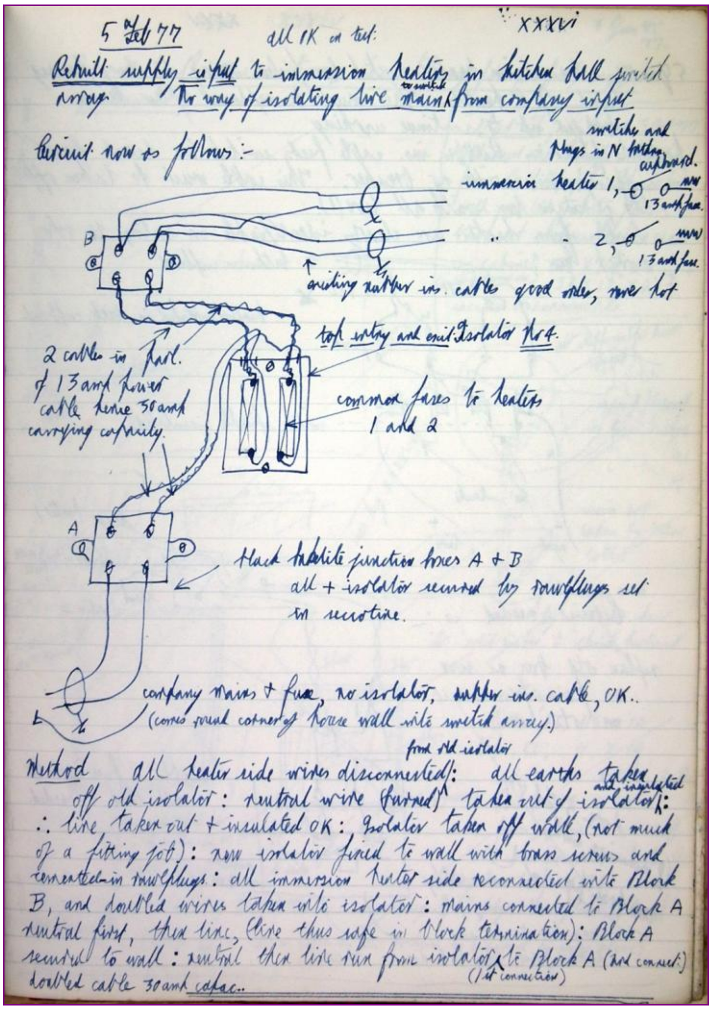


29th January 1977
Made careful comparison in transmitted light of new Beck 1.3 Achromat (coated lenses) and old circa 1930 Holos 2mm 1.25NA. Dry condenser.
Results: Using 'black flake' test; Beck gives a blacker image but aperture clearly not high. On same illumination Holos gives a golden image of considerable surface detail (slide is of gold Dutch metal). Both on full direct cone, very little stray light. Is some of this surface detail due to reflection of light in uncoated lens components? 27th February 1978: with modified operation of dry condenser there is now no gold tinge!
On diatoms; superior resolution of Holos is immediately apparent. This Holos is a repaired lens system (by WB) and was well cleaned inside and out before testing. There is much bright brass inside the mount which will be blackened. No proof yet that it is contributing to glare. Image colour on flake test must be examined. OK, real colour.
Conclusion. There is no point in purchasing another 2mm immersion objective as the Holos is clearly superior to the new Beck Achromat. This may be due to extra aperture or fluorite in construction (no fluorite was used – see catalogue). Will pay more attention to this lens after these tests. It appears to be very good for sorting out diatom structure. A true pinhole is needed for further tests or a true black particle. Possibly mineral specimens will yield both. Also important to use truly critical light from a flame.
[This Holos now finished and permanently repaired. See page 104]



6th February 1977

Following experiments of 29th January took apart again Holos 2mm objective with a view to studying it carefully. Finding were:- i. the looking-through-in-reverse test showed some marks which could be dirt or improperly cleaned Balsam from the repair ii. Front lens; some dirt of some kind around edge very near mount, this cleared off with lens cloth under long finger nail and polished, by this means cleaned right up to mount iii. other components cleaned with aid of magnifying glass in some careful way including removal of bead of Balsam on back lens, this done with fresh clean match stick, end of which was frayed to make a brush, used with saliva at first, then polished with new camel hair brush. iv. All put on Shadbolt turntable and mounts right up…*(next page)*

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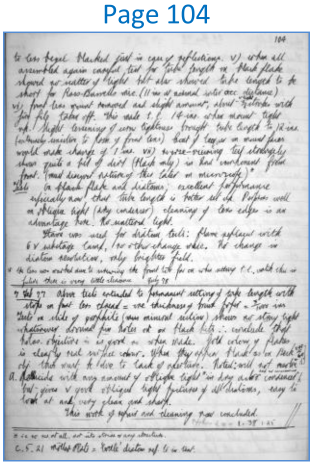

…to lens bezel blacked just in case of reflections. v. when all assembled again careful test for tube length in black flake show no scatter of light but also showed tube length to be short for Ross-Burrells microscope (11ins at normal inter-ocular distance).

vi. front lens mount removed and slight amount, about 3 very light strokes with fine file taken off. This made tube length 14 inches when mount tight up. Slight lessening of screw tightness brought tube length to 12 inches (extremely sensitive to position of front lens). Coat of lacquer on mount faces would make change of 1in.

vii. Reverse-viewing test strangely shows quite a bit of dirt (black only) in 2nd component from front (must discover nature of this later on microscope)*

Tests. On ~~black~~ flake and diatoms; excellent performance especially now that tube length is better set up. Performs well on oblique light (any condenser) cleaning of lens edges is an advantage here. No scattered light.

Flame was used for diatom tests: flame replaced with 6V substage lamp, no other change made. No change in diatom resolution, only brightness field.

*the lens was marked due to screwing the front too far on when setting tube length, watch this in future, there is very little clearance. July 1978.

7th February 1977

Above tests extended to permanent setting of tube length with stops in front lens thread – one thickness of brown paper = 3.1000 ins. Tests on slide of Graphite (mineral section) shows no stray light whatsoever around pin holes or on black bits therefore conclude that Holos objective is as good as when made. Gold colour of flakes is clearly real surface colour. When they appear black as on Beck x45 or $^1/_{12}$ objective this must be due to lack of aperture. Noted: will not resolve *Amphipleura pellucida* with any amount of oblique light* in dry achromatic condenser and no accessories but gives very good oblique light pictures of all diatoms, easy to look at and very clean and sharp. This work of repair and cleaning now concluded. Holos 2mm ~~1.37~~ 1.25. C.5.21 Möller Plate – 'bottle' diatom referred to in test.

*i.e. no resolution at all, nor into striae of any structure.

10th February 1977

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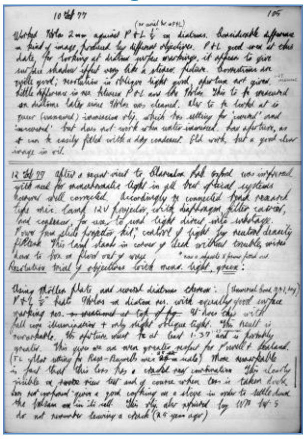

Worked on Holos 2mm against Powell and Lealand ⅛" (no serial no. on Powell and Lealand) on diatoms. Considerable difference in kind of image produced by different objectives. Powell and Lealand good even at this date for looking at diatom surface markings, it appears to give surface shadow effect very like a stereo picture. Corrections are quite good; resolution in oblique light good, aperture not given (1.27 measured) Little difference in resolution between Powell and Lealand and the Holos. This to be measured on diatoms later since Holos was cleaned. Also to be looked at is queer (un-named) immersion objective which has setting for 'covered' and 'uncovered' but does not work when water-immersed. Low aperture, as it can be easily filled with a dry condenser. Old work, but a good clear image in oil.

11th February 1977

New outside lantern in conservatory South West corner put in place; only small wiring connection needed. A bracket standing well away from corner was put in place; actually a shelf bracket. This an advantage as now all lanterns are properly made, of good quality, and situated all round house. This is the only pentagonal lantern with a copper roof because it is exposed to weather. Lanterns with wood top plate are in general under eaves and so protected from rain. Method of construction just as for square lanterns but top lugs made deliberately bendable when riveted to roof to adjust the squareness before sweating. Lamp holder suspended across lamp top on piece of old shade support. Glass puttied in, as 5 sides do not support each other so well as 4 sides with flat top plate. Access by sliding one glass panel downwards. (all successful).

12th February 1977

After a recent visit to Clarendon Lab., Oxford was impressed with need for monochromatic light in all best optical systems however well corrected. Accordingly re-connected bench research type microscope lamp 12V projector, with diaphragm, filter carrier, and condenser, for use to send light direct into substage. Power from slide projector kit*, control of light by neutral density filters. This lamp stands in corner of desk without trouble, wires down to box on floor out of way.

*now a separate transformer fitted out

Resolution trial of objectives with mono. Light, green: Using Möller's Plate and several diatoms thereon: (Universal Condenser NA.1, dry), Powell and Lealand ⅛" beats Holos in diatom resolution with equally good surface marking resolution ~~as mentioned at top of page~~ It does this with full core illumination and only slight oblique light. The result is remarkable. Its aperture must be at least 1.37 (1.27 measured) and is probably greater. This gives one an even greater respect for Powell and Lealand. (Tube Length collar setting for Ross-Burrells microscope ~~28~~ ~~22~~ 25 in scale). More remarkable in fact that this lens has a cracked rear combination. This clearly visible in reverse view test and of course when lens is taken down. Lens rear component given a good cooking on a stove in order to settle down the Balsam in its cell. This objective also repaired by WB but I do not remember leaving a crack (25 years ago).

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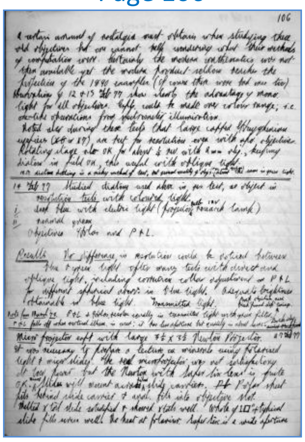


A certain amount of nostalgia must obtain when studying these old objectives but one cannot help wondering what their methods of compensation were. Certainly the modern mathematics was not then available yet the modern product seldom reaches the perfection of the 1890 examples (of course there were bad ones too).

Observations of 12th and 15th February 1977 show clearly the advantage of mono light for all objectives. Experiments could be made over colour range; i.e. one-line observations from spectrometer illumination.

Noted also during these tests that large capped Huyghenian eyepieces (~~x6 or~~ x7) are best for resolution even with apochromat Objectives. Rotating stage also OK for about ¼ revolution with 2mm objective, keeping diatom in field OK, this useful with oblique light.

NB. diatom dotting is a risky method of test, but general quality of objectives (Powell and Lealand and Holos) about the same in green light.

14th February 1977

Studied diatoms used above in resolution test, as object in resolution tests with coloured light.

i. Deep blue with electric light (projector bulb 12V research lamp)
ii. Normal green

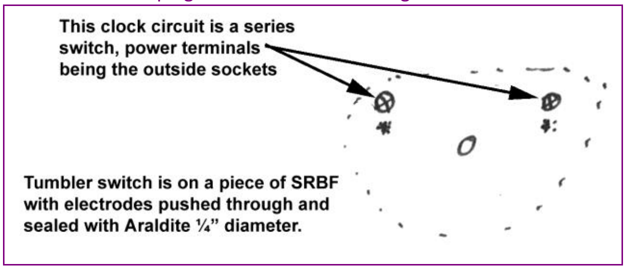
Objectives Holos and Powell and Lealand

Results. No difference in resolution could be noticed between blue and green light after many tests with direct and oblique light, including corrective collar adjustment on Powell and Lealand for different spherical observation in blue light. Adequate brightness obtainable in blue light. Transmitted light. Best objective funnel stop linings.

Note from March 1978. Powell and Lealand and Holos resolve equally in transmitted light with green filter. Powell and Lealand falls off when vertical illumination is used: it has less aperture but quality is about same.

25th February 1977

Made a switch to plug in to time clock in dining room heater circuit. A large tumbler, double pole, but one side only in use.



The whole unit pulls out (a tight push fit) and is replaced with the clock. Tested for temperature rise OK. (about 5 hours work). The switch merely connects the outer sockets together.

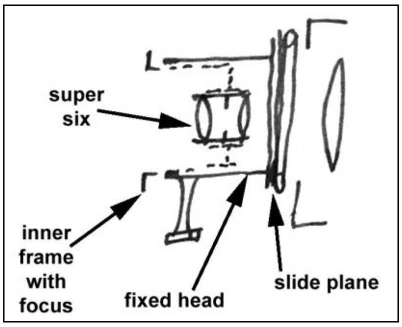
27th February 1977

Micro projector experiment with large 3½x3½ Newton Projector.

It was necessary to prepare a lecture on minerals using polarised light and microslides. The real microprojector was not satisfactory at low power but the Newton with Super Six lens is quite OK. Microslides will mount across film slide carriers. Polaroid sheet fits behind slide carrier and analyser fits into objective slot.

Melted crystal slide, solidified and showed crystals well. Whole of 1" of typical slide fills area well. No heat at polariser. Super Six is a wide aperture…*(next page)*

…2" objective 'projector' design f1.9. Lens diameter ¾". If this lens could be mounted in projector with field unlimited it would do very well. It would need the whole focussing front of the projector to be unscrewed and a sliding holder inserted (no monumental difficulty). At present it is in a long reach tube which vignettes its screen diameter.



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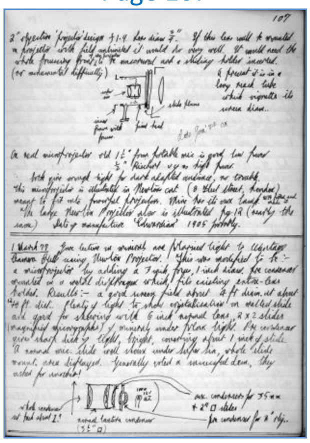
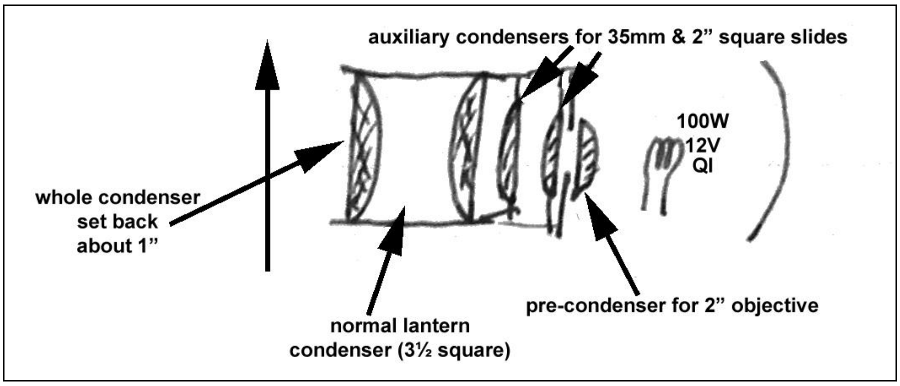


On real microprojector old 1½" from portable microscope is a good low power, ½" Reichert very good as high power. Both give enough light for dark adapted audience, no trouble.

This microprojector is illustrated in Newton's catalogue (8 Fleet Street, London), meant to fit into powerful projectors. Mine has its own lamp (WB fitted and made it). The large Newton projector also is illustrated page 12 (nearly the same). Date of manufacture 'Edwardian' 1905 probably.

1st March 1977

Gave lecture on minerals and polarised light to Wantage Camera Club using Newton projector. This was modified to be:- a microprojector by adding a 3 inch focus, 1 inch draw. Pre-condenser mounted in a metal diaphragm which fits existing extra lens holder. Results:- a good screen field about 4ft diameter at about ~~10~~ 12ft. distance. Plenty of light to show crystallisation on melted slide and good showing with 6 inch normal lens, 2x2 slides (magnified micrographs) of mineral under polarised light. Pre-condenser give sharp disk of light, bright, covering about q inch of slide mount area displayed. Generally voted a successful demonstration, they asked for another!



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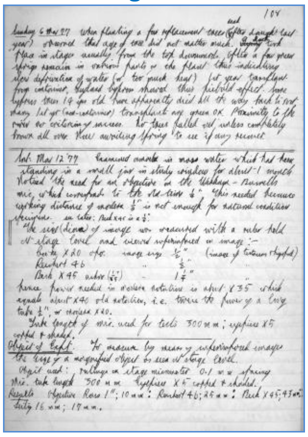

Sunday 6th March 1977

When planting a few replacement trees (dead after drought last year) observed that age of tree did not matter much. Death took place in stages, usually from the top downwards. Often a few green sprigs remain in various parts of the plant thus indicating slow deprivation of water (or too much heat). 1st year transplant from container, Leyland Cypress showed this piebald effect. Some Cypress tree 14 years old have apparently died all the way back to root. Many 1st year (non-container) transplants are green OK. Proximity to the river no criterion of success. No trees pulled out unless completely brown all over. Now awaiting Spring to see if any recover.

Saturday 12th March 1977.

Examined amoebae in moss water which had been standing in a small jar in study window for about 1 month. Noticed the need for an objective on the Wenham-Burrells microscope which corresponds to the old-time ¼". This needed because working distance of modern ⅙" is not enough for natural condition specimens. (see later: Beck x45 is a ⅕")

The size (diameter) of image was measured with a ruler held at stage level and viewed superimposed on image:-
Cooke x20 apochromat, image size ½" (image of testaceous rhizopod)
Reichert 4b, image size ½" (image of testaceous rhizopod)
Beck x45 achromat (⅕"), image size 1¼" (image of testaceous rhizopod)
Hence power needed in modern notation is about x35 which equals about x40 old notation, i.e. twice the power of a long tube ½" or x20. Tube length of microscope used for tests 300mm; eyepiece x5 capped and shaded.

Object of Experiment

To measure by means of superimposed images the size of a magnified object as seen at stage level.
Object used: ruling on stage micrometer 0.1mm spacing. Microscope tube length 300mm. Eyepiece x5 capped and shaded.
Results. Objective Ross 1": 10mm; Reichert 4b: 25mm; Beck x45: 43mm; Leitz 16mm: 17mm.
(next page)

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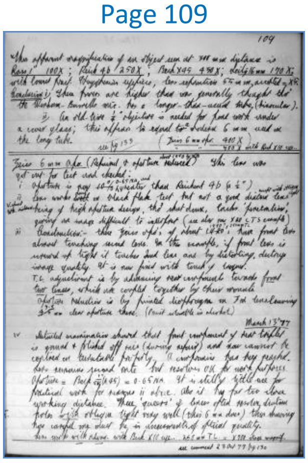

This apparent magnification of an object seen at 300mm distance is Ross 1" 100x; Reichert 4b 250x, Beck x45 430x, Leitz 16mm 170x, with lowest practical Huyghenian eyepiece, less separation 55mm, accepted = x7.

Conclusion

- i. These powers are higher than was generally thought though the Wenham-Burrells microscope has a longer-than-usual tube (binocular).
- ii. An old-time ¼" objective is needed for fine work under a cover glass; this appears to equal a modern 6mm used in the long tube.

Zeiss 6mm apochromat 400x
Zeiss 6mm apochromat 700x with Beck x10 eyepiece.

See page 133.

Zeiss 6mm Apochromat (repaired and aperture reduced, about 1950 by WB)
This lens was got out and checked:

- i. aperture is now ~~10%~~ 0.65 and greater than Reichert 4b (a ½")
- ii. Lens works best on black flake test but not a good diatom lens except with oblique light (very short working distance) being a high aperture design, though shut down, lacks 'penetration', giving an image difficult to interpret (see also new x20 CTS example)

iii. Construction:- the Zeiss apochromats of about 1880? (x250 mm tube length) have front lens almost touching second lens. In this example, if front lens is screwed up tight it touches 2nd lens and by distorting, destroys image quality. It is now fixed with touch of lacquer. Tube length adjustment is by advancing rear component in 3rd lens leaving 7.5mm clear aperture there. (Paint soluble in alcohol.)

iv. 13th March 1977. Detailed examination showed that front component of rear triplet is ground and polished off axis (during repair) and now cannot be centred on turntable properly. A compromise has been reached. Lens remains second rate but resolves OK for work purposes. Aperture = Beck ⅕" (x45) = 0.65 NA. It is still of little use for practical work for reasons ii above. Also it has far too close working distance. There 'queers' of lenses often resolve diatom holes with oblique light very well (this 6mm does) thus showing how careful one must be in assessments of optical quality. Lens works with advantage with Beck x10 eyepiece. 260mm Tube length – x700 stage magnification.

See comment 23rd October 1977 page 130.

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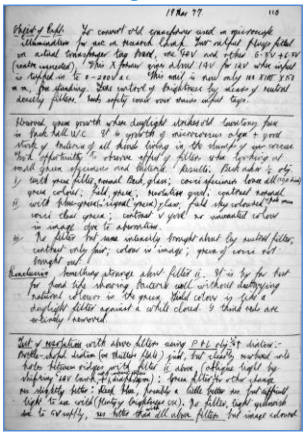

19th March 1977

Object of Experiment.

To convert old transformer used on microscope illumination for use of research lamp.

Two output plugs fitted on actual transformer tag board, one ~~10V~~ 5V and other 6.3V+6.3V (centre connected). This transformer gives about 14V for 12V when input tapped in to 0-200V AC. This unit is now only 100x100x150mm, free standing. Fine control of brightness by means of neutral density filters. Needs safety cover on mains input tags.

Observed green growth where daylight strikes old lavatory pan in back hall W.C. It is growth of micrococcus alga and good stock of bacteria of all kinds living in the clumps of coccus. Took opportunity to observe effect of filters when looking at small green specimens and bacteria. Results: Beck Achromat ⅙" objective.

i. With green filter, normal Beck glass; cocci specimens (10µ diameter) all green colour; field green; resolution good; contrast normal

ii. With blue-green (=signal green) glass; field sky coloured, very pale green; cocci clear green; contrast very good, no unwanted colour in image due to aberration.

iii. No filter but same intensity brought about by neutral filter; contrast only fair; colour in image; green of cocci not brought out.

Conclusion. Something strange about filter ii. It is by far best for pond life showing bacteria well without destroying natural colours in the green. Field colour is like a daylight filter against a white cloud. I think reds are entirely removed.

Test of resolution with above filters using Powell and Lealand objective ⅛" and diatom:-

Bottle shaped diatom (on Möller's plate) just, but clearly resolved into holes between ridges with filter ii. Above (oblique light by shifting ~~10V~~ 5V lamp, and use of condenser oblique and diaphragm): Green filter i., no other change. Resolution slightly better: Deep blue, possibly a little better resolution but difficult light to see with (plenty of brightness OK). No filter, light yellowish due to 5V supply, resolution better than with all above filters but image coloured…*(next page)*

…due to outstanding objective lack of correction.

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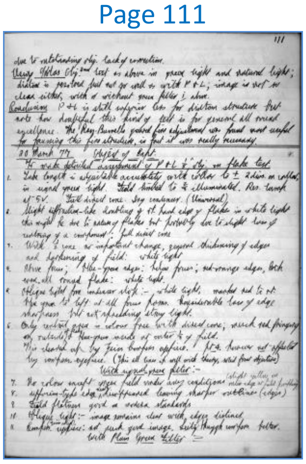

Using Holos objective 2mm. Test as above in green light and natural light; diatom is resolved but not so well as with Powell and Lealand; image is not so clean either, with or without green filter i. above,

Conclusion. Powell and Lealand is still superior lens for diatom structure but note how doubtful this kind of test is for general all round excellence. The Ross-Burrells geared fine adjustment was found most useful for focussing this fine structure, in fact it was really necessary.

20th March 1977

Object of Experiment

To make detailed assessment of Powell and Lealand ⅛" objective on flake test.

1. Tube length is adjustable accurately with collar to ± 2 divisions on collar, in signal green light. Field limited to ⅔ illuminated. Research lamp at 5V. Full direct cone. Dry condenser (Universal)
2. Slight diffraction like doubling of right hand edge of flake in white light. This might be due to nature of flakes but probably due to slight loss of centring of a component; full direct cone.
3. With ½ cone no important change, general thickening of edge and darkening of field; white light

4. Above focus; blue-green edges: below focus; red-orange edges, both even all round flake: white light
5. Oblique light from condenser stop:- white light, marked red to right, blue-green to left at all focus positions. Considerable loss of edge sharpness but no spreading stray light.
6. Only central area is colour free with direct cone; much red fringing on outside of flake, blue-green inside at outer ⅓ of field. This cleaned up by Zeiss Compensating eyepiece. Pt.4. however not affected by compensating eyepiece (this all lines up well with theory, solid front objective)

With signal-green filter:-

7. No colour except green field under any conditions (slight yellow on outer edge at field periphery)
8. Diffusion-type edge nearly disappeared leaving sharper outlines (edges)
9. Field flatness good on modern standards
10. Oblique light:- image remains clear with edges distinct
11. Compensating (Zeiss solid) eyepiece: not such good image. Leitz Huyghenian Compensating better.

With Plain Green Filter:- *(next page)*

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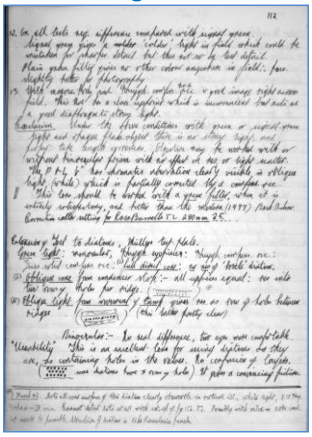


1. On all tests requiring difference compared with signal green. Signal green gives a 'colder' light in field which could be mistaken for sharper detail but this not so on test detail. Plain green filter gives no other colour anywhere in field therefore possibly slightly better for photography.
2. With monocular body and Huyghenian compensating No.4. ocular, very good image right across field. This No.4. has a close eye-point which is inconvenient but acts as a good diaphragm to stray light.

Conclusion. Under the above conditions with green or signal-green light and opaque flake object There is no stray light, and perfect tube length correction. Objective may be worked with or without binocular prism with no effect on resolution or light scatter. The Powell and Lealand ⅛" has chromatic aberration clearly visible in oblique light (white) which is partially corrected by a compensating ocular. This lens should be worked with a great filter, when it is entirely satisfactory, and better than modern (1977) Beck achromatic. Correction collar setting for Ross-Burrells tube length 280mm 25.

Extension of Test to diatoms. Möller's test plate. Green light: monocular, Huyghenian eyepieces, Huyghenian compensating ocular, Zeiss solid compensation ocular.

i. Full direct cone, no resolution of 'bottle' diatom
ii. Oblique cone from condenser stop, all eyepieces equal, resolution into two rows of holes per ridge.*

iii. Oblique light from movement of lamp gives resolution do row of holes between ridges. (this latter pretty clear.

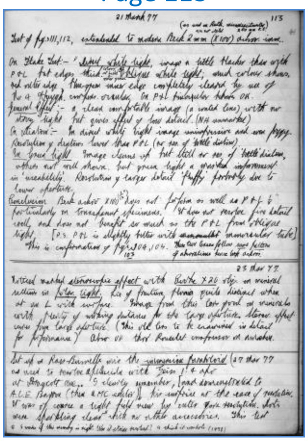
Binocular:- No real difference, two eyes more comfortable. "Useability". This is an excellent lens for seeing diatoms as they are, as containing holes in the valves. No confusion of layers.

It gives a convincing picture.

*1st March 82. Dots all over surface of this diatom clearly observable in vertical illumination. White light, x10 Huyghenian, Wenham-Burrells microscope. Cannot detect dots at all with set-up of page 112 Transmitted Illumination. Possibly oiled on Abbe and it would be possible. Structure of diatom is like *Pinnularia* panels.

21st March 1977

Page 113



Test of pages 111, 112

Extended to modern Beck 2mm (x100) achromat immersion (as used on Ruth. microdensitometer NA not stated 250mm tube length.

On flake test:- Direct white light, image a little blacker than with Powell and Lealand but edges thick. Colour at field outer zones. Oblique white light; much colour shows, red outer edge, blue-green inner edge completely cleared by use of No.4 Huyghenian compensating ocular. On Powell and Lealand binocular colours OK.

General effect:- a clean comfortable image (a coated lens) with no stray light but gives effect of low detail (NA unmarked)

On diatom:- In direct white light image unimpressive and even foggy. Resolution of diatoms lower than Powell and Lealand (no resolution of 'little' diatoms).

In green light. Image cleans up but still no resolution of 'little' diatoms, others not well shown, but green light a marked improvement in 'useability'. Resolution of larger detail 'fluffy' probably due to lower aperture.

Conclusion. Beck achromat x100 ($\frac{1}{12}$") does not perform as well as Powell and Lealand ⅛" particularly in transparent specimens. It does not resolve fine detail well and does not benefit so much as the Powell and Lealand from oblique light. [P.S. Powell and Lealand is slightly better with monocular tube]
This is confirmation of pgs 104, 105. These two lenses follow same pattern of aberrations hence both achromats.

23rd March 1977

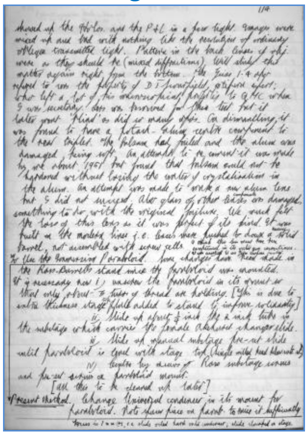
Noticed marked stereoscopic effect with Cooke x20 objective in mineral sections in polarised light. Lie of fracture planes quite distinct when at an angle with surface. Image from this lens good in minerals with plenty of working distance for the large aperture. Stereo effect comes from large aperture. (This old lens to be examined in detail for performance.) Also OK through Rousselet compressor on amoebae.

27th March 1977

Set up on Ross-Burrells microscope the immersion paraboloid as used to resolve *Amphipleura pellucida* with Zeiss 1.4 apochromat at Draycott Avenue. I clearly remember, [and documented to A. L. E. Barron (then QMC editor)], his surprise at the ease of resolution. It was of course a light field view by outer zone resolution. Dots were sparkling clear* with no other accessories. This test…*(next page)*

*I wonder if this memory is right. Was it striae resolved? I think it was dots. 1979

Page 114



…showed up the Holos and the Powell and Lealand in a poor light. Images were mixed up and bad with nothing like the resolution of ordinary oblique transmitted light. Patten in the back lenses of objectives were as they should be (mixed diffractions). Will study this matter again right from the bottom. The Zeiss 1.4 apochromat referred to was the property of D. J. Scourfield, rotifera expert; who left a lot of his microscopical property to QMC when I was secretary. Lens was borrowed for this test but it later went 'blind' as did so many apochromats. On dismantling, it was found to have a potash-alum centre component to the rear triplet. The Balsam had failed and the alum was damaged, being soft. An attempt to re-cement it was made by me about 1951 but found the Balsam could not be hardened without losing the water of crystallisation in the alum. An attempt was made to make a new alum lens but I did not succeed. Also glass of other lenses (components) was damaged, something to do with the original failure. We much felt the loss of this lens as it was perfect of its kind. It was built on the modern lines i.e. lenses were pushed down a heavy solid barrel, not assembled with screw cells. I think this lens must have been exceptional in its outer zone corrections. It was essential to use Zeiss compensating ocular.

To use the Immersion Paraboloid. Some changes have been made in the Ross-Burrells stand since the paraboloid was mounted. It is necessary now

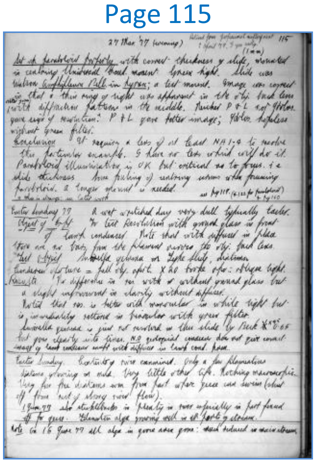
i. Unscrew the paraboloid in its mount so that only about 3 turns of thread are holding [This is due to extra thickness stage top plate added to stand to improve solidity.]
ii. Slide up about ¼ inch the 2 inch tube in the substage which carries the female Akehurst change slide.
iii. Slide up manual substage pre-set slide until paraboloid is level with stage top (single milled head below substage)
iv. Centre by means of Ross substage screws and pre-set screws on paraboloid mount.

[All this to be cleared up later.]

Present Method. Change Universal condenser in its mount for paraboloid. Note spacer piece on paraboloid to raise it sufficiently. Focus is 1mm(+) i.e. slide oiled hard onto condenser; slide clamped on stage.
(next page)

27th March 1977 (evening)

Page 115



Set up paraboloid properly with correct thickness of slide (1mm), mounted in centring Universal Condenser mount. Green light. Slide was Watson *Amphipleura pellucida* in Styrax; a test mount. Image was correct in that a thin ring of light was apparent in the objective back lens outer zones with diffraction patterns in the middle. Neither Powell and Lealand nor Holos gave sign of resolution*. Powell and Lealand gave better image; Holos hopeless without Green filter.

Conclusion. It requires a lens of at least NA1.4 to resolve this particular example. I have no lens which will do it. Paraboloid illumination is OK but critical as to focus i.e. slide thickness. Some fouling of centring screws when focussing paraboloid. A longer mount is needed.

See page 118 (and 122 for paraboloid) and page 160

*this is strange: see later work

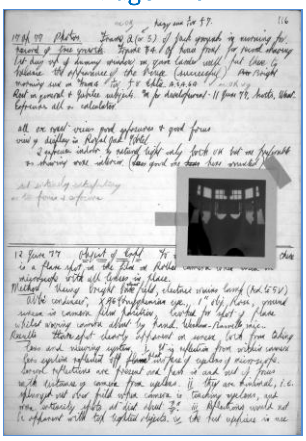
Retired from Professional Employment 1st April 1977. 3 Years early.

Easter Sunday 1977
A wet wretched day, very dull, typically Easter.
Object of Experiment
To test resolution with ground glass in front of lamp condenser. Note that with diffuser in place there are no bars from the filament across the objective back lens.
Test object. *Surirella gemma* on Type Slide, diatoms.
Condenser aperture – full objective aperture, x20 Cooke Apochromat; oblique light.
Results:- No difference in resolution with or without ground glass but a slight improvement in clarity without diffuser.
Noted that resolution is better with monocular in white light but is immediately restored in binocular with green filter.
Surirella gemma is just not resolved in this slide by Beck x45 0.65 but goes clearly into lines. NB. geological condenser does not give correct image of lamp condenser except with diffuser in lamp condenser position.

Easter Sunday. Contents of river examined. Only a few filamentous diatoms growing on mud. Very little other life. Nothing macroscopic. Very few free diatoms even from part where geese can swim (shut off from rest of strong river flow).
1st June 1977 – Sticklebacks in plenty in river especially in part fenced off for geese. Filamentous algae growing well in all parts of stream.
Note: On 16th June 1977 all algae in goose area gone: much reduced in main stream.

Monday 18th April 1977
Roof Insulation
1½ hours work
20x16ft (herring-bone beams)
Used 10 bags of Micafil; easy to lift each sealed bag; covered No.1 bedroom sealing right out to eaves; joints about 4 inches deep but irregular carrying split willow laths and thick plaster; owing to ceiling raising in past; slope to east wall not covered (about 1ft height); 10 bags did about ⅔ of job. NB. It requires about 15 standard bags to cover a largish room 4 inches deep.
This is out by a factor of two on advertisements.
Job easy to do but a bit dusty. Care is needed at eaves where, unless stuffed with something Micafil would roll down to the outside of house. In Manor some kind of stiffing is needed at East side eaves. Probably old clothes and sacking will be used when job finally completed (only 10 bags ordered).
This now completed 15 bags – about June 1977.

Page 116



17th April 1977
Photos
Frame 2 (or 3) Exposure OK. Hazy sun $^{1}/_{100}$ f7, of back grounds in morning for record of tree growth. Frame 4 of house front for record showing 1st day up of dummy window in game larder wall, put there to balance the appearance of the house (successful). Bright morning sun on Frame 4 $^{1}/_{100}$ f8 Ektachrome ASA64. Exposure OK, very good.
Rest in general and Jubilee subjects. In for development 11th June 1977, Scotts, Wantage. Exposures all on Calculator.
All over exposed, most views good exposures and good focus.
View of display in Royal Oak Hotel.
2 exposures indoor by natural light only, both OK but one preferable as showing more interior (less good one here mounted).

Set entirely satisfactory as to focus and exposure.

12th June 1977

Object of Experiment

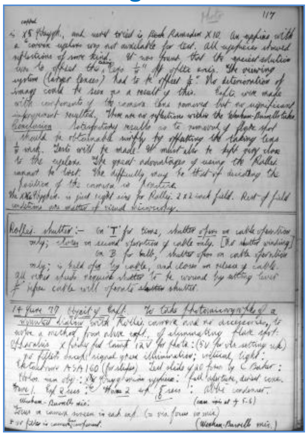
To observe whether or not there is a flare spot on the film on Rolleiflex camera when used on microscope with all lenses in place.

Method:- Using bright bare clear field, electric mains lamp (red. to 5v), Abbe condenser, x6 Huyghenian eyepiece, 1" objective Ross, ground screen in camera film position, looked for spot of flare whilst moving camera about by hand. Wenham-Burrells microscope.

Results:- Flare spot clearly apparent on screen both from taking lens and viewing system

i. It is reflection from within camera lens system, reflected off flat surface of eye-lens of microscope. Several reflections are present and pass in and out of focus with distance of camera from eye-lens
ii. They are minimal, i.e. splurged out over field when camera is touching eye-lens, and more intensity spots at distance of about $^3/_8$"
iii. Reflections would not be apparent with top lighted objects
iv. The best eyepiece in use…*(next page)*

Page 117



…is capped x6 Huyghenian, and worst tried is Ramsden x10.

An eyepiece with a convex eye-lens was not available for test. All eyepieces showed reflections of some kind. It was found that the easiest solution was to offset the taking lens ⅛" off optic axis. The viewing system (larger lenses) had to be offset ¼". No deterioration of image could be seen as a result of this. Experiments were made with components of the camera lens removed but no significant improvement resulted. There are no reflections within the Wenham-Burrells tubes.

Conclusion. Satisfactory results as to removal of flare spot should be obtainable simply by offsetting the taking lens ⅛ inch. Tests will be made. It must also be kept very close to the eye-lens. The great advantages of using the Rolleiflex cannot be lost. The difficulty may be that of deciding the position of the camera in practise.

The x6 Huyghenian is just right size for Rolleiflex 2x2 inch field. Rest of field conditions are matter of visual microscopy.

Rolleiflex shutter:= On 'T' for time, shutter opens on cable operation only; closes on second operation of cable only. [No shutter winding]

On 'B' for bulb, shutter opens on cable operation only; is held open by cable, and closes on release of cable.

All other speeds require shutter to be wound by setting lever before cable will operate shutter.

14th June 1977

Object of Experiment

To take photomicrographs of a mounted diatom, with Rolleiflex camera and no accessories, to evolve a method, from above experiment, of eliminating flare spot.

Apparatus:- transformer fed lamp 12V for photo: (5V for visual setting up); no filters (UV filter in camera lens component) except signal green illuminator; critical light; Ektachrome ASA160 (for slides); Test slide of 20 forms by C. Baker; Holos immersion objective; x6 Huyghenian eyepiece; full aperture, direct cone; Abbe condenser; Wenham-Burrells microscope

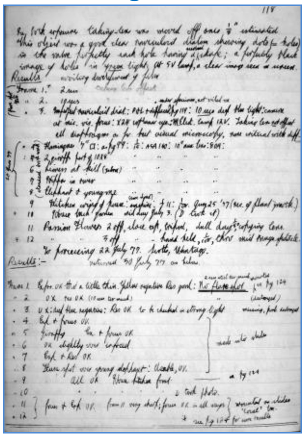
Focus in camera screen in each exposure (=visual focus in microscope), Camera iris at f5.6

Frame 1. Exposure 2 seconds

Frame 2. Exposure 10 second

(next page)

Page 118

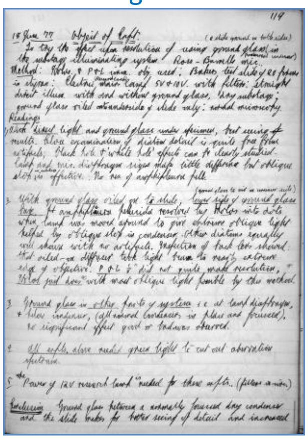


In both exposures taking lens moved off axis ⅛" estimated. This object was a good clear naviculoid diatom showing dots (=holes) in the valve perfectly, each hole having a resolved shape; a perfectly black image of holes in green light. At 5V lamp, a clear image seen on screen.
Results:- awaiting development of film.
Frame 1. 2 seconds. Taking lens offset
Frame 2. 10 seconds. Taking lens offset
Frame 3. Imperfect naviculoid diatom: Powell and Lealand and diffuser under specimen, not oiled, page 119: 10 seconds deep blue light, camera at microscope visual focus, x25 coplanar eyepiece, main electric lamp 12V, taking lens not offset. All diaphragms as for best visual microscopy, none critical with diffuser.
Frames 4,5,6,7,8 20th June 1977 – standard book work
Frame 4. Flamingos 7" square, as page 99, $\frac{1}{15}$, ASA160, 10" auxiliary lens, 80A
Frame 5. 2 giraffe, part of 10"x8" , $\frac{1}{15}$, ASA160, 10" auxiliary lens, 80A
Frame 6. Lioness at kill (zebra) , $\frac{1}{15}$, ASA160, 10" auxiliary lens, 80A
Frame 7. Hippos in river, $\frac{1}{15}$, ASA160, 10" auxiliary lens, 80A
Frame 8. Elephant and young one, $\frac{1}{15}$, ASA160, 10" auxiliary lens, 80A

Frame 9. Kitchen wing of house, sunshine (some cloud), f11, $\frac{1}{100}$, 25h June 1977 (record of plant growth)
Frame 10. House back garden, midday, 3rd July (D took it)
Frame 11. Passion flowers 2 off, close up, tripod, dull day, $\frac{1}{50}$, copying lens
Frame 12. Passion flowers, 3 off, close up, hand held, $\frac{1}{100}$, through mid range spectacle
To processing 22nd July 1977. Scotts, Wantage.
Results:- returned 30th July 1977 as below.
Frame 1. Exposure OK though a little thin. Yellow negative. Resolution good. 2 second still too much (mounted). No flare spot. See. Page 124.
Frame 2. Over exposed. Resolution OK (10 seconds too much) (destroyed)
Frame 3. Under exposed, deep blue negative, resolution OK. To be checked in strong light, missing, probably destroyed
Frame 4. Exposure and focus OK – made into slide
Frame 5. Giraffes. Exposure and focus OK - made into slide
Frame 6. OK slightly over exposed – made into slide
Frame 7. Exposure and resolution OK – made into slide
Frame 8. Flare spot over young elephant. Usable OK – made into slide
Frame 9. All OK. House kitchen front – on page 124
Frame 10. All OK. House kitchen front – D took photo
Frames 11 and 12. Focus and exposure OK. Frame 11 very sharp, focus OK in all ways. Mounted as slides 'local' box. See page 124 for some results.

18th June 1977

Page 119



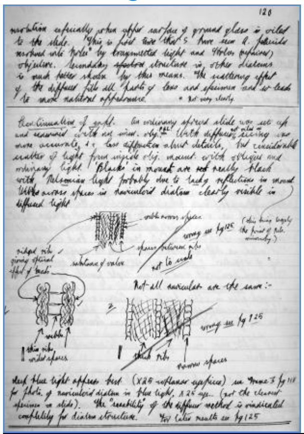
Object of Experiment
To try the effect upon resolution of using ground glass (a slide ground on both sides) in the substage illuminating system (Universal Condenser) on the Ross-Burrells Microscope
Method:- Holos and Powell and Lealand immersion objectives used; Baker's Test slide of 20 forms in Styrax; Electric Mains (Research) lamp 5V and 10V with filters; straight direct illumination with and without ground glass, dry substage; ground glass oiled onto underside of slide only; normal microscopy.
Readings:-

1. With direct light and ground glass under specimen, best seeing results. Close examination of diatom detail is quite free from artefacts; black hole and 'white hole' effects can be clearly studied. Lamp and microscope diaphragm sizes make little difference but oblique stop in substage is effective. No resolution of *Amphipleura pellucida*.
2. With ground glass oiled onto slide (ground glass to end on condenser side), lower side of ground glass bare, *Amphipleura pellucida* resolved by Holos into dots when lamp was moved around to give extreme oblique light helped by oblique stop in condenser. Other diatoms equally well shown with no artefacts. Inspection of back lens showed that oiled-on diffuser took light beam to nearly extreme edge of objective. Powell and Lealand ⅛" did not quite make resolution, *Holos just does* with most oblique light possible by this method.

3. Ground glass in other parts of system i.e. at lamp diaphragm, and below condenser, (all normal condensers in place and focussed), no significant effect good or bad was observed.
4. All experiments above needed green light to cut out aberration spectrum.
5. The power of 12V research lamp is needed for these experiments (filters in use)

Conclusion. Ground glass between a normally focussed dry condenser and the slide makes for better seeing of detail and increased…*(next page)*

Page 120

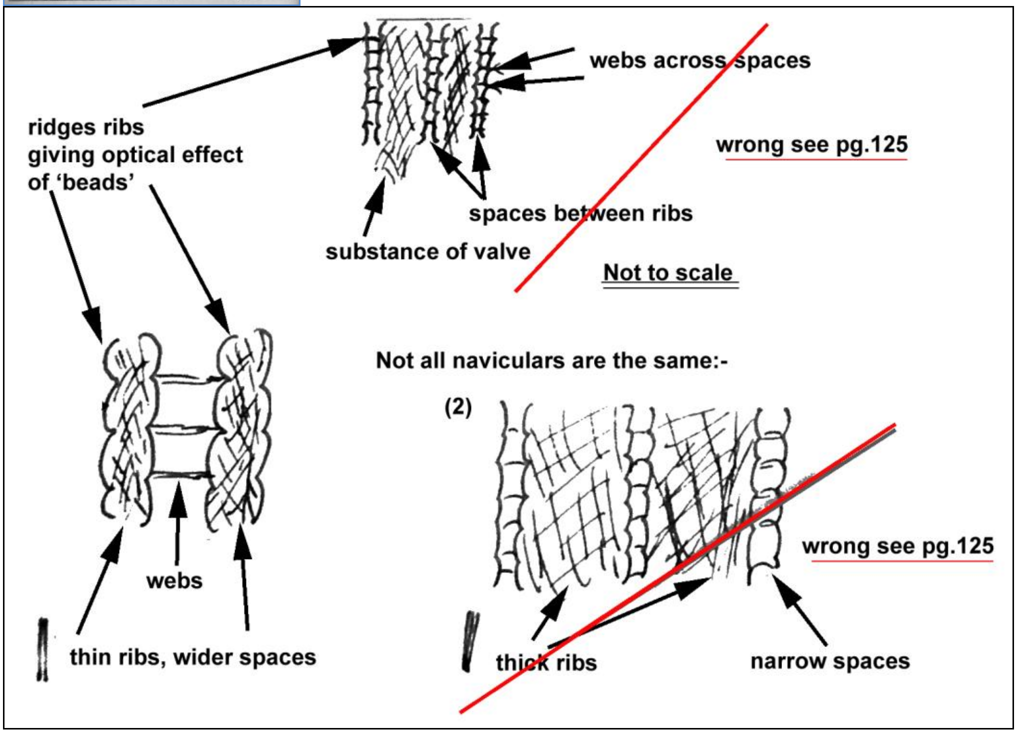


…resolution especially when upper surface of ground glass is oiled to the slide. This is first that I have seen *Amphipleura pellucida* resolved into holes* by transmitted light and Holos (repaired) objective diatoms is much better shown by this means. The scattering effect of the diffuser fills all parts of lens and specimen and so leads to more natural appearance.

*Not very clearly

Continuation of Experiment

An ordinary spread slide was set up and examined with an immersion objective (Powell and Lealand). With diffuser not oiled on seeing was more accurate, i.e. less diffraction about details, but considerable scatter of light. ‘Blacks’ in mount are really black with Nelsonian light probably due to lack of reflections in mount. Webs across spaces in naviculoid diatoms clearly visible in diffused light.



Deep blue light appears best (x25 coplanar eyepiece) see Frame 3 page 118 for photo. Of naviculoid diatom in blue light, x25 eye. (not the clearest specimen on slide). The ‘seeability’ of the diffuser method is vindicated completely for diatom structure. For later results see page 125.

7th July 1977

Object of Experiment

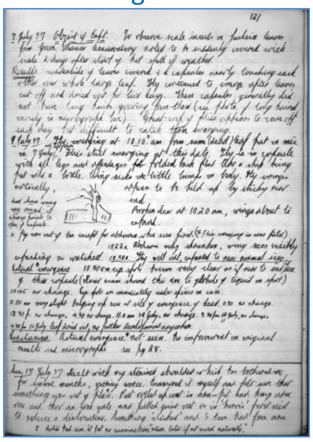
To observe scale insect on Fuchsia leaves from Grove Manor Conservatory noted to be suddenly covered with scales 2 days after start of hot spell of weather.

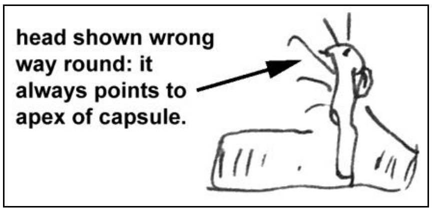
Results:- Underside of leaves covered i.e. capsules nearly touching each other over whole large leaf. Fly continued to emerge after leaves cut off and dried out for two days. These capsules generally did not have long hairs growing from them (see photograph of long-haired variety in micrograph box). Great crop of flies appears to come off each day but difficult to catch them emerging.

9th July 1977

Fly emerging at 10.10am* from same (dead) leaf but on microscope on 7th July and left there. Flies still emerging at this date. Fly is in capsule with all legs and appendages folded back flat like a ship being put into a bottle. Wing sacs are little lumps in body. Fly emerges vertically, appears to be held up by sticky rear end.

Page 121





Broken clear at 10.20am, wings about to expand.

*fly was out of box except for abdomen when seen first (3 flies emerging in same field)

1022am. Abdomen very shrunken, wing sacs visibly expanding as watched. 10.30am Fly well out, expanded to near normal size.

Actual emergence. 10.30am eye spots become very clear as if near to surface of thin capsule (closer examination showed this due to globule of liquid on spot).

10.45am no change. Eye spots are immediately under spines on case.

11.00am very slight bulging up seen at site of emergence of head.

11.30 no change

12.30pm no change

4.30 no change

11.00am 12th July, no change

7.30pm 12th July, no change

4.30pm 12th July leaf dried out, no further development anywhere.

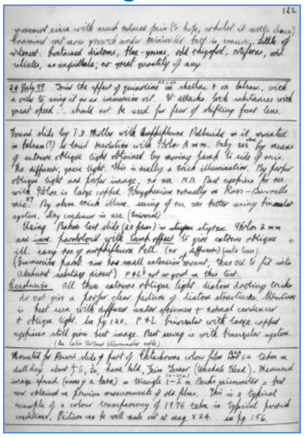
Conclusions. Actual emergence not seen . No improvement on original results and micrographs. See page 28.

Sunday 17th July 1977

Dealt with my strained shoulder which has bothered me for several months, getting worse. Examined it myself and felt sure that something was out of place*. Put rolled up vest in arm-pit and hung arm over and through an iron gate and pulled joint out as in 'heroic' first aid to reduce a dislocation. Something 'clicked' and I have had free arm…*(next page)*

* doctor had seen it but no examination: "return later if not cured naturally."

Page 122



…movement since with much reduced pain (I hope, whilst it settles down).

Examined wet moss growth under rainwater butt in conservatory. Little of interest. Contained diatoms, blue-greens, odd rhizopod, rotifera, odd ciliates, an ?*anguilla*?; no great quantity of any.

24th July 1977

Tried the effect of quinodine (R.I.1.62) on shellac and on balsam, with a view to using it as an immersion oil. It attacks both substances with great speed therefore should not be used for fear of shifting front lens.

Found slide by J. D. Möller with *Amphipleura pellucida* on it mounted in balsam(?) so tried resolution with Holos 2mm. Only resolved by means of extreme oblique light obtained by moving lamp to side of axis. No diffusers; green light. This is really a trick illumination. By proper oblique light and proper image, no resolution. NB. Best eyepiece for resolution with Holos is large capped Huyghenian normally on Ross-Burrells microscope x7. By above trick illumination seeing of resolution was better using binocular system. Dry condenser in use (Universal).

Using Baker's test slide (20 forms) in Styrax Holos 2mm and immersion paraboloid with lamp offset to give extreme oblique illumination easy resolution of *Amphipleura pellucida* (no difference) (into lines).

(Immersion paraboloid now has small extension of mount, thus OK to fit into Akehurst substage direct). Powell and Lealand ⅛" not so good in this test.

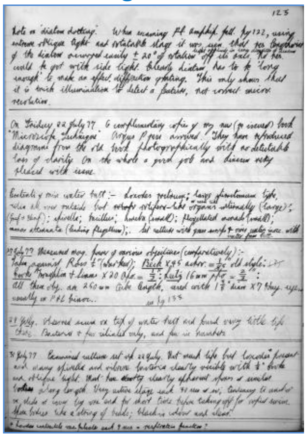
Conclusion. All these extreme oblique light diatom dotting tricks do not give a proper clear picture of diatom structure. Structure is best seen with diffuser under specimen and normal condenser and oblique light. See page 120. Powell and Lealand binocular with large capped eyepieces still gives best image. Best seeing is with binocular system.

(see later Vertical Illumination experiments)

Mounted for record slide of part of Ektachrome colour film ASA64 taken on dull day, about f6, 1.50, hand held, Zeiss Tessar (Wasdale Head). Measured image spread (eaves of a barn) = triangle 1-2 (10-20μ) on Becks micrometer = best

ever obtained in previous experiments of old films. This is a typical example of a colour transparency of 1976 taken in typical poorish conditions. Picture can be well made out at magnification x24.
See page 156.

Page 123



Note on 'diatom dotting'.
When examining *Amphipleura pellucida* page 122, using extreme oblique light and rotatable stage it was seen that resolution lengthwise of the diatom occurred easily ±20° of rotation off its axis (light applied in long diagnostic of diatoms). No resolution could be got with side light. Clearly diatom has to be 'long enough' to make an effective diffraction grating. This only shows that it is trick illumination to detect a feature, not correct microscopic resolution.

On Friday 22nd July 1977 6 complimentary copies of my new (re-issued) book "Microscope Technique" Argus Press arrived. They have reproduced diagrams from the old book photomicrographically with no detectable loss of clarity. On the whole a good job and Linssen every pleased with issue.

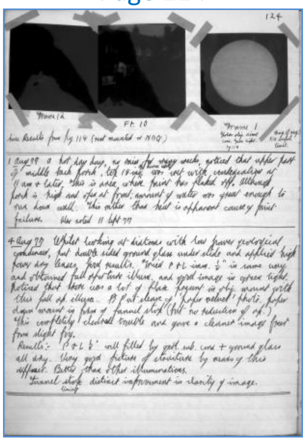
Contents of rain water butt:- *loxodes rostrum*; large *spirostomum* type, cilia all over outside but rotifera-like or with like organs internally (large) (Griffith and Henfrey); *spirella*; amoeba (small); flagellated monads (small); *Monas attenuata* (leading flagellum); Set culture with grass scraps and river water inoculated with water from butt.

27th July 1977.
Measured magnifying power of various objectives (comparatively):-
Taken against Ross ½" (marked); Beck x45 achromat = ⅕" old style;
Cooke, Troughton and Simms x20 Apochromat = ⅓"; Leitz 16mm Apochromat = ⅔";
All true objectives are 250mm tube length, used with 1⅜diameter x7 Huyghenian eyepiece usually on Powell and Lealand binocular. (see page 133)

28th July 1977
Observed scum on top of water butt and found very little life there. Bacteria and few ciliates only, and few in number.

31st July 1977.
Examined culture set up on 22nd July. Not much life but *ioxodes** present and many *spirella* and *vibrone* bacteria clearly visible with ⅓" Cooke and oblique light. Most have clearly apparent spores or similar bodies along length. Very active stage each 30 seconds or so, tendency to anchor on slide or cover by one end for short time before taking off for rapid swim. Spore bodies like a string of beads; black in colour and clear.
**Ioxodes* contractile vacuole pulsates each 7 seconds – respiration function?

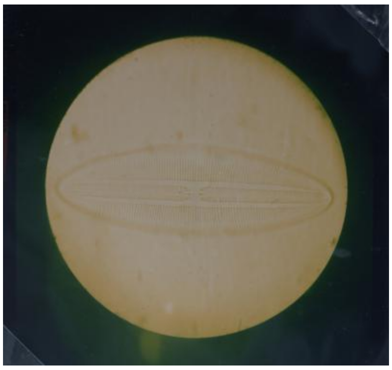
Page 124



Some results from page 118 (rest mounted or no bloody good)

Frame 12

Frame 10



Frame 1
Holos objective, direct cone, green light. Page 118
Magnification of negative x10, usual limit

1st August 1977
A hot dry day, no rain for many weeks, noticed that upper part of middle back porch, top 18 inches of house wall was wet with condensation at 11am and later. This is area where paint has flaked off. Although porch is high and open at front, amount of water was great enough to run down wall. This rather than heat is apparent cause of paint failure.
Also noted 11th September 1977.

4th August 1977
Whilst looking at diatoms with low power geological condenser, put double sided ground glass under slide and applied high power dry lenses. Good results. Tried Powell and Lealand immersion ⅛" in same way and obtained full aperture illumination and good image in green light. Noticed that there was a lot of flare present in objective mount with this full aperture illumination. Put sleeve of 'paper velvet' photographic paper down mount in form of funnel stop (but no reduction of aperture)
This completely cleared trouble and gave a cleaner image freer from slight fog.
Results:- Powell and Lealand ⅛" well filled by geological substage condenser and ground glass, all dry. Very good picture of structure by means of this diffuser. Better than other illuminations.
Funnel lining distinct improvement in clarity of image.

6th August 1977
Object of Experiment
To study structures of Navicular diatoms using immersion objectives and double-surface ground glass under specimen Universal dry condenser. It is convenient that several broken valves are found on Tempére's slide of Gulf Yadd collection. Diffuser NOT oiled to slide.
Method. Set up using Powell & Lealand ⅛ and Holos 2mm with ground glass under slide and focussed condenser as well, obtaining oblique (or shadow) light by moving the lamp. Green light.
Results.

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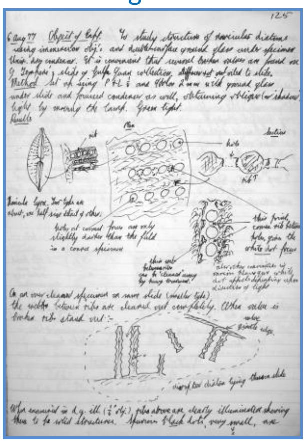
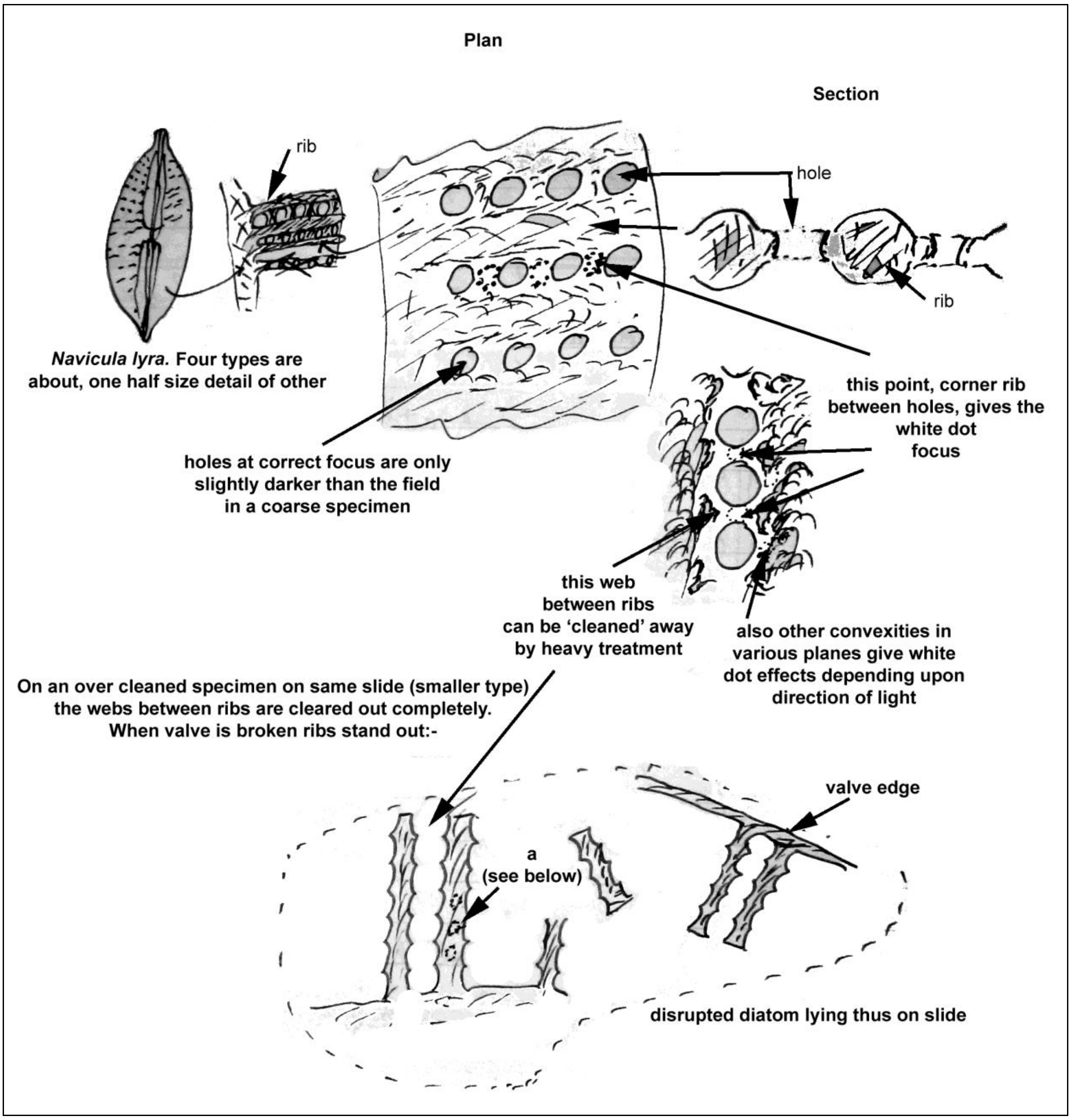
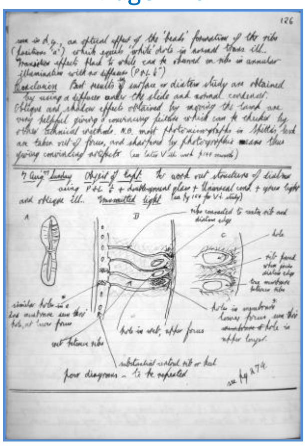

125



When examined in dark ground illumination (⅙" obj.) ribs above are clearly illuminated showing them to be solid structures. Spurious black dots, very small (a), are…*(next page)*

Page 126



…seen in dark-ground, an optical effect of the 'beads' formation of the ribs (positions 'a') which equals 'white dots' in normal Transmitted Illumination.

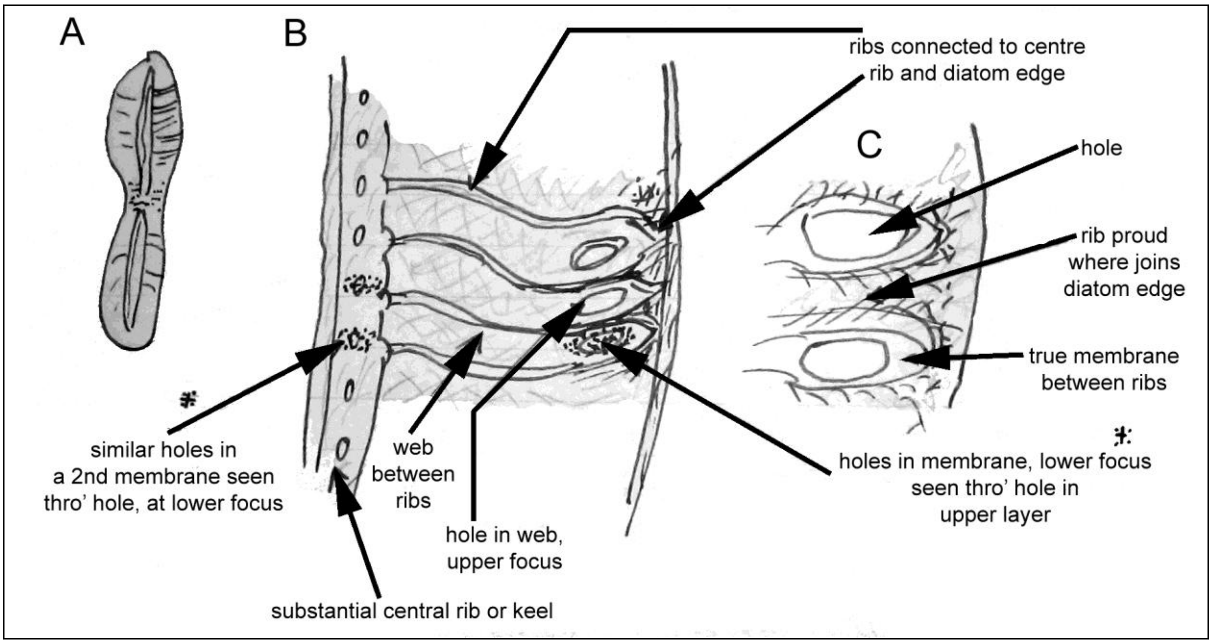
Transition effects back to white can be observed in ribs in annular illumination with no diffusers (Powell & Lealand ⅛")

Conclusion. Best results in surface or diatom study are obtained by using a diffuser under the slide and normal condenser. Oblique and shadow effects obtained by moving the lamp are very helpful in giving a convincing picture which can be checked by other technical methods. NB. most photomicrographs in Spitta's book are taken out of focus, and sharpened by photographic means thus giving convincing artefacts (see later Vertical illumination work, page 149 onwards)

Sunday 7th August 1977.

Object of Experiment.

To work out structure of diatoms using Powell & Lealand ⅛ + double-ground glass + Universal Condenser + green light and oblique illumination. Transmitted light (see page 154 for Vertical Illumination study)



Poor diagrams – to be repeated (see page 274)

8th August 1977
Object of Experiment
To make another Zeiss-type objective changer.
Method: By hand and vice using any bits and pieces to hand. The first instrument-making job tackled entirely at home since retirement. Sawed and filed out all bits on model of Zeiss job: hand filed dovetail slides; a steel taper washer used to get tapered part. Centring by screw and stop Y direction, and by movement of mount under slotted heads for X. This changer intended for low power only.
A squaring-on rudimentary fitting is present whereby lens-mount part of slide can be tilted and locked in the dovetail part:-

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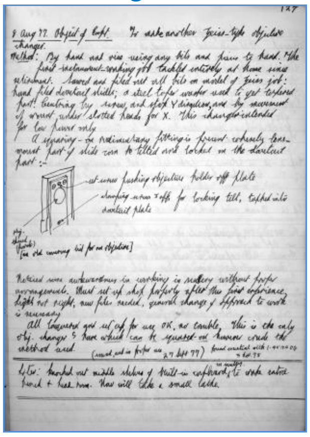
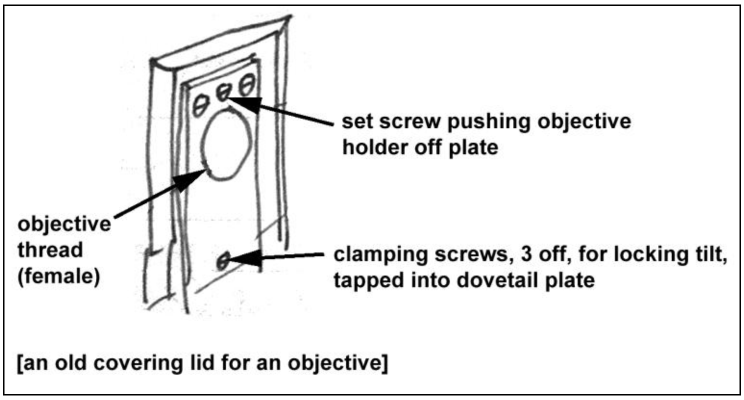
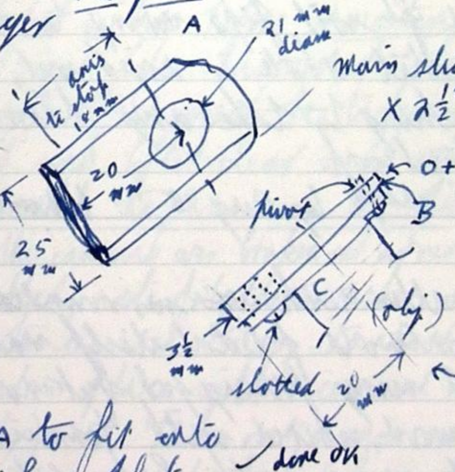




'Zeiss' Obj. Changer (copy) 5 Aug 77

An entirely satisfactory accessory done in 1 day.

Found essential to level Novitka 1.45 OG 2 Nov. 78.



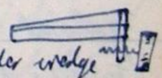
Main slider piece 35 mm X 25 mm X 2½ mm or 3/32" thick (make plain part.)

Taper piece 28 mm wide & part. X 35 mm ~~make of plain sheet.~~ drill 22 mm. diam on axis

Finally a taper washer was used.*

Method (1) make part A to fit onto mic. female slide; brass plate.

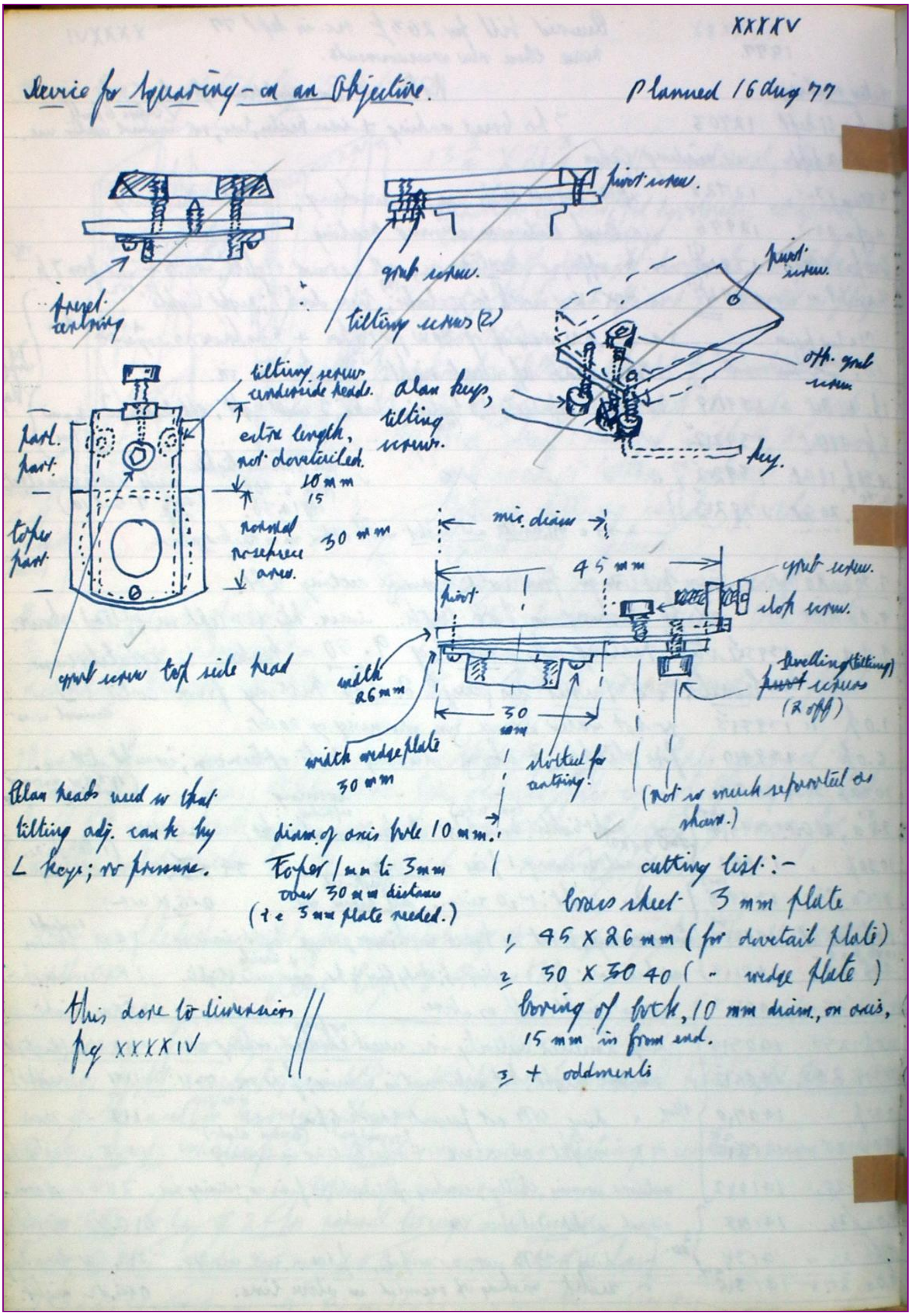
(2) make taper ~~wedge~~ piece* and secure firm to A. Fit stop at its end and make correct fit on nosepiece of mic. also levelling screws fitted under wedge for squaring-on ✓ OK



(3) Use pre-set objective box lid as part C. ~~No adj. needed for low power~~ ✓ OK Adjustment incorp. by means of slotted screws on part C.

4. Y motion stop by means of 10 BA screw in lug on part A, as on Zeiss changers.

At the thick end of the wedge piece between ~~beside~~ the two fixing ~~slotted~~ screws, ~~two~~ a grub screw is positioned to stand-off the wedge piece. Thus a levelling adj. is available by adj. of the fixing screws & the grub screw.


XXXXV

Device for Squaring-on an Objective. Planned 16 Aug 77

pivot screw.

preset centring

grub screw.

tilting screws (2)

pivot screw.

opp. grub screw

Alan keys, tilting screws.

key.

tilting screws underside heads.

extra length, not dovetailed.

10 mm

15

normal nosepiece area.

30 mm

part. part

taper part

grub screw top side head

mic. diam

45 mm

grub screw.

lock screw.

pivot

width 26 mm

levelling (tilting) pivot screws (2 off)

30 mm

with wedge plate 30 mm

slotted for centring.

(not so much separated as shown.)

Alan heads used so that tilting adj. can be by L keys; no pressure.

diam. of axis hole 10 mm.

Taper 1 mm to 3 mm over 30 mm distance (i.e. 3 mm plate needed.)

cutting list:-

brass sheet 3 mm plate

1, 45 X 26 mm (for dovetail plate)

2, 30 X 30 40 (- wedge plate)

boring of both, 10 mm diam, on axis, 15 mm in from end.

3, + oddments

this done to dimensions pg XXXXIV

Noticed some awkwardness in working in scullery without proper arrangements. Must set up shop properly after this first experience. Lights not right, new files needed, general change of approach to work is necessary.

All lacquered and set up for use OK, no trouble. This is the only objective changer I have which can be squared-on however crude the method used.

(sound, and in proper use 27th September 1977)

Found essential with 1.45 NA Object Glass 3rd November 1978

Later: knocked out middle shelves of built-in cupboard in scullery to make extra bench & head room. Now will take a small lathe.

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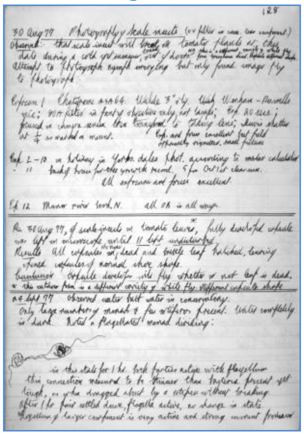


30th August 1977

Photography of Scale Insects (UV filter in camera lens confirmed)

Observed:- that scale insect will breed OK (on) tomato plants at this date during a cold wet summer, out of doors. NO, this is a different variety of white fly from greenhouse kind. Capsule different shape.

Attempt to photograph nymph emerging but only found imago fly to photograph:-

Exposure 1. Ektachrome ASA64 Wild 3" objective. Wenham-Burrells microscope; 80A filter in front of objective only, not lamps; Exp. 20 seconds; focussed in camera screen then transferred to taking lens; Davis shutter at ¼ as marked on mount. (Exp. And focus excellent but field apparently vignetted, small picture.

Exp. 2-10 on holiday in Yorkshire Dales. Photo according to calculator

Exp. 11. Back of house for tree growth record. 5pm. October 1st, clear sun.

All exposures and focus excellent.

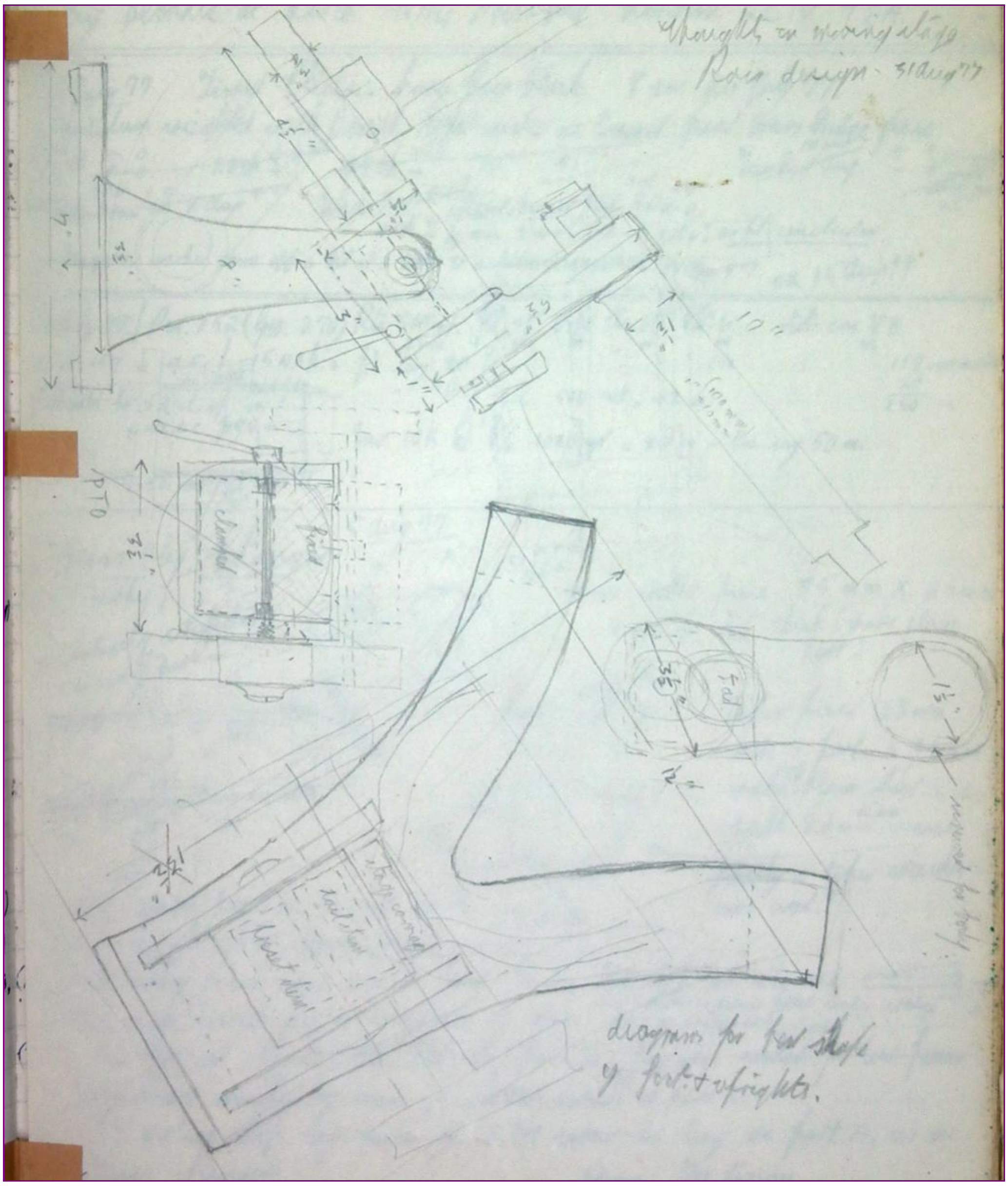
Exp. 12. Manor river look. N. All OK in all ways.

Re. 30th August 1977, of scale insects on tomato leaves*, fully developed capsule was left in microscope until 11th September undisturbed.

Results. All capsules on the now dead and brittle leaf hatched leaving opened capsules of normal shoe shape.

Conclusion. Capsule develops into fly whether or not leaf is dead.

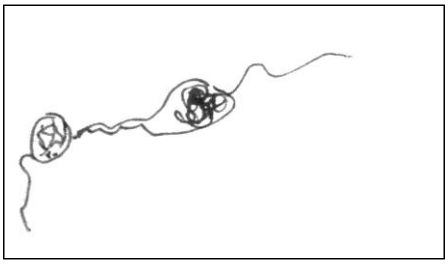
*this indoor form is a different variety of white fly, different capsule shape.



24th September 1977

Observed water butt water in conservatory.

Only large numbers of monads and few rotifers present. Water completely in dark. Noted a flagellated monad dividing:



In this state for 1hr. both parties active with flagellum, thin connection measured to be thinner than bacteria present yet tough, as when dragged about by a rotifer without breaking. After 1 hour pair settled down, flagella active, no change in state.

Flagellum of larger component is very active and strong current produced…*(next page)*

…and could well be a feeding mechanism. After 1½hrs:-

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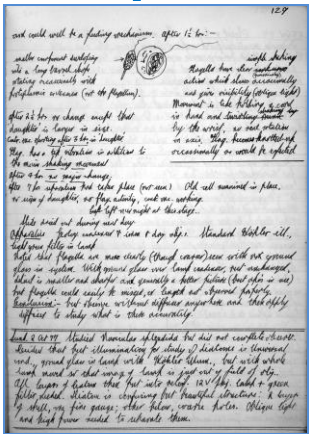
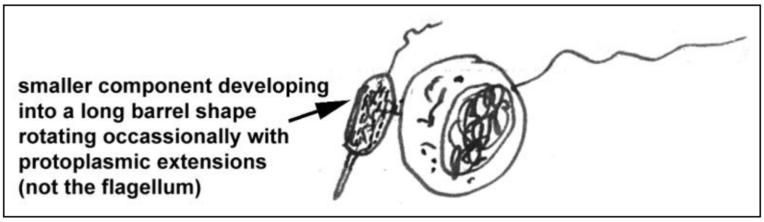




Simple shaking flagella have clear ~~corkscrew~~ (periodically) action which slows occasionally and gives visibility (oblique light). Movement is like holding a cord in hand and ~~twirling round~~ shaking by the wrist. No real rotation on axis. Flagellum becomes knotted-up occasionally as would be expected.

After 2¼ hours no change except that 'daughter' is larger in size. Contractile vacuole operating after 3 hours, in 'daughter'. Flagellum has a tip vibration in addition to the main shaking movement.

After 4 hours no major change.

After 7 hours separation had taken place (not seen). Old cell remained in place. No sign of daughter, no flagellum activity, contractile vacuole working. Left overnight at this stage.

Slide dried out during next day.

Apparatus:- Geological Condenser & immersion & dry objectives. Standard Köhler illumination, light green filter in lamp.

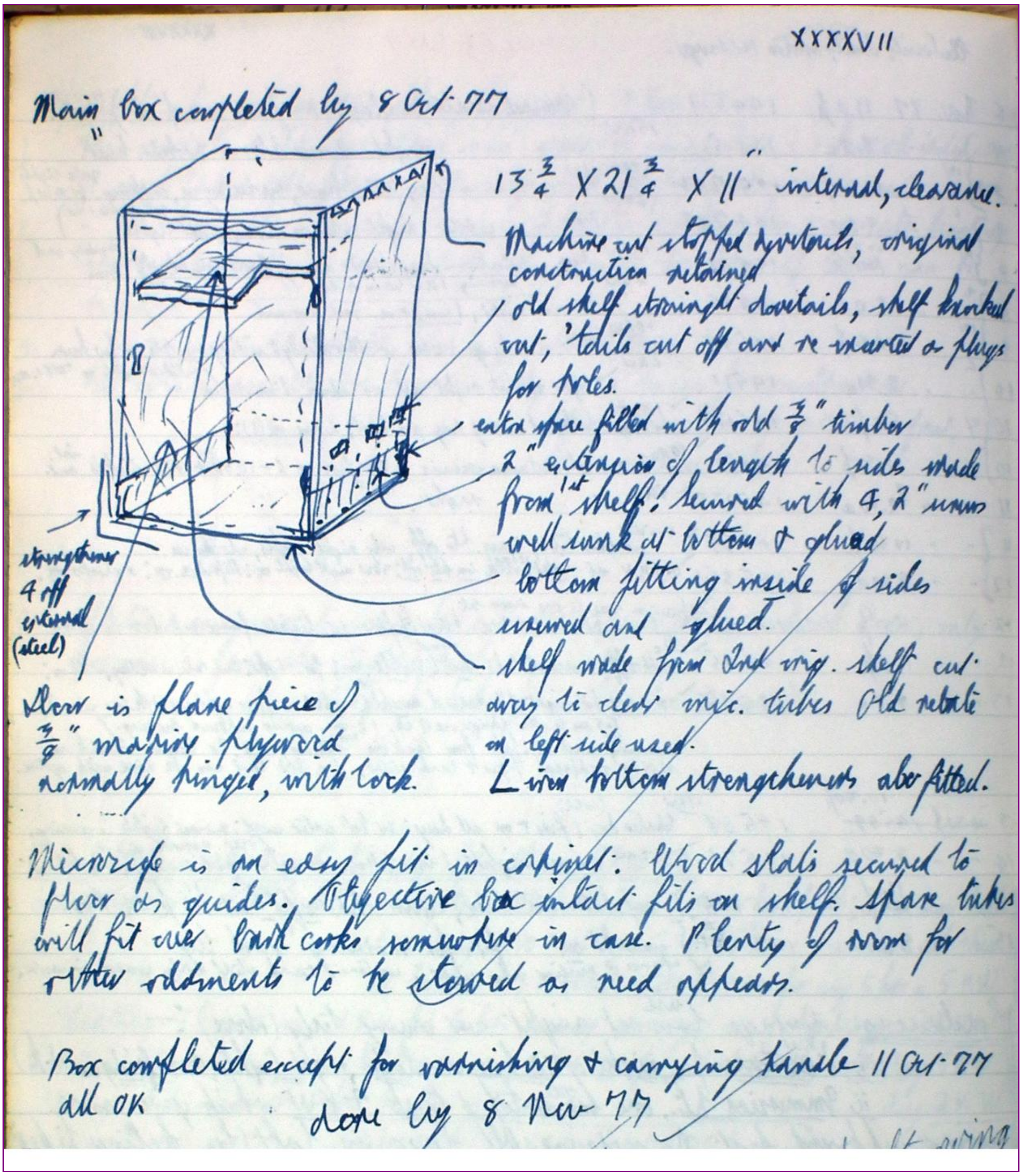
Noted that flagella are more clearly (though coarser) seen with no ground glass in system. With ground glass over lamp condenser, rest unchanged, detail is smaller and sharper and generally a better picture (best apochromats in use) but flagella could easily be missed, or length not observed properly.

Conclusion:- best observe without diffuser anywhere and then apply diffuser to study what is there accurately.

Sunday 2nd October 1977

Studied *Navicula splendida* but did not complete observation. Decided that best illumination for study of diatoms is Universal cond., ground glass in lamp with Köhler illumination, but with whole lamp moved so that image of lamp is just out of field of objective.

All layers of diatom then put into relief. 12V projector lamp + green filter needed. Diatom is confusing but beautiful structure: 2 layers of shell, one fine gauge; other below, coarse holes. Oblique light and high power needed to separate them.



XXXXVII

Main box completed by 8 Oct 77

13 3/4 x 21 3/4 x 11" internal, clearance.

Machine cut stopped dovetails, original construction retained

old shelf straight dovetails, shelf knocked out, 'tails cut off and re inserted as plugs for holes.

extra space filled with old 3/8" timber

2" extension of length to side made from 1st shelf. Secured with 4, 2" screws well sunk at bottom & glued

bottom fitting inside of sides screwed and glued.

shelf made from 2nd orig. shelf cut away to clear mic. tubes Old rebate on left side used.

L iron bottom strengtheners also fitted.

strengthener 4 off external (steel)

Door is flame piece of 3/8" marine plywood normally hinged, with lock.

Microscope is an easy fit in cabinet. Wood slats secured to floor as guides. Objective box intact fits on shelf. Spare tubes will fit over back corks somewhere in case. Plenty of room for other oddments to be stowed as need appears.

Box completed except for varnishing & carrying handle 11 Oct 77

all OK

done by 8 Nov 77

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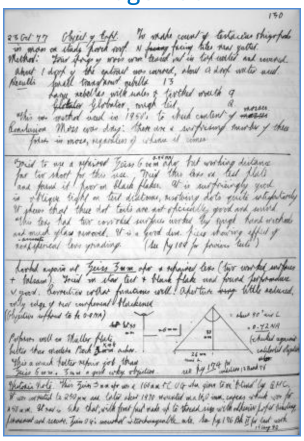


23rd October 1977

Object of Experiment

To make count of testaceous rhizopods in moss on study porch roof. North facing tiles near gutter.

Method: Four sprigs of moss were teased out in tap water and covered. About 1 drop of the extract was covered, about 4 drops water used.

Results.

Small transparent *Nebella* – 13

Large *Nebella* with males & toothed mouth – 9

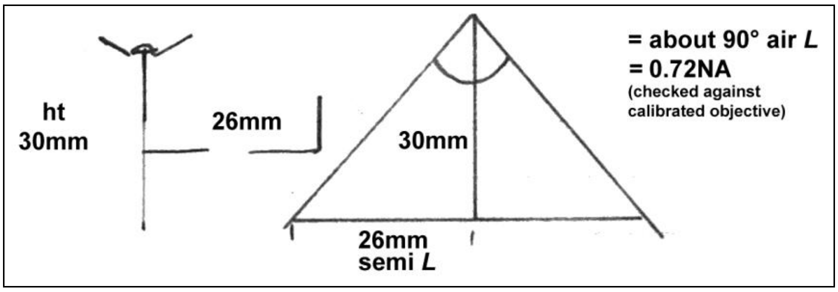
Globator, rough test – 2

This was method used in the 1950s to check content of mosses.

Conclusion:- Moss was dry: there are surprising number of these forms in moss, regardless of whence it comes.

Tried to use a repaired Zeiss 6mm 0.95NA Apo, but working distance far too short for this use. Tried this lens on test plate and found it poor on black flakes. It is surprisingly good in oblique light on test diatoms, resolving dots quite satisfactorily. It shows that these dot tests are not optically good and sound. This lens had two corroded surfaces worked by rough hand methods and much glass removed. It is a good demonstration piece showing effect of non-accurate spherical lens grinding. (see page 109 for previous tests)

Looked again at Zeiss 3mm Apo & repaired lens (two worked surfaces + balsam). Tried on start test & black flake and found performance v. good. Correction collar functions well. Aperture little reduced, only edge of rear component blackened.
(Objective appears to be 0.9NA)



Performs well on Möller plate, better than modern Beck x45 achromat.
This a much better repair job than Zeiss 6mm. 3mm a good working objective.
See page 174 for condition 13th March 1978.

Historic Note.
This Zeiss 3mm Apochromat was a 160mm tube length object glass when given to me 'blind' by QMC. It was corrected to 250mm and later, about 1970, mounted on a H2) immersion. Carcass which was for 250mm. IT now is like that, with front pair made up to thread size with adhesive paper biding, permanent and secure. Zeiss object glasses somewhat interchangeable mounts. See page 176 Bk.II for last work. 15th August 1980.

24th October 1977
Historic Note

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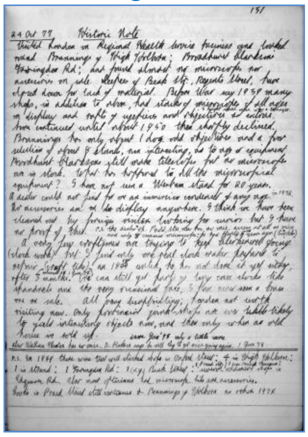

Visited London on Regional Health Service business and looked round Brunnings of High Holborn; Broadhurst Clarkson's, Farringdon Road; and found almost no microscopes nor accessories on sale. Deepees of Beak Street, Regents Street, have closed down for lack of material. Before War say 1939 many shops, in addition to above, had stacks of microscopes of all ages on display and rafts of eyepieces and objectives (I bought several microscopes when a teenager) as extras. Some continued until about 1950 then sharply declined.
Brunnings has only about 1 doz. Old objectives and a poor selection of about 8 stands, non-interesting, as to age of equipment.
Broadhurst Clarkson still make telescopes but no microscopes are in stock. What has happened to all the microscopical equipment? I have not seen a Wenham stand for 20 years.
A dealer could not find for me an immersion condenser of any age in 1972.
No accessories are on display anywhere. I think we have been cleaned out by foreign visitors looking for curios but I have no proof of this.
P.S. The dealer opposite Paddington Station (Cookes) now has no microscope accessories at all on view and only 8 common microscopes: he had plenty 10 years ago.
A very few craftsmen are trying to keep Clerkenwell going (clock work) but I find only one real clock maker prepared to repair (craft like) an 1815 watch, he has not done it yet either, after 3 months (returned on 1st June 1979). One can still get parts of long case clocks like spandrels and the very occasional face, I have never seen a brass one on sale. All very disappointing; London not worth visiting now. Only provincial junk-shops are ever likely to yield interesting objects now, and then only when an old house is sold up.
(Same January 1978, only a little more)
Also Wallace Heaton has no microscopes. B. Clarkson says he will try to get microscopes going again. 1st June 1978.

P.S. In 1959 there were two well stocked shops in Oxford Street: 4 in High Holborn: 1 in Strand: 1 Farringdon Road: 1 (v.g.) Beak Street: 1 Praed Street: 1 rear British Museum: several oddment shops in Edgware Road. Also most opticians had microscope bits and accessories.
Cook's in Praed Street still continues & Brunnings of Holborn, no others 1978.

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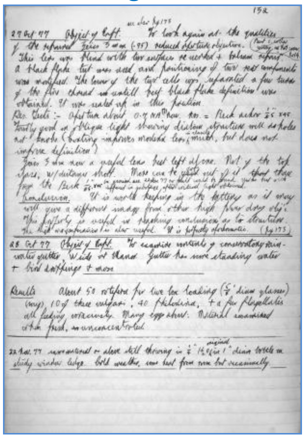

27th October 1977
Object of Experiment.
See also page 173.
To look again at the qualities of the repaired Zeiss 3mm. (.95) reduced aperture objective.
This lens was blind with two surfaces re-worked and Balsam repair. A black flake test was used and positioning of two rear components was modified. The lower of the two cells was separated a few turns of the fine thread until best black flake definition was obtained. It was sealed up in this position.
Resolution Tests:- Aperture about 0.7 NA now. Res.=Beck achromat ⅕" x45.
Fairly good on oblique light showing diatom structure well as holes not knobs. (Coating improves modern lens in clarity much, but does not improve definition.)
Zeiss 3mm now a useful lens best left alone. Not of the top class, with diatoms short. More can be got out of it than from the Beck ⅕" x45. In general use 22nd December 1977 no fault could be found. Works but with diffuser in substage after critical light obtained.
Conclusion. It is worth keeping in the battery as it may well give a different image from other high power dry objectives. This property is useful in reaching conclusion as to structure. The high magnification is also useful. It is perfectly apochromatic. (Page 173)

28th October 1977
Object of Experiment
To examine contents of conservatory rainwater gutter, West side at Manor. Gutter has some standing water and bird droppings and moss.
Results. About 50 rotifera for live box loading (5.8" diameter glasses) (say) 10 of these *vulgaris*, 40 *philodina*, and a few flagellates all feeding voraciously. Many eggs about. Material examined when fresh, un-concentrated.

22nd November 1977
Same material as above still thriving in ¼" of original water (H2O) in 1" diameter bottle on study window ledge. Cold weather, some heat from room but occasionally.

30th October 1977
Object of Experiment
Calibration of Objectives on Ross-Burrells Microscope
Measurement of Equivalent Powers (in inches(on long tube 272mm (=10¾") of objective battery. Divisions on stage micrometer 0.1mm

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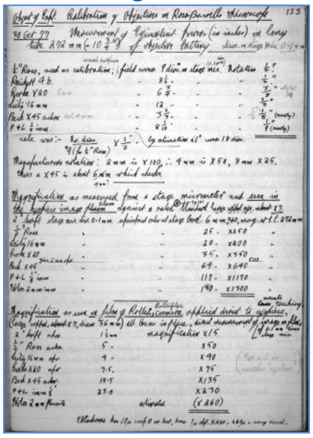

½" Ross, used as calibration; usual eyepiece; field covers	9 divisions on stage micrometer.	Notation ½"
Reichert 4b field covers	8½ divisions on stage micrometer.	Notation ½
Cooke x20 (6mm) field covers (stated ⅓)	6¾ divisions on stage micrometer.	Notation $^3/_8$"
Leitz 16mm field covers	12 divisions on stage micrometer.	Notation ⅔"
Beck x45 achromat (est. 4mm) field covers (nearly)	3⅔ divisions on stage micrometer.	Notation $^1/_5$"
Powell and Lealand ⅛" immersion (nearly)	2 $^1/_{10}$ divisions on stage micrometer.	Notation ⅛"

Calculation was:- (No. of divisions/9 [9for ½" Ross]) x ½"
Manufacturers notation: 2mm is x140 therefore 4mm is x50, 8mm x25. Thus a x45 is about 4mm (which checks)

Magnification as measured from a stage micrometer and seen in the eyepiece image plane against a ruler (see page 75). Standard large capped eyepiece x7, stage micrometer division 0.1mm, all at tube length 272mm.

2" Swift, superimposed ruler at stage level	6mm	x60 magnification
½" Ross, superimposed ruler at stage level	25mm	x250 magnification
Leitz 16mm, superimposed ruler at stage level	20mm	x200 magnification
Cooke x20, superimposed ruler at stage level	35mm	x350 magnification
Zeiss 6mm apochromat		x500 magnification
Beck x45, superimposed ruler at stage level	64mm	x640 magnification
Powell and Lealand ⅛" immersion, superimposed ruler at stage level	117mm	x1170 magnification
Holos 2mm immersion, superimposed ruler at stage level	130mm,	x1300 magnification

Magnification as seen on Rolleiflex Camera applied direct to eyepiece (mounts toughing), large capped x7, diameter 36mm, all lenses in place, direct measurement of image on film of 0.1mm lines of stage micrometer.

2" Swift apochromat	1½mm	Magnification x15
½" Ross achromat	5mm	Magnification x50
Leitz 16mm apochromat	4mm	Magnification x40
Cooke x20 apochromat	7½mm	Magnification x75
Beck x45 achromat	13½mm	Magnification x135
Powell and Lealand immersion ⅛"	23mm	Magnification x230
Holos 2mm fluorite estimated		Magnification (x260)

(Eye acts as another 'eyepiece')
Ektachrome has 10µ confusion circle at best, hence 1µ object x260 = 260µ = easy record.

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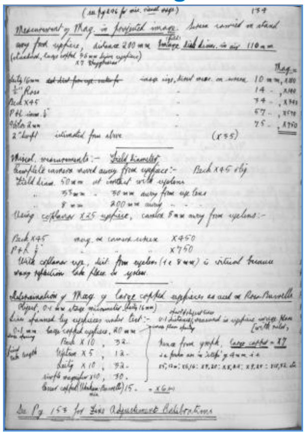

(see page 246 for microscope visual magnifications)
Measurement of Magnification in projected image. Screen carried on stand way from eyepiece (large capped 36mm diameter eyepiece, x7 Huyghenian) distance 200mm, imaged (field) disk diameter in air 110mm.

Objective	Image size (direct measurement on screen)	Magnification
Leitz 16mm	10mm	x100
½" Ross	14mm	x140
Beck x45	34mm	x340
Powell and Lealand immersion ⅛"	57mm	x570
Holos 2mm	75mm	x750
2" Swift	Estimated from above (x35)	

Miscellaneous measurements:- Field Diameter
Complete camera moved away from eyepiece:- Beck x45 objective
Field diameter 50mm at contact with eye lens
Field diameter 33mm at 30mm away from eye lens
Field diameter 8mm at 200mm away from eye lens
Using coplanar x25 eyepiece, camera 8mm away from eye lens:
Beck x45 magnification on camera screen x450
Powell and Lealand ⅛" magnification on camera screen x750
With coplanar eyepiece, distance from eye lens (i.e. 8mm) is critical because many reflections take place in system.

Determination of Magnification of large capped eyepieces as used on Ross-Burrells.
Object 0.1mm stage micrometer (Leitz 16mm)
Lines spanned by eyepieces under test:- 0.1 distance apart of object lines measured in eyepiece image plane (with ruler), 0.1 mm stage spacing, fixed tube length
Large capped eyepiece 20mm (image plane spacing)*
Beck x10, 32mm*
Watson x5, 12mm*
Leitz x10, 32mm*
Simple magnifier x10, 30mm
Lesser capped (Wenham-Burrells microscope) 15mm = x6(-)
*Hence from graph, large capped = x7. i.e. powers are in ‘steps’ of 4mm i.e.
x5:12mm; x6:16mm; x7:20mm; x8:24mm; x9:28mm; x10:32mm etc.

See page 153 for Fine Adjustment calibrations.
(next page)

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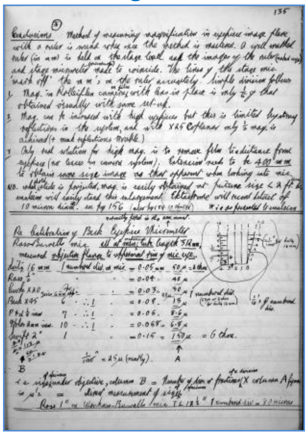


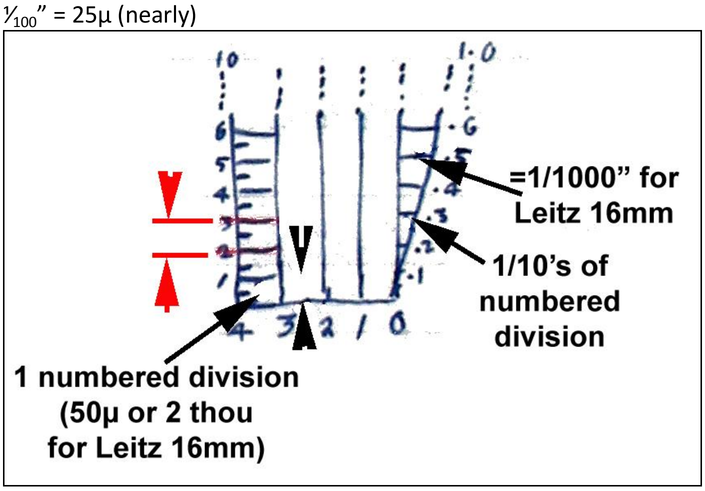
Conclusions: Method of measuring magnifications in eyepiece image plane with a ruler is sound when once the method is mastered. A well marked ruler (in mm) is held on the stage level and the images of the ruler (naked eye) and stage micrometer made to coincide. The lines of the stage micrometer ‘mark off’ the mms on the ruler accurately. Simple division follows.

1. Magnification in Rolleiflex camera on film with lens in place is only ⅕ of that obtained visually with same set-up.
2. Magnification can be increased with high eyepieces but this is limited by stray reflections in the system, and with x25 coplanar only ½ magnification is achieved (and much reflections trouble).
3. Only real solution for high magnification is to remove film to a distance from eyepiece (no lenses in camera system). Extension needs to be 400mm to obtain same size image as that apparent when looking into microscope. NB. when photo slide is projected, magnification is easily obtained at picture size < 2ft diameter, emulsion will easily stand this enlargement. Ektachrome will record detail of 10 micron diameter (as presented to emulsion). See page 156 (also page 189 10th April 1978).

Re: Calibration of Beck Eyepiece Micrometer
Ross-Burrells microscope. All at minimum mechanical tube length 312mm, measured objective flange to uppermost rim of microscope eyepiece.

Objective	No. of divisions on micrometer	
A		B
Leitz 16mm	1 (=0.05mm)	50µ(=2 thou)
Ross ½	1 (=0.04mm)	40µ
Cooke x20	1(=0.03mm)	30µ
Zeiss 6mm apochromat		20µ
Beck x45	6 therefore 1(=0.09mm)	13µ
Powell and Lealand ⅛” immersion	7 therefore 1(=0.06mm)	8.6µ
Holos 2mm immersion	10 therefore 1(=0.068mm)	6.8µ
Swift 2”	1(=0.15mm)	150µ(=6thou)

1/100” = 25µ (nearly)



i.e. size of specimen under objective, column B = Number of division or fractions of a division/magnification (column A.) in microns = Direct measurement of size of specimen.
Ross 1” on Wenham-Burrells microscope tube length 12½” 1 numbered division = 80 microns.

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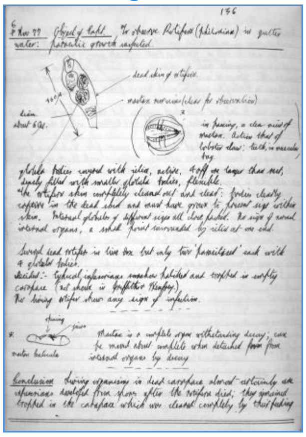
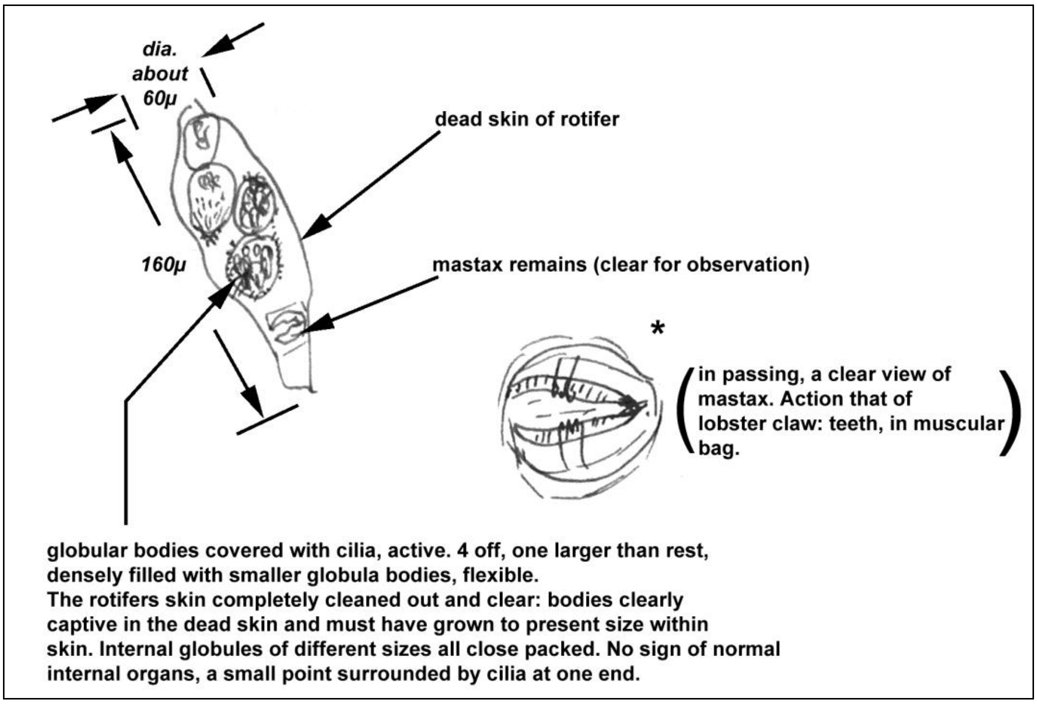
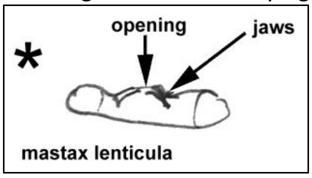


6th November 1977
Object of Experiment
To observe Rotifers (*philodina*) in gutter water: parasitic growth suspected.



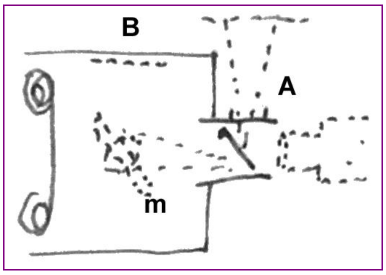
Several dead rotifers in live box but only two ‘parasitized’ each with 4 globular bodies.
Decided:- Typical infusorians somehow hatched and trapped in empty carapace (not shown in Griffith and Henfrey).
No living rotifer shows any sign of infection.



Mastax is a complete organ withstanding decay; can be moved about complete when detached from internal organs by decay.
Conclusion. Living organism in dead carapace almost certainly are infusorians developed from spores after the rotifer died; they remained trapped in the carapace which was cleared completely by their feeding.

7th November 1977
Thoughts upon a Micrographic Camera

1. This must be on its own stand and useable anywhere, i.e. have all inclinations
2. It must take a roll film or difficulty with development will occur
3. It must have the Burrells image deflector system for accurate focussing. This could be built in front of the camera box body if lenses can be removed.
4. 2¼” square i.e. 120 or 620 film is practical size
5. Best obtain some old box camera body as a basis for construction. Reflector mirror can be at A in front, or B within body.



6. Deflector arrangement does not have to be light tight in a dark room, only removable from the light track.

(Try the junk shops for such a box camera)

The Powell and Lealand Prism

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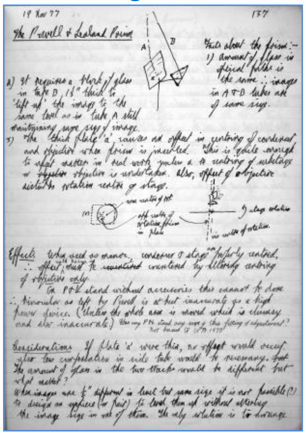
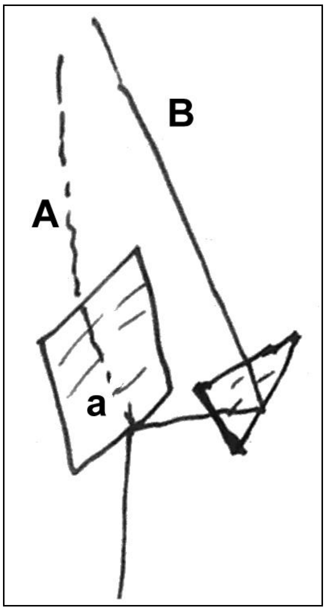
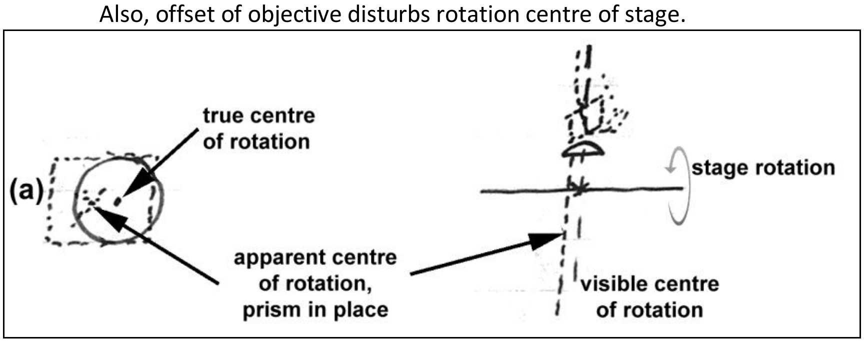


Facts about the prism:-

1. Amount of glass in optical paths is the same therefore images in A and B tubes (below) is the same.



1. It requires a block of glass in tube B 1½" thick to 'lift up' the image to the same level as in tube A, still maintaining same size image.
2. The thick plate 'a' causes an offset in centring of condenser and objective when prism is inserted. This is quite enough to upset matters in real work unless a re-centring of substage or objective is undertaken. Also, offset of objective disturbs rotation centre of stage.



Effects:- When used as monocular, condenser and stage are properly centred, therefore offset with prism in must be countered by altering centring of objective only.

On Powell and Lealand stand without accessories this cannot be done, therefore binocular as left by Powell is at best inaccurate as a high power device, (unless the whole arm is moved which is clumsy and also inaccurate.) Has any Powell and Lealand stand any sign of this fitting or adjustment? Not known to WB 1977.

Considerations. If plate 'a' were thin no offset would occur, also less compensation in side tube would be necessary. The amount of glass in the two tracks would be different but what matter?

When images are ½" different in level but same size it is not possible(?) to design an eyepiece (or pair) to level them up without altering the image size in one of them. The only solution is to arrange…*(next page)*

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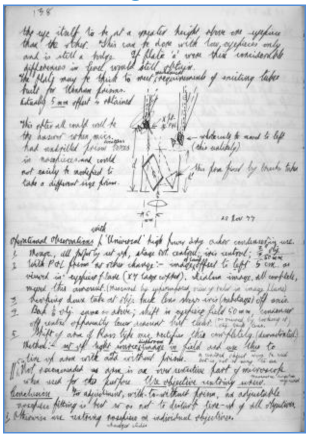
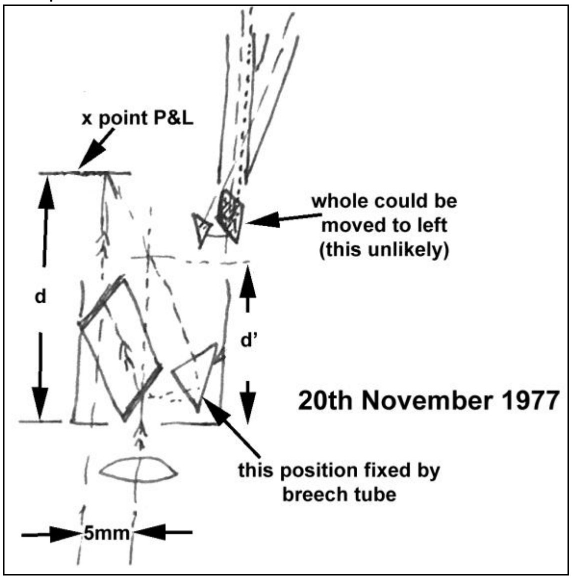


…the eye itself to be at a greater height above one eyepiece than the other. This can be done with low eyepieces only and is still a bodge. If plate 'a' were thin considerable difference in level would still obtain.

The plate mat be thick to meet mechanical requirements of existing tubes built for Wenham prisms.

Actually 5mm offset is retained.

This after all could well be the answer when microscopes had undrilled prism locations boxes in nosepieces and could not easily be modified to take a different size prism.



Operational Observations. With 'Universal' high power dry achromatic condenser in use.

1. Monocular all properly set up, stage rotation central; iris control; ⅔" objective
2. With Powell and Lealand prism no other change:- image of lamp offset to left 5cm (50mm) as viewed in eyepiece plane (x7 large capped). Diatom image all complete, moved this amount (measured by superimposed view of ruler in image plane)
3. Looking down tube at objective back lens shows iris (substage) off axis.
4. Beck ⅙" objective, same as above; shift in eyepiece field 50mm, condenser off centre apparently lower amount, but clear. (As viewed by looking at objective back lens.)
5. Shift of arm of Ross type microscope rectifies this completely (demonstrated). Method:- Set up light source diaphragm image in field and use this to line up arm with and/or without prism. A centred object may be used but is not so easy to see.

   5 is NOT recommended as arm is an over-sensitive part of microscope when used for this purpose. Use objective centring screw (transverse direction only needed).

   Conclusion. For adjustment, with to without prism, an adjustable nosepiece fitting is best so as not to disturb line-up of all objectives.

   i. Otherwise use centring ~~nosepiece~~ changer slides on individual objectives.

(next page)

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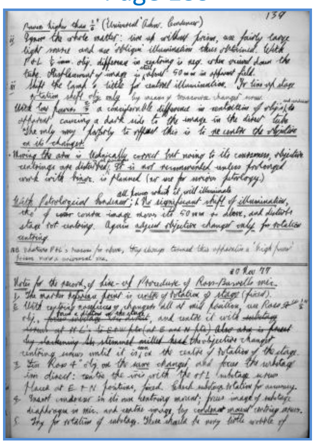

Powers higher than ⅙" ('Universal' Achromatic Condenser)

i. Ignore the whole matter: line up without prism, use fairly large light source and use 'oblique' illumination thus obtained. With Powell and Lealand ⅛" immersion objective difference in centring is negated when viewed down the tube. Displacement of image is still about 50mm in apparent field.

ii. Shift the lamp a little for central illumination. To line up stage rotation shift objective only by means of transverse changeover screw. With low powers ⅔" a considerable difference in centration of objectives and condenser is apparent causing a dark side to the image in the direct tube. The only way properly to affect this is to re-centre the objective on its changer.

   Moving the arm is technically correct but owing to its coarseness, objective centrings are disturbed in all directions. It is not recommended unless prolonged work with binocular is planned (no use for serious petrology).

With Petrological condenser: all powers which it will illuminate, no significant shift of illumination, though of course image moves its 50mm as above, and disturbs stage rotation centring. Again adjust objective changer only for rotation centring.

NB. Whatever Powell and Lealand’s reasons for above, they always termed this apparatus a ‘high power’ prism never a universal one.

20th November 1977

Notes for the record, of Line-up Procedure of Ross-Burrells Microscope

1. The marker reference point is centre of rotation of stage (fixed)
2. With centring nosepieces or changers all at mid position, use Ross ½” objective, focus a diatom on the stage, and centre it with ~~substage screws at right angles to East and West pointer (at East and North pointer). Also arm is preset by slackening its stemmed milled head~~ the objective changer centring screws until it is seen on the centre of rotation of the stage.
3. Fix Ross 4” objective on the same changer and focus the substage iris direct; centre the iris with the right angle substage screws placed at East and North positions, fixed. Check substage rotation for accuracy.
4. Insert condenser in its own centring mount; focus image of substage diaphragm in microscope and centre image by condenser mount centring screws.
5. Try for rotation of substage. There should be very little wobble of…*(next page)*

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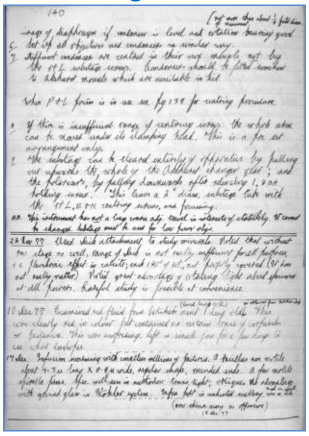
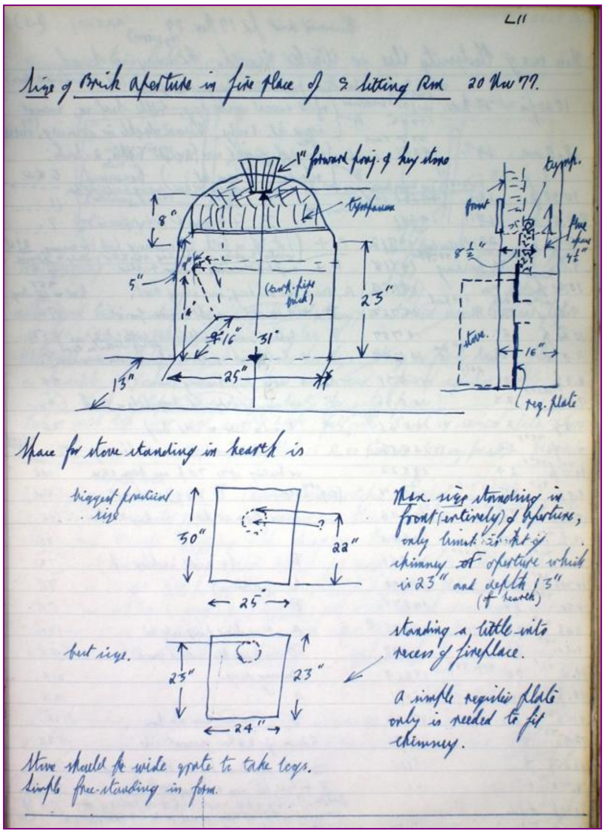


…image of diaphragm if condenser is level and rotation bearing good (not more than about ⅛ field diameter of movement).

6. Set up all objectives and condenser in similar way
7. Different condensers are centred in their own mounts not by the right angle substage screws. Condensers should be fitted somehow to Akehurst mounts which are available in kit.

   When Powell and Lealand prism is in use see page 139 for centring procedure.
8. If there is insufficient range of centring screws the whole arm can be moved under its clamping head. This is a pre-set arrangement only.
9. The substage can be cleared entirely of apparatus by pulling out upwards the whole of the Akehurst changer gear; and the polariser, by pulling downwards after releasing 1, 8BA holding screw. This leaves a 2” diameter substage tube with the right angle, East and North centring screws, and focussing.

NB. This instrument has not a long coarse adjustment travel in interests of stability. It cannot be changed. Substage must be used for low power objectives.



22nd November 1977

Used Dick attachment to study minerals. Noted that without revolving stage as well, range of Dick is not really sufficient for all purposes, i.e. pleochroic effect in calcite; each 180° rotation not properly covered (it does not really matter). Noted great advantage of rotating light about specimen at all powers. Careful study is possible at convenience.

8th December 1977

State of play of Finances

Salary to hand (tax deducted)	215	
County Council Allowances £33 (extra, covers cars running and maintenance as expenses)		
Result of investments not yet known, say £700 clear (60 months)		
Total		£215
Typical Electricity bill	13?	
Rates	22	
House Keeping	100	
Telephone	10	
Cars	10	
B	20	
Total		£175
Spare for clothes, insurance, general expenses, maintenance of property		£40

10th December 1977

Examined red fluid form butcher's meat (boned lamb roll) 1 day old, as obtained from butcher's shop. This was clearly red in colour but contained no certain trace of corpuscles or bacteria. This was surprising. Left in small jar for a few days to see what develops.

17th December 1977

Infusion swarming with countless millions of bacteria. A bacillus non-motile about 4.3µ long x 0.4µ wide, regular shape, rounded ends. A few motile *spirella* forms. Specimens well seen with orthodox transmitted light, oblique. No advantage with ground glass in Köhler system. Infusion kept in unheated scullery, 'high' in smell, even on slide. (Now thrown away as offensive – 18th December 1977)

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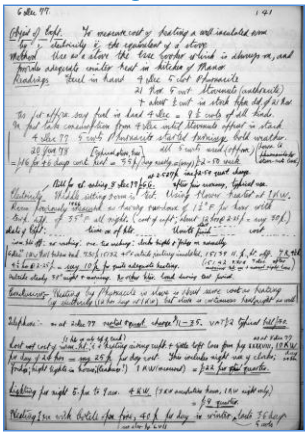

6th December 1977

Object of Experiment

To measure cost of heating a well insulated room by i. electricity, ii. The equivalent of a stove

Method:- Use as a stove the Esse cooker which is always on, and provides adequate winter heat in kitchen of Manor.

Readings:- Fuel in hand –

4th December 5cwt Phurnacite

21st November 5cwt Stovenuts (anthracite)

+ about ½cwt in stock before delivery of 21st November.

As set approximately say fuel in hand 4th December - 9½cwts of all kinds.

In fact take consumption from 4th December until stovenuts appear in stack.

4th December 1977 5cwts phurnacite started turning cold weather

20th January 1978 [typical stove, Esse) all 5cwts used (approximately) (down to stovenuts level)

= £16 for 46 days continuous heat = 35p/day nearly – say (£2.50/week.

Electricity. (Bill at ending 8th December 1977 £66 at 2.527p inc £2.54 quarterly charge) Middle sitting room is test. Using blower heater at 1Kw. Room previously (1966) measured as having run-down of 1½°F per hour with temperature difference of 35°F all night. (cost of experiment; about 12hrs @ 2.25p = say 30p)

Date of Experiment:……… Time on of heater:………… Units start:……… Units Finish:……… Cost:……….

Immersion heater off: no washing: occasional tea making: Lab lights and 'fridge on normally

6th December 1988 1Kw heater, bedroom radiator, 7.30p, 15132, 40°F outside, ceiling insulated, 15139, 11p, heater off, 7K, 4½h (Transcribers Note: according to me this should be 3½ hours) (15142, 9.40a, 7th December, after maintaining heater on plus normal night stove)

4½hours @ 2.25p = say 10p for quite adequate heating.

Outside steady 38° night and morning. No other heater load during test period.

Conclusion. Heating by Phurnacite in stove is about same cost as heating by electricity (12hrs day at 1Kw) but stove is continuous heat, might as well.

Telephone:- as at 2nd December 1977 rental and quarterly charge £11.35. VAT £2. Typical bill £30

Lost cost of immersion heater, i.e. heating airing cupboard and little lost loss from page XXXXVIII, as at 8th December 1977, 10KW per day 24hours = say 25p per day cost. This included night use of clocks, 'fridge, night lights in house, (leakage?) 1KW (measured) = £22 per quarter.

Lighting per night 5pm to 9am. 4KW (3KW occupation hours, 1Kw night only) = £9 quarter
Heating 1 room with Colite open fire, 40p per day in winter. 5cwts lasts 36 days.
(see also page LVII)

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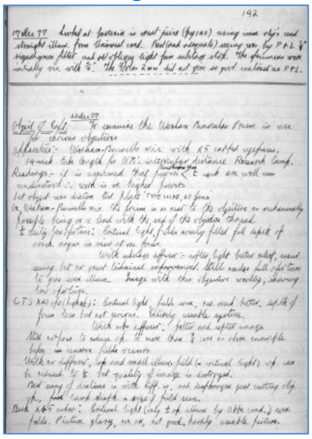

11th December 1977
Looked at Bacteria in meat juice (page 140) using immersion objectives and straight illumination from Universal condenser. Best (and adequate) seeing was by Powell & Lealand ⅛”, signal green filter and oblique light from substage stop. The specimens were initially visible with ⅔”. The Holos 2mm did not give so good contrast as Powell & Lealand.

22nd December 1977
Object of Experiment.
To examine the Wenham Binocular Prism in use for various objectives.
Apparatus:- Wenham-Burrells microscope with x5 capped eyepieces. 14-inch tube length for Wenham Binocular inter-ocular distance. Research lamp.
Readings:- It is assumed that powers lower than ½ inch are well understood therefore work is on higher powers.
1st object was diatom test plate 'Type Slide, 20 forms'
On Wenham-Burrells microscope the prism is as near to the objective as mechanically possible being on a level with the end of the objective thread.
½” Leitz low aperture: Critical light. Fields evenly filled full depth of *Arachnoidiscus argus* in view at one focus.
With substage diffuser:- softer light filter relief, easier seeing but no great technical improvement. Still needs full aperture to give even illumination. Image with this objective woolly, showing low aperture.
CTS x20 Apochromat (HighAp): Critical light; fields were resolved much better, depth of focus less but not serious. Entirely usable system.
With substage diffuser: better and softer image. Still not possible to reduce aperture to more than ¾ cone as above example before uneven field occurs.
With no diffuser, and small illuminated field (=critical light), aperture can be reduced to ½ but quality of image is destroyed.
Best seeing of diatoms is with diffuser in and diaphragm just cutting objective aperture, lamp diaphragm = size of field seen.
Beck x45 Achromat: Critical light (only ½ aperture illuminated by Abbe condenser), even fields. Picture glary, resolution OK, not good, hardly usable picture.
(next page)

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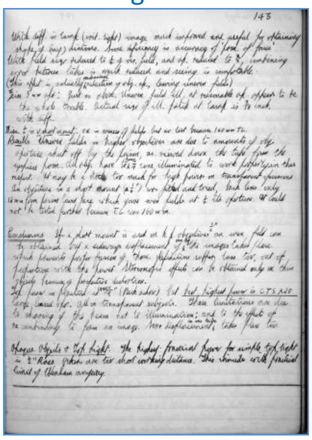

With diffuser in lamp (critical light) image much improved and useful for retaining shape of (say) diatoms. Some deficiency in accuracy of 'position of focus'. With field size reduced to ½ of visible field, and aperture reduced to ⅔, combining error between tubes is much reduced and seeing is comfortable. This effect is actually mechanical reduction of objective aperture, leaving uneven fields.)
Zeiss 3mm Apo: Just as above. Uneven field illumination at reasonable Aperture appears to be the whole trouble. Actual size of illuminated patch at lamp is 3.10 inch with diffuser.
Miscellaneous ⅙” in very short mount: OK in evenness of fields but no test because 160mm tube length.
Results. Uneven fields in higher objectives are due to amounts of objective aperture shut off by the prism, as viewed down the tube from the eyepiece position. All objectives have to have ¾ cone illuminated to work properly in this respect. It may be a little too much for high powers on transparent specimens. An objective in a short mount (a⅙”) was fitted and tried, back lens only 12mm from prism lower face, which gave even fields at ½ its aperture. It could not be tested further because tube length was 160mm.
Conclusions. If a short mount is used on high power objectives ⅙”, an even field can be obtained but a sideways displacement of one of the images takes place which prevents proper fusion of them. Definition suffers loss too, out

of proportion with the power. Stereoscopic effects can be obtained only in thin objects because of perspective distortion.

(x45) 1.5" (Beck Achromat) but best highest power is CTS x20 large lensed apochromat. All on transparent subjects. These limitations are due to sharing of the beam not to illumination; and to the effects of recombining to form an image. Some displacement in one tube takes place too.

Opaque objects and Top light: The highest practical power for simple top light is ½" Ross. Others are too short working distance. This coincides with practical limit of Wenham anyway.

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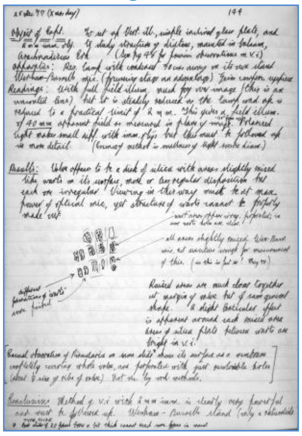


25th December 1977

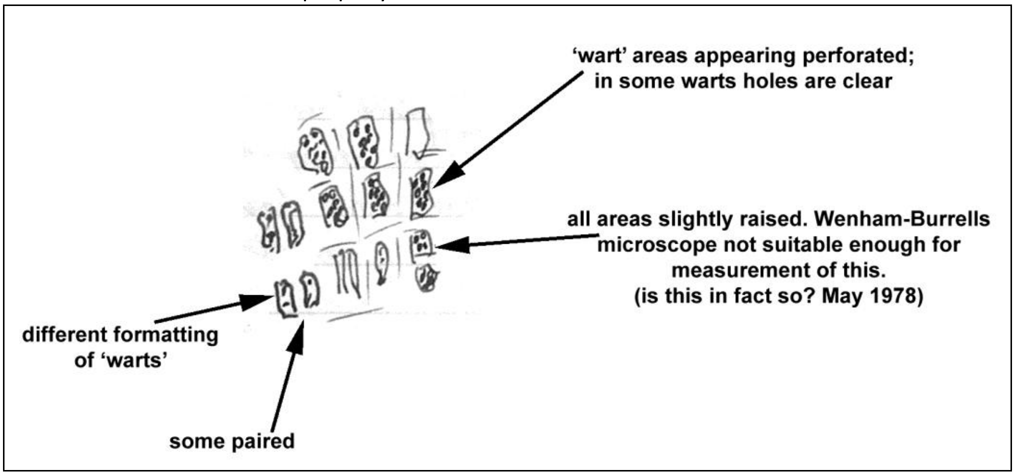
Object of Experiment

To set up Vert. Ill., simple inclined glass plate, and 2mm immersion Objective. To study structure of diatom, mounted in balsam, *Arachnoidiscus Ehrenbergii* (see page 48 for previous observations on Vertical Illumination.)

Apparatus: Research lamp with condenser 50cms away on its own stand, Wenham-Burrells microscope (focussing stage an advantage), Zeiss compensating eyepiece.

Readings: With full field illumination much fog over image (this is an uncoated lens) but it is steadily reduced as the lamp condenser aperture is reduced to a practical limit of 2mm. This gives a field illumination of 40mm apparent field as measured in plane of image (10" from eyes). Polarised light makes small difference with immersion Objectives but must be followed up in more detail. (Essence of method is smallness of light source diameter.)

Results: Valve appears to be a disk of silica with areas slightly raised like warts on its surface, more or less regular disposition but each one irregular. Viewing in this way must be at maximum power of optical microscope, yet structure of warts cannot be properly made out.



Raised areas are much closer together at margin of valve but of same general shape. A slight lenticular effect is apparent around each raised area. Areas of silica plate between warts are bright in Vertical Illumination.

[Casual observation of *Pinnularia* on same slide* shows its surface as a membrane completely covering whole valve, and perforated with just resolvable holes [about ⅛ size of ribs of valve] Not visible by ordinary methods.)

*Type Slide of 20 forms. Cover a bit thick cannot reach some forms in mount.

Conclusions. Method of Vertical Illumination. With 2mm immersion Is clearly very powerful and must be followed up. Wenham-Burrells stand (only a Naturalists…*(next page)*

..job) is not good enough in fine adjustment or stand stability to work out properly the conclusions. Future work:- make up car headlamp bulb on a separate stand, possibly with a condenser, arranged to be over-run from a transformer thus very bright and disposable (6V job probably easiest to over-run). See page 146. See page 226.

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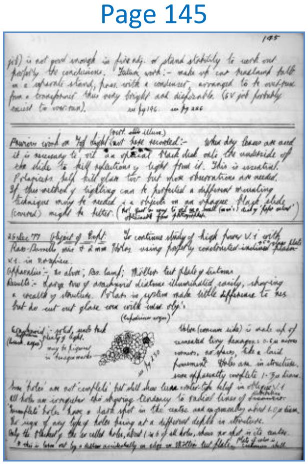


Previous work on Top Light (vertical illumination) not here recorded:- When dry lenses are used it is necessary to il an optical black disk onto the underside of the slide to kill reflections of light from it. This is essential. Polarisers help kill glare too but more observations are needed. If this method of lighting can be perfected a different mounting technique may be needed i.e. objects on an opaque black slide (covered) might be better. (No! Just as easy to oil on a small (mms) disk of 'paper velvet', obtainable from photographers.)

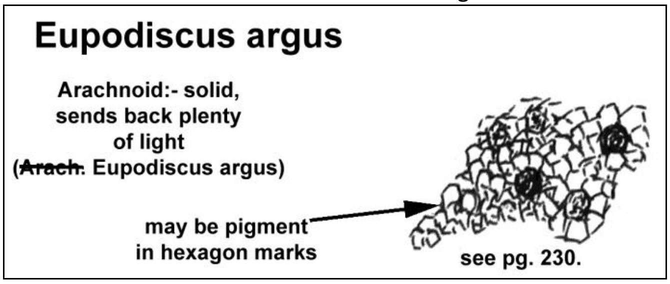
26th December 1977

Object of Experiment

To continue study of high power Vertical Illumination with Ross-Burrells microscope and 2mm Holos, using properly constructed ~~inclined plain~~ 45° glass plate in nosepiece.

Apparatus:- As above; Research lamp; Möller's test plate of diatoms

Results:- Large row of arachnoid diatoms illuminated easily, showing a wealth of structure. Polars in system make little difference to resolution but do cut out glare even with immersion Objectives.



Valve (concave side) is made up of cemented tiny hexagons 0.5µ across corners, no spaces, like a laid pavement.* Holes are in structure some apparently complete 1.3µ diameter. Some 'Holes are not; complete' but still show lunar crater-type relief in oblique Vertical Illumination. All holes are irregular though showing tendency to radial lines of distribution. 'Incomplete' holes have a dark spot in the centre and are generally about 1.0µ diameter. No sign of any type of holes being at a different depth in structure. Only the blackest of the so called holes, about 1 in 6 of all holes, shows no spot in its centre.

*This is borne out by a diatom accidentally on edge on Möller's Test Plate. Plate of valve is continuous shell.

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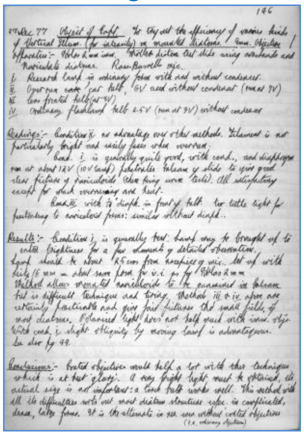


27th December 1977

Object of Experiment

To try out the efficiency of various kinds of Vertical illumination (for intensity) on mounted diatoms. Immersion objective.

Apparatus:- Holos 2mm immersion. Möller diatom test slide using *Arachnoidiscus* and Naviculoid diatoms. Ross-Burrells microscope.

i. Research lamp in ordinary form with and without condenser
ii. Overrun car bulb, 6V used without condenser (run at 7V)
iii. Lens fronted bulb (at 3V)
iv. Ordinary flash-lamp bulb 2.5V (run at 3V) without condenser

Readings:- Condition ii. No advantage over other methods. Filament is not particularly bright and easily fuses when overrun.

Condition i. is generally quite good, with condenser, and diaphragm run at about 12V (10V lamp) penetrates Balsam of slide to give good clear picture of naviculoids (these being severe tests). All absolutely satisfactory except for much overrunning and heat.

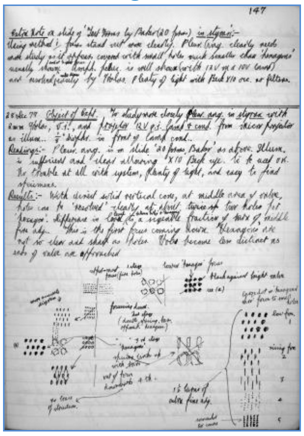
Condition iii. With ¹⁄₁₆" diaphragm in front of bulb. Too little light for penetrating to naviculoid forms: similar without diaphragm.

Results:- Condition i. is generally best: lamp may be brought up to extra brightness for a few moments of detailed observation. Lamp should be about 25cms from nosepiece of microscope. Set up with Leitz 16mm = about same for Vertical Illumination as for Holos 2mm.

Method allows mounted naviculoids to be examined in Balsam but is difficult technique and tiring. Methods iii. and iv. Above are certainly practicable and give fair pictures though small fields of mounted diatoms. Polarised light does not help much with immersion objectives. With condenser i. slight obliquity by moving lamp is advantageous.

Conclusions. Coated objectives would help a lot with this technique which is at best 'glary'. A very bright light must be obtained, its actual size is not important: a torch bulb works well. This method with all its difficulties sorts out most diatom structure especially in complicated, dense, large forms. It is the ultimate in resolution even without 'coated objectives (i.e. ordinary objectives)

Page 147



Extra Note on a slide of 'Test Forms by Baker (20 forms) in Styrax':-
Using method i. forms stand out more clearly. *Pleurosigma angulatum* clearly needs more study as it appears covered with small holes much smaller than 'hexagons' usually shown and at higher focus. *Amphipleura pellucida* is well shown (with 12V on a 10V lamp) and resolved into lines by Holos. Plenty of light with Beck x10 ocular, no filters.

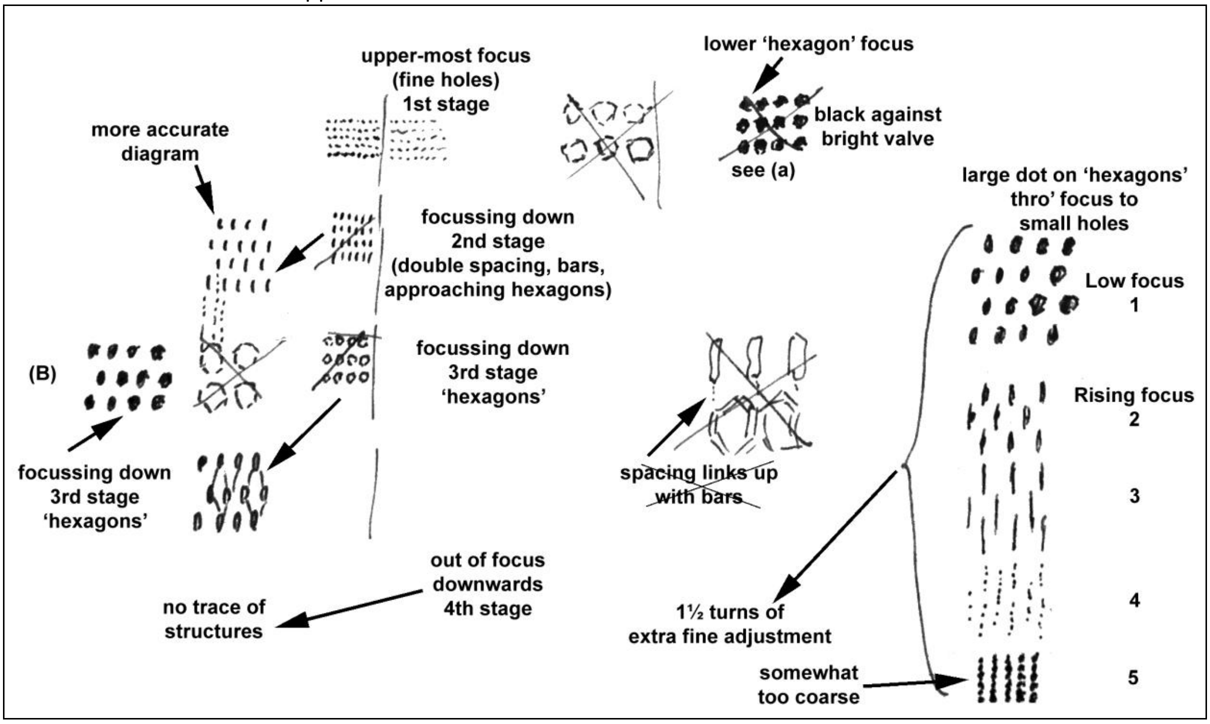
28th December 1977

Object of Experiment

To study more clearly *Pleurosigma angulatum* in Styrax with 2mm Holos, Vertical Illumination, and projector 12V Quartz Iodide lamp and Condenser from microprojector as illuminator, ⅛" diaphragm in front of lamp condenser.

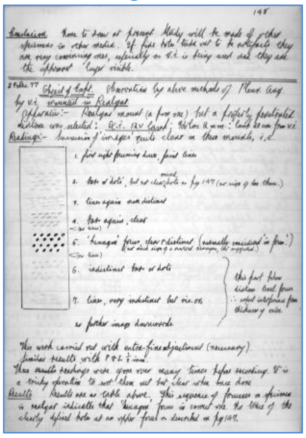
Readings:- *Pleurosigma angulatum* is on slide '20 forms, Baker' as above. Illumination is sufficient and clear allowing x10 Beck eyepiece to be used OK. No trouble at all with system, plenty of light, and easy to find specimens.

Results:- With direct solid vertical cone, at middle area of valve, holes can be 'resolved' clearly at about two holes per 'hexagon'. Difference in level between 'holes' and hexagons, is a sizeable fraction of turn of middle fine adjustment. This is the first focus coming down. 'Hexagons' are not so clear and sharp as holes. Holes become less distinct as ends of valve are approached.



(next page)

Page 148



Conclusion. None to draw at present. Study will be made of other specimens in other media. If fine holes turn out to be artefacts they are very convincing ones, especially as Vertical Illumination is being used and they are the uppermost layer visible.

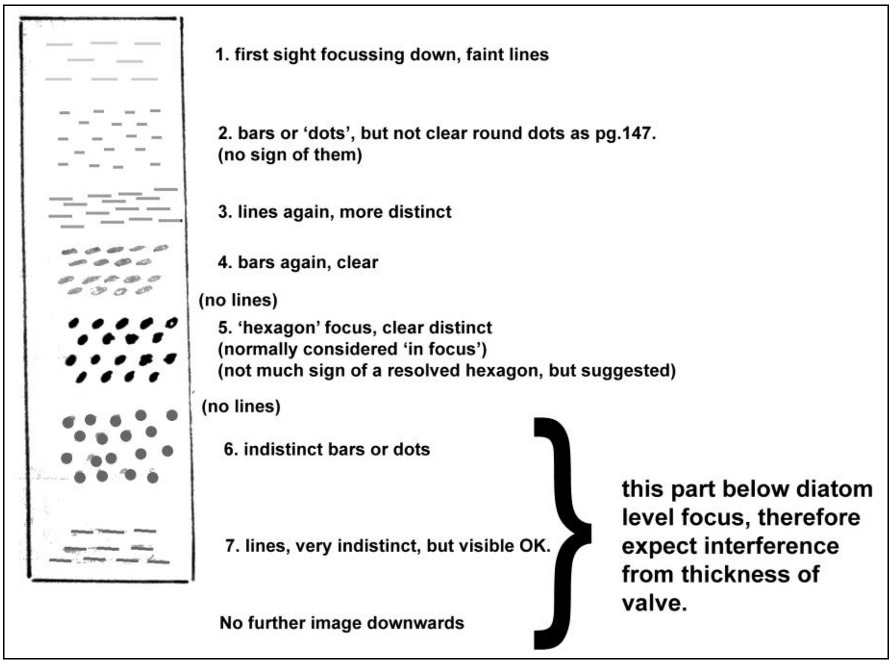
29th December 1977

Object of Experiment

Observation by the above methods of *Pleurosigma angulatum* by Vertical Illumination, mounted in Realgar.

Apparatus:- Realgar mount (a poor one) but a properly penetrated diatom was selected: Quartz Iodide 12V lamp: Holos 2mm: lamp 20cms from VI.

Readings:- Succession of 'images' quite clear on these mounts, i.e.



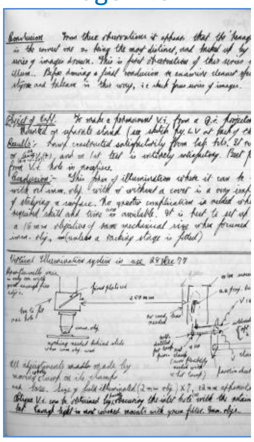
This work carried out with extra-fine adjustment (necessary).

Similar results with Powell and Lealand ⅛" immersion.

These readings were gone over many times before recording. It is a tricky operation to sort them out but clear when once done.

Results. Results are as table above. This sequence of focuses on specimen in Realgar indicated that 'hexagon' focus is correct one. No trace of the clearly defined holes at an upper focus as described on page 147. *(next page)*

Page 149



Conclusion. From these observations it appears that the 'hexagon' focus is the correct one as being the most distinct, and backed up by the in-and-out series of images drawn. This is first observation of this series with Vertical Illumination. Before drawing a final conclusion re-examine cleaner specimens in Styrax and Balsam in this way, i.e. check focus series of images.

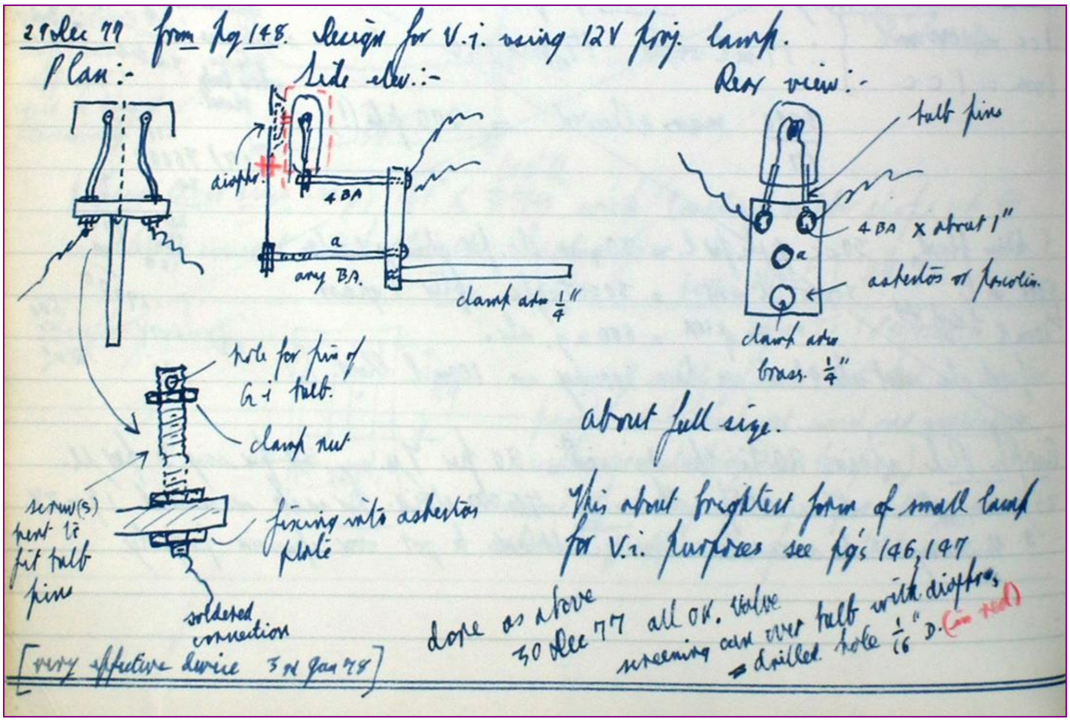
30th December 1977

Object of Experiment

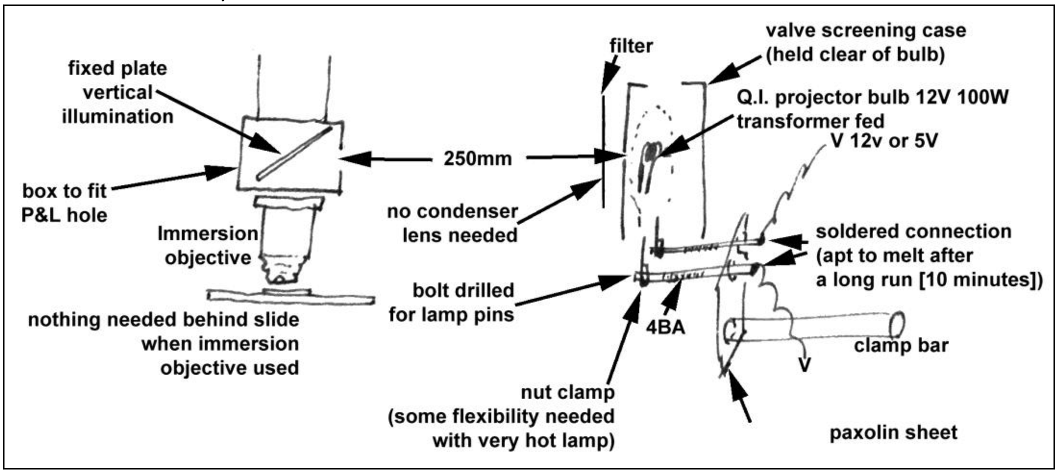
To make a permanent Vertical Illuminator for a Quartz Iodide projector bulb. Mounted on separate stand (see sketch page LV at back of this book).

Results:- Lamp constructed satisfactorily from laboratory bits. It runs on 5V or 12V+ (6.3-0-6.3) and on 1st test is entirely satisfactory. Best position is 250mm from Vertical Illuminator hole in nosepiece.

Conclusion:- This form of illumination where it can be used, i.e. with oil immersion objectives with or without a cover is a very important way of studying a surface. No greater complication is needed where the required skill and time are available. It is best to set up with a 16mm objective of same mechanical size when focussed as the immersion objective, (unless a racking stage is fitted).

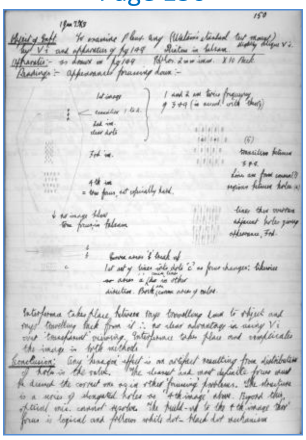


28th December 1977
Vertical Illuminator System in use

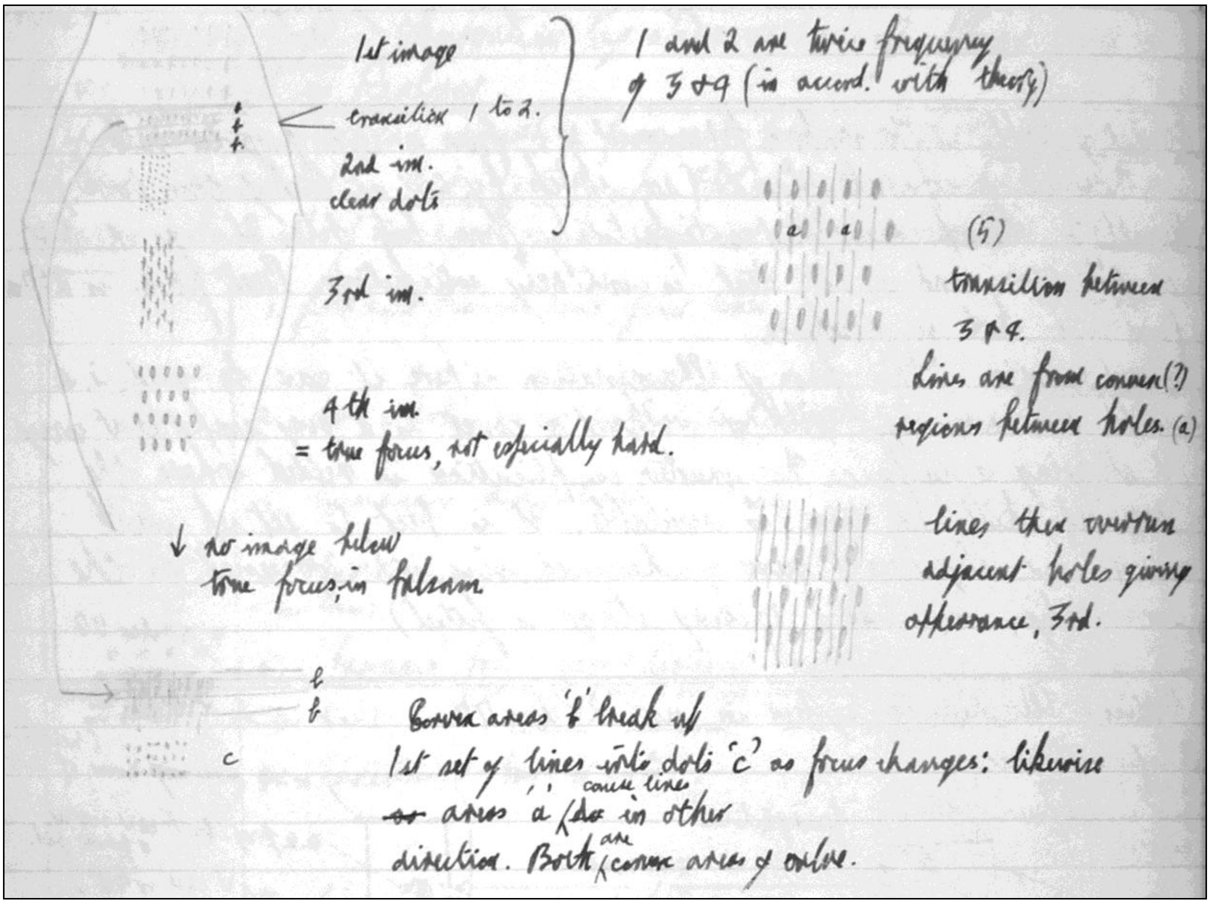


All adjustments made by moving whole lamp on its clamps and base. Size of field illuminated (2mm objective) x7, 12mm apparent at 250mm distance.
Oblique Vertical Illumination can be obtained by partly obscuring the inlet hole (a) with the retaining clamp bar. Enough light in most covered mounts with green filter. Immersion Objectives.

Page 150



1st January 1978
Object of Experiment
To examine *Pleurosigma angulatum* (Watson's standard test mount) by Vertical Illumination and apparatus of page 149. Diatom in balsam. Slightly oblique Vertical illumination.
Apparatus:- as drawn on page 149, Holos 2mm immersion, x10 Beck
Readings:- Appearances focussing down:



Interference takes place between rays travelling down to object and rays travelling back from it, therefore no clear advantage in using Vertical Illumination over 'transparent' viewing. Interference takes place and complicates the image in both methods.

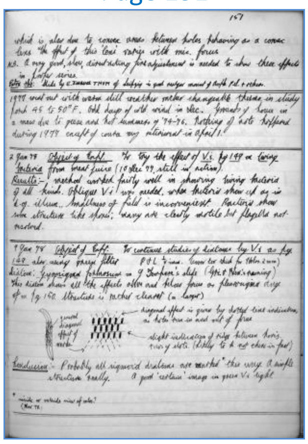
Conclusion. Any 'hexagon' effect is an artefact resulting from distribution of holes in the valve. The clearest and most definite focus must be deemed the correct one as in other 'focussing' problems. The structure is a series of elongated holes as '4th image' above. Beyond this, optical microscope cannot resolve. The build-up to the 4th image through focus is logical and follows white dot-black dot mechanism…*(next page)*

…which is also due to convex areas between holes behaving as a convex lens. The effect of this 'lens' varies with microscope focus.

NB. A very good, slow, direct acting fine adjustment is needed to show these effects in proper series.

Extra observations: Slide by E. ~~Thrum~~ Thum of Leipzig is good Realgar mount of *Amphipleura pellucida* and others.

Page 151



1977 went out with warm still weather rather changeable, thermometer in study porch 45° to 50°F. Odd days of cold wind in December. Grounds of house in a mess due to geese and hot summers of 1974-1976. Nothing of note happened during 1977 except, of course, my retirement on April 1st.

Amphipleura pellucida striae. 20 to the division (this may not be accurate as micrometer could not be got over specimen properly) = 20 per 7μ = say 3 per μ.

25μ = 1⁄1000" therefore striae 75 per thou or 75,000 stria per inch measured 1st January 1978.

2nd January 1978

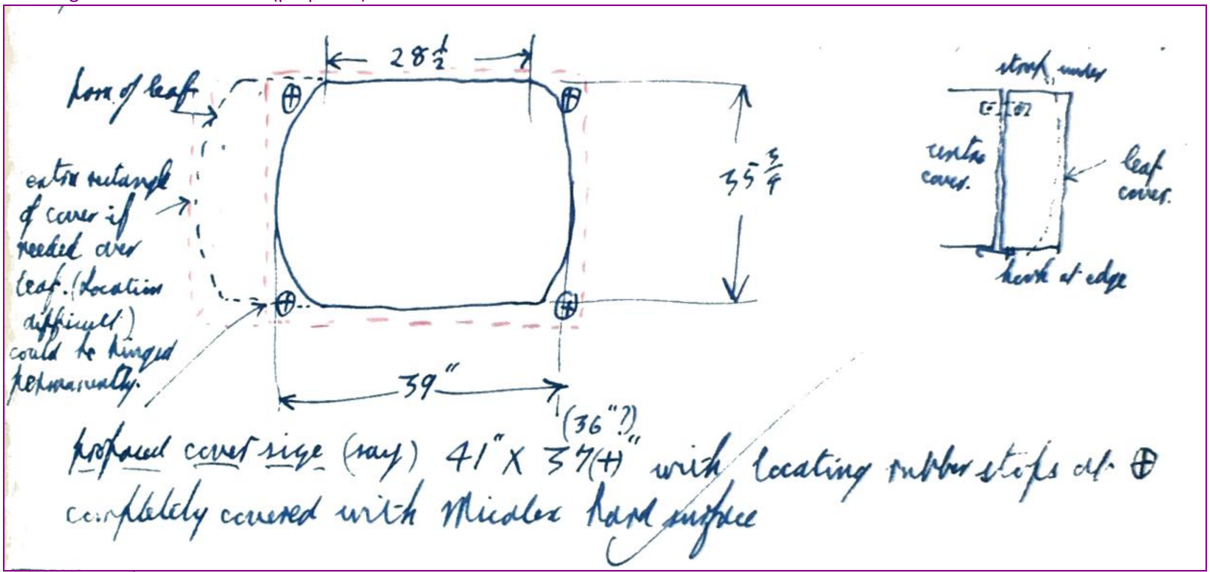
Object of Experiment

To try the effect of Vertical Illumination page 149 on living bacteria from meat juice (10th December 1977, still in action)

Results:- Method worked fairly well in showing living bacteria of all kinds. Oblique Vertical Illumination was needed, when bacteria show up as in dark ground illumination. Smallness of field is inconvenient. Bacteria show some structure like spores; many are clearly motile but flagella not resolved.

8th January 1978

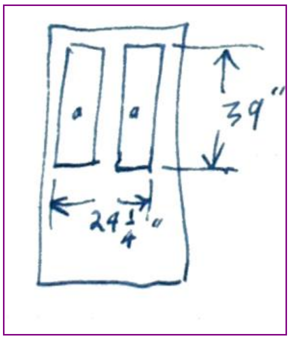
Covering for Kitchen Oak table (proposed)



Put in hand 20th January 1978 Ray Haynes (Wantage)

Done about 1st February 1978

Scullery Door



Size of whole glass but best use smaller panels 'a; (knock out wood and mouldings without disturbing door hanging. (Await painting of inside of scullery, in interests of appearance from outside room.)

9th January 1978

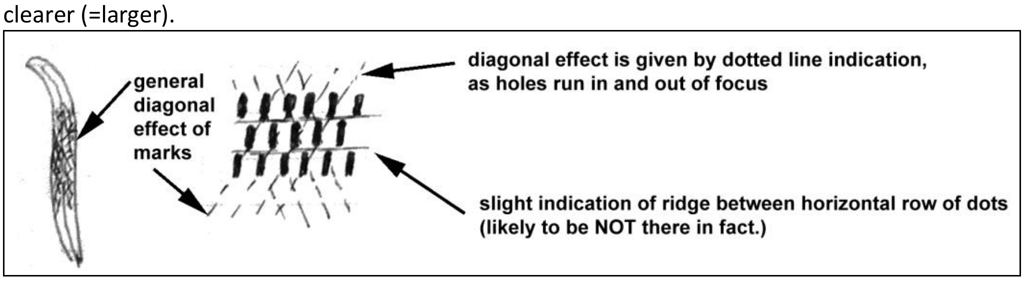
Object of Experiment

To continue studies of diatoms by Vertical Illumination as page 149. also using green filter.

Powell and Lealand ⅛"immersion (cover too thick for Holos 2mm)

Diatom: *Gyrosigma formosum* on J. Tempere's slide (Griffith and Henfrey's naming)

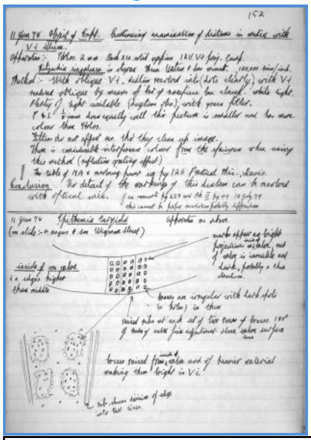
This diatom shows all the effects above and below focus as *Pleurosigma angulatum* on page 150. Structure is rather clearer (=larger).



Conclusion. Probably all sigmoid diatoms are marked* this way. A simple structure really. A good 'certain' image in green Vertical Illumination light.

*inside or outside of valve? (March 1978)

Page 152

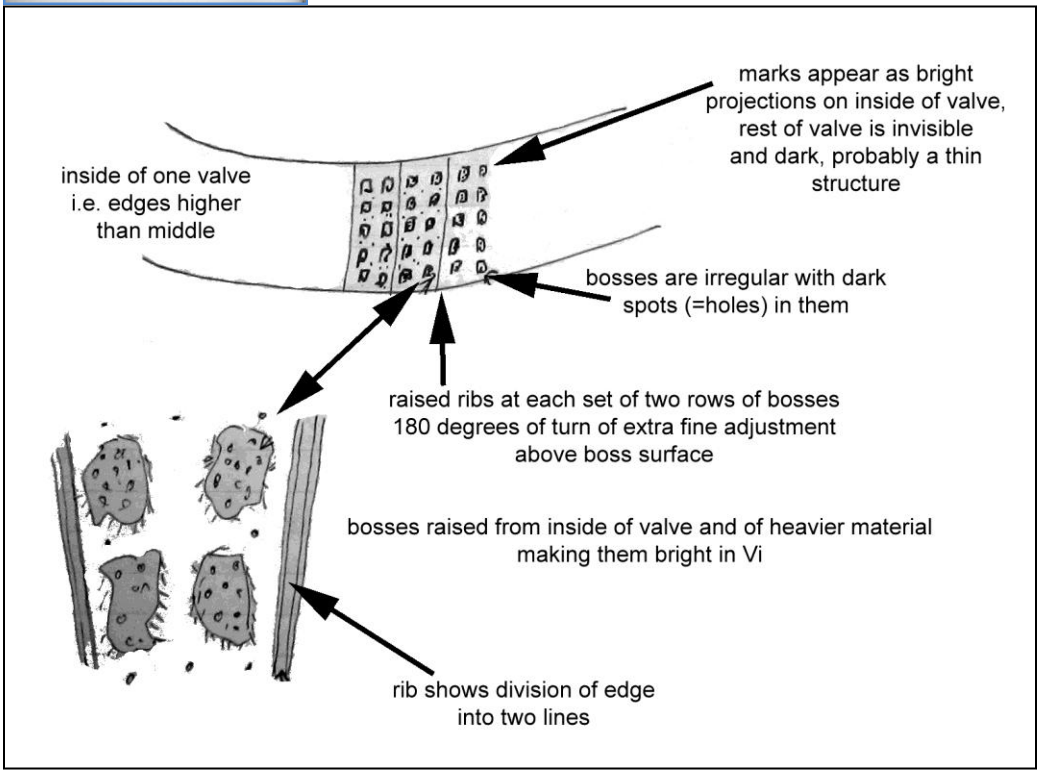


11th January 1978

Epithemia turgida

(On slide:- F. Angus & Son, Wigmore Street)

(Apparatus as above)



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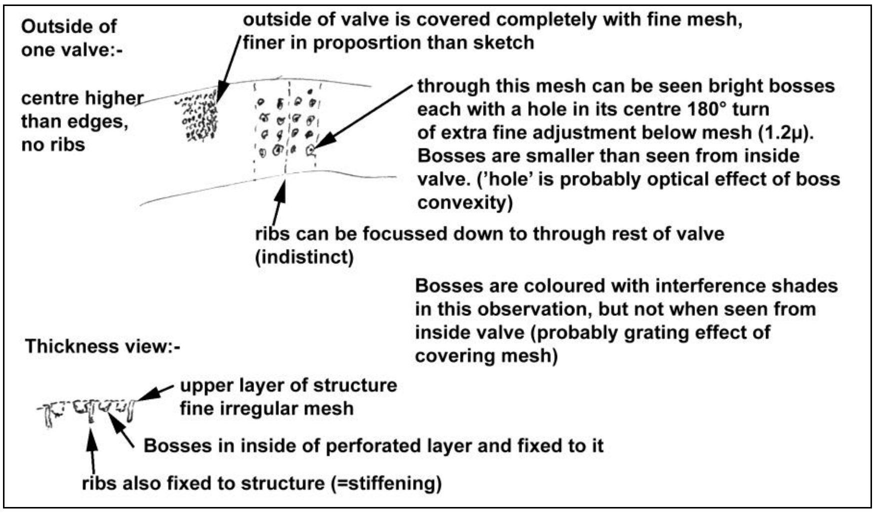
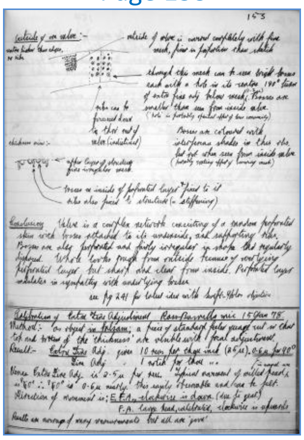


Page 153

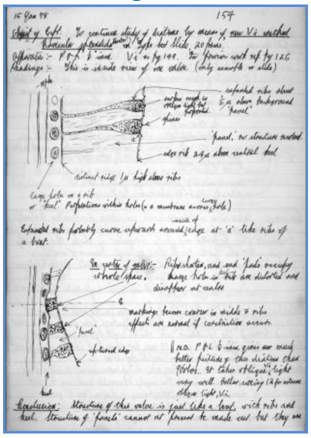


Conclusion. Valve is a complex network consisting of a random perforated skin with bosses attached to its underside, and supporting ribs. Bosses are also perforated and fairly irregular in shape though regularly disposed. Whole looks rough from outside because of overlying perforated layer but sharp and clear from inside. Perforated layer undulates in sympathy with underlying bosses.

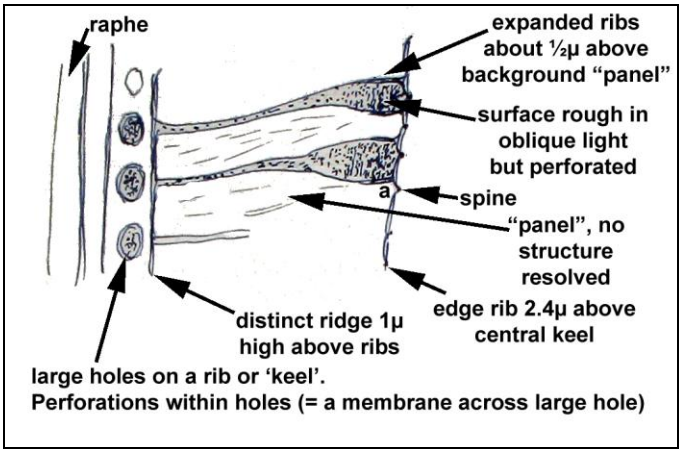
See page 241 for latest idea with Swift-Holos objective.

15th January 1978
Calibration of Extra fine adjustment Ross-Burrells microscope.
Method:- An object in balsam; a piece of standard feeler gauge cut so that top and bottom of the 'thickness' are visible with focal adjustment.
Results:- Extra fine adjustment gives 10 revolutions per thou inch (25µ) 0.6µ per 90°
Fine adjustment gives 1 notch per thou inch
Hence extra fine adjustment is 2.5µ per revolution. Typical movement of milled head in normal use is 90°, therefore 90° is 0.6µ nearly. This easily observable and can be felt.
Direction of movement if; E.F.A clockwise is down (due to gear)
Fine adjustment large head, calibrated, clockwise is upwards.
Results are average of many measurements but all are 'good'.

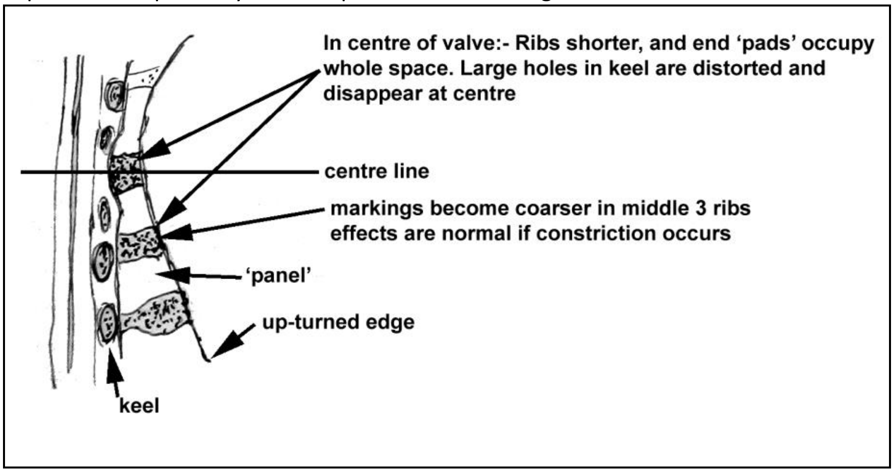
Page 154



15th January 1978
Object of Experiment.
To continue study of diatoms by means of new Vertical illumination method.
Navicula splendida (crabro?) on Type slide, 20 forms.
Apparatus:- Powell & Lealand ⅛" immersion. Vertical illumination as page 149. For previous work refer page 126.
Readings:- This is inside view of one valve (only example on slide)

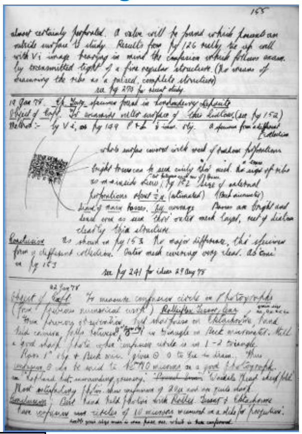


Expanded ribs probably curved upwards inside of edge at 'a' like ribs of a boat.



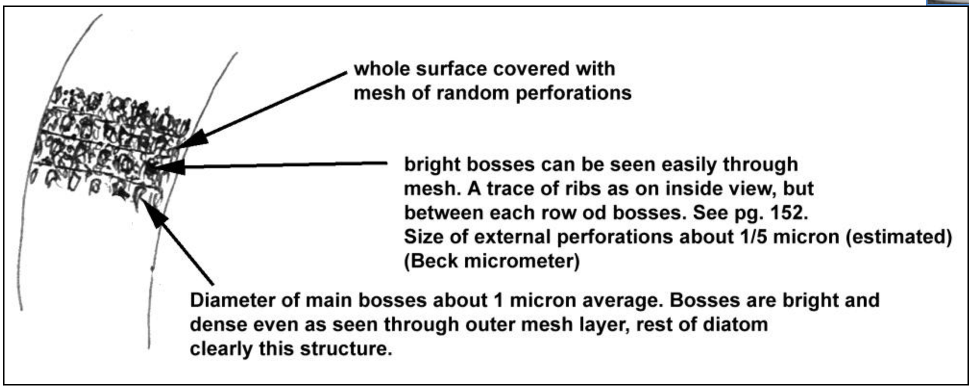
Conclusion: Structure of this valve is just like a boat, with ribs and keel. Structure of 'panels' cannot at present be made out, but they are…*(next page)*

Page 155



…almost certainly perforated. A valve will be found that presents an outside surface to study. Results from page 126 really tie up will with Vertical Illumination image bearing in mind the confusion which follows examination by transmitted light of a fine regular structure. (No means of measuring the ribs as a raised complete structure.)
See page 274 for recent study.

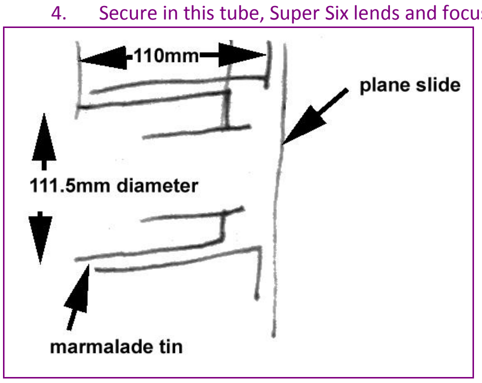
19th January 1978
Epithemia turgida specimen found in Londonderry deposit.
Object of experiment.
To examine out surface of this diatom (see page 152)
Method:- by Vertical Illumination. As per page 149, Powell and Lealand ⅛" immersion objective, a specimen from a different collection.



Conclusion. As shown on page 153. No major difference, though specimen from a different collection. Outer mesh covering very clear. As concluded on page 153.
See page 241 for ideas 29th August 1978

22nd January 1978
Object of Experiment
To measure confusion circle on Photographs (from previous numerical work). Rolleiflex Tessar lens.
From previous observation best sharpness on Ektachrome (grain size all 6µ or < 6µ), hand held camera, falls between (1" Ross objective) 0-1 in triangle on Beck Micrometer. Still a good sharp photo when confusion circle is in 1-2 triangle. Ross 1" objective and Beck micrometer gives circle 0 to 8µ in diameter. Thus confusion circle can be said to be (say) 110 microns on a good photograph.
See "Lapland hut. Surround greenery", "Wasdale Head, sheep fold."
Most satisfactory photos show confusion of 20µ and are quite sharp.
Conclusion. Best hand held photos with Rolleiflex Tessar and Ektachrome have confusion circles of 10 microns measured on a slide from 'projection'.
Double grain size measurement is maximum passable resolution which is here confirmed.

22nd January 1978 (page LVIII from back of book)
To fit wide angle 'Super Six' lens to projector without vignetting:-
1. Unscrew whole front of projector
2. Insert marmalade tin wrapped with carpet into main opening
3. Cut out end of marmalade tin and solder in short length of brass (2" long) tube (to hand)
4. Secure in this tube, Super Six lends and focus by sliding whole.



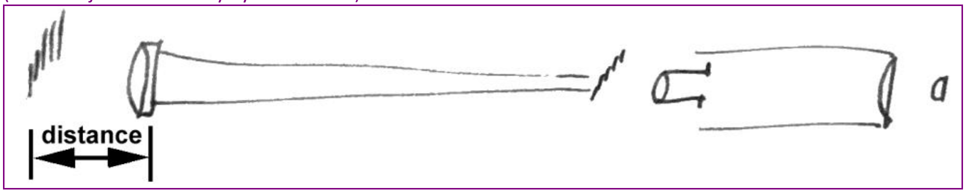
All this tried, only permanent structure needed.

Proposed measurement of resolution of telescope object glasses:-

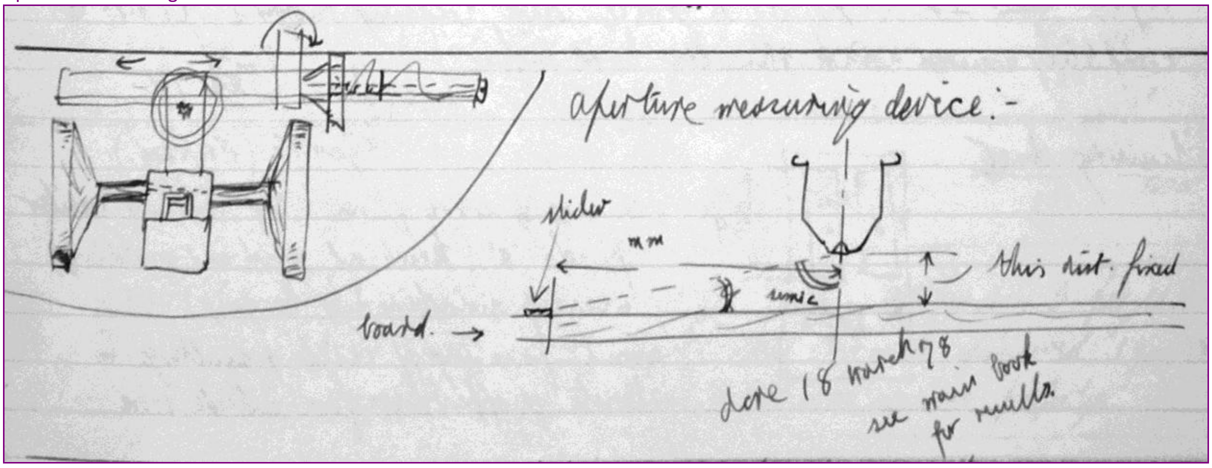
1. Use microscope to observe telescope image of scale ruler.
2. Move ruler away until resolution fails.
3. State result as distance from object glass at which mm lines can be separated.

First lens in scale rule (6") = 66 lines/inch (130 lines per 50mm = 26 lines/mm

(2.6 scale just resolved by eye at 600mm)



Aperture Measuring device:



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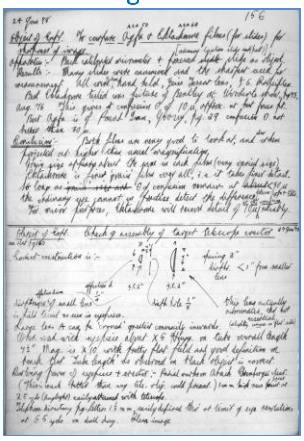


24th January 1978

Object of Experiment

To compare Agfa ASA50 & Ektachrome ASA64 films (for slides) for sharpness of image

Apparatus:- Beck calibrated micrometer and patterned slide (ordinary lantern slide section (part)) as object.

Results:- Many slides were examined and the sharpest used for measurement. All were taken hand held, Zeiss Tessar lens, f6 Rolleiflex. Best Ektachrome tested was picture of Bentley at Woodcote show, pg,73, August 1976. This gives a confusion circle of 10 µ approximately at best focus point. Best Agfa is of Pound Inn, Goosey, page 29, confusion circle not better than 30µ.

Conclusion. Both films are very good to look at, and also when projected at higher than usual magnification.

Grain size appears about the same in each film (very varied size). Ektachrome is finer 'grain' film over all, i.e. it takes finer detail. So long as circle of confusion remain at < 30µ the ordinary eye cannot in practise detect the difference between Agfa and Ektachrome.

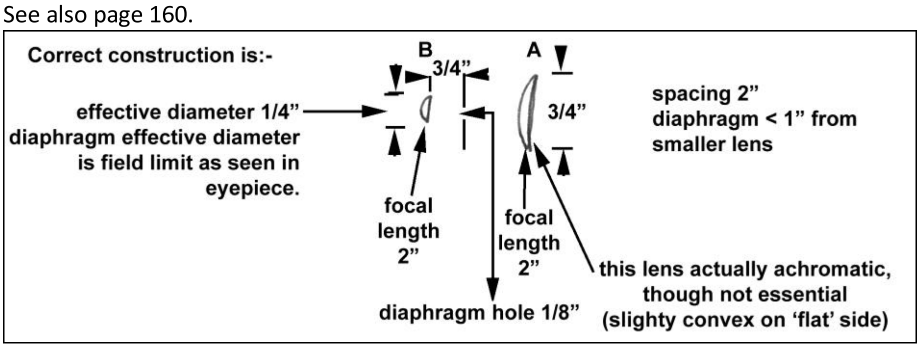
For micro purposes, Ektachrome will record detail of 70µ at the emulsion reliably.

27th January 1978

Object of Experiment

Check of assembly of target telescope erector.

See also page 160.



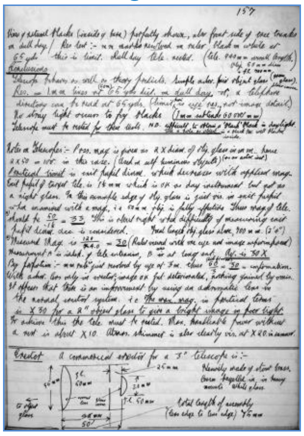
Large lens A can be 'crossed' greater convexity inwards.

When used with eyepiece about x5 Huyghenian on tube overall length 7½". Magnification is x10 with pretty flat field and good definition on bench test. 'Tube length' as observed on black object is correct. Resolving power of eyepiece and erector:- Radial marks on *Arachnoidiscus Ehrenbergii* clear. (This much better than any tele objective could present) 1mm high news print at 25 yards (daylight) easily attained with telescope.

Telephone directory page letter 1½mm, easily defined though at limit of eye resolution, at 65 yards on dull day. Clean image.

(next page)

Page 157



Views of natural blacks (inside of barn) perfectly shown, also front side of tree trunks on dull day. Resolution test:- mm marks resolved on ruler black on white at 65 yards, this is limit. Dull day telescope rested. (telescope 940mm overall length, objective 50mm diameter = focal length 700mm)

Conclusions. Telescope behaves well as theory predicts. Simple achromatic pair object glass (green glass, plano-convex).

Resolution = 1mm lines at 65 yards (60metres) distance on a dull day, or a telephone directory can be read at 65 yards (limit here is eye resolution, not image detail). No stray light occurs to fog blacks (1mm subtends 60,000mm). Telescope must be rested for these tests. NB. Difficult to obtain a ‘black’ black in daylight. Use a hole as object in a black box well blacked inside.

Notes on Telescopes:- Possible magnification is given as 2x diameter of object glass in mm, hence 2x50-100, in this case. (Used on self-luminous objects) (as an astronomical instrument)

Practical limit is exit pupil diameter which decreases with applied magnification. Exit pupil of target telescope is 1½mm which is OK as day instrument but not as a night glass. In this example edge of object glass is just visible in exit pupil when examined with a magnifier, i.e. 50mm objective is fully effective. Thus magnification of telescope

A. Should be 50/1½=33. This is about right when difficulty of measuring exit pupil diameter acc. Is considered. Focal length object glass above 700mm (2’4”)

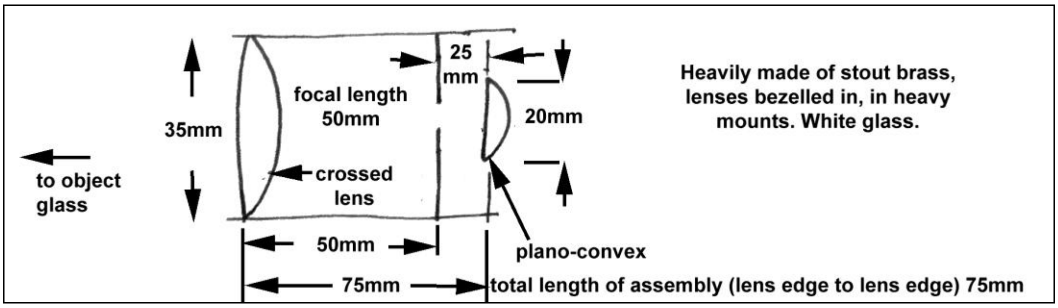
B. Measured magnification is $^{120}/_{40}$=30 (Ruler viewed with one eye and image superimposed).

Measurement A is index of telescope extension, B was at long end. Average is 30x.

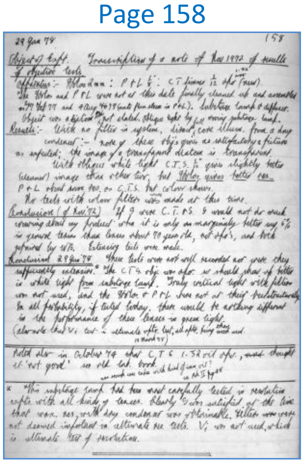
By proportion:- mm rule is just resolved by eye at 3m, thus $^{60}/_{3}$ = 30 = confirmation.

(transcribers Note: 60 divided by 3 = 20 – not confirmation)

With achromatic lens only in erector; image OK but deteriorated, nothing gained by omission. It appears that there is an improvement by using an achromatic lens in the normal erector system, i.e. the maximum magnification in practical terms is x30 for a 2” object glass to give a bright image in poor light. To achieve this the telescope must be rested. Maximum handle-able power without a rest is about x10. Atmospheric shimmer is also clearly visible at x20 in summer.



Page 158



29th January 1978

Object of Experiment

Transcription of a note of November 1972 of results of objective tests.

Apparatus:- Holos 2mm: Powell and Lealand ⅛”: Cooke, Troughton and Simms $^1/_{12}$ Apo (new) 1.35NA.

The Holos and Powell and Lealand were not at this date finally cleaned up and assembled as by 7th February 1977 and 4th August 1977 (anti flare sleeve in Powell and Lealand). Substage lamp and diffuser. Object was a diatom, sp. not stated. Oblique light by moving substage lamp.

Results:- With no filter in system, direct full cone illumination from a dry condenser:- none of these objectives gives as satisfactory a picture as expected; the image of a transparent diatom is transparent.

With oblique white light C.T.S. $^1/_{12}$” gives slightly better (cleaner) image than other two, but Holos gives better resolution. Powell and Lealand about same resolution as C.T.S. but colour shows.

No tests with colour filters were made at this time.

Conclusion (of November 1972). If I were C.T.S. I would not do much crowing about m y product when it is only marginally better say, 5% in general terms than lenses about 70 years old, not Apochromats, and both repaired by WB. Extensive tests were made.

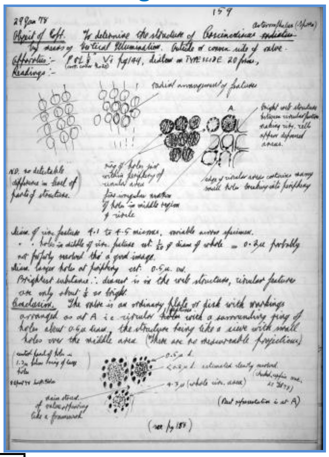
Conclusion 29th January 1978. These tests were not well recorded nor were they sufficiently extensive*. The C.T.S. objective was apochromat so should show up better in white light from substage lamp. Truly critical light with filters was not used, and the Holos and Powell and Lealand were not at their best structurally. In all probability, if tested today, there would be nothing different in the performance of these lenses in green light.

*This substage lamp had been most carefully tested is resolution experiments with all kinds of lenses. Clearly I was satisfied at the time that maximum resolution with dry condenser was obtainable. Filters were not deemed important in ultimate resolution tests. Vertical Illumination was not used, which is ultimate test of resolution.

Noted also in October 1974 that C.T.S. 1.32 oil apochromat, though it 'not good' – see old lab book (transcribers note: no previous lab. book) – was enough care taken with kind of immersion oil? See Bk.II page 48.

28th January 1978

Page 159

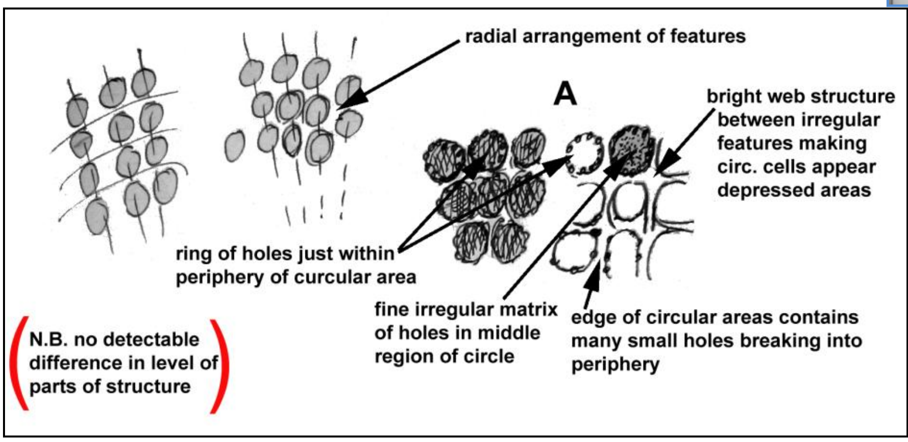


Object of Experiment.

To determine the structure of *Coscinodiscus* ~~*radiatus*~~ *Asteromphalus* (Spitta) by means of Vertical Illumination. Outside of convex side of valve.

Apparatus:- Powell & Lealand ⅛" (correction collar No.20), Vertical Illumination, diatom on Type Slide 20 forms

Readings:-



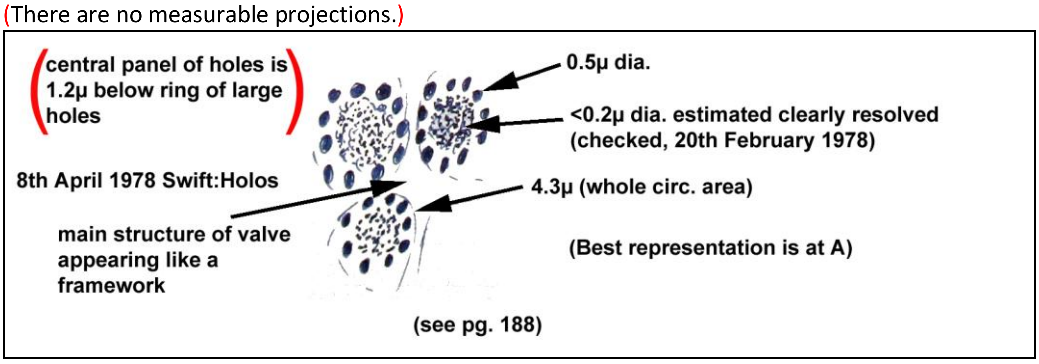
Diameter of circular feature 4.1 to 4.5 microns, variable across specimen.

Diameter of holes in middle of circular feature est. $\frac{1}{20}$th of diameter of whole = 0.2µ probably, not properly resolved though a good image.

Diameter larger holes at periphery estimated 0.5µ OW.

Brightest substance therefore densest is in the web structure, circular features are only about ¼ as bright.

Conclusion. The valve is an ordinary plate or disk with markings arranged as at A i.e. circular features with a surrounding ring of holes about 0.5µ diameter, the structure being like a sieve with small holes over the middle area. (There are no measurable projections.)



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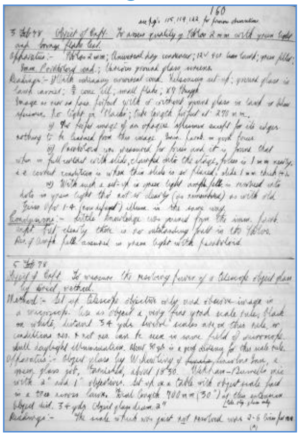


3rd February 1978

Object of experiment: To assess the quality of Holos 2mm with Green Light and Bronze Flake text. (see pages 115, 119, 122 for previous observations)

Apparatus:- Holos 2mm; Universal dry condenser; 12V research lamp; green filter; 9mm Paraboloid condenser; Various ground glass screens.

Readings:- i) With ordinary universal condenser. Nelsonian set-up; ground glass in lamp carrier; ⅔ cone illumination; small flake; x7 Huyghenian.

Image as near as possible perfect with or without ground glass in lamp or below specimen. No light on 'blacks'; tube length perfect at 270mm.

ii) No proper image of an opaque specimen except for its edges, nothing to be learned from this image. 9mm paraboloid in good focus.

iii) Paraboloid condenser measured for focus and it is found that when in full contact with slide, clamped onto the stage, focus is 1mm nearly. i.e. correct condition is when this slide is so placed, slide 1mm thick(+).

iv) With such a set-up in green light *Amphipleura pellucida* is resolved into dots in green light though not so clearly (as remembered) as with old Zeiss Apochromat 1.4 (now defunct) illuminated in the same way.

Conclusions:- Little knowledge was gained from the immersion paraboloid experiment, but clearly there is no outstanding fault in the Holos. Resolution of *Amphipleura pellucida* assured in green light with paraboloid.

5th February 1978

Object of Experiment. To measure the resolving power of a telescope object glass by direct method.

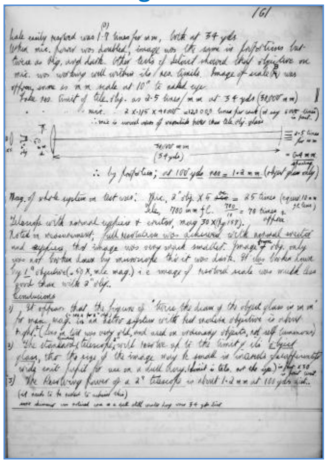
Method:- Set up telescope objective only and observe image in Microscope. Use as object a very fine graduated scale rule, black on white, distinct 34 yards. Several scales are on this rule, so conditions resolved and not resolved can be seen in same field of microscope.

Dull daylight illumination. About 30 yards is a good distance for this scale rule.

Apparatus:- Object glass by W. Rowling of Lincolns Inn, a green glass job, tarnished, about 1830. Wenham-Burrells microscope with 2" and 1" objectives. Set up on a table with object scale fixed in a tree across lawn. Total length 700mm (30") at this extension (telescope object glass only). Object distance 34 yards. Object glass diameter 2".

Readings:- The scale which was just NOT resolved was 2.6 (A) lines per row. *(next page)*

Page 161



Scale easily resolved was 1.7 lines per mm, both at 34 yards.

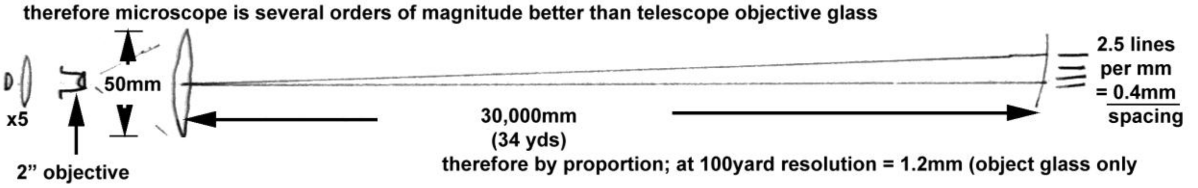
When microscope power was doubled, image was the same in proportions but twice as big, and dark. Other tests of detail showed that objective on microscope was working well within its resolution limits. Image of scale (B) was approximately same as mm scale at 10" to naked eye.

Take resolution limit of telescope as 2.5 lines/mm at 34 yards (30,9999mm)

Take resolution limit of microscope objective as 2x$^1/_5$x40000=12,000 lines per inch (or say 6000 lines in practice)

(Transcribers notes: - I'm failing to relate the mathematics to the results here!)

therefore microscope is several orders of magnitude better than telescope objective glass



therefore by proportion; at 100yard resolution = 1.2mm (object glass only

Magnification of whole system on test was:

Microscope 2" objective x5 ocular = 25 times (equivalent 10mm focal length lens)

Telescope 700mm focal length = $^{700}/_{10}$ = 70 times approximately.

Telescope with normal eyepiece and erector, magnification 30x (page 159)

Noted in measurement; full resolution was achieved with normal erector and eyepiece though image was very much smaller. Image from objective only was not broken down by microscope though it was dark, It was broken down by 1" objective (=50x, microscope magnification) i.e. image of resolved scale was much less good than with 2" objective.

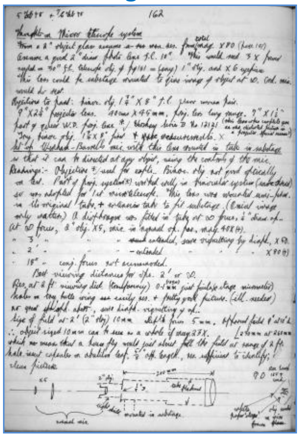
Conclusions.

1. It appears that the figure of 'twice the diameter of the object glass in mm' for maximum magnification (=100x for 2" objective) in an astronomical system with best modern objective is about right. (Lens on test was very old, and used on ordinary objects, not self luminous)
2. The standard terrestrial telescope 2" will resolve up to the limit of its object glass, though the size of the image may be small in interests of a sufficiently wide exit pupil for use on a dull day. (Limit is telescope not the eye) in fact x30 is power limit.
3. The resolving power of a 2" telescope is about 1.2mm at 100 yards distance. (it needs to be rested to achieve this)

Some shimmer was noticed even on a dull still winter day over 34 yards distance.

(Transcribers notes: - I'm failing to follow any of this – seems completely disjointed!)

Page 162



5th and 7th February 1978

Thoughts on Micro Telescope system

From a 2" object glass assume monocular resolution from total magnification x80 (page 161).

Assume a good 2" diameter photo lens focal length 10". This would need 3x power needed on 30" focal length telescope objective of page 161 – (say) 1" objective and x6 eyepiece. This lens could be substage mounted to give image of object at infinity. Ordinary microscope would do rest.

Objectives to hand: Binocular objective 1¾" x 8" focal length, plan-convex pair. 9" x 2¼" projector lens. 40cms x 45mm projector lens long range. 7" x 1½" part of queer W.D. projector lens*. Kershaw Series B No.12121 (this lens when complete gave an off distorted picture in a projector. Special reasons?)

Try binocular objective 1¾x8" first and make measurements.

Set up Wenham-Burrells microscope with this lens mounted in tube in substage so that it can be directed at any object, using the controls of the microscope.

Readings:- Objective* used for experiments. Binocular objective not good optically on test. Part of projector system(*) worked well in binocular system (same thread) so was adapted for 1st micro-telescope. This lens was mounted semi-permanently in its original tube and extension tube at infinity focus, ¼" diameter aperture.

At infinity focus, 2" objective x5, microscope in normal operational position, magnification 40x(+)

At 3' focus, 2" objective x5, microscope extended, same vignetting by diaphragm, x50

At 2' focus, 2" objective x5, microscope extended, same vignetting by diaphragm, x80

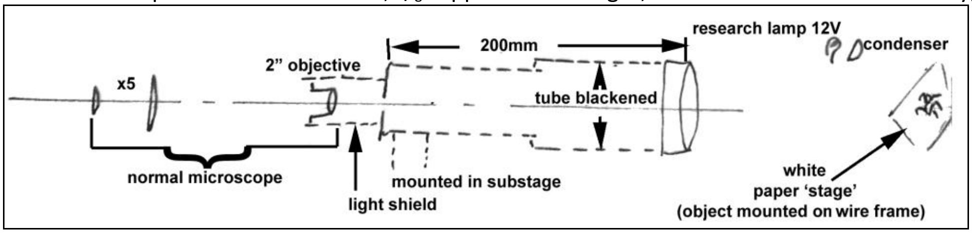
At 18" focus conjugate focus not accommodated. Best viewing distance for operation 2' to infinity

Resolution at 2ft viewing distance (transparency) 0.1mm (180µ) just fails (a stage micrometer)

Scales on tree beetle wing easily resolved and pretty good picture (illumination needed)

No great optical aberration, some diaphragm vignetting of aperture. Size of field at 2' (2" objective) 10mm. Depth of focus 5mm. Apparent field 9" at 10" (230mm at 260mm) distance, therefore object sized 10mm can be seen as a whole if magnified 23x. which means that a housefly would just about fill the field at range of 2ft.

Scale insect capsules on abutilon leaf, $^5/_8$" approximate length, resolution sufficient to identify; clean picture.



(next page)

Conclusions. A useful device has been made which enables objects to be examined at distances 2' to infinity at magnifications 80 to 50 using an ordinary microscope as a supporting framework. There is nothing to be gained over a telescope at ranges greater than (say) 20ft (though the telescope would have to be mounted) but for shorter ranges this micro-telescope is very good (and perhaps the only way to magnify such objects).

Size of field 10mm.

Resolution 0.1mm (say 120µ)

Range distance 2ft

Apparent field 9"

Magnification 80x

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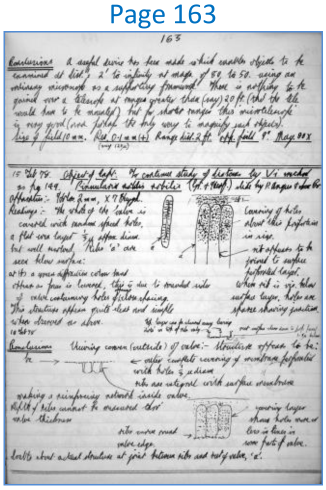


15th February 1978

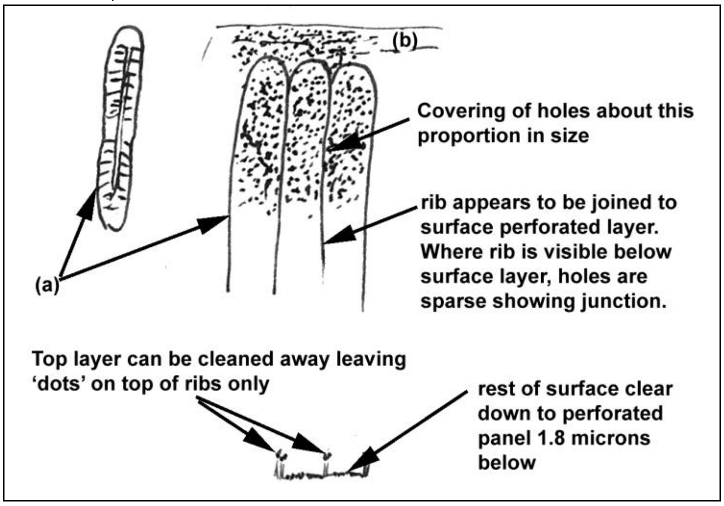
Object of experiment

To continue study of diatoms by Vertical Illumination method as page 149.

Pinnularia nobilis (Griffith and Henfrey) slide by F. Angus and Co.

Apparatus:- Holos 2mm, x7 Huyghenian

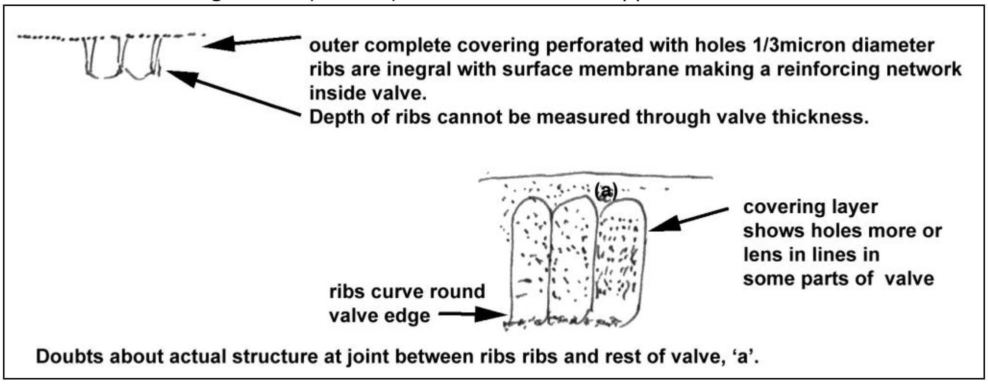
Readings:- The whole of the valve is covered with random spaced holes, a flat even layer ⅓µ approximate dimension, but well resolved.



Ribs 'a' are seen below surface: at 'b' a green diffraction colour band appears as focus is lowered, this is due to rounded sides of valve containing holes of apparent close spacing. This structure appears quite clear and simple when observed as above.

16th February 1978

Conclusions. Viewing convex (outside) of valve – structure appears to be:



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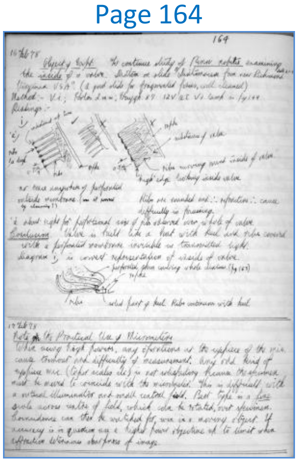


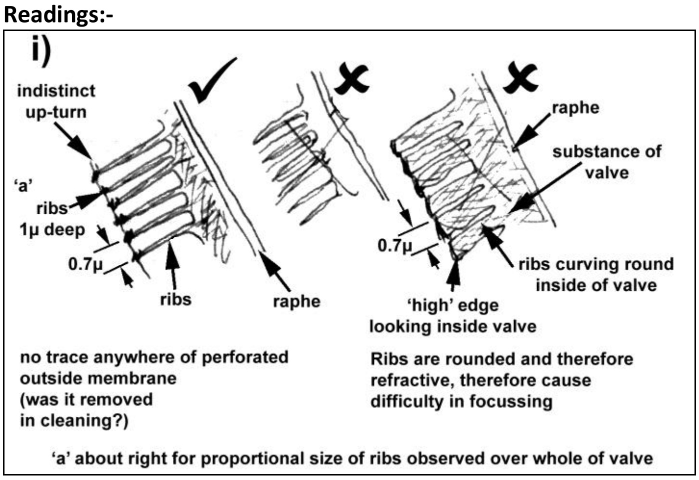
16th February 1978

Object of Experiment

To continue study of *Pinnularia nobilis* examining the inside of a valve. Diatom on slide "Diatomaceae from near Richmond, Virginia, USA" (a good slide for fragmented forms, well cleaned)

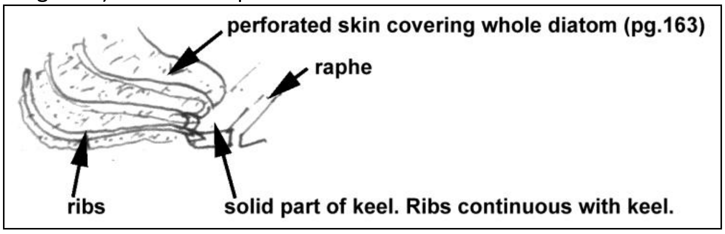
Method:- Vertical Illumination; Holos 2mm; Huyghenian X7; 12V Quartz Iodide Vertical Illumination lamp as per page 149.

Readings:-



Conclusion. Valve is built like a boat with keel and ribs covered with a perforated membrane invisible in transmitted light.

Diagram i) is correct representation of inside of valve.



17th February 1978

Note on Practical Use of Micrometers

When using high powers, any operations at the eyepiece of the microscope cause tremor and difficulty of measurement. Any odd kind of eyepiece micrometer (taper scales etc.) is not satisfactory because the specimen must be moved to coincide with the micrometer. This is difficult with a vertical illuminator and small central field. Best type is a fine scale across centre of field, which can be rotated, over specimen. Coincidence can then be watched for, even in a moving object. If accuracy is in question use a higher power objective up to limit when diffraction determines sharpness of image.

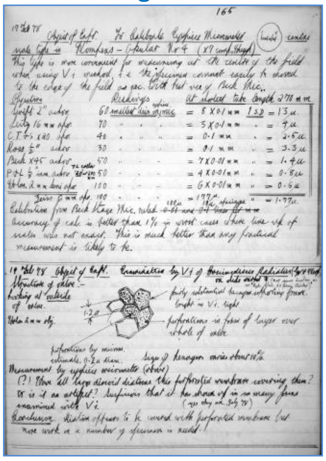
17th February 1978

Object of Experiment

To calibrate Eyepiece Micrometer centre scale type in Kompens-Okular No.4 (x7 Compensating Huyghenian)

This type is more convenient for measuring at the centre of the field when using Vertical Illumination method, i.e. the specimen cannot easily be moved to the edge of the field as necessary for best use with Beck Microscope.

Page 165



Objective	Readings	At shortest tube length 270mm
Swift 2" achromatic	60 smallest disc on eyepiece micrometer	= 8 x 0.1mm 1S.D = 13µ
Leitz 16mm apochromat	70 smallest disc on eyepiece micrometer	= 3 x 0.1mm 1S.D = 4µ
C.T.&S. x20 apochromat	40 smallest disc on eyepiece micrometer	= 0.1mm 1S.D = 2.5µ
Ross ½" achromat	30 smallest disc on eyepiece micrometer	= 0.1mm 1S.D = 3.3µ
Beck x45 achromat	50 smallest disc on eyepiece micrometer	= 7 x 0.01mm 1S.D = 1.4µ
Powell and Lealand ⅛" immersion achromat Tube length collar '20' at 280mm	50 smallest disc on eyepiece micrometer	= 4 x 0.01mm 1S.D = 0.8µ
Holos 2mm Semi-apochromat	100 smallest disc on eyepiece micrometer	= 6 x 0.1mm 1S.D = 0.6µ
Zeiss 6mm apochromat	100 smallest disc on eyepiece micrometer	= 177µ = 1.77µ

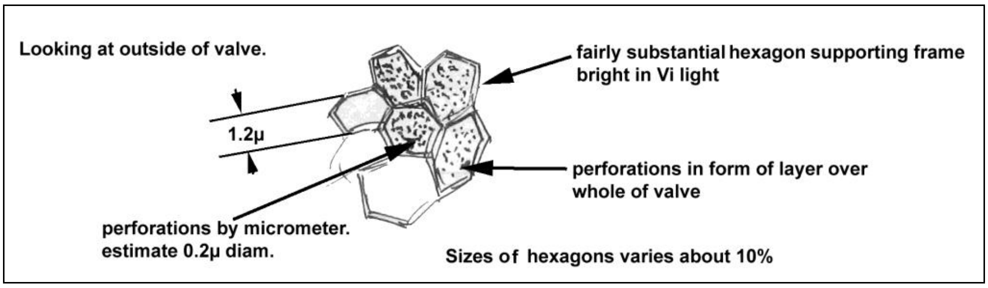
Calibration from Beck Stage Micrometer ruled 100µ, 10µ spacings.

Accuracy of calibration is better than 1% in worst cases where line-up of scales was not exact. This is much better than any practical measurement is likely to be.

18th February 1978

Object of Experiment

Examination by Vertical Illumination of *Coscinodiscus radiatus* (Griffith and Henfrey) on slide marked ‡ (not same diatom as on 'Type slide 20 forms Baker)



Measurement by eyepiece micrometer (above)
(?) Have all large discoid diatoms this perforated membrane covering them or is it an artefact? Suspicious that it has shown up in so many forms. (Yes they are – July 1978)
Conclusion. Diatom appears to be covered with perforated membrane but more work on a number of specimens is needed.

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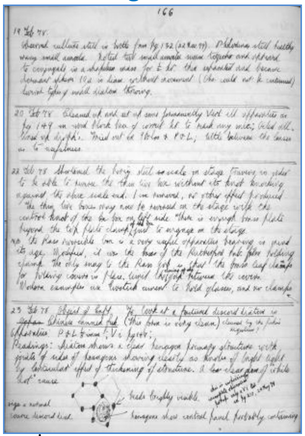
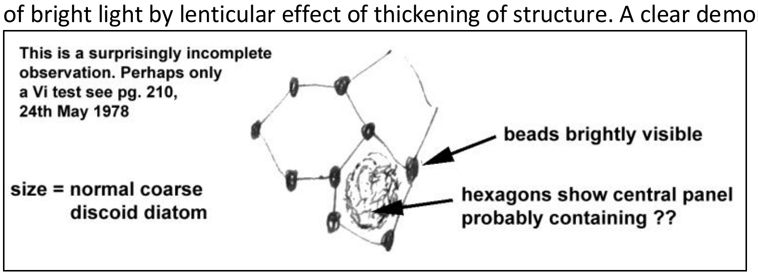


19th February 1978
Observed culture still in bottle from page 132 (22nd November 1977). *Philodina* still healthy, many small amoeba. Noted two small amoeba swam together and appeared to conjugate in a shapeless mass for ½hr, then separated and became dormant spheres 10µ in diameter, without movement. (Observation could not be continued). Several types of small diatom thriving.

20th February 1978
Cleaned up and set up semi-permanently Vertical Illuminator apparatus as page 49 on wood block base of correct height to reach any microscope; oils all, line up diaphragms. Tried out on Holos and Powell and Lealand; little between the lenses as to usefulness.

22nd February 1978
Shortened the horizontal steel scale in stage traverse in order to be able to reverse the thin live box without its knob knocking against the above scale end. 1cm removed, no other effect produced. The thin live boxes may now be reversed on the stage with the control knob of the box on left side. There is enough brass plate beyond the top plate clamp of the box just to engage on the stage.
NB. The Ross reversible box is a very useful apparatus bearing in mind its age. Modified, it was the basis of the Rutherford Lab. film holding clamp. The only snag to the Ross job is that the brass leaf clamp for holding covers in place, limit the closing of the gap between the covers.
Modern examples use Evostick cement to hold glasses, and no clamps.

23rd February 1978
Object of Experiment
To look at a fractured discoid diatom in Chinese Canned Fish (this form is very clean – cleaned by the fish's digestion?)
Apparatus:- Powell and Lealand ⅛ immersion; Vertical Illumination page 149;
Readings:- Diatom shoes a clear hexagon primary structure with joints of sides of hexagons showing clearly as knobs of bright light by lenticular effect of thickening of structure. A clear demonstration of 'white dot' cause…*(next page)*



…perforations, but these not resolved. (Some interference shade of colour indicated a structure.)
Conclusion:- Nothing special about this structure, but bright knobs die to rounded thickened edges worth noting as a 'bright dot' cause.
See page 210 for recent work with Swift-Holos objective.

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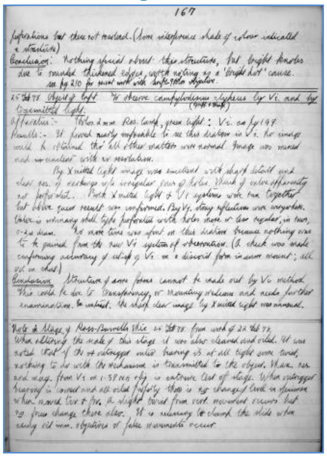

25th February 1978
Object of Experiment
To observe *Campylodiscus clypeus* by Vertical Illumination and by Transmitted Light.
Apparatus:- Holos 2mm, Research lamp, green light; Vertical illumination as page 149.
Results:- It proved nearly impossible to see this diatom in Vertical Illumination. No image could be obtained though all other matters were normal. Image was mixed and unclear with no resolution.
By transmitted light image was excellent with sharp detail and clear resolution of markings into irregular rows of holes. Much of valve apparently not perforated. Both transmitted light and Vertical Illumination systems were run together but above queer result was confirmed. By Vertical Illumination stray reflections were everywhere. Valve is ordinary shell type perforated with holes more or less regular, in rows, 0.2µ diameter. No more time was spent on this diatom because nothing was to be gained from the new Vertical Illumination system of observation. (A check was made confirming accuracy of set-up of Vertical Illumination on a discoid form in same mount; all OK on that.)
Conclusion. Structure of some forms cannot be made out by Vertical Illumination method. This could be due to transparency, or mounting medium and needs further examination. In contrast, the sharp clear image by transmitted light was unusual.

25th February 1978
Note on Stage of Ross-Burrells Microscope, from work of 22nd February 1978.
When altering the make of this stage it was also cleaned and oiled. It was noted that if the outrigger outer bearing is at all tight some twist, nothing to do with the mechanism is transmitted to the object. Maximum resolution and magnification from Vertical Illumination on 1.37NA objective is extreme test of stage. When outrigger bearing is correct and all oiled properly there in no change of level in specimen when moved to and fro. A slight twist from vertical movement occurs but no focus change there also. It is necessary to clamp the slide when using oil immersion objectives or false movements occur.

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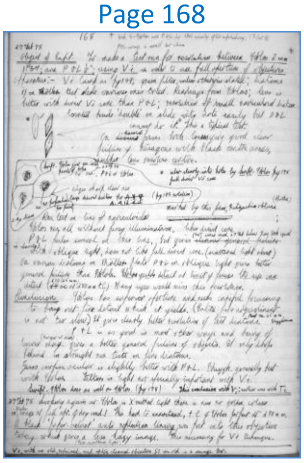
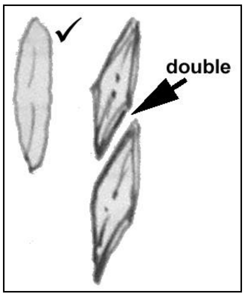
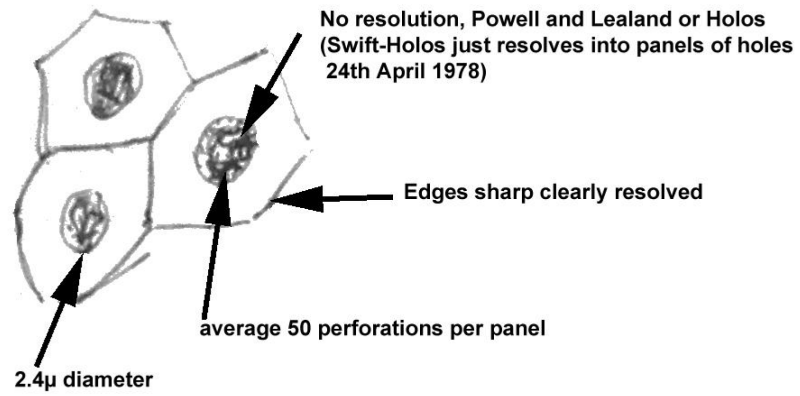


27th February 1978
Object of Experiment
To make a test run from resolution between Holos 2mm 1.27 and Powell and Lealand ⅛" using Vertical Illumination in order to use full aperture of objectives.
Apparatus:- Vertical Illumination lamp as page 149, green filter unless otherwise stated, diatoms
On Möller's test slide various ones tried. Readings from Holos – lens is better with direct Vertical Illumination cone than Powell and Lealand, resolution of small naviculoid located beside 'double' on slide, into dots easily, but Powell and Lealand cannot do it.



(Both Swift-Holos and Powell and Lealand do this nicely after re-polishing, 13th October 1981. Powell and Lealand image is small but clean.)
(Also clearly into holes by Swift-Holos page 178 – full direct cone.)
This is a typical test. On discoid forms both lenses give good clear picture of hexagons with black centre areas, neither lens resolves centre.



Large discoid diatom A.4.12 (pg. 193 notation)

Resolution test on line of naviculoids marked by this form, *Nitzschia obtusa* (Spitta)

Holos resolves all without fussy illumination, likes direct cone. Powell and Lealand fails several on this line, but gives cleaner general picture with oblique light (not since modification of 27th February below, now both equal in clarity), does not like oblique lights, does not like full direct cone (scattered light about). On various diatoms on Möller's plate Powell and Lealand in oblique light gives better general picture than Holos. Holos yield detail at limit of lenses the eye can detect (x10 [25mm] at 280mm tube length). Many eyes would miss this resolution.

Conclusion. Holos has superior aperture and needs careful focussing to bring out fine detail which it yields (Extra fine adjustment is not too slow). It gives clearly better resolution of test diatoms. Best with 25mm Huyghenian.

Powell and Lealand is as good in most other ways and being of lower magnification (larger working distance) gives a better general picture of objects. It only drops behind in straight resolution test on fine diatoms.

Zeiss compensating ocular is slightly better with Powell and Lealand. Huyghenian generally best with Holos. Filter in light not specially important with Vertical Illumination.

Swift-Holos does as well as Holos (page 178) This conclusion with Vertical Illumination; earlier ones with Transmitted Illumination.

Vertical Illumination with an old repaired and later cleaned objective 50 years old is a savage test.

27th February 1978.

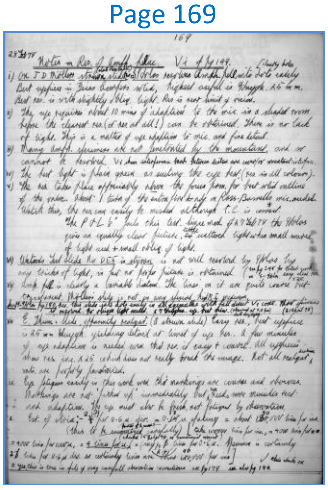
Looking again at Holos in transmitted light there is now no golden colour in flake image at full aperture of dry condenser! This hard to understand, tube length of Holos perfect at 270mm. A black 'paper velvet' anti-reflection lining was put into this objective today which gives a less hazy image (less scattered light). This necessary for Vertical Illumination technique.

28th February 1978

Notes on resolution of *Amphipleura pellucida*

Vertical Illumination of page 149.

Page 169



i. On J. D. Möller's strewn slide (No.12) Holos resolves *Amphipleura pellucida* into dots easily. Best eyepiece is Zeiss compensating solid, highest useful is Huyghenian 25mm. Best resolution is with slightly oblique light. Resolution is near limit of vision.

ii. The eye requires about 10 minutes of 'adaptation' to the microscope in a shaded room before the clearest resolution (or resolution at all!) can be obtained. There is no lack of light. This is a matter of eye adaptation to microscope and fine detail.

iii. Many *Amphipleura* specimens are not penetrated by the mountant, and so cannot be resolved. Vertical Illumination interference bands between diatom and cover/or mountant interface.

iv. The best light is plain green as suiting the eye best. (resolution in all colours)

v. The resolution takes place appreciably above the focus position for best solid outline of the valve. About 1 turn of the extra fine adjustment on Ross-Burrells microscope needed. Watch this, the resolution can easily be missed although tube length is correct. (Yes, this is true in spite of very careful observation conditions. See page 179. See also page 184.

The Powell and Lealand ⅛” fails this test. Since modification of 27th February 1978 the Holos gives an equally clear picture, little scattered light when small source of light used and small obliquity of light.

vi. Watson’s Test Slide No.DE5 in Styrax is not well resolved by Holos by any tricks of light, in fact no proper picture is obtained (see page 245 for latest work on Swift-Holos. Easy clear resolution x25)

vii. *Amphipleura pellucida* is clearly a variable diatom. The ‘lines’ on it are quite coarse but transparent. Möller’s slide is not in any special High R.I. medium.

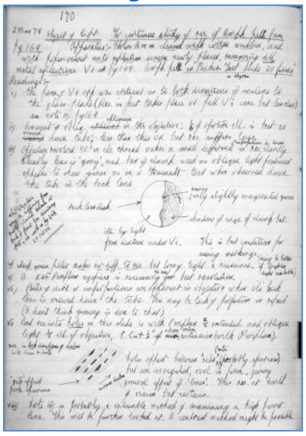
Swift-Holos page 180, resolves this slide into dots easily in all azimuths with full direct Vertical Illumination cone. Most specimens so resolved. No oblique light needed. X7 Huyghenian eyepiece best view (obtained at 5.0pm, dull daylight) (21st April 1978)

viii. E. Thum’s slide, apparently Realgar. (a strewn slide). Easy resolution, best eyepiece is 25mm Huyghenian yielding detail at limit of eye resolution. A few minutes of eye adaptation is needed even though resolution is easy and coarse. All eyepieces show resolution including x25 which does not really break the image. Not all Realgar diatom mounts are properly penetrated.

ix. Eye fatigues easily in this work even though marking are coarse and obvious. Workings are not ‘picked up’ immediately but eye needs some minutes rest and adaptation. The eye must also be fresh, not fatigued by observation.

x. Estimate of striae:- 2 per 0.6µ. division = 0.3µ spacing = about 90,000 lines per inch [take 100,000 lines per inch = 4,000 lines per mm. = 400 lines per 1,000µ = 4 lines per µ.

Page 170



2nd March 1978

Object of Experiment

To continue study of resolution of *Amphipleura pellucida* from page 169.

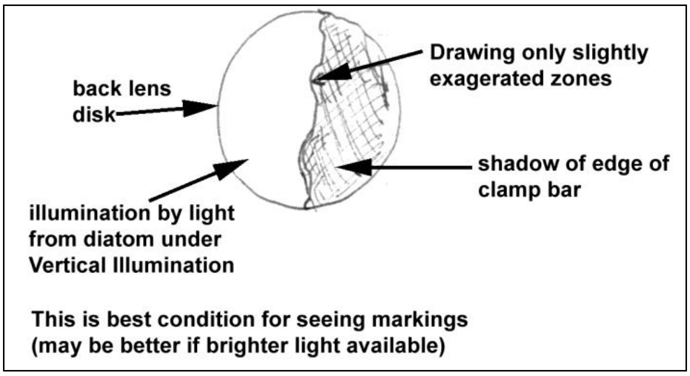
Apparatus:- Holos 2mm cleaned with cotton muslin, and with paper-velvet anti-reflection screen newly placed, removing all metal reflections. Vertical Illumination as page 149. *Amphipleura pellucida* on ‘Baker’s Test Slide 20 forms’

Readings:-

i. The form of Vertical Illumination apparatus was critical as to both directions of incline to the glass plate. (Resolution if fact takes place at full Vertical Illumination cone but less clear, see note ii. Page 169.

ii. Amount of oblique ~~critical~~ optimum in the objective: ⅓ of aperture illuminated is best as viewed down tube; less than this OK but resolution suffers loss.

iii. Objective revolved 90° on its thread makes a small difference (imperfections in lenses) in resolution clarity. Clearly lens is ‘zoney’, and bar of clamp used as oblique light producer appears to show zones as on a Foucault test when observed down the tube in the back lens.

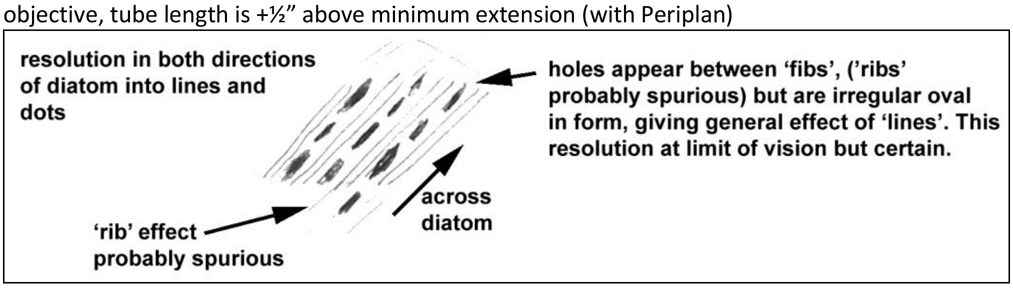


iv. Deep green filter makes no difference to resolution but loss of light a nuisance (may be better if brighter light available)

v. A x25 Periplan eyepiece is necessary to see best resolution

vi. Bits of dirt or imperfections are apparent in objective when it’s back lens is viewed down the tube. This may be lack of perfection in repair (I don’t think zoning is due to that)

vii. Best resolution into holes on this slide is with Periplan ⅔ extended and oblique light ⅓ illumination of objective, tube length is +½” above minimum extension (with Periplan)

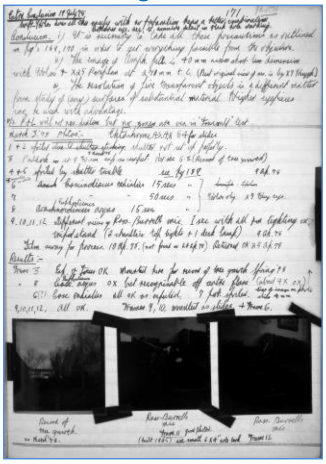


viii. Note iii) is probably a valuable method of examining a high power lens. This will be further looked at. A contrast method might be possible.

(next page)

Conclusion.

Page 171



i. It is necessary to take all these precautions as outlined on pages 169, 170 in order to get everything possible from the objective.

ii. The image of *Amphipleura pellucida* is 40mm across short dimension with Holos and x25 Periplan at 270mm tube length (Best original view of resolution is by x7 Huyghenian)

iii. The resolution of fine transparent objects is a different matter from study of (say) surfaces of substantial material. Higher eyepieces can be used with advantage.

P.S. Powell and Lealand will not resolve diatom but no zones are visible in "Foucault' test.

Extra Conclusion. 19th July 1978. Swift-Holos does all this easily with no preparation hence a better combination, Coplanar eyepiece necessary to examine detail in black hole marking.

3rd March 1978

Photos:

Ektachrome ASA64 for slides.

1 and 2. Spoiled – shutter not set up properly

3. Paddock at 9.30am 3rd March 1978. Exposure as computed. $\frac{1}{100}$ second f6.3 (Record of tree growth)

4 and 5. Spoiled by shutter trouble.

6. *Coscinodiscus radiatus* 15 seconds. 9th April 1978. See page 189. Holos objective, x7 Huyghenian eyepiece

7. *Coscinodiscus radiatus* 50 seconds. 9th April 1978. See page 189. Holos objective, x7 Huyghenian eyepiece

8. *Eupodiscus argus* 15 seconds. 9th April 1978. See page 189. Holos objective, x7 Huyghenian eyepiece

9, 10, 11, 12. Different views of Ross-Burrells microscope. 1 second with all lighting on, tripod stand (2 chandelier top lights and 1 desk lamp) 9th April 1978

Film away for processing. 10th April 1978 (not found on 24th April 1974) Returned OK 25th April 1978.

Results:-

Frame 3. Exposure and focus OK. Mounted here for record of tree growth Spring 1978

Frame 8. *Eupodiscus argus*, Over exposed but recognisable off-centre flare (about 4x over exposed)

Frame 6. *Coscinodiscus radiatus*. All OK as expected.

Frame 7. Spoiled. Size of image on photo slide 4mm.

Frames 9,10,11,12. All OK.

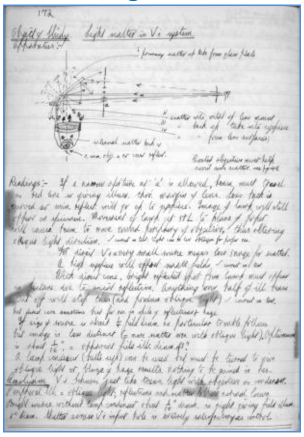
Frames 9, 10, mounted as slides + frame 6.

Record of tree growth as at March 1978

Ross-Burrells Microscope
Frame 11 Good photo
(built 1945)
See small 6"x4" note book
[Transcribers Note: Currently no record of where this notebook might be]

Ross-Burrells Microscope
Frame 12 Good photo

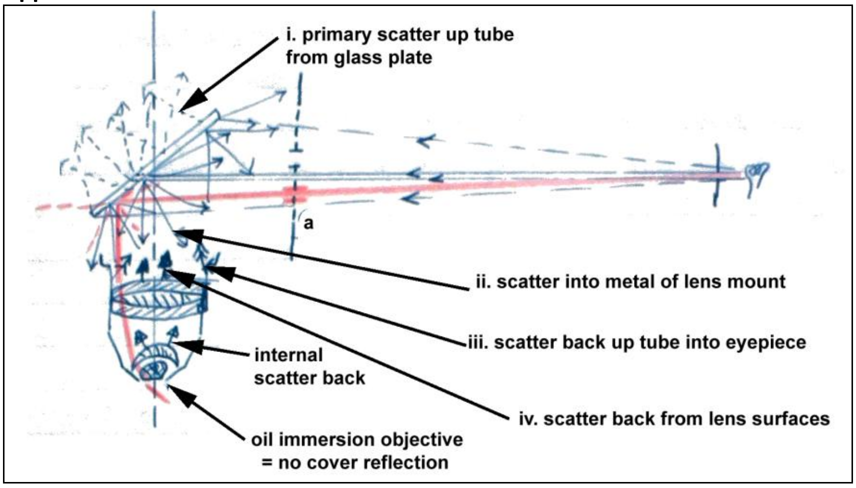
Page 172



Object of Study

Light matter in Vertical Illumination system

Apparatus:-



Readings:- If a narrow aperture at 'a' is allowed, beam must travel as red line so giving illumination through margin of lens. Lens back is curved so minimum reflection will go up to eyepiece. Image of lamp will still appear on specimen. Movement of lamp at right angle to plane of paper will cause beam to move round periphery of objective, this altering oblique light direction. (correct on test: light can be too oblique for proper resolution.)

For direct Vertical Illumination a very small source means less range of scatter.

A high eyepiece will offset small fields (correct on test)

With direct cone, bright reflected spot from lamp must appear in picture due to axial reflection. Anything over half of illuminated beam cut off will stop this (and produce oblique light) (correct on test), but direct cone sometimes best for resolution in spite of reflections and haze.

If size of source is about ¼ field diameter, no particular trouble follows but image is less distinct (= more scatter even with oblique light). Optimum is about $\frac{1}{16}$" = apparent field illumination diameter of 1".

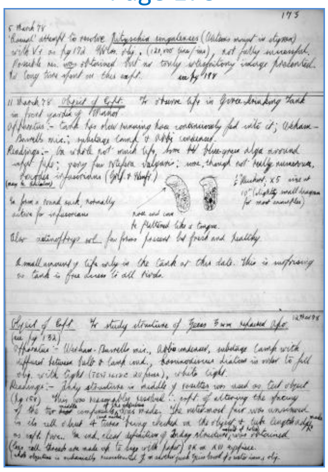
A lamp condenser (bull's-eye) can be used but must be turned to give oblique light or blaze of haze results. Nothing to be gained in resolution.

Conclusion. Vertical Illumination behaves just like transmitted light with objective as condenser. Peripheral illumination – oblique light; reflections and scatter follow normal laws. Bright source without lamp condenser about $\frac{1}{16}$" diameter is right giving field illumination 1" diameter. Shutter across Vertical Illumination input hole is entirely satisfactory as control.

5th March 1978

'Casual' attempt to resolve *Nitzschia singalensis* (Watson mount in Styrax) with Vertical Illumination as page 172, Holos Objective, (120,000 lines/inch), not fully successful. Possible resolution was obtained but no truly satisfactory image presented. No long time spent on this experiment. See page 188.

Page 173



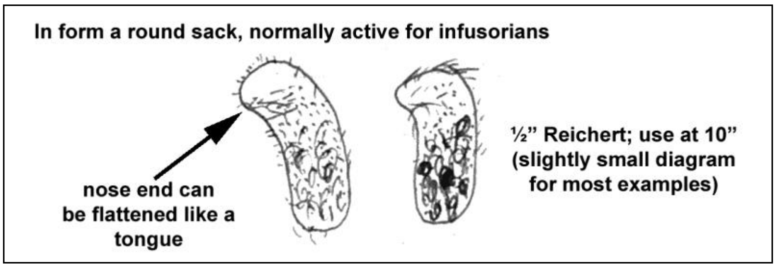
11th March 1978.

Object of Experiment

To observe life in Grove Drinking Tank in front garden of Manor.

Apparatus:- Tank has slow running hose continuously fed into it; Wenham-Burrells microscope; substage lamp and Abbe condenser.

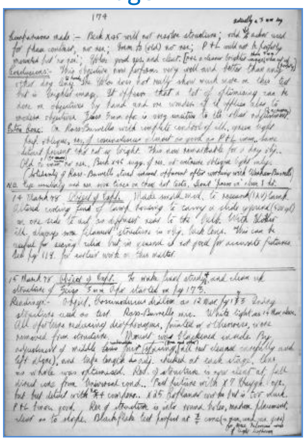
Readings:- On whole not much life. Some blue-green algae around input pipe; very few R*otifera vulgaris*; some, though not really numerous, *ioxodes* infusorians (Griffith and Henfrey) (may be *Chilodon*).



Also *Actinophrys sol*. Few forms present but fresh and healthy.
A small amount of life only in the tank at this date. This is surprising as tank is free access to all birds.

12th March 1978
Object of Experiment
To study structure of Zeiss 3mm repaired Apochromat (see page 132)
Apparatus:- Wenham-Burrells microscope, Abbe condenser, substage lamp with diffuser between bulb and lamp condenser, *Coscinodiscus* diatom in order to fill objective with light (Test Slide 20 forms), white light.
Readings:- Secondary structure in middle of rosettes was used as test object (page 159). This was reasonably resolved there experiment of altering the spacing of the two middle components of the objective was made. The outer-most pair was unscrewed in its cell about 4 turns being checked on the object, and tube length adjustment made as experiment proceeded. In end, clear definition of secondary structure (web of holes) was obtained.
(Lens cell threads are made up to size with paper) OK on x10 eyepiece. Whole objective is mechanically reconstructed on another junk Zeiss barrel of a water immersion objective.) *(next page)*

Page 174



Comparisons made:- Beck x45 will not resolve structure; odd, actually a 3mm achromat dry used for Phase Contrast, no resolution; Immersion $\frac{1}{10}$ (old) no resolution; Powell and Lealand could not be properly mounted but 'no resolution'; Holos good resolution and clear. [Powell and Lealand cleaner brighter image than 3mm when set up properly].
Conclusions. This objective now performs very well and better than any other dry lens to hand. The Holos does not really show much more on this test but is brightest image. It appears that a lot of optimising can be done on objectives by hand and one wonders if it applies also to modern objectives. Zeiss 3mm apochromat is very sensitive to its collar adjustment (½ a degree).

Extra Conclusion. On Ross-Burrells with complete control of illumination, green light preferred, oblique, resolution of *Coscinodiscus* almost as good as Powell and Lealand immersion. Same detail present though not as bright. This now remarkable for a dry objective. Old $\frac{1}{10}$ immersion (no name), no resolution. Beck x45 suggestion of resolution at extreme oblique light only. (Solidity of Ross-Burrells stand immediately apparent after working with Wenham-Burrells)
NB. Eye sensitivity and resolution soon tires on these dot tests. Don't 'press on' above 1 hour.

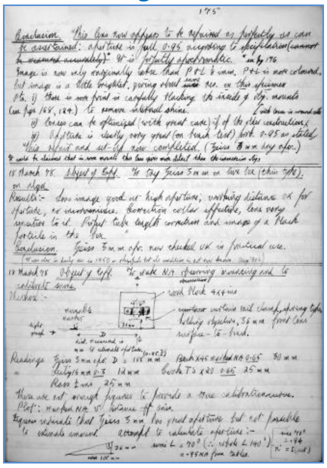
14th March 1978
Object of Experiment
Made small modification to research (12V) lamp.
Altered cooling fins of lamp housing to carry a slide ground (500 gra) on one side to act as diffuser near to the bulb. With Köhler illumination always some filament structure in objective back lens. This can be useful for seeing cilia but in general is not good for accurate pictures.
See page 119 for earlier work on this matter.

15th March 1978
Object of Experiment
To make final study of and clean up structure of Zeiss 3mm apochromat started on page 173.
Readings:- Object *Coscinodiscus* diatom as 12th March, page 173. Secondary structure used as test. Ross-Burrells microscope. White light as 14th March above. All aperture reducing diaphragms, painted or otherwise, were removed from structure. Mount was blackened inside. By adjustment of middle combination pair spacing (from each other), all rest cleaned carefully and left alone, and tube length adjustment checked at each stage, lens as whole was optimised. Resolution of structure is now clear at full direct cone from Universal condenser. Best picture with x7 Huyghenian eyepiece, but best detail with No.4. compensating. X25 Coplanar works but is too much. Powell and

Lealand binocular good. Resolution of structure is into round holes, random placement, clear as to shape. Black flake test perfect at ¾ cone (= maximum condenser can give – for true Nelsonian rings of light diaphragm)

(next page)

Page 175



Conclusion. This lens now appears to be repaired as perfectly as can be ascertained: aperture is full 0.95 according to specification (~~cannot be measured accurately~~ – See page 176).

Image is now only marginally worse than Powell and Lealand ⅛" immersion. Powell and Lealand is more coloured, but image is a little brighter, giving about same resolution on this specimen.

Points.

i. There is some point in carefully blacking the inside of objective mounts (see page 168, 124) to remove internal shine
ii. Lenses can be optimised (with great care) if of the older construction, with lenses in screwed cells.
iii. Aperture is clearly very great (on bench test) probably 0.95 as stated.

This repair and set up now completed (Zeiss 3mm dry apochromat)

It could be claimed that in some mounts this lens gives more detail than the immersion objectives.

18th March 1978

Object of Experiment

To try Zeiss 3mm on live box (thin type), on algae.

Results:- Lens image good at high aperture; working distance OK for aperture, no inconvenience. Correction collar effective, lens very sensitive to it. Perfect tube length correction and image of a black particle in the box.

Conclusion. Zeiss 3mm apochromat now checked OK in practical use.

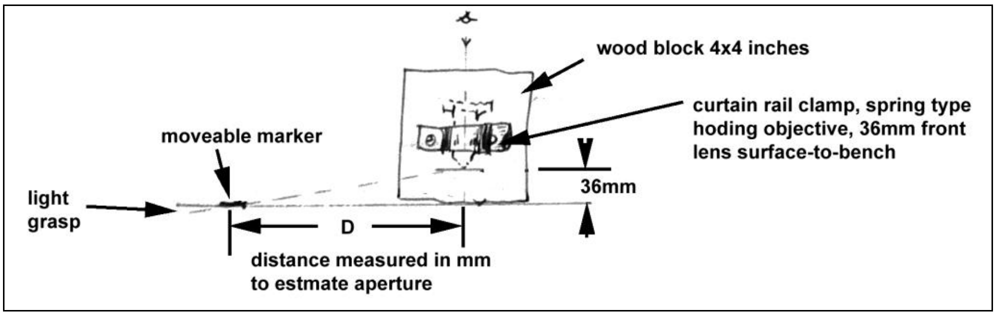
(It was also in daily use in 1950 on rhizopods but its condition is not now known (August 1980)

18th March 1978

Object of Experiment

To make NA observing mounting and calibrate same

Method:



Readings:-

Zeiss 3mm apochromat: D = 100mm

Beck x45 marked NA 0.65: D = 30mm

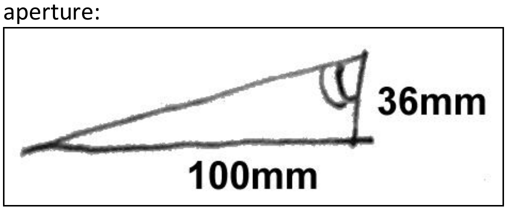
Leitz 16mm 0.3: D = 12mm

Cooke, Troughton and Simms x20 0.65: D = 25mm

Ross ½ inch: D = 25mm

These are not enough figures to provide a true calibration curve. Plot: marked NA v. distance off axis.

Figures indicate that Zeiss 3mm has no great aperture but not possible to estimate amount. Attempt to calculate aperture:



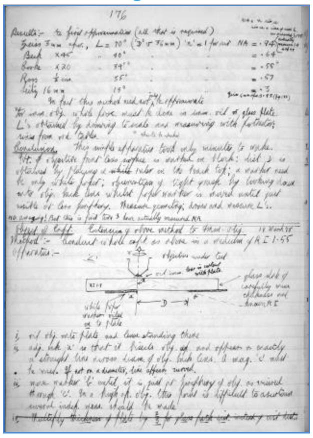
Semi angle = 70° (therefore whole angle 140°)

Sine 70° = 0.94 'n' = I(air)

= 0.95 from tables.

(next page)

Page 176



Results:- to first approximation (all that is required)

Note: NA=n sin µ. sin µ = sin of semi angle (as measured page 175)

Zeiss 3mm apochromat	Angle=70° ('D' ~ 36mm) 'n' = 1 for air NA=0.94 (actually measures 1.0 4th April 1979)
Beck x45	Angle=40° ('D' ~ 36mm) 'n' = 1 for air NA=0.64
Cooke x20	Angle=34° ('D' ~ 36mm) 'n' = 1 for air NA=0.55 (this to be checked)
Ross ½"	Angle=35° ('D' ~ 36mm) 'n' = 1 for air NA=0.57
Leitz 16mm	Angle=18° ('D' ~ 36mm) 'n' = 1 for air NA=0.3
Zeiss 6mm apochromat	NA 0.93 (page 183)

In fact this method need not only be approximate.

For immersion objectives whole process must be done in immersion oil or glass plate. Angles obtained by drawing to scale and measuring with protractor; sines from ordinary tables.

Conclusion. This simple apparatus took only minutes to make. Height of objective front lens surface is marked on block: distance D is obtained by placing a ruler on the bench top; a marker need be only white paper; observation of light grasp by looking down onto objective back lens whilst proper marker is moved until just visible at lens periphery. Measure geometry; draw and measure angles.

NB. Amazing! But this is first time I have actually measured NA.

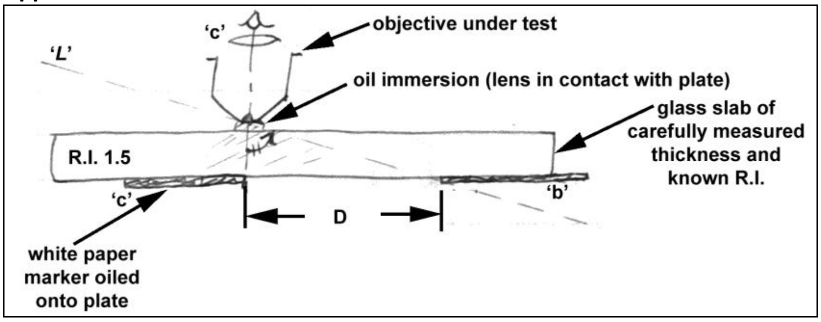
18th March 1978

Object of Experiment

Extension of above method to Immersion objectives.

Method:- Conduct whole experiment as above in a medium of RI 1.55.

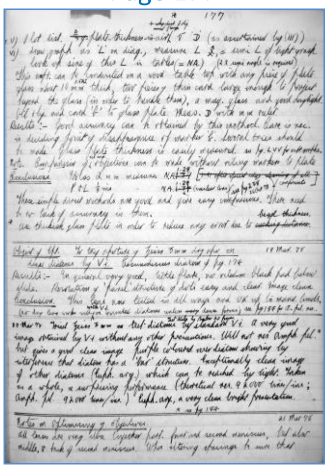
Apparatus:-



i. Oil objective onto plate and leave standing there
ii. Adjust ink 'a' so that it bisects objective aperture and appears as exactly a straight line across diameter of objective back lens. A magnifier 'c' must be used. If not on a diameter, line appears curved.
iii. Move marker 'b' until it is just at periphery of objective as viewed through 'c'. In a high aperture objective this point is difficult to ascertain, several independent measurements should be made.
iv. ~~Multiply thickness of plate by⅔ for glass path distance instead of air distance.~~

(next page)

Page 177



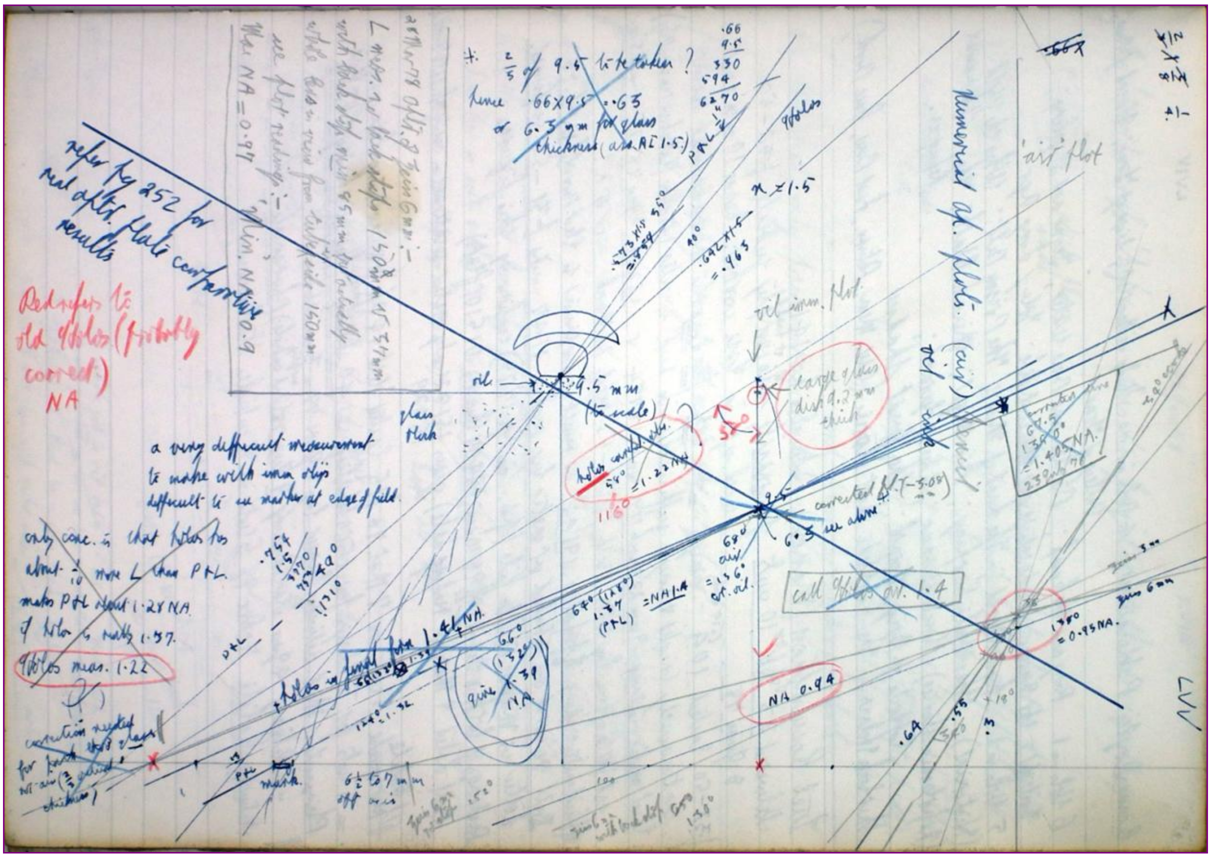
v. Plot distance plate-thickness in air v. 'd' (as ascertained by [iii.])
vi. Draw graph as angle in diagram. Measure angle = semi angle of light grasp. Look up sine of this angle in tables = NA) (2xsemi-angle required)

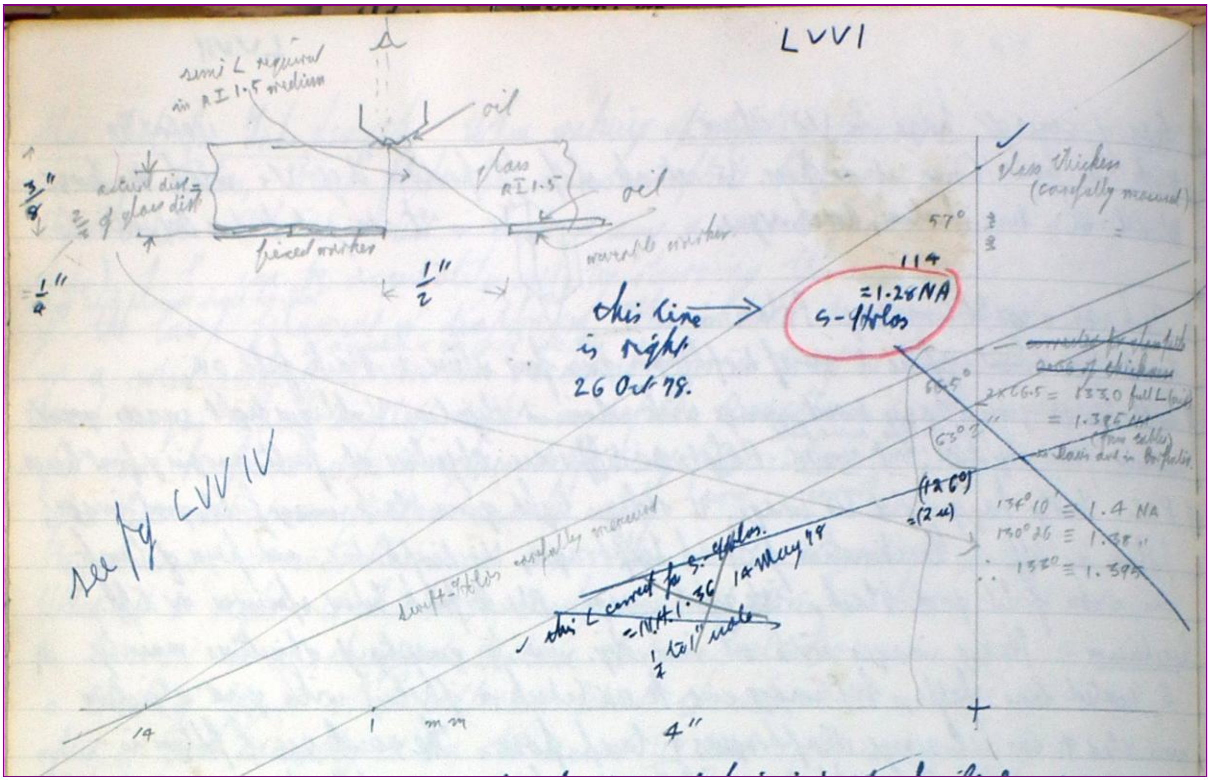
This experiment can be conducted on a wood table top with any piece of plate glass about 10mm thick, two pieces of thin card large enough to project beyond the glass (in order to handle them), a magnifying glass and good daylight. Oil objectives and card 'b' to glass plate. Measure D with mm. ruler.

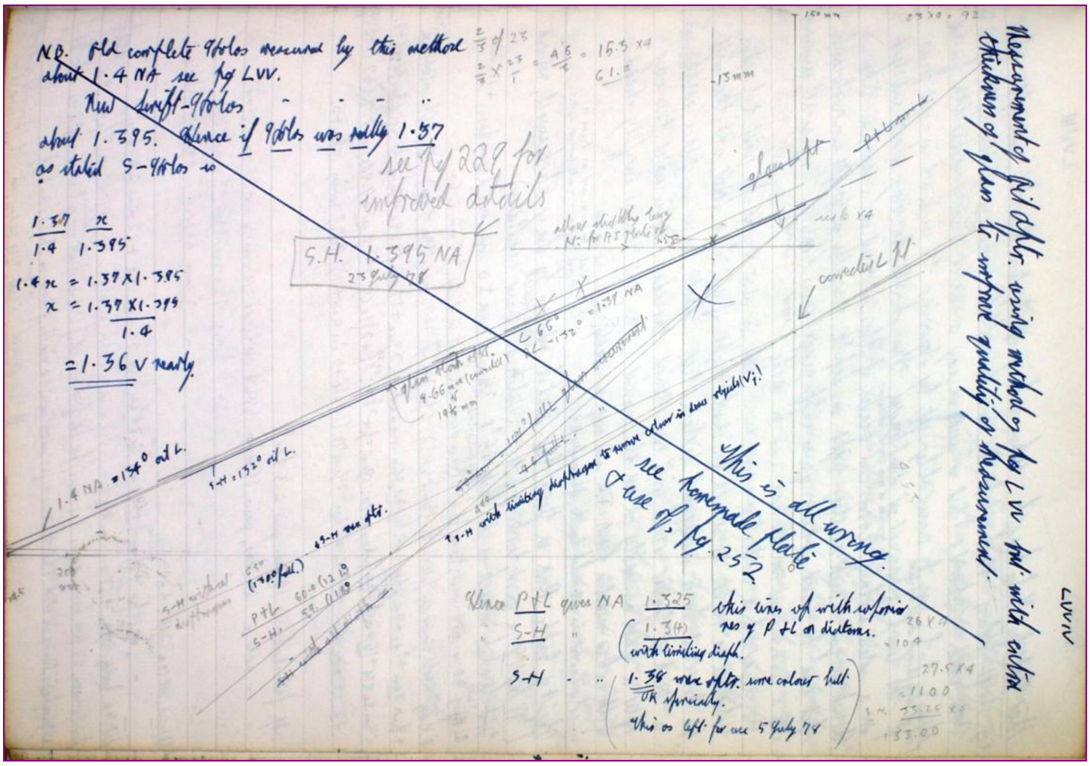
Results:- Good accuracy can be obtained by this method. Care is necessary in deciding point of disappearance of marker 'b'. Several tries should be made. Glass plate thickness is easily measured. See page LVV for experiment graphs (reproduced below).

Note. Comparison of oil immersion objectives can be made without oiling markers to plate.

Conclusions. Holos 2mm measures NA ~~1.39~~ 1.28 ~~[1.41 after special edge cleaning of all components]~~
Powell and Lealand ⅛" measures NA ~~1.37~~ 1.28 (unclear lens) (see page 238 26th October 1978)
These simple direct methods are good and give easy comparisons. There need be no lack of accuracy in them.
Use thickish glass plate in order to reduce any error due to ~~working distance~~ bezel thickness.







19th March 1978

Object of experiment

To try aperture of Zeiss 3mm dry apochromat on dense diatoms by Vertical Illumination. (*Coscinodiscus* diatom of page 174)

Results:- In general very good, little flare, no oiled-on black pad below slide. Resolution of 'panel' structure of dots easy and clear. Image clean.

Conclusion. This lens now tested in all ways and OK up to manufacturers limits. (No dry lens works well with Vertical Illumination on un-mounted diatoms unless dense forms.) See page 184 for *Amphipleura pellucida* resolution.

20th March 1978

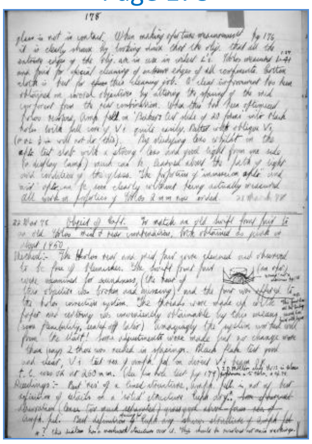
Tried Zeiss 3mm on test diatoms (Test slide by Baker 20 forms) by standard Vertical Illumination. A very good image obtained by Vertical Illumination without any other precautions. Will not resolve *Amphipleura pellucida* (see page 184) but gives a good clean image, purple coloured over diatom showing by interference that diatom has a 'bar' structure. Exceptionally clean image of other diatoms (*Eup. argus*) which can be reached by light. Taken as a whole, a surprising performance (theoretical resolution 92,000 lines per inch); *Amphipleura pellucida* 92,000 lines per inch). *Eup. argus*, a very clean bright presentation.

21st March 1978

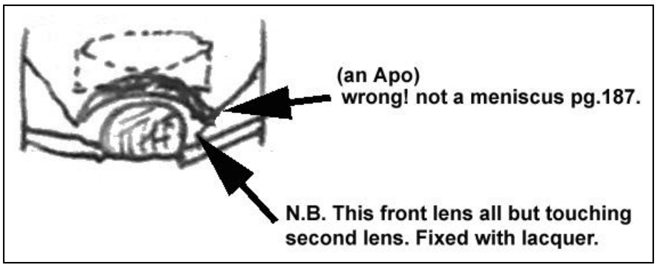
Notes on optimising of objectives.

All lenses are very close together particularly front and second meniscus, but also middle and back of second meniscus. When altering spacings be sure that…*(next page)*

Page 178



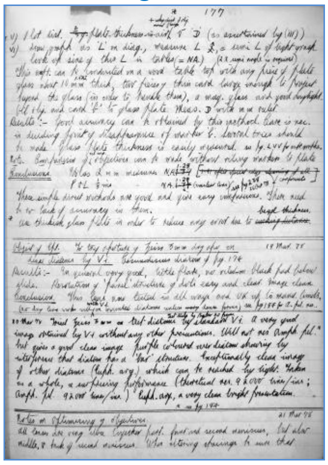
…glass is not in contact. When making aperture measurement page 176, it is clearly shown by looking through the objective that all the extreme edges of the objective are in use in widest angles. Holos measured ~~1.41~~ 1.27 and paid for special cleaning of extreme edges of all components. Cotton cloth is best for this cleaning job. A clear improvement has been obtained on several objectives by altering the spacing of the mid component from the rear combination. When this had been optimised Holos resolved *Amphipleura pellucida* on 'Bakers test slide of 20 forms' into black holes with full cone of Vertical Illumination quite easily. Better with oblique Vertical Illumination (Powell and Lealand ⅛" will not do this). By studying lens whilst on the aperture test slab with a strong lens and good light from one side (a display lamp) much can be learned about the path of light and condition of the glass. The proportion of 'immersion aperture' and 'sir aperture' can be seen clearly without being actually measured. All work on properties of Holos 2mm now ended. 21st March 1978.



22nd March 1978
Object of Experiment
To match an old Swift front pair to an old Holos mid and rear combinations, both obtained as junk in about 1950.
Method:- The Holos rear and mid pair were cleaned and observed to be free of blemished. The Swift front-pair (an apochromat) were examined for soundness (the rear of this objective was broken and missing) and the pair was offered to the Holos correction system. The threads were made up with paper and centring was conveniently obtainable by this means (some flexibility, sealed off later). Amazingly the system worked well from the start! Some adjustments were made but no change more than (say) 2 thou was needed in spacings. Black plate test good and clear, Vertical Illumination test resolved *Amphipleura pellucida* on direct Vertical Illumination beam OK. Tube length was OK at 260mm. (See pin hole test page 179) J.D. Möller slide No.12 in Balsam performance = to Holos, 4th April 1978.
Readings:- Best resolution of a lines structure, *Amphipleura pellucida*, is not at best definition of detail on a 'solid' structure. *Eupodiscus argus**. ~~Some spherical aberration (lenses too much separated) gives good above focus resolution of *Amphipleura pellucida*. Best definition of spacing for *Eupodiscus argus* shows structure of *Amphipleura pellucida*~~…*(next page)*
*? This diatom has a meshwork structure over it. This should be resolved not main markings!

~~Reasonably but in same plane as diatom outline.~~ Colour correction also is affected by position of front pair of components. This form when checked on opaque flake is correct. Objective now sealed with lacquer; front lens up against its stop in normal position; all as good as can be expected. *Amphipleura pellucida* resolved into dots by direct Vertical Illumination (Huyghenian x7 eyepiece) – Fresh eyes are needed!
Different immersion objectives do not resolve tests in some way. E.g. easy resolution of 'bars' on *Amphipleura pellucida* does not lead to 'easy' dot resolution. Correct spherical correction appears to be indicated by structure and outline being in same plane of focus.
Aperture Plate Examination. NA of new combination ~~1.395~~ 1.27. Very clean lens system showing no fault or blemishes. [Powell and Lealand measured at same time ~~1.32~~ 1.25 but lens is unclear [also a crack as mentioned earlier]). New combination appears entirely satisfactory but is of less aperture than the Holos. Holos measured 1.27 by same apparatus may not have all been accurate).

Page 179



NB. It is possible to move front pair towards middle combination about 10 thou and obtain easy resolution of a line structure above focus of main outline. Same setting gives poor surface detail of a dense object and not so good black flake image (see ii. below. Front lens 2½ thou away from normal stop in interests of corrections.). This sort of 'resolution' is probably a phase contrast effect between zones of objective. To be looked at again with pinhole test.

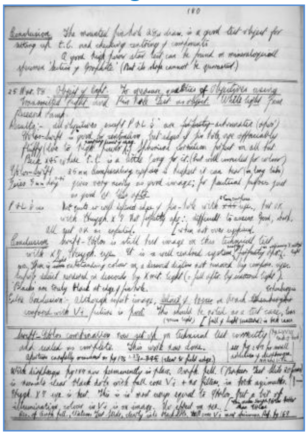
24th March 1978
Object of Experiment
To mount for test purposes pin holes in phosphor bronze made at Oxford University for Mr. ? (Bill Turner of Rutherford's, friend) in 1977. In balsam, not covered, by ordinary methods.
Readings:- 2 'holes' mounted 28µ and 89.6µ diameter. Both good clean holes, fairly accurate, in this sheet. (28µ is smallest provided.)
Experiment II. To use this mount as a test object. Illuminated by Universal condenser.
Results:-

i. The smaller hole makes a very good tube length determining device and also shows up errors in centring of a component.
ii. The edges of the hole are a severe test of definition and the test objectives (Zeiss 3mm) do not give so sharp an image as expected.
iii. The Holos-Swift combination shows perfect tube length adjustment as now set up, i.e. with front pair hard up to mid pair. This also shows perfect centring now (it did not when first put on test, as left from above experiments pages 178, 179). Definition at least as good as all rest of objectives.

iv. Holos-Swift now as good in correction as it can be regardless of comments in paragraph top of page 179, under NB. Equal to the Holos in image and resolution since iii. above.

(next page)

Page 180



Conclusion. The mounted pinhole 28μ diameter is a good test object for setting up tube length and checking centring of components.
A good high power test can be found on mineralogical specimen 'Section of Graphite' (But it's shape cannot be guaranteed.)

25th March 1978
Object of Experiment
To measure qualities of objectives using transmitted light and pinhole test as object. White light from Research lamp.

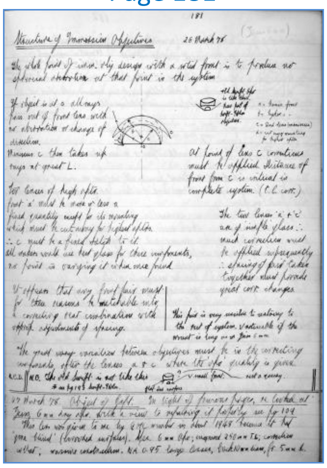
Results:- All objectives except Powell and Lealand are achromatic.
Holos-Swift is good for centration, but edges of pin hole are appreciably fluffy (due to high power, nearing limit of magnification). Spherical correction perfect on all but Beck x45 where tube length is a little long for it (but well corrected for colour)
Holos-Swift. 25mm compensating eyepiece is highest it can bear (in long tube)
Zeiss 3mm dry 0.95. gives very nearly as good image; for practical purposes just as good at this aperture.
Powell and Lealand ⅛". Not quite as well defined edge of pinhole with 25mm compensating eyepiece, but OK with Huyghenian x7. Not perfectly apochromatic, difficult to assess. Good, sharp, when not over eyepieced. All rest OK as expected.
Conclusion. Swift-Holos is still best image on this technical test with x7 Huyghenian eyepiece. It is a well centred system, nearly apochromatic in ordinary transmitted light.
NB. There is slight outstanding colour on a discoid diatom not removed by compensating eyepiece.
Superb detail rendered on discoids by transmitted light (=full aperture by scattered light). 'Blacks' are truly black at edge of pinhole.
Extra Conclusion. Although superb image, detail of bosses on *Arachnoidiscus Ehrenbergii* compared with Vertical Illumination picture is poor. This should be noted as a test case, lens full of light (scattered) in back lens (green light).

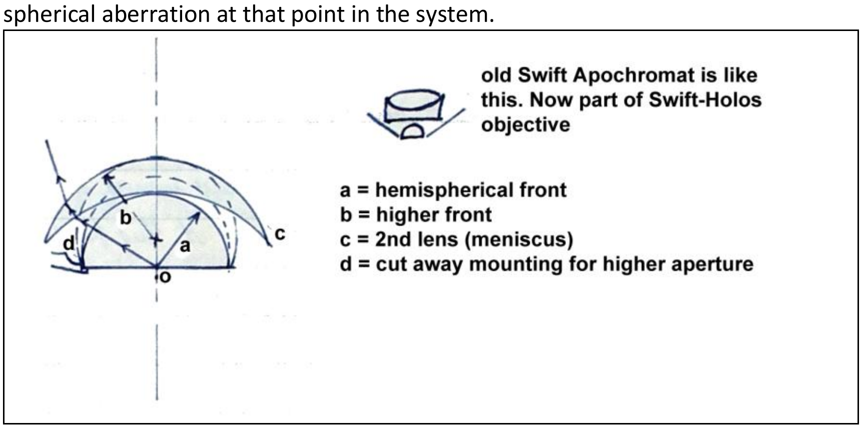
Swift-Holos combination now set up on technical test correctly (page LVIII back of book) and sealed as complete. This work now done. Aperture carefully measured as page 176. ~~1.395~~ 1.27 (clear to edge of field)
See page 187 for small addition of diaphragm. NA now 1.36.
With diaphragm page 187 now permanently in place, *Amphipleura pellucida* (Baker's Test Slide 20 Forms) is resolved into clear black dots with full cone Vertical Illumination and no filters, in both azimuths.

Huyghenian x7 eyepiece is best. This is in most ways equal to Holos but a bit of illumination colour in Vertical Illumination is on image. No effect on resolution. Resolution of *Ampipleura pellucida*, Watson's Test slide, clearly into black dots, Full cone Vertical Illumination most specimens. Ref. page 169. [This makes Swift-Holos better than Holos.]

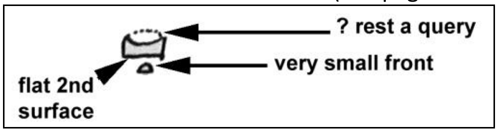
26th March 1978
Structure of Immersion Objectives
The whole point of immersion objective design with a solid front is to produce no spherical aberration at that point in the system.

Page 181





If object is at 'o' all rays pass out of front lens with no aberration or change of direction.
Meniscus c then takes up rays at great angle.
At point of lens 'c' corrections must be applied. Distance of front from 'c' is critical in complete system (tube length correction).
For lenses of high aperture front 'a' must be more or less a fixed quantity except for its mounting which must be cut away for highest apertures. Therefore 'c' must be a fixed match to it. All makers would use best glass for these components, no point in varying it when once found.
The two lenses 'a' and 'c' are of 'simple glass, therefore much correction must be applied subsequently, therefore spacing of pair taken together must provide great correction changes.
It appears that any front pair must for these reasons be match-able into a correcting rear combination with appropriate adjustments of spacing.
This pair is very sensitive to centring to the rest of system. Very noticeable if the mount is long as in Zeiss 6mm.
The great variations between objectives must be in the correcting components after the lenses 'a' and 'c' where 'apochromat' quality is given.
NB. The old Swift is not like this (see page 193 Swift-Holos)

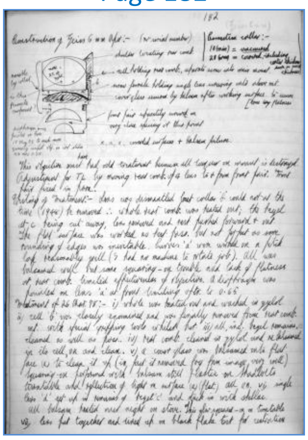


27th March 1978

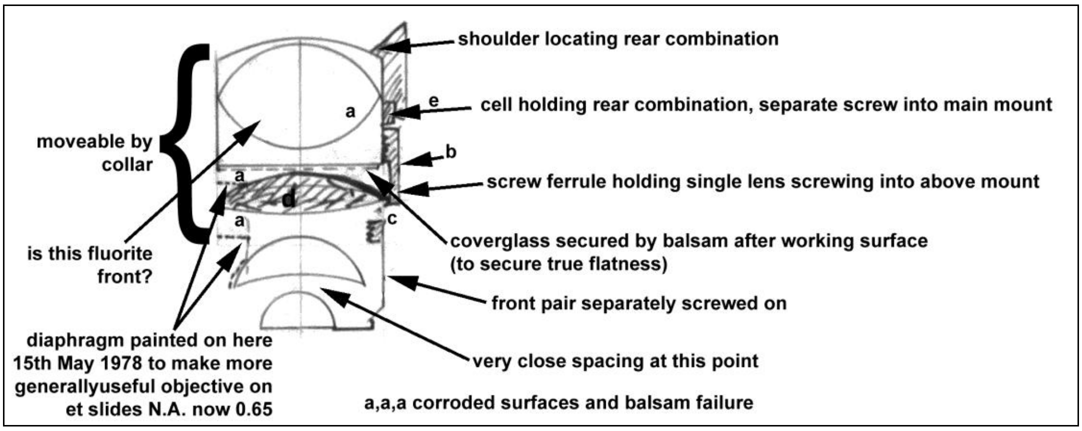
Object of Experiment

In light of previous pages, re-looked at Zeiss 6mm dry apochromat with a view to repairing it properly. See page 109.
This lens was given to me by a QMC member in about 1948 because it had 'gone blind' (corroded surfaces). Spec. 6mm Apochromat, engraved 250mm Tube Length; correction collar, massive construction. NA 0.95, large lenses, back 10mm diameter, font 5mm diameter.
(next page)

Page 182



Construction of Zeiss 6mm Apochromat (no serial number)
Correction collar: 10(min) = uncovered, 20 (max) = covered including water thickness, same as cover thickness.



This objective must have had odd treatment because all lacquer on mount is destroyed. Adjustment of Tube length by moving rear combination of 4 lenses to and from front pair. Front pair fixed in position.
History of treatment:- Lens was dismantled but collar 'b' could not at the time (1948) be removed, therefore whole rear combination was heated out; the bezel at 'c' being cut away, lens removed and rest pushed forward and out. The flat surface was worked as best as possible, but not perfect as some rounding of edges was inevitable. Curves 'a' were worked on a pitch lap reasonably well (I had no machine to rotate job). All was balsamed well but some

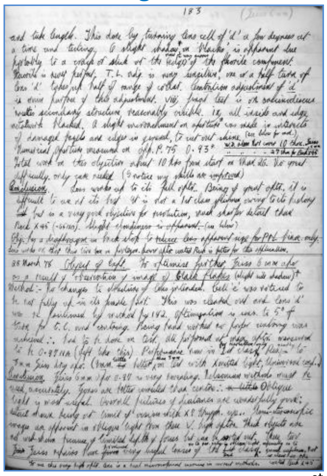
squaring-on trouble and lack of flatness at read combination. Limited effectiveness of objective. A diaphragm was painted on lens 'a' at front limiting aperture to 0.65.

Treatment of 26th March 1978:-

i. Whole was heated out and washed in xylol
ii. Cell 'b' was closely examined and was finally removed from rear combination mount with special gripping tools whilst hot
iii. All, including bezel remains cleaned as well as possible
iv. Rear combination cleaned in xylol and re-balsamed in its cell, OK, and clean
v. A cover glass was balsamed into flat face 'a' to clean it up (in fact it removed fog from image very well)
   Squaring-on performed with Balsam still plastic on Shadbolt's turntable and reflection of light on surface (a)(flat). All OK
vi. Single lens 'd' set up in remains of bezel 'c' and stuck in with shellac.
   All Balsam heated over-night on stove. This also squared-on on turntable
vii. Lens put together and lined up on black flake test for centration…*(next page)*

   …and tube length. This done by turning lens cell of 'd' a few degrees at a time and testing. A slight shadow on 'blacks' is apparent due probably to a crack or slick at the edge (now half way across) of the fluorite component. Fluorite is never perfect. Tube length adjustment is very sensitive, one or half a turn of lens 'd' takes up half of range of collar. Centration adjustment of 'd' is main purpose of this adjustment.

Page 183



viii. Final test is on *Coscinodiscus* 'rosettes' secondary structure reasonably visible
ix. All inside and edge metalwork blacked. A slight encroachment on aperture was made in interests of damaged bezels and edges in general, to cut out shine (see below for modification)

Numerical aperture measured on Aperture plate 75 0.93. Working distance above No.1 cover 10 though, Zeiss 3mm. Working distance above No. 1 cover 27 though for Beck x45.

Total work on this objective about 10 hours from start on 26th March. No great difficulty, only care needed. (I notice my skills are improved).

Conclusion. Lens works up to its full aperture. Being of great aperture it is difficult to use at its best. It is not a 1st class specimen owing to its history but is a very good objective for resolution, much sharper detail than Beck x45 (0.65NA). ~~Slight cloudiness is apparent~~ (see below).

~~Objective has a diaphragm in back stop to reduce lens apparent size for Powell and Lealand binocular only.~~

Lens works OK through thin live box on protozoa. Lower aperture. Coated. Reichert is better for this application.

28th March 1978

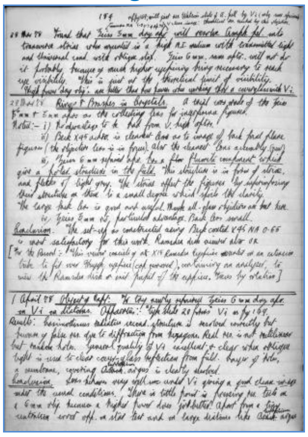
Object of Experiment

To optimise further Zeiss 6mm apochromat as a result of observation of image of black flakes (slight side shadow)

Method:- No changes to structure of lens intended. Cell 'e' was noticed to be not fully up in its female part. This was cleared out and lens 'd' was re-positioned by method page 182. Optimisation in lens to 5° of turn for tube length and centring. Being hand worked no proper centring was achieved, therefore had to be done on test. All performed at maximum aperture, measured to be 0.97NA (left like this). Performance now is 1st class (for resolution only). Resolution nearly equal to Zeiss 3mm dry apochromat (immersion little better than 3mm on test with transmitted light and Universal condenser).

Conclusion. Zeiss 6mm apochromat 0.97 is very revealing. Nelsonian methods must be used accurately. Zones are better corrected than centre, therefore oblique light is most useful. Overall pictures of diatoms are wonderfully good; detail shown being at limit of vision with x7 Huyghenian eyepiece. Some stereoscopic images are apparent in oblique light from these very high apertures. Thick objects are not well shown because of limited depth of focus but can be sorted out. These two Zeiss repairs have produced very useful lenses of the 2nd class as to resolution only in oblique light, especially as to general usefulness. Not so clear as the coated x45 Beck. To use this very high aperture lens is a real microscopical exercise in correct methods.

Page 184



28th March 1978

Found that Zeiss 3mm dry apochromat (measured NA 1.0 4th April 1979) will resolve *Amphipleura pellucida* into transverse striae when mounted in a high R.I. medium with transmitted light and Universal condenser with oblique stop (ref. page 169; will just resolve Watson's slide of *Amphipleura pellucida* by Vertical Illumination [only some specimens], very clean image; theoretical resolution reached by this objective). Zeiss 6mm, same aperture, will not do it, probably because of much higher eyepieceing being necessary to reach eye visibility. This is just at the theoretical limit of visibility. High power dry objectives are better than low powers when working through a coverglass with Vertical illumination.

29th March 1978

Rings and Brushes in crystals

A trial was made of the Zeiss 6,, and 3mm apochromats as the collecting lens for interference figures.

Noted:-

i. No advantage to be had from very high aperture

ii. Beck x45 achromat is clearer lens as to image of back focal plane figures (the objective lens is in focus). Also the cleanest lens assembly (new)

iii. Zeiss 6mm repaired apochromat has a fluorite component which gives a polarised structure in the field. This structure is in form of striae, and flecks of light grey. The striae affect the figures by superimposing their structure on them to a small degree which spoils the clarity. The large back lens is good and useful. Maybe all-glass objectives are best here.

iv. Zeiss 3mm no particular advantage. Back lens small.

Conclusion. The set up as constructed using Beck coated x45 NA 0.65 is most satisfactory for this work. Ramsden disk viewer also Ok.

[For the record:- This viewer consists of a x15 Ramsden eyepiece mounted on an extension tube to fit over Huyghenian eyepiece (cap removed), containing an analyser, to view the Ramsden disk or exit pupil of the eyepiece. Focus by rotation.]

1st April 1978

Object of Experiment

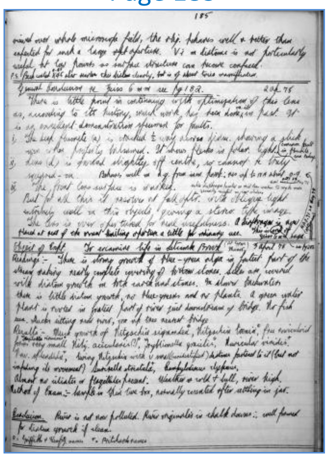
To try newly repaired Zeiss 6mm dry apochromat on Vertical Illumination on diatoms.

Apparatus:- 'Type Slide 20 forms', Vertical Illumination as page 149.

Results:- *Coscinodiscus radiatus* secondary structure is resolved correctly but beware of false resolution due to diffraction from hexagons. Real resolution is not rectilinear but random holes. General quality of Vertical Illumination excellent and clear when oblique light is used to clear cover-glass reflection from field. Layer of 'holes', a membrane, covering *Eupodiscus argus* is clearly resolved.

Conclusion. Lens behaves very well under Vertical Illumination giving a good clean image under the usual conditions. There is little point in pressing resolution tests on a 6mm objective because a higher power does job better. Apart from a tiny centration error apparent in star test and in large diatoms like *Eupodiscus argus*…*(next page)*

Page 185



…viewed over the whole microscope field, the objective behaves well and better than expected for such a large aperture. Vertical Illumination on diatoms is not particularly useful at low powers as surface structure can become confused.

P.S. Beck coated x45 0.65 also resolves this diatom clearly, but is of about twice magnification.

2nd April 1978

General Conclusion re. Zeiss 6mm. see page 182

There is little point in continuing with optimisation of this lens as, according to its history, much more has been done on it in past. It is an excellent demonstration specimen for faults.

1. The deep fluorite (a) is cracked ½ way across diameter showing a slick even when properly balsamed. It shows flecks in polarised light (common fault in fluorite even today)
2. Lens (d) is grooved slightly, off centre, so cannot be truly squared-on. Behaves well in dark ground from immersion paraboloid; resolution up to NA about 0.9 (now 0.65 15th May 1978, 0.71 24th May 1978 [optimum]). Extra diaphragm painted on mid lens combination to make more generally useful on wet slides.
3. The front lens surface is marked.

But for all this it resolves at full aperture with oblique light extremely well on thin objects giving a stereo type image. The lens is over apertured for real usefulness. A diaphragm is now placed at rear of the mount limiting aperture a little for ordinary use.

This end of Zeiss 6mm saga (but see page 295.)

3rd April 1978

Object of Experiment

To examine life in Letcombe Brook (at Grove Manor)

Readings:- There is strong growth of blue-green algae in fastest part of the stream making nearly complete covering of bottom stones. In slower backwaters there is little diatom growth, no blue-greens and no plants. A green water plant is rooted in fastest part of river just downstream of bridge. No fish seen. Ducks sitting near river, one up tree nearest bridge.

Results:- Much growth of *Nitzschia sigmoidea**, *Nitzschia taenia**, free naviculoid forms, *Fragilaria viriscens***, very small *Nitzschia acicularis*(?)*, *Tryblionella gracilis**, *Navicula viridis***, *Navicula splendida***, living *Nitzschia* with very small (unidentified) diatoms fastened to it (but not impeding its movement), *Surirella striatula***, *Campylodiscus clypeus*.

Almost no ciliates or flagellates present. Weather cold and dull, river high

Method of examination: Sample in thin live box, normally counted after settling in jar.

Conclusion. River is not now polluted. River originates in chalk downs therefore well formed diatom growth if clean.

*=Griffith and Henfrey names

**=Pritchard names

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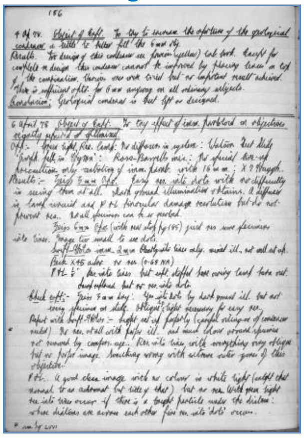

4th April 1978

Object of Experiment

To try to increase the aperture of the geological condenser a little to better fill the 6mm. objective.

Results. For the design of this condenser see previous (yellow) lab. book (Transcribers note: I do not know the whereabouts of the yellow lab. book) Except for complete re-design this condenser cannot be improved by placing lenses on top of the combination. Various ones were tried but no important result achieved. There is sufficient aperture for 6mm anyway on all ordinary subjects.

Conclusion. Geological condenser is best left as designed.

6th April 1978

Object of Experiment

To try effect of immersion paraboloid on objectives recently repaired or optimised.

Apparatus:- Green light, Research lamp; no diffusers in system; Watson Test slide '*Amphipleura pellucida* in Hyrax'; Ross-Burrells microscope; no special line-up precautions only centration of immersion paraboloid with 16mm; x7 Huyghenian.

Results:- Zeiss 3mm Apochromat. Easy resolution into dots with no difficulty in seeing them at all. Dark ground illumination obtains. A diffuser in lamp circuit and Powell and Lealand binocular damage resolution but do not prevent resolution. Not all specimens can be so resolved.

Zeiss 6mm Apochromat (with rear stop page 185) just resolved some specimens into lines. Image too small to see dots.

Swift-Holos immersion 2mm. Clearly into lines only. Mixed illumination, not well set up.

Beck x45 Achromat. No resolution (0.65 NA)

Powell and Lealand ⅛" resolution into lines but experiment stopped here owing to lamp burn out.

Lamp replaced but no resolution into dots.

Check Experiment:- Zeiss 3mm dry: Yes, into dots by dark ground illumination but not every specimen on slide. Oblique dark ground light necessary for easy resolution.

Perfect with Swift-Holos:- Light set up properly (careful oiling on of condenser needed [see page LVVI]) No resolution at all with proper illumination and much colour around specimen not removed by compensating eyepiece. Resolution into line with everything very oblique but no proper image. Something wrong with extreme outer zones of this objective.

Powell and Lealand. A good clean image with no colour in white light (except that normal to an achromat, but little of that) but no resolution. With green light resolution into lines occur if there is a bright particle under the diatom: where diatoms are across each other fine resolution into 'dots' occurs. *(next page)*

Conclusion. It is strange that the two immersion objectives though 1.25NA will not resolve diatom under this annular illumination test. A dry objective does it by same illumination, but of course, dark ground. Swift-Holos is clearly in error at extreme outer zones (note colour) but Powell and Lealand is not, yet no resolution. Are Zeiss objectives greatly superior? Further work needed. It is noteworthy that only a Zeiss 2mm apochromat really resolved this diatom by annular light (see earlier notes).

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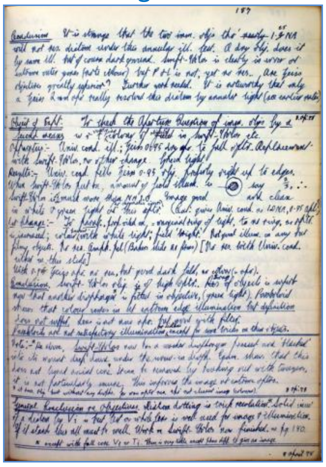
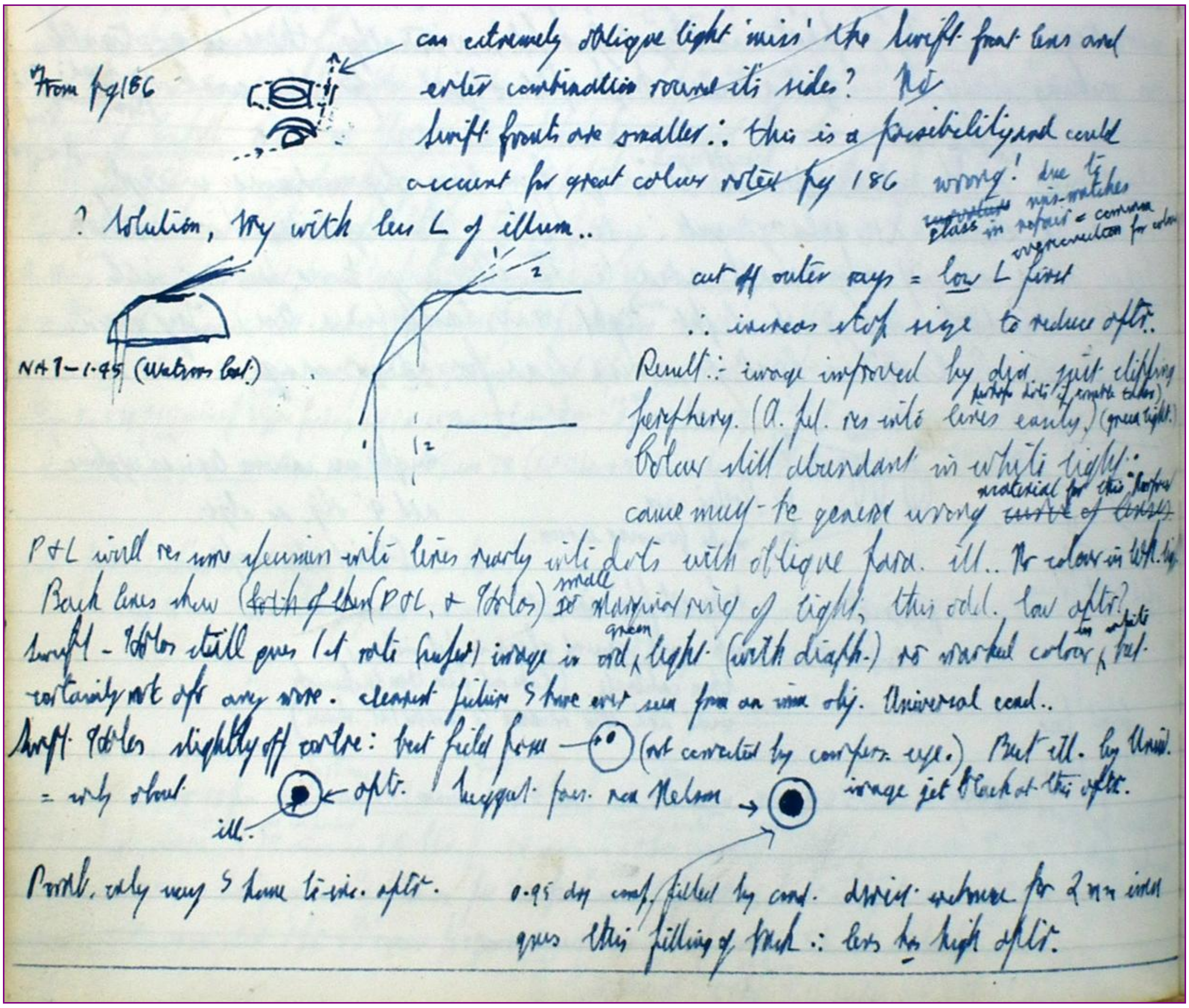




8th April 1978

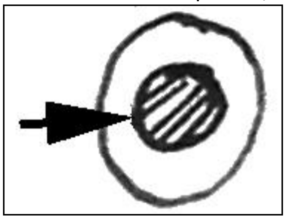
Object of Experiment

To check the aperture question of immersion objectives by a second means with reference to overlying colour of objects in Swift-Holos etc.

Apparatus:- Universal Condenser illumination, Zeiss 0.95 dry apochromat to full aperture. Replacement with Swift-Holos, no other change. Green light.

Results:- Universal condenser fills Zeiss 0.95 objective properly right up to edges.

When Swift-Holos put on, amount of field illumination is:



...say ⅔, therefore Swift-Holos is much more than NA 1.0. Image good and clean in white and green light at this aperture. (Catalogue give Universal Condenser as 1.0 NA, 0.95 aplanatic).

1st change:- To paraboloid, properly oiled on = marginal ring of light, to no ring, as aperture is increased; colour present with white light; field 'bright'. Not good illumination on any but filmy objects. No resolution *Amphipleura pellucida* (Baker's Slide 20 forms) [No resolution with Universal condenser either on this slide].

With 0.95 Zeiss apochromat no resolution, but good dark field, no colour (=apochromat).

Conclusion. Swift-Holos objective is of high aperture. Resolution of small objects is superb now that another diaphragm* is fitted in objective, (green light). Paraboloid shows that colour comes in at bottom edge illumination but definition does not suffer. Lens is not now apochromat but good with filter. Paraboloids are not satisfactory illumination for diatoms except for some tricks on thin objects.

*Note: RE: above, Swift-Holos now has a washer diaphragm pressed and 'blacked' into its mount deep down under the screw-in diaphragm. Examination shows that this does not limit axial cone (it does. Objective best without any diaphragms for maximum aperture resolution, though not cleanest image [coloured]). It can be removed by hooking out with tweezers, it is not particularly secure. This improves the image at extreme apertures.

General conclusion re: objectives. Diatom dotting is trick resolution (except with full cone Vertical Illumination or Transmitted Illumination. There is very little except phase difference to give an image). Solid view of a diatom by Vertical Illumination is best as whole lens is well used for image and illumination. It stands this all must be well. Work on Swift-Holos now finished, as page 180. 8th April 1978.

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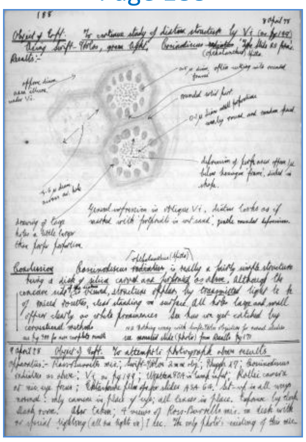
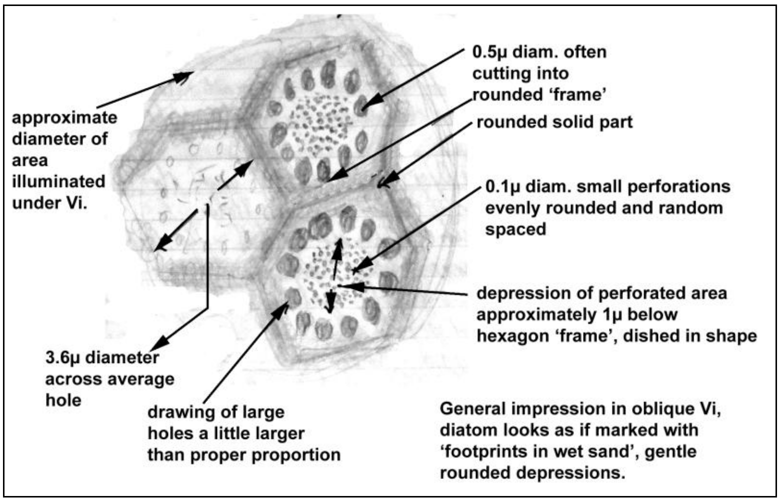


8th April 1978

Object of Experiment

To continue study of diatom structure Vertical Illumination (as page 149) using Swift-Holos, green light, *Coscinodiscus ~~radiatus~~ (ophthalanthus)* Spitta, 'Type Slide 20 Forms'.

Results:



Conclusion. *Coscinodiscus ~~radiatus~~ (ophthalanthus* [Spitta]) is really a fairly simple structure being a disk of silica carved and perforated as above. Although the concave side of the diatom is viewed, structure appears by transmitted light to be of raised rosettes, clear standing on surface. All holes large and small appear clearly as white prominences. See how we get 'catched' by conventional methods.

NB. Nothing wrong with Swift-Holos objective for normal studies.

See page 300 for more complete results
See mounted slide (photo) from results page 171.

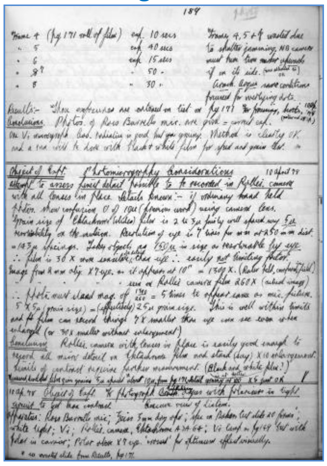
9th April 1978

Object of Experiment

To attempt to photograph above results

Apparatus:- Ross-Burrells microscope; Swift-Holos 2mm objective; Huyghenian X7; *Coscisondiscus radiatus* as above; Vertical Illumination as page 149; Wratten 80A in lamp input; Rolleiflex camera at microscope eye focus; Ektachrome film for slides ASA64. Set-up in all ways normal; only camera in place of eye; all lenses in place. Exposure by clock. Dark room. Also taken; 4 views of Ross-Burrells microscope on desk with no optical lighting (all run lights on) 1 sec. The only photos existing of this microscope.

Page 189



Frame 4 (page 171 roll of film) exposure 10 seconds
Frame 5 exposure 40 second
Frame 6 exposure 15 seconds
Frame 7 exposure 50 seconds
Frame 8 exposure 30 seconds
Frames 4, 5, and 7 wasted due to shutter jamming. NB. camera must have time marker upwards if on its side (now attended to OK)
Arachnoidiscus argus same conditions focussed for overlying dots.
Results:- These exposures are entered on list on page 171. For processing, Scotts 10th April 1978 (returned 25th April 1978)
Conclusions. Photos of Ross-Burrells microscope are good = correct exposure. One Vertical Illumination micrograph, *Coscinodiscus radiatus* is good but grainy. Method is clearly OK and a run will be done with black and white film for speed and grain test.

10th April 1978

Object of Experiment

Photomicrography Considerations

Attempt to assess finest detail possible to be recorded in Rolleiflex camera with all lenses in place.

Details known:-

Ordinary hand held photos show confusion circle of 10µ (previous work) using camera lens.
Grain size of Ektachrome (slides) film is 2 to 3µ fairly well spaced, say 5µ resolvability on the emulsion.
Resolution of eye is 7 lines per mm at 250mm distance = 143µ spacings.
Take objects as 150µ in size as resolvable by eye, therefore film is 30x more sensitive to detail than eye, therefore easily not limiting factor.
Image from 2mm objective, x7 eyepiece, as it appears at 10” = 1300x (ruler held, compared in field).
Image from 2mm objective, x7 eyepiece, seen on Rolleiflex camera film 260x (actual image), therefore photo must stand magnification of $^{1300}/_{260}$ = f times to appear same as microscope picture.
5 x 5µ (grain size) = (effectively) 25µ grain size. This is well within limits and film can record things 7x smaller than eye can see even when enlarged (or 30x smaller without enlargement).
Conclusion. Rolleiflex camera with lenses in place is easily good enough to record all micro detail on Ektachrome film and stand (say) x10 enlargement. Limits of contrast require further measurement (Black and White film?)
Measured developed film gives grains 5µ spaced (see mounted slide from Results, pg, 171) about 10µ, from page 171. Detail grainy at x10, x5 just OK.

10th April 1978

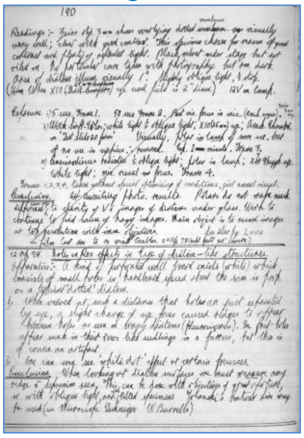
Object of Experiment

To photograph *Eupodiscus argus* with polarisers in light circuit to get maximum contrast. Concave view of diatom.

Apparatus:- Ross-Burrells microscope, Zeiss 3mm dry apochromat, specimen on ‘Baker’s test slide 20 forms’, white light, Vertical Illumination, Rolleiflex camera, Ektachrome ASA64, Vertical Illumination lamp as page 149, but with polariser in carrier, polariser above x7 eyepiece, ‘crossed’ for optimum effect, visually.

(next page)

Page 190



Readings:- Zeiss objective 3mm shows overlying dotted membrane visually very well; clear with good contrast. This specimen chosen for reason of good contrast and plenty of reflected light. Black velvet under stage but not oiled on. No particular care taken with photography but rim bark area of diatom illuminated visually 1". Slightly oblique light, ⅓ stop (when x10 (25mm) eyepiece and field is 2" diameter). 12V on lamp.

[Transcribers Note: there then follows a description of exposures and a conclusion which ends with 'film lost due to rewind troubles. 22nd April 1978 (experimenters fault not camera)'.]

12th April 1978.

Notes on resolution effects in Eye of diatom-like structures.

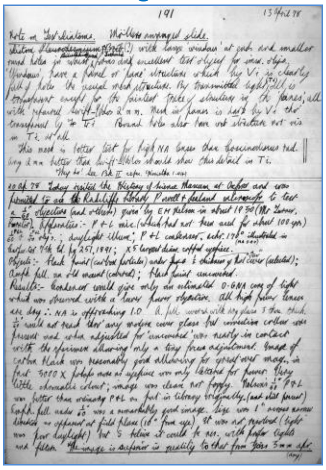
Apparatus:- A kind of perforated wall-board exists (white) which consists of small holes in hardboard spaced about the same in proportion as a typical 'dotted' diatom.

i. When viewed at such a distance that holes are just separated by eye, a slight change of eye focus caused ridges to appear between holes as seen on many diatoms (*Pleurosigma*). In fact holes appear sunk in their rows like seedlings in a furrow, but this is of course an artefact.
ii. One can even see 'white dot' effect at certain focuses.

Conclusion. When looking at diatom surfaces on must measure any ridge or depression seen. This can be done with objectives of great aperture, or with oblique light, and with tilted specimens. Tolanski's Contour Line may be used (see Microscope Technique – W. Burrells).

Note on Test Diatoms – Möller's arranged slide

Page 191



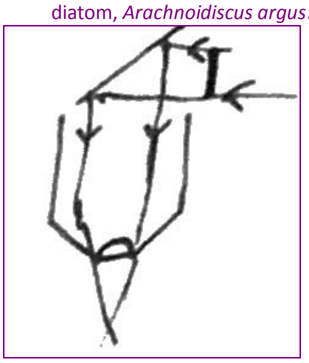
Diatoms with large 'window' at ends and smaller round holes in waist form an excellent test object for immersion objectives. 'Windows' have a panel or 'pane' structure which by Vertical Illumination is clearly full of holes, the usual mesh structure. By transmitted light (Transmitted Illumination) all is transparent except for the faintest trace of structure in the 'panes', all with repaired Swift-Holos 2mm. Mesh in panes is dark by Vertical Illumination though transparent by Transmitted Illumination. Round holes also have web structure not visible in Transmitted Illumination at all.

This mesh is better test for high NA lenses than *Coscinodiscus radiatus*. Any 2mm better than Swift-Holos should show this detail in Transmitted Illumination. (They do! See Bk.II especially Koristka 1.4(+).)

18th April 1978

Examination of cause of haze in Vertical Illumination.

i. With low power 16mm it is possible to set up stop to produce 'dark ground' Vertical illumination with no haze at all in a dense diatom, *Arachnoidiscus argus*.



It can just be done, but critical.

ii. Beck x45, a coated lens, dry. Polars in lamp and on eyepiece and use of diaphragm gives fair illumination and black field. OK.

iii. Swift-Holos gives a hazy direct image with colour in objective. Vertical Oblique light causes great colour from objective, full spectrum across field, but resolution OK. Polars no difference. Objective at fault, margins of front lenses.
iv. Powell and Lealand. Fairly hazy direct Vertical Illumination image. Very oblique light gives black field, good image; polars no difference. Combination of lamp diaphragm, Vertical Illumination lamp bar, and position of lamp can make field good black, with good image. Black patch below specimen, no difference.

Conclusion. Hazy images with oil immersion objective due to quality of objectives mainly. A coated lens helps, but image can be OK (check on photos) with good objective, uncoated and careful use of diaphragms and lamp position. The usual use of filters is advantage. Clarity of photos is object of experiment, visually there is no trouble in making study. Get a decent high aperture objective for this work. (in hand – Brunnings to try – June 1978)

20th April 1978

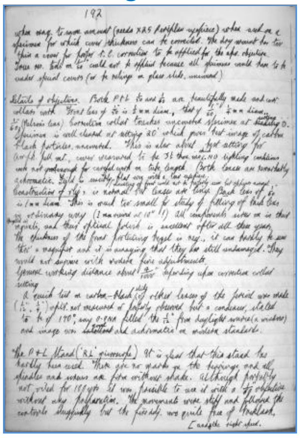
Today revisited the History of Science Museum at Oxford and was permitted to use the Radcliffe Library Powell and Lealand microscope to test a $^1/_{60}$th objective (and others) given by E. M. Nelson in about 1930 (Mr. Turner, Curator).

Apparatus:- Powell and Lealand Microscope (which had not been used for about 100 years), 1.60 Powell and Lealand & 1.50 Powell and Lealand objectives; daylight illumination; Powell and Lealand condenser, achromat 170° (NA 0.9+) illustrated in Carpenter 7th Edition, page 251, 1891; x5 largest diameter capped eyepiece.

Objects:- black point (carbon particles) under ½ thickness ($^4/_{1000}$")of No.1 cover (selected); *Amphipleura pellucida* on old mount (covered); black paint uncovered.

Results:- Condenser would give only an estimate 0.6NA cone of light which was observed with a lower power objective. All high power lenses are dry therefore NA is approaching 1.0. *Amphipleura pellucida* covered with dry glass 3 thou think. $^1/_{60}$" would not reach through any modern cover glass, but correction collar was present and when adjusted for 'uncovered' was nearly in contact with the specimen allowing only a tiny focus adjustment. Image of carbon black was reasonably good allowing for great over magnification, in fact 3000x perhaps more as eyepiece was only lettered for power. Very little chromatic colour; image was clear not foggy. Nelsons $^1/_{60}$" Powell and Lealand was better than ordinary Powell and Lealand as put in library originally (and still present). *Amphipleura pellucida* under $^1/_{60}$" was a remarkably good image. Size was 1" across narrow direction as apparent at field plane (10" from eye). It was not resolved (light was poor daylight) but I believe it could be resolved with proper lights and filters. The image is superior in quality to that from Zeiss 3mm apochromat (dry)...*(next page)*

Page 192



…when magnification to same amount (needs x25 Periplan eyepiece) when used on a specimen for which cover thickness can be corrected. The dry mount has too thin a cover for proper tube length correction to be applied for the apochromat objective. True resolution test on $^1/_{60}$" could not be applied because all specimens would have to be under special covers (or be rulings on glass slide, uncovered).

Details of objectives. Both Powell and Lealand 1.50 and 1.60 are beautifully made and correction collars work. Front lens of $^1/_{50}$" is ½mm diameter, that of 1.60" ¼mm diameter. $^1/_{60}$" (Nelson's lens). Correction collar touches uncovered specimen at setting '0'. Specimen well cleared at setting '20' which gives best image of carbon black particles, uncovered. This is also about best setting for *Amphipleura pellucida* mount, cover measured at 3½ thousands of an inch thick. NB. Lighting conditions were not good enough for careful work on tube length. Both lenses are remarkable achromatic. Field is sensibly flat even with a low eyepiece.

Construction of objectives is normal but lenses are tiny, mounting of front could not be properly seen but appears normal. Back lens of $^1/_{50}$" is 1mm diameter. This is much too small for study of filling back lens in ordinary way (1mm viewed at 10"!). All components screw on in their mounts, and their optical polish is excellent after all these years. The thickness of the front protecting bezel is regular, it can hardly be seen through a magnifier and it is amazing that they are still undamaged. They would not survive with modern fine adjustments.

General working distance about $^4/_{1000}$" depending upon correction collar setting.

A quick test on carbon-black slide of other lenses of the period was made ($^1/_{12}$", ¼") aperture not measured or properly observed but a condenser, stated to be 170°, say 0.9NA filled the $^1/_{12}$" from daylight source (a window) and image was good and achromatic on modern stands.

The Powell and Lealand stand ('RL' microscope). It is clear that this stand has hardly been used. There are no marks on the bearings and all spindles and screws are firm without shake. Although probably not oiled for 100 years it was possible to use it with a $^1/_{60}$" objective without any preparation. The movements were stiff and followed the controls sluggishly but the fine adjustment was quite free of backlash and of the right speed,…*(next page)*

[Transcribers Note: Following this visit a report (3 A4 sheets typescript) was produced – presumably for the Museum – it is reproduced below]

Page 1

Object of Experiment

To make a first examination of a typical high power dry objective circa 1864. A test of performance only without dismantling the objective was attempted.

Apparatus

By kind permission of the Curator of the Museum of the History of Science, Oxford (Mr. Turner), I was allowed to examine a ¹⁄₆₀ inch and a ¹⁄₅₀ inch objective by Powell and Lealand on the historic stand by Powell and Lealand which was placed in the Radcliffe Library and marked 'RL'. Attention was paid to the ¹⁄₆₀ inch objective which was presented to the museum by E. M. Nelson and was known to be a good example. A standard condenser belong to the 'RL' stand was used which was illustrated in Carpenter 7th Ed. Page 251 and is there stated to be of 170° air angle. Daylight illumination was chosen as being typical for use in 1864, a framed part of a north pointing window was focussed. The objects were

- *i) Carbon-black particles without a cover and*
- *ii) A special test mount of Amphipleura pellucida, dry, under a covering thickness of glass 3 thou inch thick, circa 1850.*

Carbon particles were also mounted under a modern No.1 cover glass but neither objective would work through it. A Powell and Lealand low power standard eyepiece belonging to the 'RL' stand and normally fitted for museum exhibition was used, power about x5 Huyghenian type.

Readings

Because of the time available attention was given to the ¹⁄₆₀ inch objective though an image was observed with the ¹⁄₅₀ inch example belonging to the RL stand which was extremely satisfactory.

Structure of the Objective, ¹⁄₆₀ inch

This follows exactly the P & L normal method so far as could be observed without dismantling the objective. The brasswork is as near perfect as old or new craftsmanship can make it, and the correction collar worked without any attention. The front lens is 0.25mm diam., and the back lens 1.0mm diam. (estimated). The thickness of the protecting bezel…

Page 2

…of the front lens is truly too thin for ordinary measurement and can be observed only with a magnifier in oblique light. It is clear that this objective has been much used judged by the rubbing of the brass around the lens. It must have been used only by an expert person on a stand with a light nosepiece fine adjustment (I suggest also a P & L stand?) for without such safeguards the front lens could not have survived. The polish of the glass is perfect and the whole object is clean.

Optical Performance

The 1.60 inch objective is without doubt difficult to use. An uncovered specimen was first tried and setting-up was performed with a 1 inch objective. The condenser was observed to be giving an aplanatic cone of about 0.7 NA, its stated total aperture being 0.9 NA, These figures for the condenser were estimated from the degree of filling of the lenses of 1.12 inch objective of known aperture. The 1.60 inch objective had to be lowered towards the specimen because it was impossible to judge the distance of the front lens from the specimen owing to the size of the brass mount and the nearness of working. This was deemed safe on an uncovered specimen after the lightness of the fine adjustment had been tried manually by lifting the nosepiece.

When the image of the layer of carbon particles was found, each particle was about ½ micron diam., the image was found to be remarkable free from chromatic aberration even in the full spectrum of daylight. The 'blacks' were clear of fog and the field sensibly flat. Spherical correction as judged by the similarity of the out-of-focus images above and below focus was as good as in a modern objective eyepieced up to the same magnification and of similar aperture. Experiments with light filters were not possible because of light intensity. No deterioration of the image in oblique light from the condenser was observed but in the circumstances this test cannot be considered complete. The confusion circle at the junction of black and light parts of the field was even all over the field and was, of course, rather large owing to the high magnification (3000X) but on first observation I consider it was less than in the modern objective eyepieced up to 3000X magnification which gives a confusion circle measured with an eyepiece micrometer of about 0.4microns. This test of black particles in a bright field in daylight is a sever one. A typical use of the objective was on a slide of Amphipleura pellucida or other diatoms (see below). The confusion circle of a modern objective 1.4 NA Apo, X1000 on the same carbon particles is less than 0.1µ. The…

Page 3

…range of the correction collar is such that for an uncovered object, setting '0', the front lens just touches the object thus giving maximum aperture. The thickest cover (glass) which can be worked through is 3½ thou. Of an inch, and a collar setting of '20' is correct for such a cover. The image of a dry mounted A. pellucida was obtained without difficulty when once the system was set up. The daylight was fading by the time this was done but it was possible to adjust the objective for optimum spherical correction to about ± five graduations on the collar. The image in the microscope measured 1 inch across the widest part of the diatom and about 12 inches in length as observed against a ruler held beside the field of the microscope. No resolution of the diatom could be seen (92,000 lines per inch) but the image was of such quality that I believe resolution possible given sufficient light and accessories. It is to be noted that a modern dry apochromat 0.95 NA will not resolve this diatom in transmitted light but requires vertical illumination carefully arranged. It is not practicable to study the distribution of light in the back lens of the ¹⁄₆₀ inch objective because of its very small size.*

The Powell and Lealand Stand Marked 'RL'

The history of this microscope is stated clearly on the museum display card. When used for the above objective test it probably had not been used for the previous 100 years. Its condition is as nearly perfect as any example known to me, in fact judging by the lack of marks on the bearing surfaces it has seldom been used. It has been in the care of the Museum for perhaps 100 years and yet the stand was used to carry a ¹⁄₆₀ inch objective of unknown qualities used at full aperture, the whole being taken from the display case with 1 days notice. The stand gave no trouble and is a credit to the curator and manufacturer. So far as has been ascertained after 2 hours examination there is no deterioration anywhere to working metal of optical surfaces.

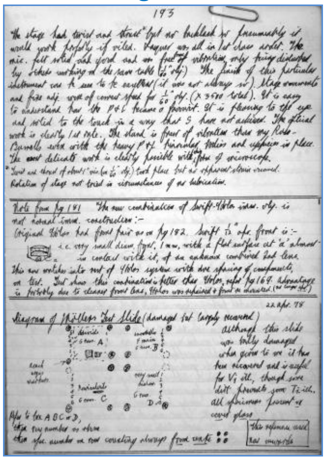
W. Burrells

28th April 1978

**This diatom on this slide cannot be resolved by a 1.37 apochromat and vertical illumination. A similar diatom directly exchanges, in Styrax, is resolved easily by a 1.25 N,A, 0.9. (no change in the Vi.) This to be examined.*

Diatom is resolved see Bk.II page 224 (bad cover contact to Diatoms.

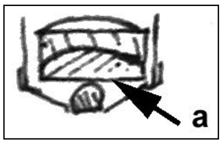
Page 193



The stage had twist and thrust (twist and thrust of about 1" visible [on $\frac{1}{60}$" objective] took place but no apparent strain occurred. Rotation of stage not tried in circumstances of no lubrication) but no backlash so presumably it would work properly if oiled. Lacquer was all in 1st class order. The microscope felt solid and good and was free from vibration, only being disturbed by others working on the same table ($\frac{1}{69}$" objective). The finish of this particular instrument can be seen to be excellent (it was not always so). Stage movements and fine adjustment were of correct speed for $\frac{1}{20}$" objective (x3500 total). It is easy to understand how the Powell and Lealand became a favourite. It is pleasing to the eye and solid to the touch in a way that I have not achieved. The optical work is clearly 1st rate. The stand is freer of vibration than my Ross-Burrells even with the heavy Powell and Lealand binocular bodies and eyepieces in place. The most delicate work is clearly possible with this form of microscope.

Note from page 181.

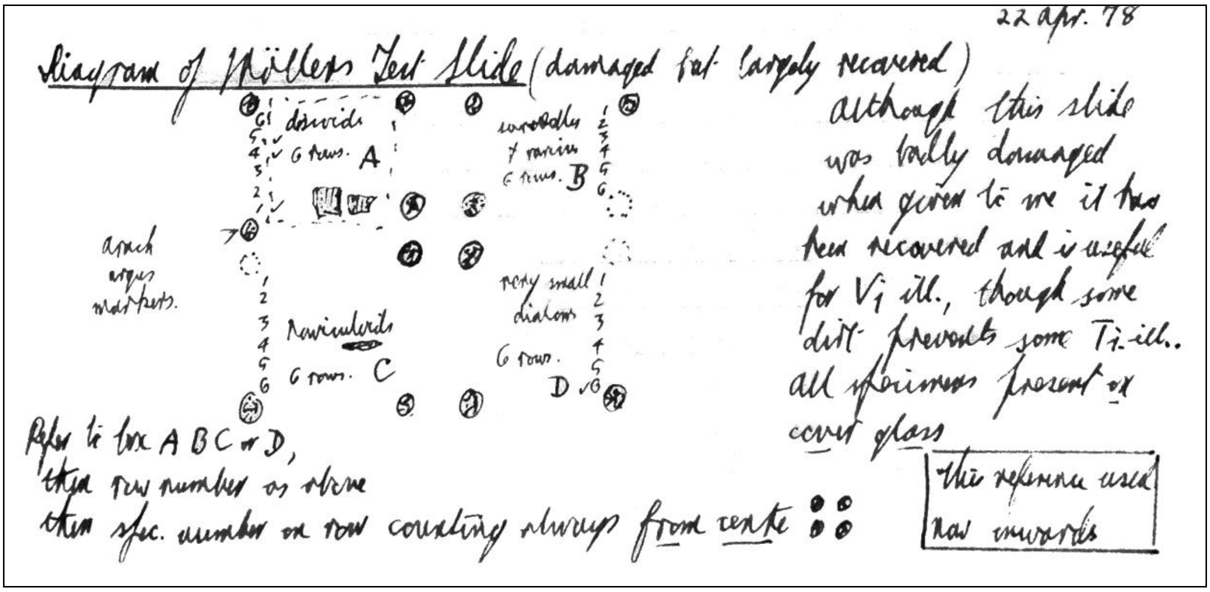
The new combination of Swift-Holos immersion objective is not normal immersion construction,



Original Holos had front pair as on page 182. Swift $\frac{1}{12}$" apochromat front is:-

i.e. a very small diameter front, 1mm with a flat surface at 'a' almost in contact with it, of an unknown combined 2nd lens.

This now matches into rest of Holos system with due spacing of components, on test. Test shows this combination is better than Holos, refer page 169. Advantage is probably due to cleaner front lens, Holos was repaired and front re-mounted (no longer apochromat).



See APPENDIX D for Möller 400 documentation.

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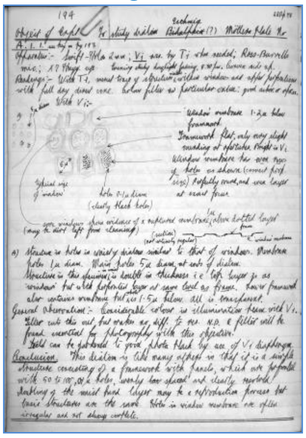


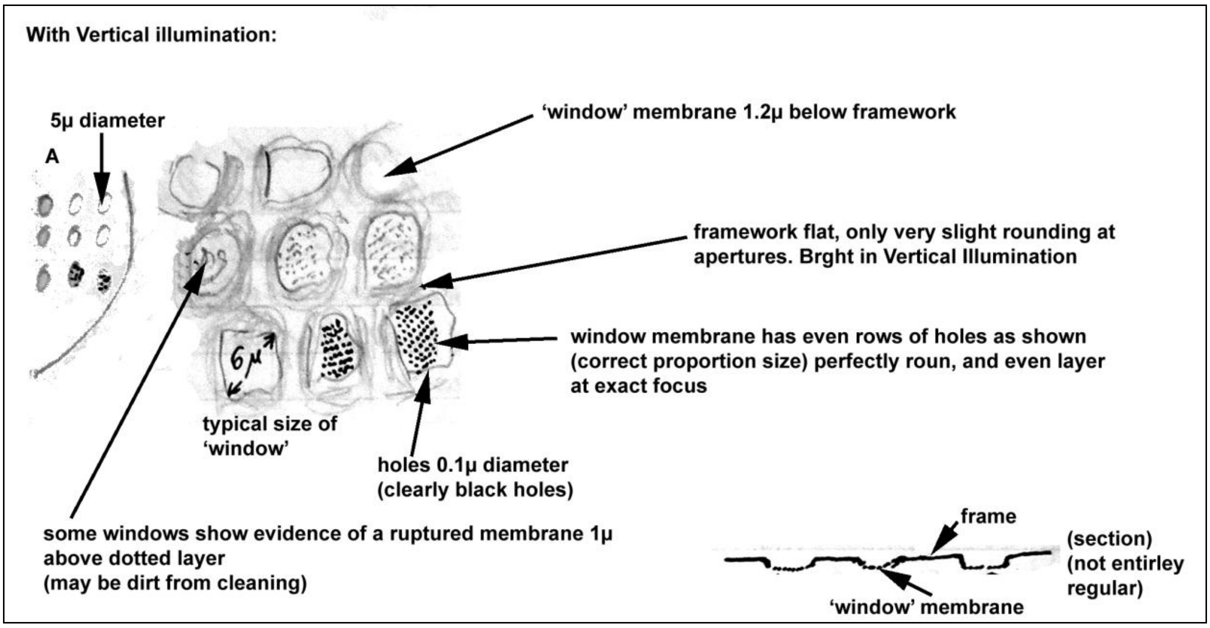
22nd April 1978

Object of Experiment

To study diatom *Isthmia* (?) Möller's Plate No. A.1.1. see key pn page 183.

Apparatus:- Swift-Holos 2mm; Vertical Illumination assisted by Transmitted Illumination when needed, Ross-Burrells microscope, x7 Huyghenian eyepiece. Evening study. Daylight focussing, 8.30 p.m. Convex side up.

Readings:- with Transmitted Illumination merest trace of structure visible within windows and upper perforations with full dry direct cone. Colour filter no particular value; good achromat or apochromat OK.



(A) structure is holes in waist of diatom similar to that of windows. Membrane holes 1µ diameter. Main holes 5µ at ends of diatom.

Structure in this specimen in waist is double in thickness i.e. top layer is as ‘windows’ but with perforated layer at same level as frame. Lower framework also contains membrane but whole is 1.5µ below. All is transparent.

General Observation:- Considerable colour in illumination beam with Vertical Illumination. Filter cuts this out but makes no difference to resolution. NB. A filter will be found essential for photography with this objective.

Field can be darkened to good photo black by use of Vertical Illumination diaphragm.

Conclusion. This diatom is like many others in that it is a simple structure consisting of a framework with panels, which are perforated with 50 to 100 0.1µ holes, evenly spaced and clearly resolved. Doubling of the waist band layer may be a reproduction process but basic structures are the same. Holes in window membrane are often irregular and not always complete.

24th April 1978

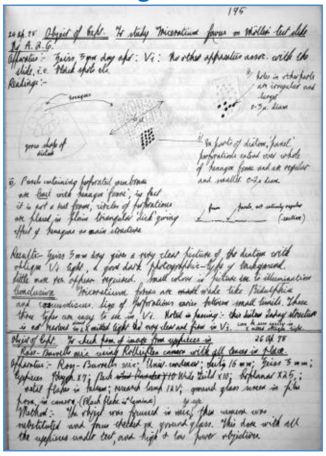
Object of Experiment

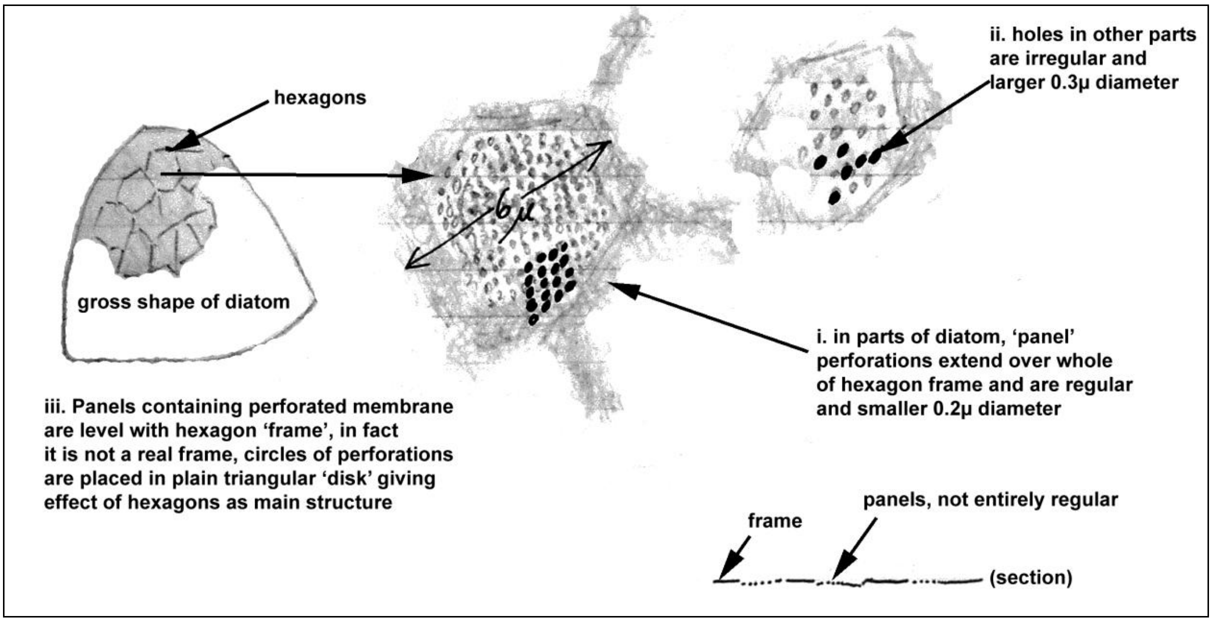
To study *Triceratium favus* on Möller’s test slide No. A.2.6.

Apparatus:- Zeiss 3mm dry apochromat, Vertical Illumination, no other apparatus associated with the slide i.e. black spots etc.

Readings:-

Page 195





Results:- Zeiss 3mm dry gives a very clear picture of the diatom with oblique Vertical Illumination light, a good dark photographic-type of background. Little more resolution appears required. Small colour in picture due to illumination.

Conclusion. *Triceratium* forms are made like *Buddulphia* and *Coscinodiscus*. Size of perforations varies between small limits. These three types are easy to see in Vertical Illumination. Noted in passing: this diatom's secondary structure is not resolved in direct transmitted light though very clear and form in Vertical Illumination (can be seen easily in transmitted oblique light).

26th April 1978

Object of Experiment

To check image from eyepieces in Ross-Burrells microscope using Rolleiflex camera with all lenses in place.

Apparatus:- Ross- Burrells microscope, Universal Condenser, Leitz 6mm, Zeiss 3mm, x7 Huyghenian eyepieces, Beck x10 widefield eyepieces, x25 coplanar, metal flakes in balsam, research lamp 12V, ground glass screen in film position in camera (black flake a laminae)

Method:- The object was focussed in microscope by eye, then camera was substituted and focus checked on ground glass. This done with all the eyepieces under test, and high and low power objectives.

(next page)

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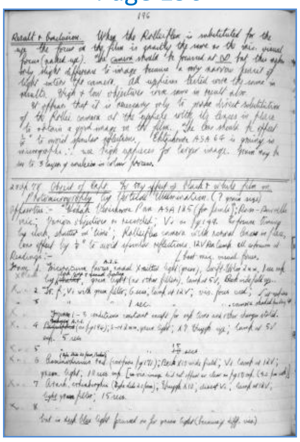

Result and Conclusion. When the Rolleiflex is substituted for the eye the focus on the film is exactly the same at the microscope visual focus (naked eye). The camera should be focussed at infinity but this makes only slight difference to image because a very narrow pencil of light enters the camera. All eyepieces tested were the same in results. High and low objectives were same in result also.

It appears that it is necessary only to make direct substitution of the Rolleiflex camera at the eyepiece with its lenses in place to obtain a good image on the film. The lens should be offset ⅛" to avoid specular reflections. Ektachrome ASA64 is grainy in micrographs, therefore use high eyepieces for larger image. Grain may be due to 3 layers of emulsion in colour process.

28th April 1978

Object of Experiment.

To try effect of Black and White film on Photomicrography by Vertical Illumination (? Grain size)

Apparatus:- "Kodak Verichrome Pan ASA125 (for prints)", Ross-Burrells microscope, Various objectives as recorded, Vertical Illumination as page 149, exposure timing by clock, shutter on 'time', Rolleiflex camera with normal lenses in place, lens offset by ⅛" to avoid specular reflections, 12V Research lamp, all exposures at best microscope visual focus.

Readings:-

Frame 1. *Triceratium favus* A.2.6, normal transmitted light (green), Swift-Holos 2mm, 1 second exposure by clock time and manual operation (no other filters), lamp at 5V, Beck wide-field eyepiece.
Frame 2. *Triceratium favius*, with green filter, 6 seconds, lamp at 12V, visual focus used
Frame 3. *Triceratium favius*, with green filter, 1 second, lamp at 12V, focus at eyepiece camera shaded for long time
Frame 4. *Isthmia* A.1.1 (as page 194), Swift-Holos 2mm, green light, x7 Huyghenian eyepiece, lamp at 5V, exposure 5 seconds
Frame 5. *Isthmia* A.1.1 (as page 194), Swift-Holos 2mm, green light, x7 Huyghenian eyepiece, lamp at 5V, exposure 15 seconds
Frame 6. *Coscinodiscus radiatus* (Type slide 20 Form Baker) compare page 171) Beck x10 wide-field eyepiece, Vertical Illuminator, lamp at 12V, green light, 10 seconds exposure {with visual image did not appear so clean as page 171 exposure (3.0 pm work)
Frame 7. *Arachnoidiscus Ehrenbergii* (Type slide 20 forms), Huyghenian x10, direct Vertical Illumination, lamp at 12V, light green filter, 15 seconds.
Frame 8. *Arachnoidiscus Ehrenbergii* (Type slide 20 forms), Huyghenian x10, direct Vertical Illumination, lamp at 12V, but in deep blue light, focussed as for green light (because of different vision)…
(next page)

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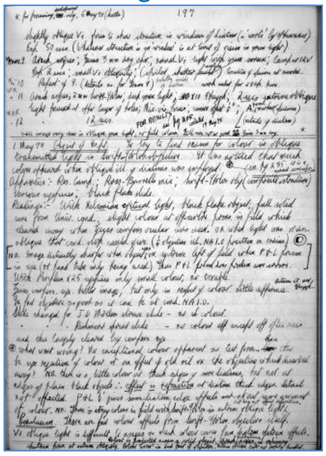
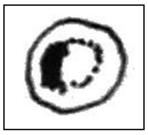


…slightly oblique Vertical Illumination focus to show structure in window of diatom (='warts' by appearance). Exposure 50 seconds (whatever structure is in 'window' is at limit of vision in green light).
Frame 9. *Arachnoidiscus argus*, Zeiss 3mm dry apochromat, normal Vertical Illumination light with green screen, lamp at 12V, exposure 2 seconds, small Vertical Illumination obliquity (spoiled shutter mistake) Location of specimen not recorded.
Frame 10. Repeat of 9 (details as for Frame 9). Probably inside of diatom. Work ended for 28th April here.
Frame 11. *Arachnoidiscus argus*, 2mm Swift-Holos, deep green light, x10 Huyghenian, 2 seconds, extreme oblique light focussed at upper layer of holes, microscope visual focus, camera offset ⅛", A. panel marker specimen, outside of diatom.
Frame 12. As 11. Exposure 12 seconds.
For processing, development only 6th May 1978 (Scotts).
For results see page 205. Collected 19th May 1978.
Frames 11 and 12 very clear in oblique green light, no field colours. Full cone not so good as Zeiss 3mm dry.

1st May 1978
Object of Experiment.
To try to find reason for colour in oblique transmitted light in Swift-Holos objective.
It was noticed that much colour appeared when oblique illumination of diatoms was employed. (see page 235. It is a normal mistake) See 'What went wrong?' below.
Apparatus:- Research lamp, Ross-Burrells microscope, Swift-Holos objective, full solid cone from Universal condenser. Slight colour at off-centre positions in field which cleared away when Zeiss compensating ocular was used. OK when light was maximum oblique that condenser stop would give (¼ oblique illumination, NA 1.0 position on radius).



NB. Image distinctly sharper when object was on extreme left of field when Powell and Lealand prism in use (right hand tube only being used). Thus Powell and Lealand prism does produce some errors. With Periplan x25 eyepiece only small colour, no trouble. Zeiss compensating eyepiece better image, but only in respect of colour. Little difference between it and Huyghenian.
In fact objective as good as it can be at condenser NA 1.0.
Slide changed for J. D. Möller's strewn slide – no colour
Slide changed for Richmond spread slide – no colour except off optic axis and this largely cleared by compensating eyepiece.
What went wrong?
No exceptional colour apparent as test proceeded. Can this be eye rejection of colour or an effect of old oil on the objective which dissolved away? NB. There is a little colour at thick edge of some diatoms, but not at edges of plain black objects, therefore effect is refraction at diatom thick edge. Detail not affected. Powell and Lealand ⅛" gives same diatom edge effects and about same amount of colour. NB. There is stray colour in field with Swift-Holos in extreme light (it does not affect definition).
Conclusion. There are few colour effects from Swift-Holos objective itself. Vertical Illumination oblique light is difficult to assess as much colour comes from diatom structure effects.
Colour is projected across a solid object, *Eupodiscus argus*, in ordinary spectrum form at extreme obliquity. Colour 'error' in second pair of objectives. Extreme oblique light not properly handled.

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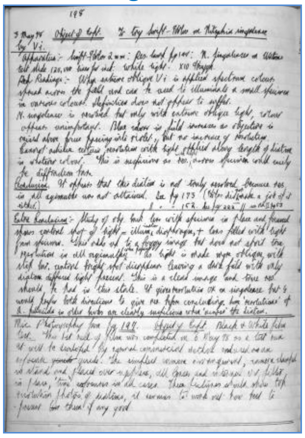

3rd May 1978

Object of Experiment

To try Swift-Holos on *Nitzschia singalense* by Vertical Illumination.

Apparatus:- Swift-Holos 2mm, Research lamp page 149, *Nitzschia singalense* on Watson's test slide 120,000 lines per inch, white light, x10 Huyghenian eyepiece.

Readings:- When extreme oblique Vertical illumination is applied spectrum colours spread across the field and can be used to illuminate a small specimen in various colours. Definition does not appear to suffer. *N. singalense* is resolved but only with extreme oblique light, colour appears unimportant. Blue colour in field increases as objective is raised above focus passing into violet, but no increase of resolution. Cannot achieve certain resolution with light applied along length of diatom in whatever colour. This is suspicious as resolution with light across specimen could easily be diffraction bars.

Conclusion. It appears that this diatom is not truly resolved because resolution in all azimuths was not attained.

See page 173 (Holos did not make a job of it either)
See page 152
See page 222
See Bk.II page 53

Extra Conclusion. Study of objective back lens with specimen in place and focussed shows central spot of light = illuminator diaphragm, and lens filled with light from specimen. This adds up to a foggy image but does not spoil true resolution in all azimuths when present. As light is made more oblique with stop bar, central bright spot disappears leaving a dark field with only diatom diffused light present. This is a clear image and true resolution should be had in this state. It gives resolution OK on *singalense* but I would prefer both directions to give resolution before concluding. Some 'resolutions' of *Amphipleura pellucida* in older books are clearly suspicious when 'across' the diatom.

Microscopic photography from page 197.

Object of Experiment.

Black and White film test. This 1st reel of film was completed on 6th May 1978 as a test run. It will be developed by normal commercial method and used as an exposure guide. The simplest camera arrangement, camera clamped in stand and placed over eyepiece, all lenses and internal UV filter in place, 'time' exposures in all cases. These pictures should show top resolution photos of diatoms, it remain to work out how best to present them if any good.

6th May 1978

Object of Experiment

To look at markings of *Triceratium* form with Swift-Holos 2mm, Vertical Illumination. Ref. page 195.

Readings:- With certain obliquity of Vertical illumination light and selected parts of the diatom, the perforations within the hexagonal windows are just like perforated zinc in a larder window. They can be seen as holes in 'white dot' colouring, are certainly not all perfect in arrangement, many are not completely perforated. Average number per hexagon is 55 holes. Viewed in this way there cannot be any doubt about the structure.

Both Powell and Lealand ⅛" and Swift-Holos do not give a very clear fog free image in Vertical Illumination but resolution of Swift-Holos especially in Vertical oblique light (green) is greater.

Conclusion. Diatoms of this kind appear to be of similar structure i.e. stiffening panels filled with grills of holes just like a larder window in a house.

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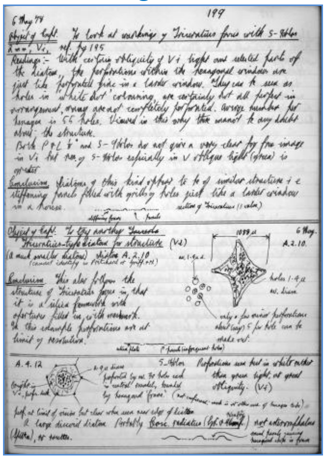
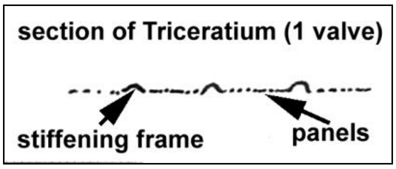
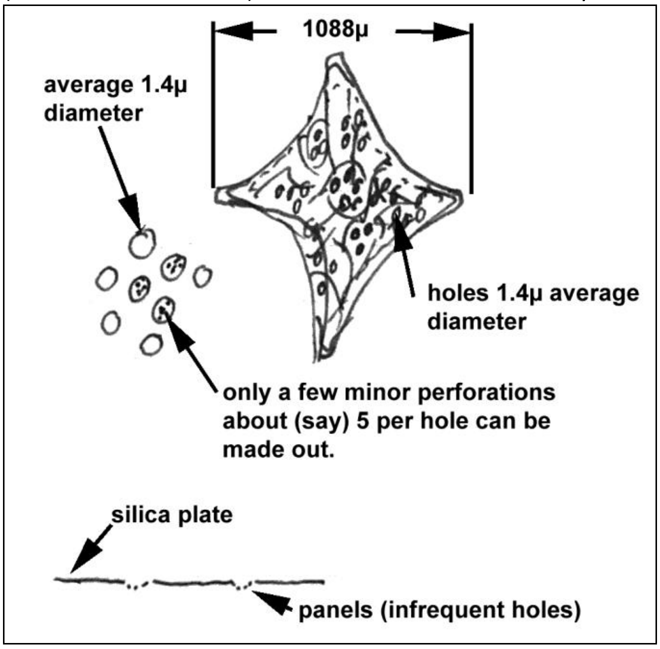




6th May 1978

Object of Experiment

To try another *Triceratium*-type diatom for structure (V2) (a much smaller diatom) Diatom A.2.10 – Cannot identify in Pritchard or Griffith and Henfrey

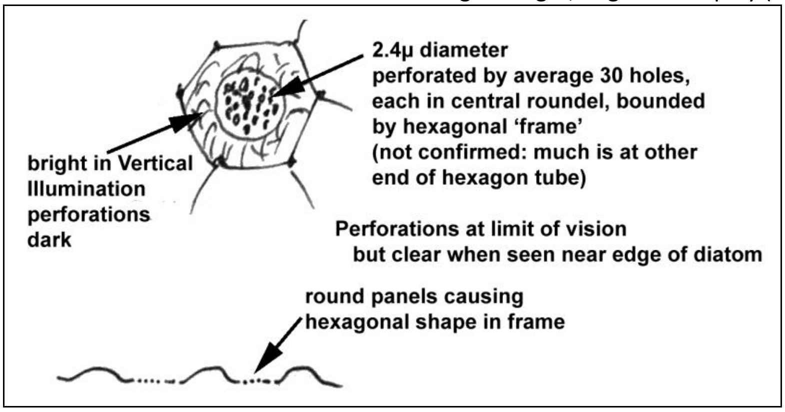


Conclusion. This also follows the structure of *Triceratium favus* in that it is a silica framework with aperture filled in with meshwork. In this example perforations are at limit of resolution.

A.4.12

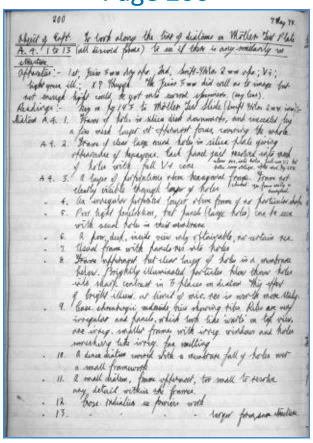
Swift-Holos

Perforations seem best in white rather than green light, at great obliquity (Vertical Illumination)



A large discoid diatom. Probably *Coscinodiscus radiatus* (Griffith and Henfrey) NOT *Asteromphallus*. (Spitta), no rosettes.

Page 200



Object of Experiment

To look along the line of diatoms on Möller's Test Plate A.4 1 to 13 (all discoid forms) to see if there is any similarity in structure.

Apparatus:- 1st, Zeiss 3mm dry apochromat. 2nd, Swift-Holos 2mm apochromat; Vertical Illumination, light green illumination; x7 Huyghenian. The Zeiss 3mm did well as to image but not enough light could be got onto several specimens (dry lens).

Readings:- Key on page 193 to Möller Test Slide (Swift-Holos 2mm immersion):-

Diatom A.4.1. Frame of holes in silica disk downwards, and concealed by a fine mesh layer at uppermost forms, covering the whole.

Diatom A.4.2. Frame of clear large round holes in silica plate giving appearance of hexagons. Each panel just resolved into mesh of holes with full Vertical Illumination cone. Clear resolution into holes, full cone Vertical Illumination but better some oblique. Optics used page 208.

Diatom A.4.3. A layer of perforations above hexagonal frame. Frame not clearly visible through layer of holes. Checked: Yes, frame really is hexagonal.

Diatom A.4.4. An irregular perforated layer above frame of no particular shape.

Diatom A.4.5. Poor light penetration, but panels (large holes) can be seen with usual holes in their membrane.

Diatom A.4.6. A poor, deep, inside view only obtainable, no certain resolution.

Diatom A.4.7. Usual frame with panels resolved into holes.

Diatom A.4.8. Frame uppermost but clear layer of holes in a membrane below. Brightly illuminated particles below throw holes into sharp contrast in 3 places on diatom. This effect of bright illumination at limit of microscope resolution is worth more study.

Diatom A.4.9. *Coscinodiscus Ehrenbergii* underside view showing ribs. Ribs are very irregular and panels, which look like 'warts' on top view, are irregular smaller frames with irregular windows and holes something like irregular fan vaulting.

Diatom A.4.10. A dense diatom covered with a membrane full of holes over a small framework.

Diatom A.4.11. A Small diatom, from uppermost, too small to resolve any detail within the frames.

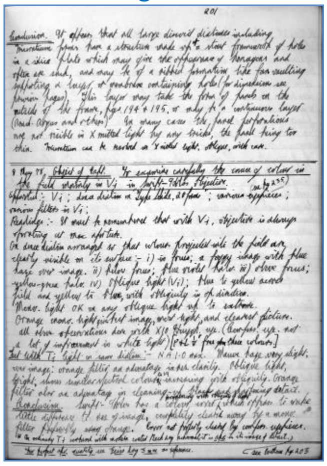
Diatom A.4.12. *Coscinodiscus radiatus*. See previous work.

Diatom A.4.13. *Coscinodicus radiatus*. See previous work. Larger form. Same structure.

(next page)

Conclusion. It appears that all large discoid diatoms including *Triceratium* forms have a structure made up of a stout framework of holes in a silica plate which may give the appearance of hexagons and often are such, and may be of a ribbed formation like fan vaulting supporting a layer or membrane containing holes (for dimensions see previous pages). This layer may take the form of panels on the outside of the frame, pages 195 and 195, or may be a continuous layer (*Arach. argus* and others). In many cases the panel perforations are not visible in transmitted light by any tricks, the panel being too thin. *Triceratium* can be resolved in transmitted light, oblique, with care.

Page 201



8th May 1978

Object of Experiment

To examine carefully the cause of colour in the field mainly in Vertical Illumination in Swift-Holos objective.

Apparatus:- Vertical Illumination; dense diatom on Type Slide, 20 forms; carious eyepieces; various filters in Vertical Illumination (see page 235)

Readings:- It must be remembered that with Vertical Illumination objective is always operating at Maximum aperture.

On dense diatom arranged so that colours projected into the field are clearly visible on its surface:-

i. In focus; a foggy image with blue haze over image
ii. Below focus; blue violet halo
iii. Above focus; yellow-green halo
iv. Oblique light (Vertical Illumination); blue to yellow across field and yellow to blue, with obliquity in opposite direction.

Mono light OK in any oblique light up to extreme.

Orange mono light gives best image, most light, and clearest picture.

All above observations done with x10 Huyghenian eyepiece (Compensating eyepiece not a lot of improvement in white light) [Powell and Lealand ⅛" free from these colours.]

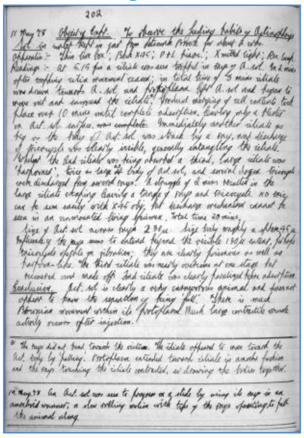
Test with Transmitted Illumination light in same diatom:- NA 1.0 maximum. Mauve haze, very slight, over image; orange filter an advantage in resolution clarity. Oblique light, bright, shows similar spectral colours to Vertical Illumination increasing with obliquity. Orange filter also an advantage in cleaning-up blacks and sharpening detail.

Conclusion. Swift-Holos has a colour error progressing with obliquity of light which appears to make little difference to resolution of image*, completely cleared away by a mono filter, preferably orange. Error not properly cleared by compensating eyepieces.

*In ordinary Transmitted Illumination compared with modern coated Beck dry achromat, it is apochromat in its image of detail. (see bottom page 203)

For perfect apochromat quality see Zeiss dry 3mm as reference.

Page 202



11th May 1978

Object of Experiment

To observe the feeding habits of *Actinophrys sol* in water kept in jar from Letcombe Brook for about 2 weeks.

Apparatus:- Thin live box; Beck x45; Powell and Lealand Binocular; transmitted light; Research Lamp.

Readings:- At 5.15pm a ciliate was seen trapped in rays of *Actinophrys sol*. In 2 minutes after trapping cilia movement ceased; in total time 3 minutes ciliate was drawn towards *Actinophrys sol* and protoplasm left *Actinophrys sol* and began to move out and surround ciliate*. Gradual merging of cell contents took place over 10 minutes until complete adsorption, leaving only a blister on *Actinophrys sol* surface. Immediately another ciliate as big as the body of *Actinophrys sol* was stuck by a ray, and discharge of tricocysts was clearly visible, generally entangling the ciliate. Whilst the 2nd ciliate was being absorbed a third, large ciliate was 'harpooned', twice as large as body of *Actinophrys sol*, and several dozen tricocysts were discharged from several rays. A struggle of 2 minutes resulted in the large ciliate escaping leaving a tangle of rays and tricocysts. NB. tricocysts can be seen easily with x45 objective but discharge mechanism cannot be seen in an un-mounted living specimen. Total time 20 minutes.

Size of *Actinophrys sol* across rays 230µ. Size body roughly a sphere, 45µ. Influence of the rays seems to extend beyond the visible 130µ extent, perhaps tricocysts operate on vibration; they are clearly poisonous as well as harpoon-like. The third ciliate was nearly overcome at one stage but recovered and made off. 2nd ciliate was clearly paralysed before adsorption.

Conclusion. *Actinophrys sol* is clearly a very carnivorous animal and does not appear to know the sensation of being 'full'. There is much Brownian motion within its protoplasm. Much large contractile vacuole activity occurs after ingestion.

*The rays did not bend towards its victim. The ciliate appeared to move toward the *Actinophrys sol* body by 'pulling'. Protoplasm extended towards ciliate in amoeba fashion and the rays toughing the ciliate contracted, so drawing the bodies together.

14th May 1978. An *Actinophrys sol* was seen to progress on a slide by using its rays in an amoeboid movement; a slow rolling motion with tips of the rays operating to pull the animal along.

19th May 1978

Object of Experiment

To observe conditions and life in Letcombe Brook where it flows through Grove Manor grounds.

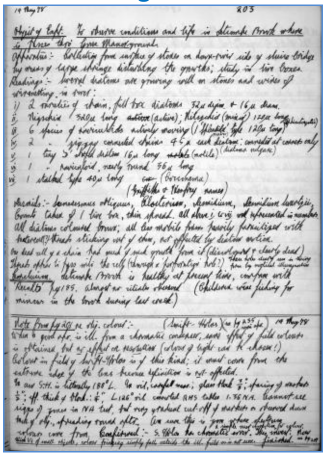
Apparatus:- Collection from surface of stones on down-river side of sluice bridge by means of large syringe disturbing the growths; study in live boxes.

Readings:- Several diatoms are growing well on stones and wires of wire-netting in river:

- i. 2 varieties of chain, pill box diatoms 32µ diameter and 16µ diameter.
- ii. *Nitzschia* 320µ long (active); *Nitzschia* (minor) 120µ long.
- iii. 6 species of naviculoids actively moving (1 '*splendida*' (*crabro*) type 120µ long)
- iv. 2 species of zigzag connected chains 45µ each diatom; connected at corners only (*Diatoma vulgare*)
- v. 1 tiny D-shaped diatom 16µ long (motile)
- vi. 1 tiny naviculoid, nearly round 36µ long
- vii. 1 stalked type 40µ long (*Cocconema*)

(Griffiths & Henfrey names)

Page 203



Desmids:- *Senedesmus obliquus*, *Closterium*, *Desmidium*, *Desmidium Swartzii*, counts taken of 1 live box, thin spread. All above i. to vii. Well represented in numbers. All diatoms coloured brown; all less mobile forms heavily parasitized with bacterial(?) threads sticking out of them, not affected by diatom motion.

One dead cell of a chain had much such growth from it (discoloured and clearly dead).

Threads appear to pass into the cell (through a 'perforation' hole?) These holes clearly seen in living form by Vertical Illumination.

Conclusion:- Letcombe Brook is healthy at present time, compare with 'results' page 185. Almost no ciliates observed. (Children were fishing for minnows in the brook during last week)

14th May 1978

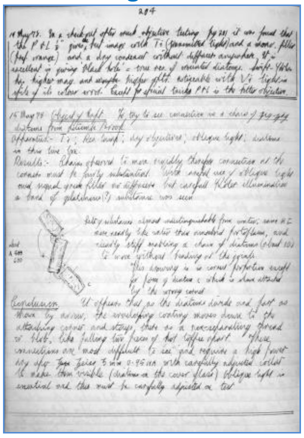
Note from page 201 re: Objective Colour (Swift-Holos) (see page 235 semi-apochromat)

When a good apochromat is illuminated from a chromatic condenser, same effect of field colours is obtained but no effect on resolution (colour of light can be chosen!)

Colour in field of Swift-Holos is of this kind; it must come from the extreme edge of the lens because definition is not affected. In air Swift-Holos is literally 180° angle. In oil, careful measuring; glass block ⅜"; spacing of markers ½"; effective thickness of block therefore ¼", angle126° oil corrected RMS tables 1.36NA. Cannot see signs of zones in NA test, but very gradual cut-off of markers observed down through track of objective, spreading round aperture. Am sure this is zone where spectrum colours come from. Confirmed:- Swift-Holos has chromatic error (a simple over correction for colour). This investigated: Now with Vertical Illumination of small objects, colour fringing simply falls outside the illuminated field as is not seen. Finished.

See page 207.

Page 204



14th May 1978

In a check-out after much objective testing page 201 it was found that the Powell and Lealand ⅛" gives the best image with Transmitted Illumination (transmitted light) and a mono filter (preferably Orange) and a dry condenser without diffusers anywhere. It is excellent in giving 'black hole' = true resolution of mounted diatoms. Swift-Holos has higher magnification and higher aperture noticeable with Vertical Illumination light in spite of its colour error. Except for special tricks Powell and Lealand is the better objective.

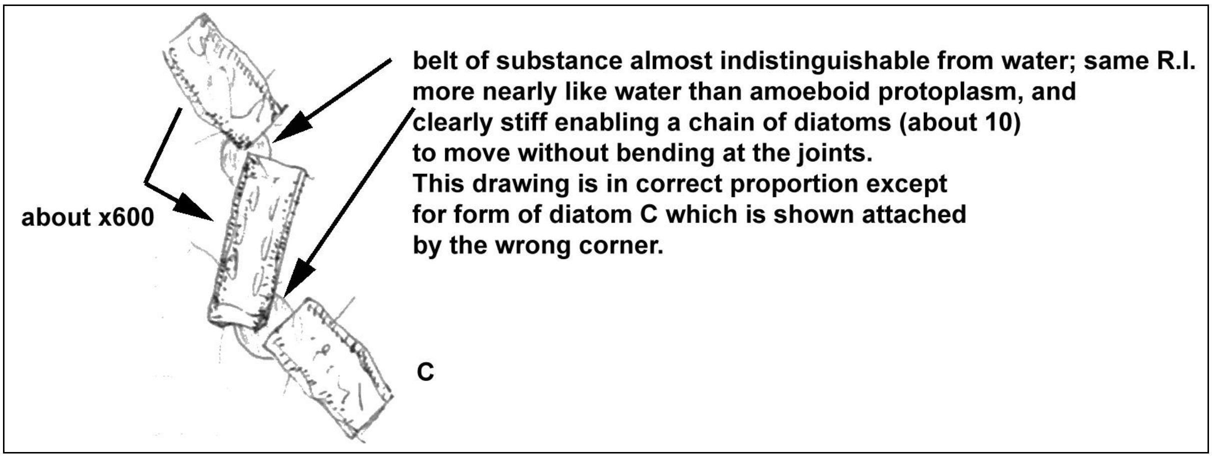
15th May 1978

Object of Experiment

To try to see connection in a chain of zigzag diatoms from Letcombe Brook.

Apparatus:- Transmitted Illumination; Research lamp; dry objective; oblique light; diatoms in thin live box.

Results:- Chains observed to move rigidly therefore connection at the corners must be fairly substantial. With careful use of oblique light and signal green filter, no diffusers, but careful Köhler illumination a band of gelatinous(?) substance was seen.



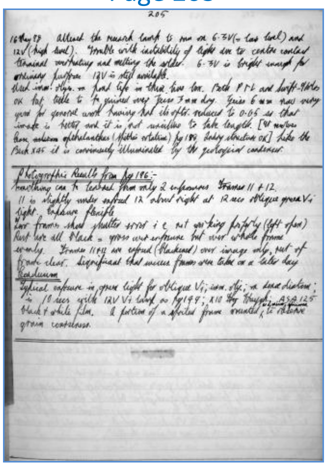
Conclusion. It appears that as the diatoms divide and part as shown by arrow, the enveloping coating moves down to the attaching corner and stays there as a non-separating thread or blob, like pulling two pieces of hot toffee apart. These connections are most difficult to see and require a high power dry apochromat Zeiss 3mm 0.95NA with carefully adjusted collar to make them visible (diatoms on the cover glass), oblique light is essential and this must be carefully adjusted on test.

16th May 1978

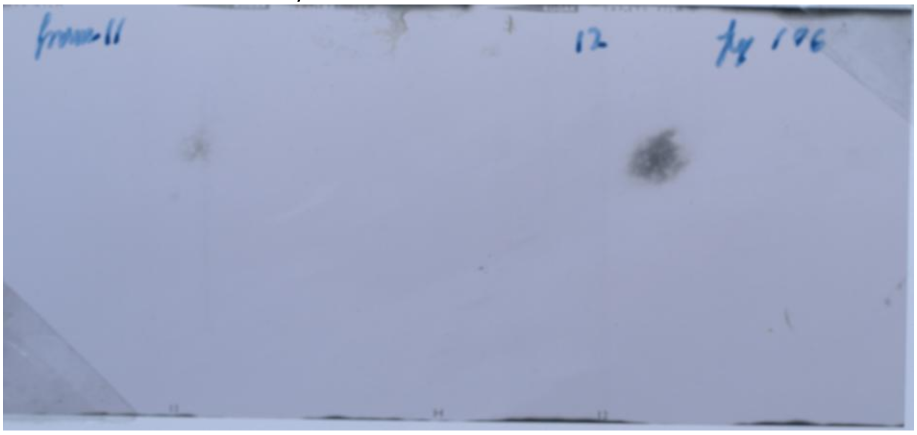
Altered the research lamp to run on 6.3V (=low level) and 12V (high level). Trouble with instability of light due to centre contact terminal overheating and melting the solder. 6.3V is bright enough for ordinary purposes. 12V is still available.

Used immersion objectives on pond life in thin live box. Both Powell and Lealand and Swift-Holos OK but little to be gained over Zeiss 3mm dry. Zeiss 6mm now very good for general work having had its aperture reduced to 0.05 so that image is better and it is not sensitive to tube length [It resolves *Coscinodiscus ophthalanthes* (Spitta's notation) page 188 secondary structure OK] Like the Beck x45 it is conveniently illuminated by the geological condenser.

Page 205

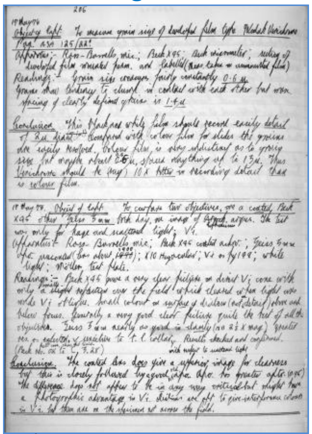


Photographic results from page 196:-
Something can be learned from only two exposures. Frames 11 and 12.
11 is slightly under exposed 12 about right at 12 seconds, oblique green Vertical Illumination light. Exposure flexible.
Two frames show shutter error i.e. not working properly (left open). Rest are all black – gross over exposure but over whole frame evenly. Frames 11 and 12 are exposed (blackened) over image only, rest of frame clear. Significant that successful frames were taken on a later day.



Conclusion.
Typical exposure in green light for oblique Vertical Illumination; immersion objective; on dense diatom; 10 seconds with 12V Vertical Illumination lamp as page 199; x10 Huyghenian; ASA125 black and white film. A portion of a spoiled frame mounted as 2 micro specimens to observe grain coarseness.

Page 206

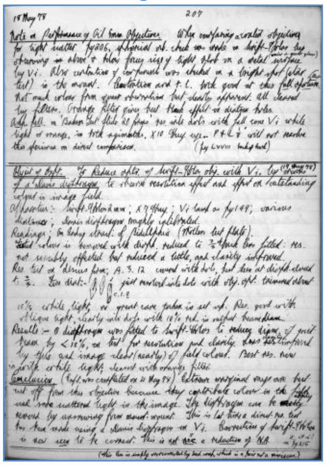


17th May 1979
Object of Experiment
To measure grain size of developed film type Kodak Verichrome Pan. ASA 125/22°
Apparatus:- Ross Burrells microscope; Beck x45; Beck micrometer; section of developed film mounted permanently and labelled (Measure taken in un-mounted film)
Readings:- Grain size measures fairly constantly 0.6µ.
Grains show tendency to clump in contact with each other but maximum spacing of clearly defined grains is 1.4µ.
Conclusion. This black and white film should record easily detail of 2µ diameter. Compared with colour film for slides the grains are easily resolved. Colour film is very indistinct as to grain size but maybe about 0.6µ, spaced anything up to 13µ. Thus Verichrome should be (say) 10x better in recording detail than is colour film.

17th May 1978
Object of Experiment
To compare two objectives, one a coated Beck x45 other Zeiss 3mm both dry, on image of *Eupodiscus argus*.
The test was only for haze and scattered light.; Vertical Illumination.
Apparatus:- Ross-Burrells Microscope; Beck x45 coated achromat; Zeiss 3mm apochromat uncoated (lens about 1900); x10 Huyghenian Ocular; Vertical Illumination as page 149; white light; Möller's Test Plate.
Readings:- Beck x45 gave a very clear picture on direct Vertical Illumination cone with only a small reflection over the field which cleared when light wade Vertical Illumination oblique. Small colour on surface of diatom (not in detail) above and below focus. Generally a very good clear picture quite like the best of all the objectives. Zeiss 3mm nearly as good in clarity (NB. 2½x magnification) greater resolution as expected, very sensitive to tube length collar with respect to scattered light. Results checked and confirmed. (Beck resolution OK to full core, clear though limit 3.28)
Consclusion. The coated lens does give a superior image for clearness but this is closely followed by a good old apochromat. Apochromat has greater aperture (0.95). The difference does not appear to be in any way critical but might have a photographic advantage in Vertical Illumination. Diatoms are apt to give interference colours in Vertical Illumination but these are on the specimen not across the field.

18th May 1978

Page 207



Note on Performance of Oil Immersion Objectives

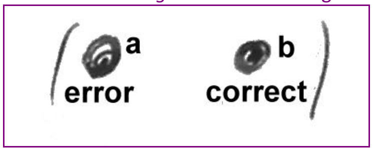
When comparing a coated objective for light scatter page 206, spherical aberration check was made on Swift-Holos by observing above and below focus size of light blob on a metal surface (under a cover glass) by Vertical Illumination. Also centration of components was checked on a bright spot (star test) in the mount. Centration and tube length both good at this full aperture test.

Not much colour from queer observation but clearly apparent. All cleared by filters. Orange filter gives best black effect on diatom holes. *Amphipleura pellucida* on 'Baker's Test Slide 20 forms' resolution into dots with full cone Vertical Illumination, white light or orange, in both azimuths, x10 Huyghenian eyepiece. Powell and Lealand ⅛" will not resolve this specimen on direct comparison.

(page LVVIII back of book – see below)

Star Test for Tube Length.

When making up objectives from bits, and after repair e.g. Swift-Holos, black flake test is not complete because of limited aperture of Universal Condenser. When Vertical Illumination test is used on, say, a covered piece of metal (the pin-hole slide) tube length can be accurately set by observing the size, and in-out-focus [coil of lamp filament should be clear] of the lamp filament or diaphragm. This should be very sharp and clear on a solid surface, or on a slide or cover interface. Errors can occur if this is tried on a surface like *Arachnoidiscus argus* which scatter light in depth. Usually a bright unresolvable spot can be found which gives diffusion rings.



Very small movement of a lens mount in rotation can be made to clear up a centration error (a). This is also very good for finer tube length adjustments. When all is right it should be clearly 'right' if all is in order, and this will be borne out on a subsequent diatom test. Seal lenses in place with a touch of lacquer which will run round threads. Swift-Holos is sealed this way after a gash assembly on an old mount (18th May 1978 – this lens set up last on this date, is now as good as it can be. It was not previously quite correct in tube length). It was carefully cleaned with cotton muslin first. Tube length sets objective accurately therefore colour error is not much trouble, spherically OK.

18th May 1978

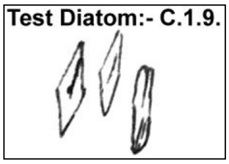
Object of Experiment

To reduce aperture of Swift-Holos objective with Vertical Illumination by means of a Davis diaphragm, to observe resolution effect and effect on outstanding colour in image field.

Apparatus:- Swift-Holos 2mm; x7 Huyghenian; Vertical Illumination lamp as page 149; various diatoms; David diaphragm roughly calibrated.

Readings:- On secondary structure of *Biddulphia* (Möller's Test Plate).

Field colour is removed with diaphragm reduced to ⅔ of back lens filled; resolution not sensibly affected but reduced a little, and clarity improved.



Resolution test on discus form A.3.12 covered with dots, best seen at diaphragm closed to ⅔. Fine diatom:

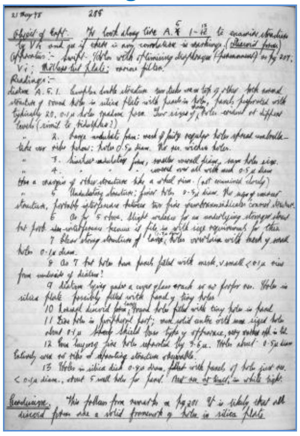
just resolved into dots with objective aperture trimmed about 10%, white light, no great care taken in set up. Resolution good with oblique light, clearly into dots with 10% reduction in output beam diameter.

Results: - A diaphragm was fitted to Swift-Holos to reduce diameter of exit beam by 10%, in test for resolution and clarity. Lens clarity improved by this and image clear (nearly) of field colour. Best resolution now is with white light; clearest with orange filter.

Conclusion. (Experiment was completed on 21st May 1978) Extreme marginal rays are best cut off from this objective because the contribute colour in the field and some scattered light in the image. The diaphragm can be easily removed by unscrewing from mount. This is first time a direct resolution test has been made using a Davis diaphragm on Vertical Illumination. Correction of Swift-Holos is now seen to be correct. This is not necessarily a reduction of NA. (it is – see page 215)

This lens is simply overcorrected by 2nd component, which is a pair, not a meniscus.)

Page 208



21st May 1978

Object of Experiment

To look along line A.5 (1013) to examine by Vertical Illumination and see if there is any correlation in markings (Discoid forms)

Apparatus:- Swift-Holos with optimising diaphragm (permanent) as page 207; Vertical Illumination, Möller's test plate; various filters.

Readings:-

Diatom A.5.1. Complex double structure, two disks one on top of other, both normal structure of round holes in silica plate with panels in holes, panels perforated with typically 20, 0.1µ holes in random positions. Two signs of such holes evident at different levels (similar to *Biddulphia*)

Diatom A.5.2. Large undulate form; mesh of fairly regular holes spread umbrella-like over ribs below; holes 0.5µ diameter. No resolution within holes.

Diatom A.5.3. Similar undulating form, smaller overall dimensions, same hole size.

Diatom A.5.4. Similar undulating form, covered over all with mesh 0.5µ diameter , also a margin of other structure like a wheel rim (not examined closely)

Diatom A.5.5. Undulatory structure; finer holes 0.3µ diameter. No sign of coarser structure, probably interference between two fine membranes indicates 'coarser' structure.

Diatom A.5.6. As for 5 above. Slight evidence for an underlying stronger structure but probably interference because it fits in with size requirements for this.

Diatom A.5.7. Clear strong structure of large (1.3µ diameter) holes overlain with mesh of small holes 0.1µ diameter.

Diatom A.5.8. As 7 but holes have panels filled with mesh, very small < 0.1µ. View from underside of diatom?

Diatom A.5.9. Diatom lying under a cover glass crack so no proper resolution. Holes in silica plate possibly filled with panel of tiny holes.

Diatom A.5.10. Normal discoid form, large round holes filled with tiny holes in panel.

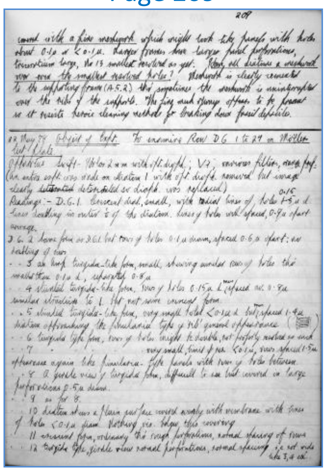
Diatom A.5.11. Fine holes in peripheral part; more solid centre with same sized holes about 0.1µ. Shield boss type of appearance, very marked appearance in literature

Diatom A.5.12. Even layers of fine holes separated by 7.6µ. Holes about 0.5µ diameter. Entirely even, no ribs or separating structure observable.

Diatom A.5.13. Holes in silica disk 0.8µ diameter with panels of holes just resolved < 0.1µ diameter, about 5 small holes per panel. Best resolution at limit, in white light.

Conclusion. This follows from remarks on page 201. It is likely that all discoid forms are a solid framework of holes in silica plate…*(next page)*

Page 209



…covered with a fine meshwork which might look like panels with holes, about 0.1µ to < 0.1µ. Larger frames have larger panel perforations, *Triceratium* large, No. 13 smallest resolved as yet. Have all diatoms a meshwork over even the smallest resolved holes? Meshwork is clearly cemented to the supporting frames (S.5.2) though sometimes the meshwork is uninterrupted over the ribs of the supports. The fine mesh always appears to be present so it resists heroic cleaning methods for breaking down fossil deposits.

22nd May 1978

Object of Experiment

To examine Row D6 (1 to 27) on Möller's test plate.

Apparatus:- Swift-Holos 2mm with aperture diaphragm, Vertical Illumination, various filters, orange preferred, (An extra experiment was made on Diatom 1 with aperture diaphragm removed but image clearly deteriorated so diaphragm was replaced.)

Readings:-

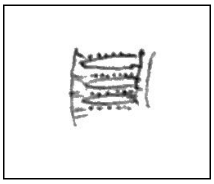
D.6.1. Crescent diatom, small, with radial lines of holes 0.15µ diameter, lines doubling in outer ⅙ of the diatom. Lines of holes well spaced, 0.9µ apart average.

D.6.2. Same form as D.6.1. but rows of holes 0.1µ diameter, spaced 0.6µ apart, no doubling of rows.

D.6.3. An *Amphipleura turgida*-like form, small, showing similar rows of holes though smaller than 0.1µ diameter, separated 0.8µ

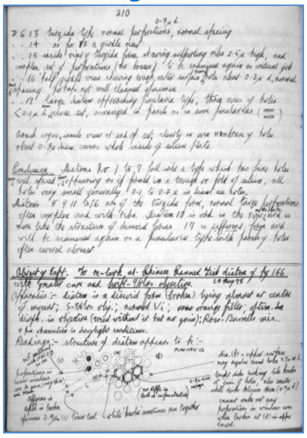
D.6.4. Stunted *turgida*-like form, rows of holes < 0.15µ diameter, rows spaced average 0.8µ, similar structure to 1, but not same crescent form.

D.6.5. Stunted *turgida*-like form, very small holes < 0.1µ diameter but rows spaced 1.4µ, diatom approaching the *Pinnularia* type of 'rib' general appearance.

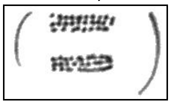


D.6.6. *turgida* type form, rows of holes might be double, not properly resolved as such
D.6.7. *turgida* type form, rows of holes very small, limit of resolution < 0.1µ, rows spaced 1.5µ
D.6.8. A girdle view of turgida form, difficult to see but covered in large perforations 0.5µ diameter.
D.6.9. as for 8
D.6.10. Diatom shows a plain surface covered evenly with membrane with lines of holes < 0.1µ diameter. Nothing visible below this covering.
D.6.11. crescent form, ordinary though rough perforations, normal spacing of rows
D.6.12. *turgida* type, girdle view, normal perforations, normal spacing i.e. not wide like 3, 4 etc.

Page 210



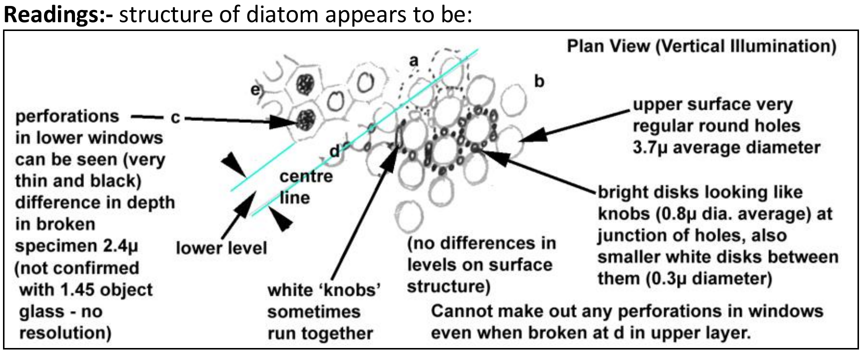
D.6.13. *turgida* type, normal perforations 0.3µ diameter, normal spacing
D.6.14. as for 13, a girdle view
D.6.15. inside view of *turgida* form showing supporting ribs 2.5µ high, and complex set of perforations (no bosses). To be examined again as critical job
D.6.16. 'half' girdle view showing rough outer surface rows of holes about 0.2µ diameter, normal row spacing, perhaps not well cleaned specimen
D.6.17. large diatom approaching *Pinnularia* type, three rows of holes < 0.1µ diameter, row close set, arranged in panels as in some *Pinnularia*



Arachnoidiscus argus, inside view at end of set, clearly an even membrane of holes about 0.3µ diameter covers whole inside of silica plate.

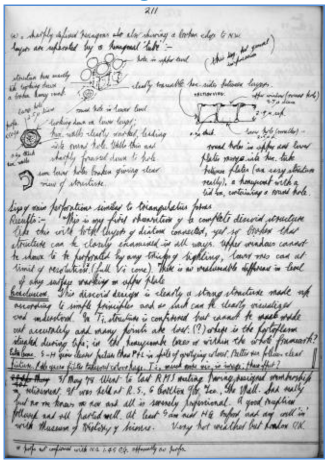
Consclusion. Diatoms No 1 to 7 fall into a type which has fine holes, rows well spaced, rows appearing as if formed in a trough or fold of silica, all holes very small generally 0.1 to 0.2µ in diameter, see notes.
Diatoms 8, 9, 11 to 16 are of the *turgida* form, normal large perforations, often complex and with ribs. Diatom 10 is odd in the row on the plate and is more like the structure of discoid forms. 17 is different form and will be examined again as a *Pinnularia* type with panels of holes often several abreast.

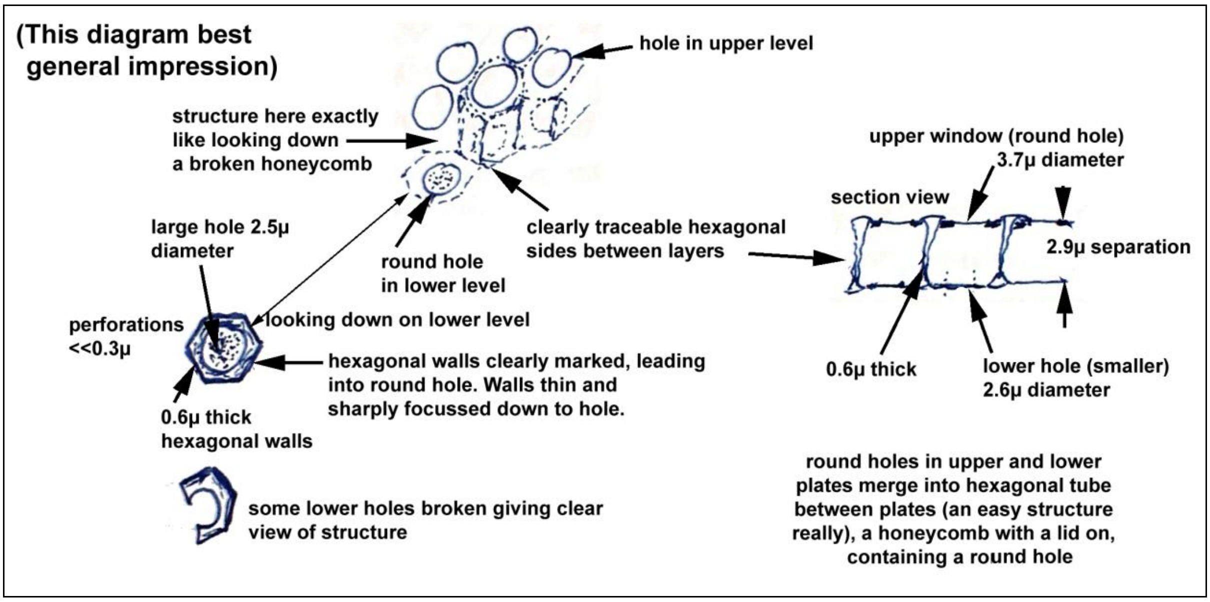
24th May 1978
Object of Experiment
To re-look at Chinese Canned Fish diatom of page 166 with greater care and Swift-Holos objective.
Apparatus:- diatom is a discoid form (broken) lying almost at centre of mount; Swift-Holos objective; normal Vertical Illumination; orange filter; optimised diaphragm in objective (tried without it but no gain); Ross-Burrells microscope. 4pm observation in daylight conditions.
Readings:- structure of diatom appears to be:



(e)=sharply defined hexagons also sharing a broken edge to N.W. layers are separated by a hexagonal 'tube':-

Page 211





Size of main perforations similar to *triangulatus* forms.

Results:- This is my first observation of a complete discoid structure like this with both layers of diatom connected, yet so broken that structure can be closely examined in all ways. Upper windows cannot be shown to be perforated by any tricks of lighting, lower ones can at limit of resolution* (full Vertical Illumination cone). There is no measurable difference in level of any surface marking on upper plate.

Conclusion. This discoid design is clearly a strong structure made up according to simple principles and as such can be clearly visualised and understood. In Transmitted Illumination structure is confirmed but cannot be made out accurately and many points are lost: (?) where is the protoplasm situated during life; in the honeycomb boxes or within the whole framework?

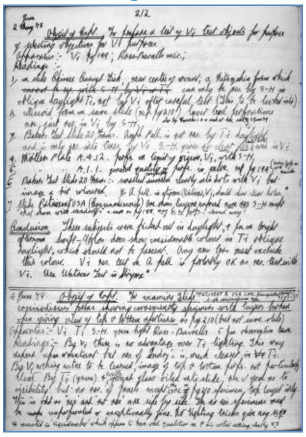
Extra Conclusion. Swift-Holos gives clearer picture then Powell and Lealand in spite of overlying colour. Better resolution follows clear picture. The green filter takes out colour haze. Transmitted Illumination much more visible in image; phase effect?

*perforations not confirmed with NA 1.45 object glass. Apparently no perforations.

31st May 1978

Went to last RMS meeting having resigned membership on retirement. It was hell at R.S., 6 Carlton Terrace, The Mall. Sad really but no one knows me now and all is severely professional. A good reaction followed and all parted well. At least I am near HQ Oxford and am well 'in' with Museum of History and Science. Very hot weather but London OK.

Page 212



2nd June 1978

Object of Experiment

To prepare a list of Vertical Illumination test objects for purpose of selecting objectives for Vertical Illumination purposes.

Apparatus:- Vertical Illumination (page 149); Ross-Burrells microscope

Readings:-

1. On slide Chinese Canned Fish, near centre of mount, a *Nitzschia* form which ~~cannot be resolved with Swift-Holos by Vertical Illumination or Transmitted Illumination~~ can only be resolved by Swift-Holos in oblique daylight Transmitted Illumination not Vertical Illumination after careful test (this is to be looked into).
2. Discoid form on same slide (ref. page 210) lower level perforations are just resolvable in Vertical Illumination by Swift-Holos (also by Koristka 1.4 + mesh, Transmitted Illumination, 2nd June 1979
3. Baker's Test Slide 20 Forms. *Amphipleura pellucida* is not resolvable by Transmitted Illumination daylight and is only resolvable into lines by Vertical Illumination. Swift-Holos gives no clear resolution (into dots) even in Vertical Illumination.
4. Möller's Plate A.4.12 perforations on limit of vision, Vertical Illumination, with Swift-Holos
5. Möller's Plate A.1.1 general quality of perforations in valve. Ref. page 194 (secondary perforations visible with Transmitted Illumination Koristka)
6. Baker's Test Slide 20 Forms:- smallest *Surirella* clearly into dots with Vertical Illumination but image a bit coloured.
7. Slide Patuxent U.S.A. (*Coscinodiscus*) One shows layers exposed none resolved Swift-Holos except 'that shown with secondaries' = case as page 188. May be no perforations, cleaned away?

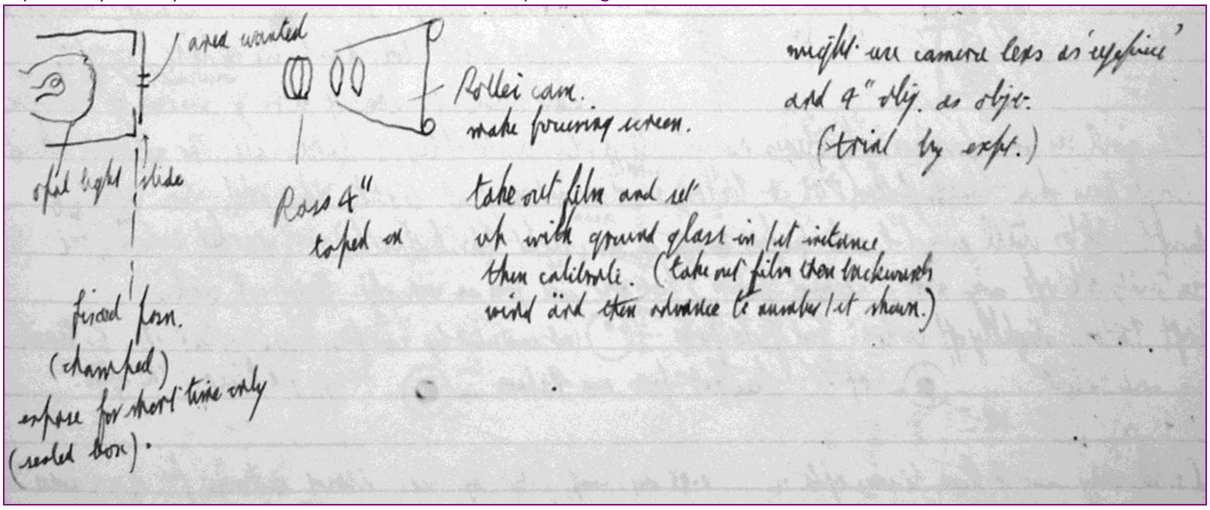
Amphipleura pellucida in Styrax (Watson), Vertical Illumination, should show clear holes.

Conclusion. These subjects were picked out in daylight, 4pm on bright afternoon. Swift-Holos does show considerable colour in Transmitted Illumination oblique daylight, which should not be present. Any new lens must exclude this colour. Vertical Illumination resolution test on *Amphipleura pellucida* is probably OK as resolution test with Vertical Illumination. Use Watson's Test in Styrax (mounted in liquid amber' which appears to have odd qualities, see Powell and Lealand collar setting, clearly 33).

June 1978

Enlargement of part of ordinary negatives: Photo image from immersion objective contains enough detail to stand x10 enlargement, therefore re-photograph the negative onto another film 2x2ins.

Only small area to be illuminated, say ½ inch diameter. Therefore illuminate from behind by (say) ordinary light microscope lamp (in a tin). Try auxiliary lens say Ross 4" in front of camera lens for adequate magnification.



4th June 1978

Object of Experiment

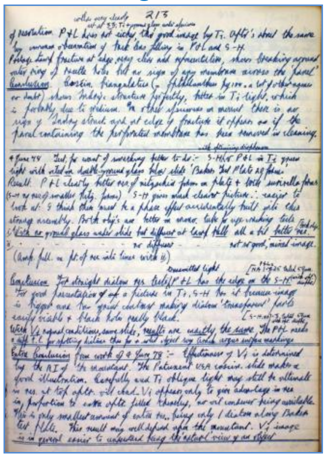
To examine slide 'Patuxent River, U.S.A. *Coscinodiscus triangulatus* (secondaries) and odd *Coscinodiscus* type 31.1.55 – *Coscinodiscus* forms showing conveniently specimens with layers broken open giving view of top and bottom apertures, as page 210 (but not same slide)

Apparatus:- Vertical Illumination, Transmitted Illumination, Swift-Holos, green light, Ross-Burrells, 5pm observation time.

Readings:- By Vertical Illumination there is no advantage over Transmitted Illumination lighting. This may depend upon mountant but resolution of secondaries is much clearer in Transmitted Illumination. By Vertical Illumination nothing extra to be learned, image of top and bottom perforations not particularly clear. By Transmitted Illumination

(green) and double ground glass oiled onto slide, resolution very good as to visibility, but no resolution of panels except the one = page 210 specimen, top layer only.
This is odd as 'resolution' and 'no resolution' are side by side. The 'no resolution' specimens must be un-perforated or exceptionally fine. No lighting tricks give any sign…*(next page)*

Page 213



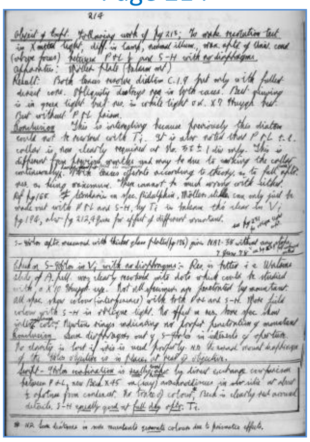
…of resolution. Powell and Lealand (collar very clearly set at 33, Transmitted Illumination and ground glass under specimen) does not either, though good image by Transmitted Illumination. Apertures about the same by common observation of back lens filling in Powell and Lealand and Swift-Holos.
Postage stamp fracture at edge, very clear and representative, shows breaking around outer ring of rosette holes but no sign of any membrane across the 'panel'.
Conclusion. *Coscinodiscus biangulatus* (=*ophthalanthus* page 188 = a lot of other names no doubt) shows secondary structure perfectly, better in Transmitted Illumination light, which is probably due to medium. In other specimens on mount there is no sign of secondary structure and at edge of fracture it appears as if the panel containing the perforated membrane has been removed in cleaning.

4th June 1978
Test for want of something better to do:
Swift-Holos with optimising diaphragm v. Powell and Lealand in Transmitted Illumination, green light with oiled on double-ground glass below slide, 'Baker's Test Plate 20 forms'.
Result:- Powell and Lealand clearly better resolution of *Nitzschia* forms on plate and both *Surirella* forms (Swift-Holos no resolution of smaller *Nitzschia* forms). Swift-Holos gives much clearer picture, therefore easier to look at. I think there must be a phase effect accidentally built into this strange assembly. Both objectives are better in monocular tube for eye-cracking tests.

i. With no ground glass under slide but diffuser at lamp bulb all a bit better resolution on both objectives
ii. With no ground glass under slide, no diffuser at lamp bulb, not so good, nixed image.

(*Amphipleura pellucida* in point of resolution into lines with ii.)
Conclusion. For straight diatom resolution tests, transmitted light, Powell and Lealand has the edge on the Swift-Holos (with aperture diaphragm). [Powell and Lealand NA 1.25 tested 5th June]
For good presentation of a picture in Transmitted Illumination, Swift-Holos has it because image is bigger and has great contrast making diatom 'transparent' parts easily visible and black holes really black. [Swift-Holos NA 1.3 tested 5th June with aperture diaphragm].
With Vertical Illumination normal conditions, same slide, results are exactly the same. The Powell and Lealand needs a different tube length for spotting diatoms than for a solid object, say *Arachnoidiscus argus* surface markings.
Extra Conclusion. From work of 4th June 1978. Effectiveness of Vertical Illumination is determined by the RI of the mountant. The Patuxent U.S.A. *Coscinodiscus* slide makes a good illustration. Carefully used Transmitted Illumination oblique light may still be ultimate in resolution at top aperture, oil condenser. Vertical illumination appears only to give advantage in resolution in proportion to extra aperture filled thereby, no oil condenser being available. This is only smallest amount of extra resolution, being only 1 diatom along Baker Test Plate. This result may well depend upon the mountant. Vertical Illumination image is in general easier to understand being the 'natural' view of an object.

Page 214



Object of Experiment
Following work of page 213.; to make resolution test in transmitted light, diffuser in lamp, normal illumination, maximum aperture of Universal condenser (above focus), between Powell and Lealand ⅛" and Swift-Holos with no diaphragms.
Apparatus:- Möller's Plate (Balsam mount)
Result:- Both lenses resolve diatom C.1.9. but only with fullest direct cone. Obliquity destroys resolution in both cases. Best viewing is in green light but resolution in white light OK. X7 Huyghenian best. But without Powell and Lealand prism.
Conclusion. This is interesting because previously this diatom could not be resolved with Transmitted Illumination. It is also noted that Powell and Lealand tube length collar is now clearly required at No.33 ± 1 division only. This is different from previous months and may be due to working the collar continuously having freed its movement. Both lenses operate according to theory, as to full (cone) aperture. There cannot be much wrong with either. Ref. page 168. Secondaries on specimen *Biddulphia*, Möller's slide, can only just be made out with Powell and Lealand and Swift-Holos by Transmitted Illumination in balsam, though clear in Vertical Illumination, page 194, also page 212 4th June for effect of different mountant.
See page 231 for oblique light experiment.

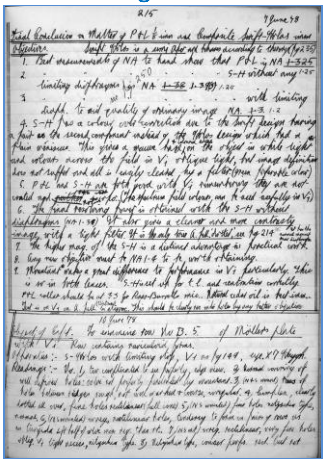
Swift-Holos aperture measured with thicker glass plates (page 176) gives NA 1.38 without any stops. 7th June 1978. See page 229 for improved method.

Check on Swift-Holos in Vertical Illumination with no diaphragms.
Resolution is better i.e. Watson's slide of *Amphipleura pellucida* was clearly resolved into dots which could be studied with a x10 Huyghenian eyepiece. Not all specimens are penetrated by mountant. All specimens show colour (interference) with both Powell and Lealand and Swift-Holos in oblique light. No effect in resolution. Some specimens show interference colours, Newton's rings indicating no proper penetration of mountant.
Conclusion. Leave diaphragms out of Swift-Holos in interests of aperture. No clarity is lost if iris is used properly. NB. the normal mount diaphragm of the Holos objective is in place, at rear of objective.

Swift-Holos combination is really semi-apochromat by direct exchange comparison between Powell and Lealand, new Beck x45 on (say) *Arachnoidiscus* in situ at about ½ aperture from condenser. No trace of colour (NB. Some diatoms in some mountants generate colours due to prismatic effects), Beck is clearly red around details. Swift-Holos equally good at full dry aperture. Transmitted Illumination.

7th June 1978

Page 215



Final conclusion on matter of Powell and Lealand ⅛" immersion and composite Swift-Holos immersion objectives.
Swift-Holos is a semi-apochromat and behaves according to theory (page 235)

1. Best measurements of NA to hand show that Powell and Lealand is NA ~~1.325~~ 1.25 (see page 250)
2. Best measurements of NA to hand show that Swift-Holos without any limiting diaphragms is NA ~~1.38~~ ~~1.39(5)~~ 1.25 (see page 250)
3. Best measurements of NA to hand show that Swift-Holos with limiting diaphragms to aid quality of ordinary image NA ~~1.3~~ 1.2 (see page 250)
4. Swift-Holos has a colour over-correction due to the Swift design having a pair as the second component instead of the Holos design which had a plain meniscus. This gives a mauve haze and coloured edges on the object in white light and colours across the field in Vertical Illumination oblique light, but image definition does not suffer and all is easily cleared by a filter (green, preferable colour)
5. Powell and Lealand and Swift-Holos are both good with Vertical Illumination remembering they are not coated and not apochromats (The spectrum field colours can be used usefully in Vertical Illumination)
6. The final resolving power is obtained with the Swift-Holos without diaphragms (NA 1.39 – see page 250). It also gives a clearer and more contrasty image with a light filter. It is the only true *Amphipleura pellucida* 'dotter', see page 214. It has the normal mount rear diaphragm.
7. The higher magnification of the Swift-Holos is a distinct advantage in practical work.
8. Any new objective must be NA 1.4 to be worth obtaining.
9. Mountant makes a great difference to performance in Vertical illumination particularly. This is so in both lenses. Swift-Holos set up for tube length and centration correctly. Powell and Lealand collar should be at 33 for Ross-Burrells microscope. Natural Cedar Oil is best immersion.

Test is on Vertical illumination on *Amphipleura pellucida* (Watson's) in Styrax. This should be clearly resolved into holes by any better objective.

10th June 1978

Object of Experiment

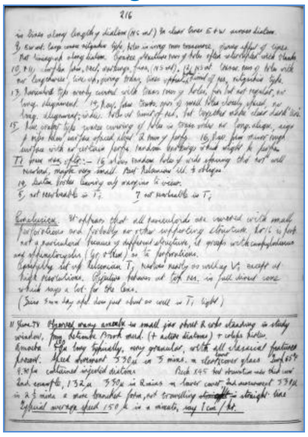
To examine row No. B.5. of Möller's Plate with Vertical Illumination. Row contains Naviculoid forms.

Apparatus:- Swift-Holos with limiting stop, Vertical Illumination as page 149, x7 Huyghenian eyepiece

Readings:-

1. Too complicated to see properly, edge view
2. Normal covering of well defined holes, valve not properly penetrated by mountant
3. (North South mount) rows of holes between ridges, rough, not well marked and coarse, irregular
4. Complex, clearly dotted all over, fine holes rectilinear (full cone)
5. (North South mounted) fine holes *Nitzschia* type, normal
6. (North South mounted) irregular rectilinear holes, tendency to form in pairs of rows as in *turgida*. Left half of valve more regular than right
7. (North South mount) irregular rectilinear, very fine holes, oblique Vertical Illumination light necessary, *Nitzschia* type
8. *Nitzschia* type, coarser Perforations, rectilinear but not…*(next page)*

Page 216



…in lines along length of diatom (North South mount). In clear lines East and West across diatom.

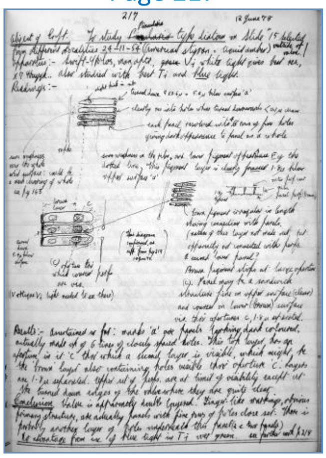
9. East West mount: large coarse *Nitzschia* type, holes in irregular rows transverse, giving effect of lines. Not lining up along diatom. Coarse structure rows of holes often interrupted with blanks.
10. & 11. Complex form, rectangular, markings fine (North South mount)
12. North South mount. Transverse rows of holes with no lengthwise line-up, giving transverse lines appearance of holes. Limit of resolution. *Nitzschia* type.
13. Naviculoid type evenly covered with transverse rows of holes, fine but not regular, no longitudinal alignment.
14. *Navicula* form. Transverse rows of small holes closely spaced, no longitudinal alignment, individual holes at limit of resolution, but together make clear dark line.
15. *Navicula crabro* type, coarse covering of holes in transapical order, no longitudinal alignment, sign of ribs below surface spaced about 2 rows of perforations
16. *Navicula* form, micro rough surface with no certain perforations, random markings which might be perforations.

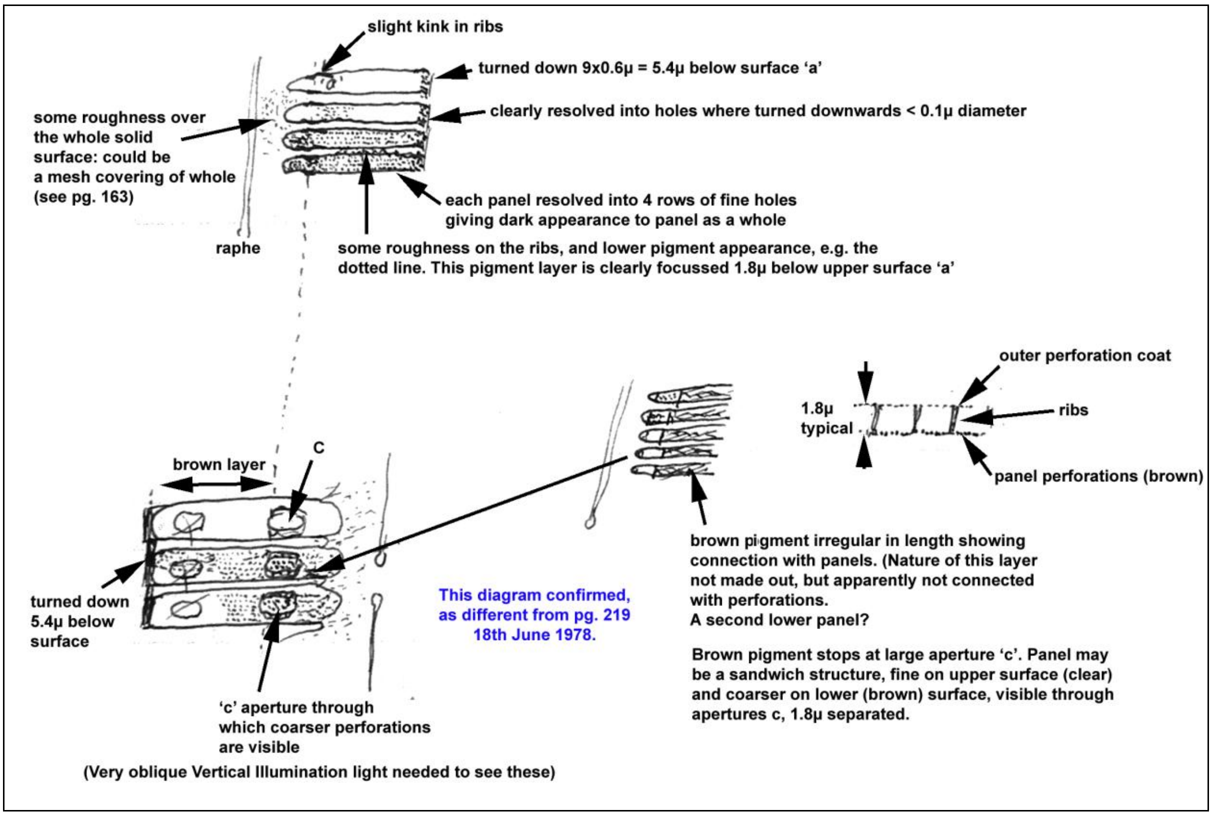
Transmitted Illumination, green light, maximum aperture:- 16, shows random holes of wide spacing though not well resolved, maybe very small. Best Nelsonian illumination ⅓ oblique.
14 diatom broken leaving only margins to view
5 not resolvable in Transmitted Illumination
7 not resolvable in Transmitted Illumination
Conclusion. It appears that all naviculoids are covered with small perforations and probably no other supporting structure, it groups with *Campylodiscus* and <u>*Sphinctocyclis*</u> [Griffith and Henfrey] (? By Transcriber) as to perforations.
Carefully set up Nelsonian Transmitted Illumination resolves nearly as well as Vertical illumination except at high resolutions. Objective behaves at high resolution in full direct cone which says a lot for the lens.
(Zeiss 3mm dry apochromat does just about as well in Transmitted Illumination light.)

11th June 1978
Observed many amoebae in small jar about 2 weeks standing in study window, from Letcombe Brook mud (= active diatoms) + *Coleps hirtus*.
Amoeba 100µ long typically, very granular, with all classical features present. Speed movement 330µ in 3 minutes on clear lover cover glass. Temperature 65°F 9.30pm. Contained ingested diatoms. Beck x45 best observation under thick cover. 2nd example , 132µ, 330µ in 2 minutes on lower cover, 2nd measurement 330µ in 2½ minutes, a more branched form, not travelling in straight line. Typical average speed 150µ in a minute, say 11cm per hour.

12th June 1978
Object of Experiment
To study *Pinnularia* type diatom on Slide "15 selected from different localities 24.11.54 (American Styrax = Liquid Amber), outside of valve.
Apparatus:- Swift-Holos, maximum aperture, Vertical Illumination white light gives best resolution, x7 Huyghenian. Also studied with best Transmitted Illumination and blue light.
Readings:-

Page 217





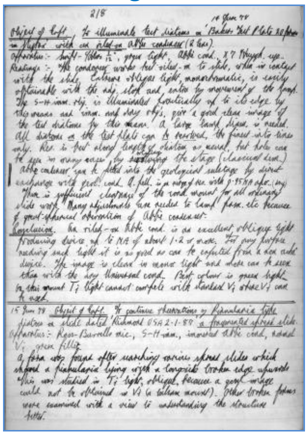
Results:- Ascertained so far: marks 'a' are panels looking dark coloured, actually made up of 6 lines of closely spaced holes. This top layer has an aperture in it 'c' through which a second layer is visible, which might be the 'brown' layer also containing holes visible through aperture 'c'. Layers are 1.8µ separated. Upper set of perforations are at limit of visibility except at the turned down edges of the valve where they are quite clear.

Conclusion. Valve is apparently double layered. Finger-like markings, obvious primary structure, are actually panels with five rows of holes close set. There is probably another layer of holes underneath this panel (i.e. two panels).

No advantage from use of blue light in Transmitted Illumination over green.

See further work page 218.

Page 218



14th June 1978

Object of Experiment

To illuminate test diatoms on 'Baker's Test Plate 20 Forms in Styrax' with an oiled on Abbe condenser (2 lens)

Apparatus: - Swift-Holos ¹⁄₁₂"; green light, Abbe Condenser, x7 Huyghenian eyepiece.

Readings:- The condenser works best oiled on to slide, when in contact with the slide. Extreme oblique light, monochromatic, is easily obtainable with the adjusting stop and extra by movement of the lamp. The Swift-Holos objective is illuminated practically up to its edge by this means and immersion and dry objectives give a good clean image of the test diatoms by this means. A large lamp diameter is needed. All diatoms on the test plate can be resolved, the finest into lines only. Resolution is best along length of diatom as usual, but holes can be seen in many cases by ~~revolving~~ rotating the stage (classical demonstration). Abbe condenser can be fitted into the geological substage by direct exchange with geological condenser. *Amphipleura pellucida* is on verge of resolution with 0.95 Apochromat (dry). There is sufficient clearance of the condenser mount for all ordinary slide work. Many adjustments are needed to lamp position etc., because of great spherical aberration of Abbe condenser.

Conclusion. An oiled on Abbe condenser is an excellent oblique light producing device up to NA of about 1.2 or more. For any purpose needing such light it is as good as can be expected from a non-achromatic device. The image is clean in mono light and more can be seen than with the dry Universal Condenser. Best colour is green light on this mount, Transmitted Illumination light cannot compete with standard Vertical Illumination where Vertical Illumination can be used.

15th June 1978

Object of Experiment

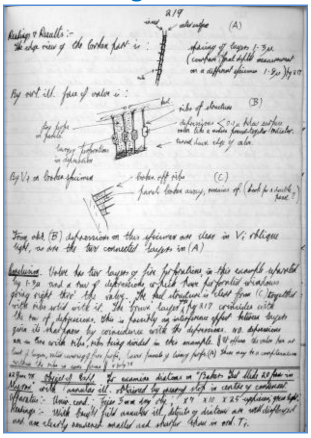
To continue observations of *Pinnularia* type diatom on slide dated 'Richmond U.S.A. 2.1.87', a fragmented spread slide.

Apparatus:- Ross-Burrells microscope, Swift-Holos immersion, immersed Abbe condenser, normal Vertical Illumination, green filter.

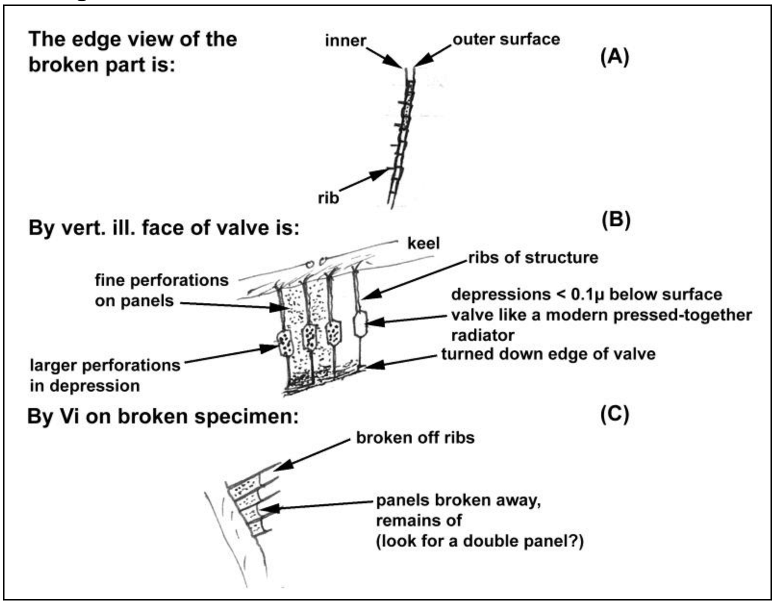
A form was found after searching various spread slides which showed a *Pinnularia* lying with a long side broken edge upwards. This was studied in Transmitted Illumination light, oblique, because a good image could not be obtained in Vertical Illumination (a Balsam mount). Other broken forma were examined with a view to understanding the structure better.

(next page)

Page 219



Readings and Results:



From observation (B) depressions on this specimen are clear in Vertical Illumination oblique light, as are the two connected layers in (A).

Conclusion. Valve has two layers of fine perforations, in this example separated by 1.3µ and a row of depressions which have perforated windows going right through the valve. The keel structure is clear from (C) together with ribs solid with it. The 'brown' layer edge, page 217, coincides with the row of depressions. This is possibly an interference effect between layers given its sharpness by coincidence with the depressions. NB. depressions are in line with ribs, ribs being divided in this example. It appears the valve has at least 2 layers, outer covering of fine perforations, lower panels of lining perforations (A). There may be a complication within the ribs in some forms. 8th July 1978.

22nd June 1978.

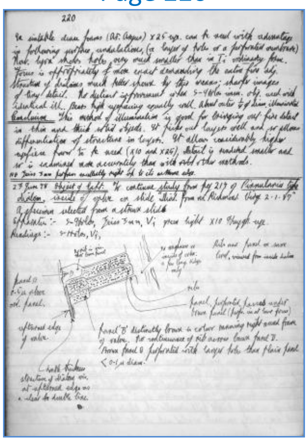
Object of Experiment

To examine diatoms on "Bakers Test Slide 20 forms in Styrax" with annular illumination obtained by means of stop in centre of condenser.

Apparatus:- Univ. Cond.; Zeiss 3mm dry obj.; x7, x10, x25 eyepieces; green light.

Readings:- With bright field annular illumination details of diatoms are well displayed and are clearly rendered smaller and sharper than in ordinary Transmitted Illumination.

Page 220



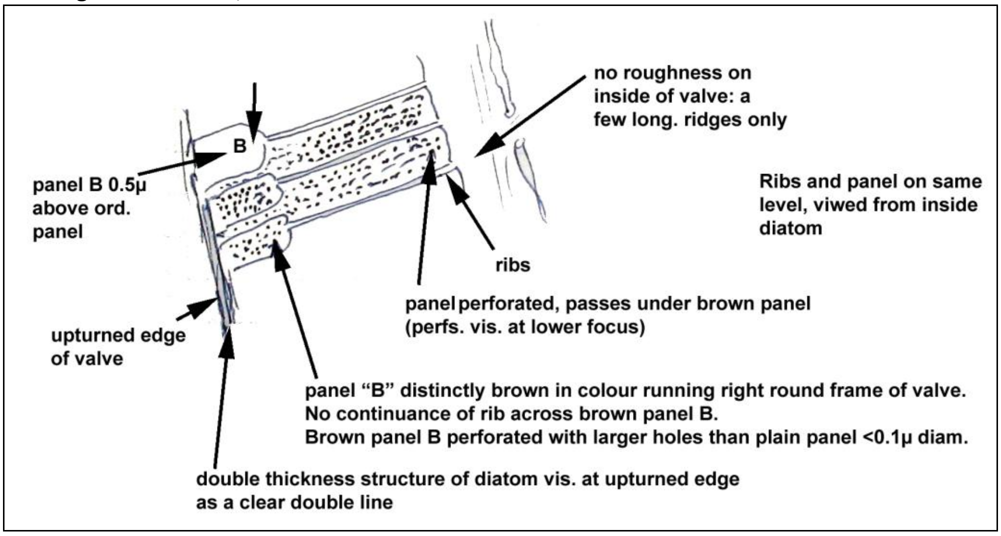
In suitable dense forms (*Arachnoidiscus argus*) x25 eyepiece can be used with advantage in following surface undulations, (a layer of holes or a perforated membrane). *Navicula lyra* shows holes very much smaller than in Transmitted Illumination ordinary form.

Focus is appropriately more exact demanding the extra fine adjustment. Structure of diatoms much better shown by this means; sharper images of tiny detail. No distinct improvement when Swift-Holos immersion objective used with identical illumination. Bears high 'eyepieceing' equally well. About outer ⅛ of diameter illuminated.

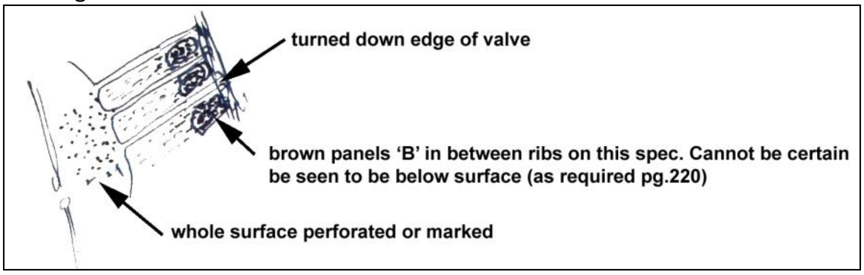
Conclusion. This method of illumination is good for bringing out fine detail in thin and thick solid objects. It picks out layers well and so allows differentiation of structure in layers. It allows considerably higher eyepiece power to be used (x10 and x25). Detail is rendered smaller and so is examined more accurately than with other methods.

NB. Zeiss 3mm performs excellently right up to its extreme edge.

23rd June 1978
Object of Experiment. To continue study from page 217 of *Pinnularia* type diatom, inside valve on slide "Diat. from nr. Richmond, Virg. 21.1.87".
A specimen selected from a strewn slide.
Apparatus:- Swift-Holos, Zeiss 3mm, Vertical Illumination green light, x10 Huyghenian eyepiece.
Readings:- Swift-Holos, Vertical Illumination



II. Using outside of valve on same slide:



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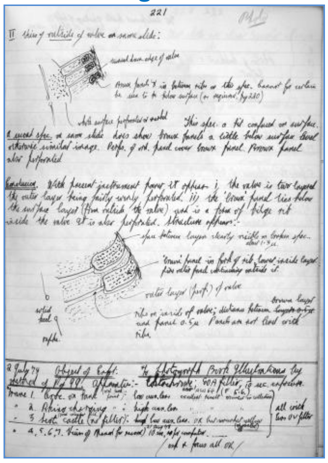
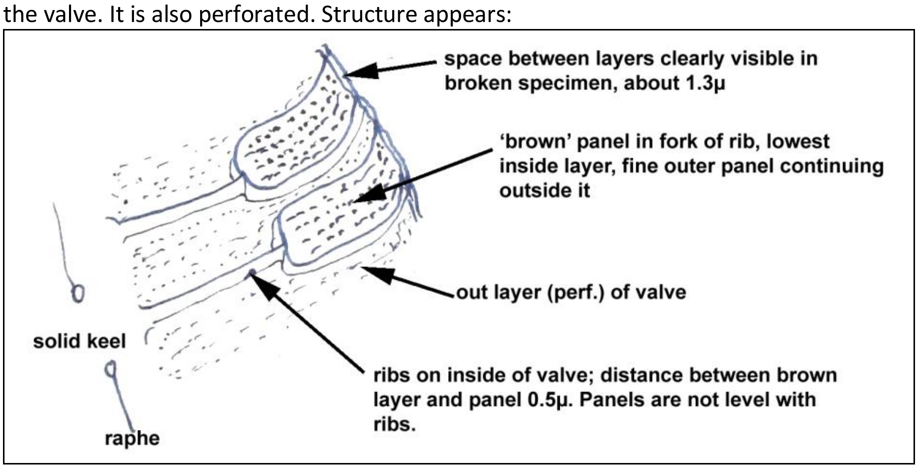


This specimen a bit confused on surface. A second specimen on same slide does show brown panels a little below surface level, otherwise similar image. Perforations of ordinary panel cover brown panel. Brown panel also perforated.

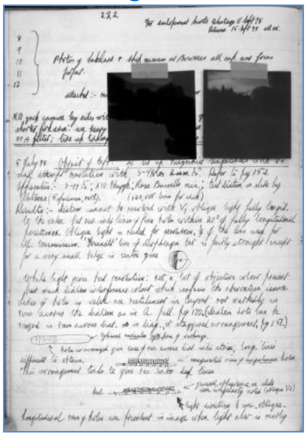
Conclusion:- With present instrument power it appears i. the valve is two layered, the outer layer being fairly evenly perforated. Ii. The 'brown' panel lies below the surface layer (from outside the valve) and is a form of bilge rib inside the valve. It is also perforated. Structure appears:



2nd July 1978
Object of Experiment: To photograph Book Illustrations by method of page 99.
Apparatus:- Ektachrome; 80A filter; $\frac{1}{10}^{th}$ second exposure. ASA64 (f5.6).
Frame 1. Crocodile on bank (ordinary book print): low auxiliary lens. Excellent result, mounted in collection

Frame 2. Rhino charging (ordinary book print): high auxiliary lens. Excellent result, mounted in collection
Frame 3. Scottish Castle (no filter): low auxiliary lens. OK but somewhat yellow (mounted)
Frames 4,5,6,7. Views of Manor (for record) 21st August 1978 10am. (exp. & focus all OK)

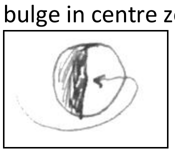
Page 222



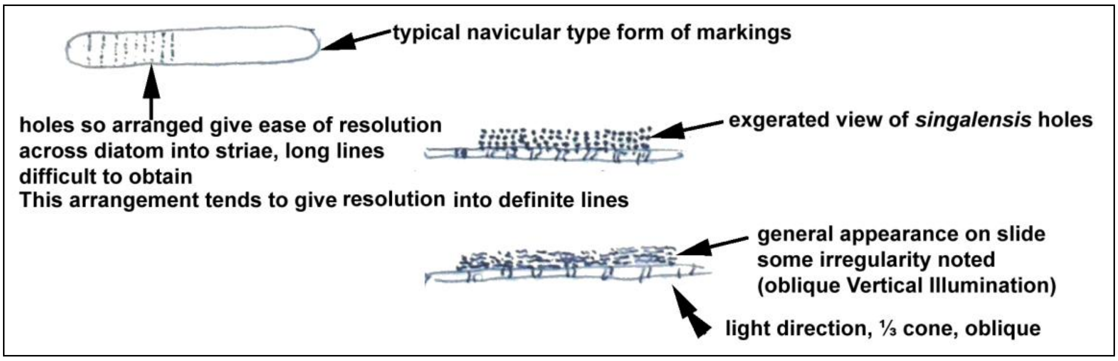
For development – Scotts, Wantage 11th September 1978 – returned 15th September 1978 – All OK.
Frames 8, 9, 10, 11, 12 – Photos of Lakeland and Ship Museum at Bowness. All exposures and focus perfect.
Attached:- Record of tree growth Grove Manor 1978 Summer.

NB. Grip camera by sides with long swivelling fork arm, grip lamp with cork lined shorter forearm, use heavy base stand (anglepoise base), use cable release, hand hold 80A filter, line up taking lens by eye, tolerate off-axis viewing lens.

5th July 1978
Object of Experiment
To set up *Nitzschia singalenses* with Vertical Illumination and attempt resolution with Swift-Holos 1.12". Refer to page 152.
Apparatus:- Swift-Holos $^1/_{12}$", x10 Huyghenian, Ross-Burrells Microscope; test diatom on slide by Watson (5 specimen, vertical) (120,000 lines per inch)
Results:- Diatom cannot be resolved with Vertical Illumination oblique light fully longitudinal to the valve but resolved into lines of fine holes within 20° of fully longitudinal position OK. Oblique light is need for resolution, ⅓ of the lens used for illumination transmission. 'Foucault' line of diaphragm bar is fairly straight except for a very small bulge in centre zone.

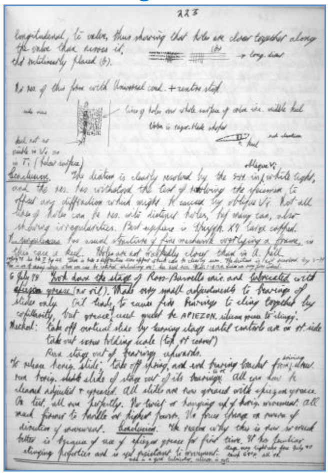


White light gives best resolution: not a lot of objective colour present but much diatom interference colour which confuses the aberration issue. Lines of holes in valve are rectilinear in layout not markedly in rows across the diatom as in *Amphipleura pellucida*, page 170 (Diatom dots can be ranged in four rows across diatom as in diagram, or staggered arrangement, page 151.)

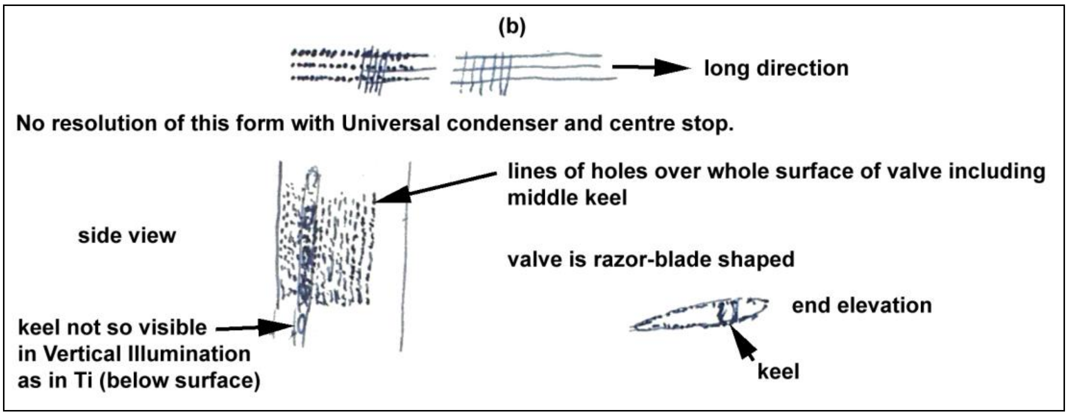


Longitudinal rows of holes are prevalent in image when light also is nearly…*(next page)*

Page 223



…longitudinal to valve, thus showing that holes are closer together along the valve than across it, though rectilinearly placed (b).



Conclusion. The diatom is clearly resolved by the Swift-Holos in oblique Vertical Illumination white light, and the resolution has withstood the test of revolving the specimen to offset any diffraction which might be caused by oblique Vertical Illumination. Not all lines of holes can be resolved into distinct holes, but many can, also showing irregularities. Best eyepiece is Huyghenian x7 large capped.

N. singalensis has usual structure of fine meshwork overlying a frame, in this case a keel. Holes are not markedly closer than in *Amphipleura pellucida*.

14th July 1979. See Bk.II page 49. There is here a diffraction line effect which can be clearly seen. The diatom is NOT resolved by Swift-Holos. This is one of many ways where one can be 'catched', including me! See real resolution Koristka 1.4NA. Lines are very fine indeed.

6th July 1978

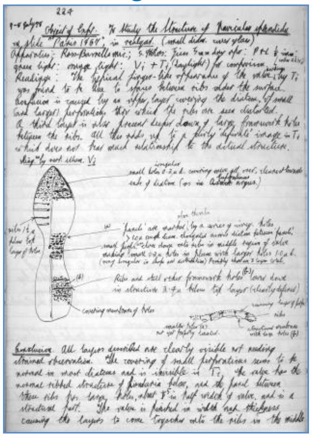
Took down the stage of Ross-Burrells microscope and lubricated with Apiezon grease (no oil). Made very small adjustments to bearings of slides only. Oil tends to cause fine bearings to cling together by capillarity, but grease if used must be APIEZON. Silicon grease too 'clingy'.

Method:- Take off vertical slide by turning stage until controls are on right side. Take out screw holding scale (top right corner). Run stage out of bearings upwards.

To release horizontal slide: take off spring and end bearing bracket from driving screw, run horizontal slide of stage out of its bearing to right. All can now be cleaned, adjusted and greased. All slides are now greased with Apiezon grease. On test, all run perfectly. No twist or hanging up of horizontal movement. All much firmer to handle at higher powers. No focus change or reverse of direction of movement.

Conclusion. The reason why this is now so much better is because of use of Apiezon grease for first time. It has peculiar clinging properties and is yet resistant to movement: and is a good lubricator, silicon is not. Stage very light and free. 30th July. Temperature 69°F. All OK.

Page 224



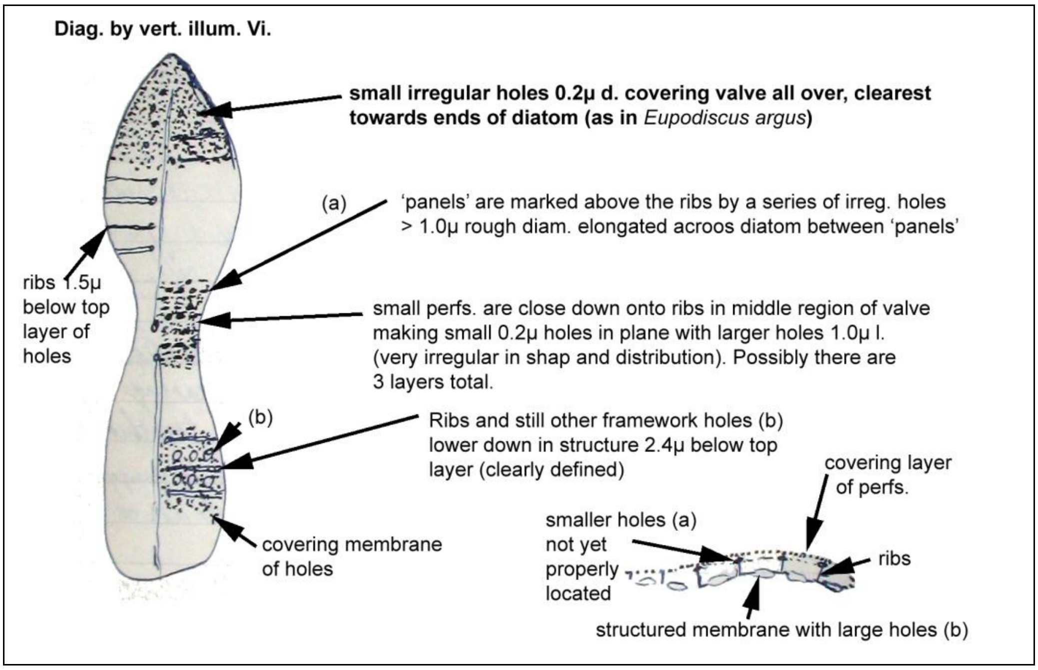
7th-8th July 1978

Object of Experiment.

To Study the Structure of *Navicula splendida* in slide "Paris 1867", in Realgar. (small diameter cover glass)

Apparatus:- Ross-Burrells microscope; S. Holos. Zeiss 3mm dry Apo; Powell & Lealand ⅛ immersion (collar 22 [Vertical Illumination]); green light: orange light: Vertical Illumination + Transmitted Illumination (daylight) for comparison.

Readings:- The typical finger-like appearance of the valve markings by Transmitted Illumination was found to be due to spaces between ribs under the surface. Confusion is caused by an upper layer covering the diatom, of small (and larger) perforations through which the ribs are seen distorted. A third layer is also present deeper down, of large framework holes between the ribs. All this adds up to a fairly 'definite' image in Transmitted Illumination which does not bear much relationship to the actual structure.

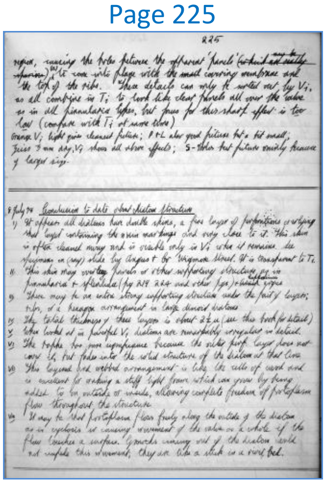


Conclusion:- All layers described are clearly visible not needing strained observation. The covering of small perforations seems to be normal in most diatoms and is invisible in Transmitted Illumination. The valve had the normal ribbed structure of *Pinnularia* below, and the panel between these ribs has large holes, about 5 in half width of valve, and is a structural part. The valve is pinched in width and thickness causing the layers to come together onto the ribs in the middle…*(next page)*

…region, causing the holes between the apparent 'panels' ~~(which are really/may be spurious)~~ (a) to come into plane with the ~~small~~ covering membrane and the top of the ribs. These details can only be sorted out by Vertical Illumination, as all combine in Transmitted Illumination to look like clear panels all over the valve as in all *Pinnularia* types, but focus for this sharp effect is too low (compare with Transmitted Illumination at same time).

Orange Vertical Illumination; light gives cleanest picture; Powell and Lealand also good picture but a bit small; Zeiss 3mm dry, Vertical illumination shows all above effects; Swift-Holos best picture mainly because of larger size.

Page 225

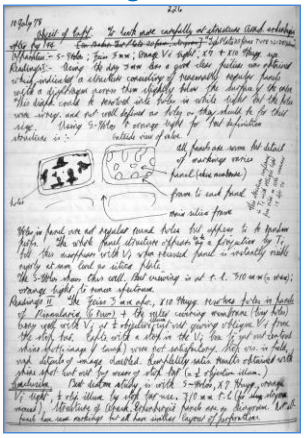


8th July 1978

Conclusion to date about Diatom structure.

1. It appears all diatoms have double skins, a fine layer of perforations overlying that layer containing the main markings and very close to it. This skin is often cleaned away and is visible only in Vertical Illumination when it remains. See specimens on (say) slide by Angus & Co., Wigmore Street. It is transparent to Transmitted Illumination.
2. This skin may overlay panels or other supporting structure as in *Pinnularia* & *splendida* (page 219. 224 and other pgs) & ~~*Arach.*~~ *Eupodiscus argus*.
3. There may be an extra strong supporting structure under the pair of layers; ribs, or a hexagon arrangement in large discoid diatoms.
4. The total thickness of three layers is about 2½μ (see this book for detail)
5. When looked at in powerful Vertical Illumination diatoms are remarkably irregular in detail.
6. The raphe has some significance because the outer perforated layer does not cover it, but fades into the solid structure of the diatom at that line.
7. This layered and webbed arrangement is like the cells of wood and is excellent for making a stiff light frame which can grow by being added to on outside or inside, allowing complete freedom of protoplasm flow throughout the structure.
8. It may be that protoplasm flows freely along the outside of the diatom as in cyclosis so causing movement of the valve as a whole of the flow touches a surface. Growths coming out of the diatom would not impede this movement, they are like a stick in a river bed.

Page 226



10th July 1978

Object of Experiment

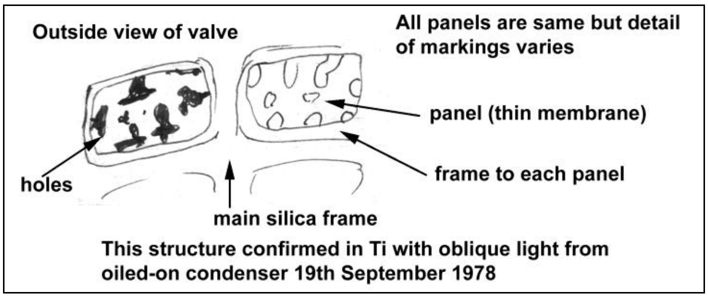
To look more carefully at structure *Arachnoidiscus Ehrenbergii* after page 194.

~~[on Bakers Test Plate 20 forms, Styrax]~~

"Type Plate 20 forms Type Slide. Balsam"

Apparatus:- Swift-Holos; Zeiss 3mm; Orange Vertical Illumination light; x7 and x10 Huyghenian Eyepieces

Readings I:- Using the dry 3mm lens a good clear picture was obtained which indicated a structure consisting of reasonable regular panels with a diaphragm across them slightly below the surface of the valve. This diaphragm could be resolved into holes in white light but the holes were irregular and not well defined as holes as they should be for their size. Using Swift-Holos and orange light for best definition structure is:



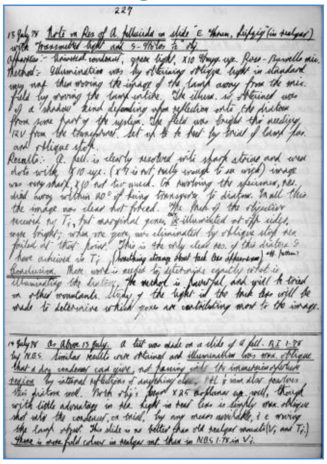
Holes in panel are not regular round holes but appear to be random perforations. The whole panel structure appears to be a projection by Transmitted Illumination but this disappears with Vertical Illumination when recessed panel is instantly visible nearly at same level as silica plate.

The Swift-Holos shows this well. Best viewing is at tube length 310mm (-maximum); orange light to remove spectrum.

Readings II:- The Zeiss 3mm apochromat, x10 Huyghenian. Resolves holes in panels of *Pinnularia* (6 rows) and the outer covering membrane (tiny holes) very well with Vertical Illumination at ½ objective illumination cut out giving oblique Vertical Illumination from the stop bar. Experiments with a stop in the Vertical Illumination box to cut out central shine spot (=image of lamp) were not satisfactory. Stop visible in field and details of image doubled. Completely satisfactory results obtained with shine spot cut out by means of stop bar (=½ objective illumination).

Conclusion. Best diatom study is with Swift-Holos, x7 Huyghenian, orange Vertical Illumination light, ½ objective illumination by stop bar use. 310mm tube length (for Styrax mount) Structure of *Arachnoidiscus Ehrenbergii* panels are as diagram. Not all panels have same markings but all have similar layout of perforations.

Page 227



13th July 1978

Note on resolution of *Amphipleura pellucida* on slide "E. Thum, Leipzig" (in Realgar) with Transmitted light and Swift-Holos $\frac{1}{12}$" objectives.

Apparatus:- Universal condenser, green light, x10 Huyghenian. Eye, Ross-Burrells microscope

Method:- Illumination was by obtaining oblique light in standard way and then moving the image of the lamp away from the microscope field by moving the lamp entire. The illumination so obtained was of a 'shadow' kind depending upon reflection onto the diatom from some part of the system. The field was bright though needing 12V from the transformer. Set up to be best by trial of lamp position and oblique stop.

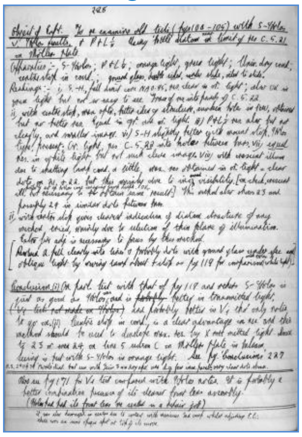
Results: *Amphipleura pellucida* is clearly resolved into sharp striae and even dots with x10 eyepiece (x7 not really enough to see with). Image was very sharp, x10 not too much. On resolving the specimen, resolution died away within 20° of being transverse to diatom. In all this the image was clear not forced. The back of the objective received no Transmitted Illumination, but marginal zones, two illuminated at opposite sides, were bright; when one zone was eliminated by oblique stop resolution failed at that point. This is the only clear resolution of this diatom I have achieved in Transmitted Illumination (something strange about back lens appearance)(diffraction pattern?).

Conclusion. More work is needed to determine exactly what is illuminating the diatom. The method is powerful and will be tried on other mountants. Study of the light in the back lens will be made to determine which zones are contributing most to the image.

14th July 1978. As above 13th July

A test was made on a slide of *Amphipleura pellucida* Refractive Index 1.78 by NB.S.(Northern Biological Supplies) Similar results were obtained and illumination was maximum oblique that a dry condenser can give, not passing into the immersion aperture region by internal reflections or anything else. Powell and Lealand ⅛" immersion also resolves this diatom well. Both objectives bear x25 Coplanar? Eyepiece well, though with little advantage in resolution. Light in rear lens is simply maximum oblique shot into the condenser, on trial, by any means available, i.e. moving the lamp about. This slide is no better than old Realgar mounts (Vertical Illumination and Transmitted Illumination). There is more field colour in Realgar mount than in NB.S. 1.78 in Vertical Illumination.

Page 228



Object of Experiment

To re-examine old tests (pages 104-105) with Swift-Holos v. Holos results and Powell and Lealand ⅛", using 'bottle' diatom near limit of resolution C.5.21 on Möller's Test Plate.

Apparatus:- Swift-Holos, Powell and Lealand ⅛", orange light, green light, Universal dry condenser, centre stop in condenser, ground glass – double slides, under slide, oiled to slide.

Readings:-

i. Swift-Holos, full direct cone NA 0.95, resolution clear in orange light; also OK in green light but not so easy to see. Trace of resolution into panels of C.5.22.
ii. With centre stop, maximum aperture, better idea of structure, sunken holes in row, obtained but no better resolution. Equal in green and orange light
iii. Powell and Lealand ⅛" resolved also but not clearly, and smaller image
iv. Swift-Holos slightly better with mount stop. Holos type present, orange light, resolved c.5.22 into holes between bars
v. Equal resolution in white light but not such clean image
vi. With crescent illumination due to shutting lamp condenser a little, maximum resolution obtained in orange light = clear dots on 21 and 22, but this mainly due to increased visibility [on check, crescent illumination properly set up hollow cone imaging lamp diaphragm not necessary to obtain same result]. This method also shows 23 and possibly 24 in similar dots between bars.

ii above, with centre stop gives clearest indication of diatom structure of any method tried, mainly due to selection of thin plane of illumination. Extra fine adjustment is necessary to focus by this method.

Resolved *Amphipleura pellucida* clearly into lines and probably dots with ground glass under specimen and oblique light by moving lamp about and stop as page 119 for comparison with Holos (white light).

Conclusion. i. On parallel test with that of page 119 and others, Swift-Holos is just as good as Holos was and is probably better in transmitted light, ~~(Vertical Illumination tests not made on Holos)~~ and probably better in Vertical Illumination, though only notes to go on. ii. Centre stop in condenser is a clear advantage in resolution and this method should be used to develop maximum resolution by transmitted light. Used to 23 or even 24 on line 5 section C on Möller's plate in balsam. Seeing is best with Swift-Holos in orange light. See page 227 Conclusion.

P.S. 23rd April 1979 'Bottle' diatom best seen with Zeiss 3mm dry apochromat and dark ground from immersion paraboloid therefore very clear dots shown.

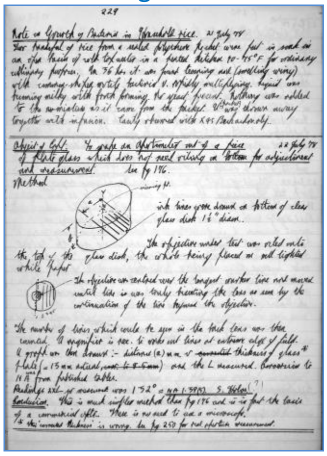
Also see page 171 for Vertical Illumination test compared with Holos notes. It is probably a better combination because of its cleaner front lens assembly (Holos has had its front lens re-seated in a repair job). It was also damaged in centre due to contact with meniscus second component whilst adjusting tube length, there was a semi-opaque spot at top of its curve.

21st July 1978

Note on growth of Bacteria in Household rice.

Two handfuls of rice from a sealed polythene packet were put in soak in an open basin of cold tap water in a heated kitchen 70-75°F for ordinary culinary purposes. In 36 hours it was found teeming (and smelling winey) with common-shaped motile bacteria very rapidly multiplying. Liquid was becoming milky with froth forming. No yeast present. Nothing was added to the mixture as it came from the packet. It (the packet) was thrown away together with infusion. Easily observed with x45 Beck achromat objective.

Page 229

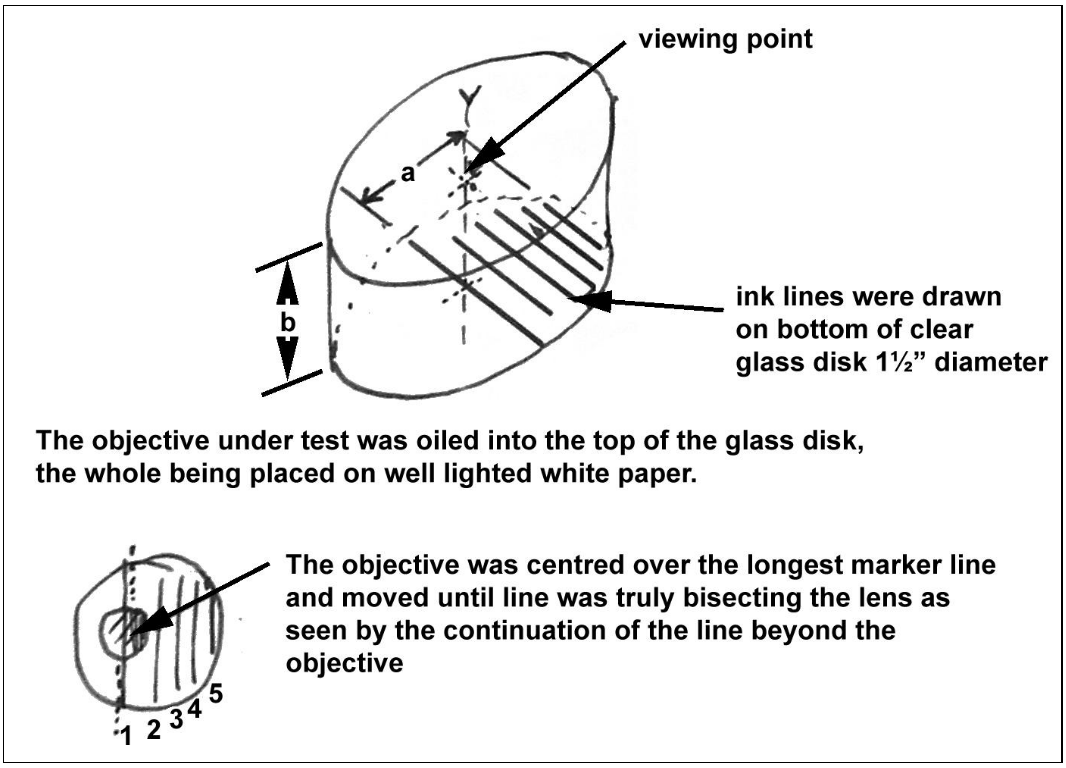


22nd July 1978

Object of Experiment

To make an apertometer out of a piece of plate glass which does not need oiling on bottom for adjustment and measurement. See page 176.

Method:-



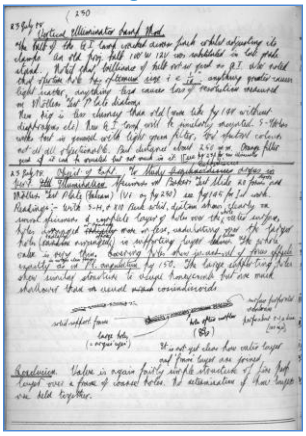
The number of lines which could be seen in the back lens was then counted. A magnifier is required to make out lines at extreme edge of field. A graph was then drawn:- diatom (a) mm. ~ thickness of glass* plate (=13mm actual) and the angle measured. Conversion to NA was from published tables.

Readings 2x angle so measurement was 132° = NA 1.39 (5) Swift-Holos(?)

Conclusion. This is much simpler method than page 176 and is in fact the basis of a commercial apertometer. There is no need to use a microscope.

*this 'corrected thickness' is wrong. See page 250 for real aperture measurement.

Page 230



23rd July 1978

Vertical Illuminator Lamp Mod.

The bulb of the Quartz Iodide Lamp cracked across pinch whilst adjusting its clamps. An old projector bulb 100W 12V was substituted in laboratory made stand. Noted that brilliance of bulb not so good as Quartz Iodide also noted that aperture hole has optimum size. i.e. $\frac{1}{16}$", anything greater causes light scatter, anything less causes loss of resolution measured on Möller's Test Plate diatoms.

New rig is less clumsy than old (more like page 144 without diaphragms etc.) New Quartz Iodide lamp will be similarly mounted. Swift-Holos works best in general with light green filter, though spectral colours not at all objectionable. Best distance about 250mm. Orange filter good if it can be mounted but not much in it. [see page 232 for new illuminator]

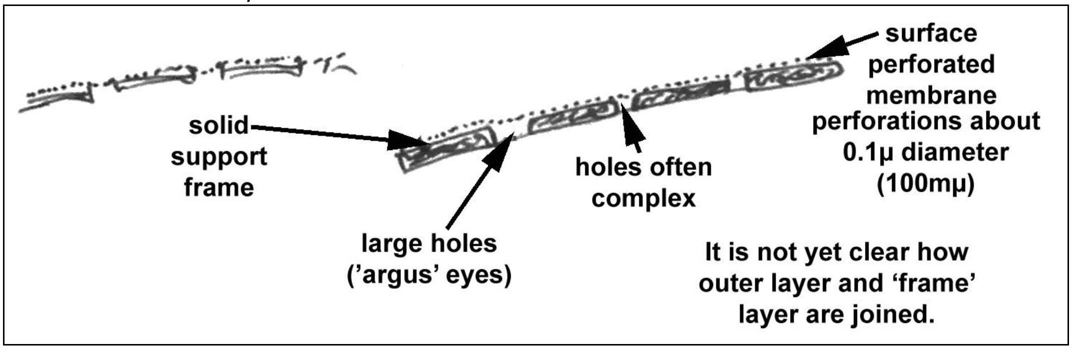
23rd July 1978

Object of Experiment

To study ~~*Arachnoidiscus*~~ *Eupodiscus argus* in Vertical Illumination.

Specimens on Baker's Test Slide 20 forms, Styrax and Möller's Test Plate (balsam) (Vertical Illumination as page 230) see page 145 for 1st work.

Readings:- With S-H, x10 Beck solid diatom shows clearly in several specimens and complete layer of holes over the whole outer surface, holes arranged ~~radially~~ at random more or less, undulating over the larger holes (~~random~~ radially arranged approximately) in supporting layer below. The whole valve is very thin. Covering holes show in-and-out of focus effects exactly as in *Pleurosigma angulatum* page 150. The large supporting holes show similar structure to usual honeycomb but are much shallower than in usual coscinodiscoids.



Conclusion. Valve is again fairly simply structure of fine perforated layer over a frame of coarse holes. No determination of how layers are held together.

30th July 1978

Object of Experiment

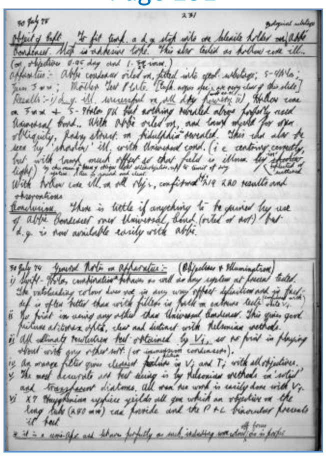
To fit temporarily a dark ground stop into a selenite holder on geological substage Abbe condenser. Stop is adhesive tape. This also tested as hollow cone illumination (on objectives 0.95 dry and 1.25 immersion)

Apparatus:- Abbe condenser oiled on, fitted into geological substage; Swift-Holos; Zeiss 3mm; Möller Test Plate [*Eupodiscus argus* specimens are very clear on this slide]

Results:-

i. Dark ground illumination successful on all dry powers except NA0.95
ii. Hollow cone on 3mm and Swift-Holos OK but nothing revealed above properly used.

Page 231



Universal Condenser with Abbe oiled on and lamp moved for more obliquity, secondary structure on *Biddulphia* is revealed. This can also be seen by 'shadow' illumination with Universal Condenser (i.e. centring correctly but with lamp much offset so that field is illuminated ~~by shadow~~ in reflected or scattered light). By this means a band of oblique light enters objectives up to limit of dry objectives. Resolution is sound and clear.

With hollow cone illumination on all objectives, confirmed pages 219 and 220 results and observations.

Conclusion. There is little, if anything, to be gained by use of Abbe condenser over Universal Condenser (oiled or not) but dark ground is now available easily with Abbe.

30th July 1978

General Notes on Apparatus (Objectives and Illumination)

i. Swift-Holos combination* behaves as well as any system at present tested. The outstanding colour does not in any way affect definition and in fact definition is often better than with filters in path on extreme tests (confirmed with white Vertical Illumination)

ii. No point in using any other than Universal Condenser. This gives good picture at its maximum aperture, clear and distinct with Nelsonian methods.

iii. All ultimate resolution best obtained by Vertical Illumination, so no point in playing about with any other sort (or immersion condensers).

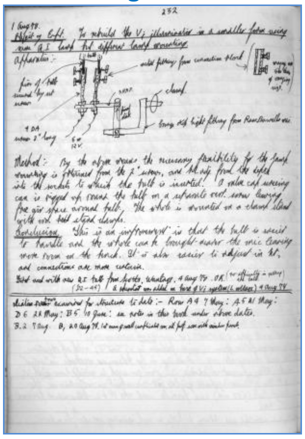
iv. An orange filter gives cleanest picture in Vertical Illumination and Transmitted Illumination with all objectives.

v. The most accurate and best seeing is by Nelsonian methods in 'solid' and transparent diatoms. All maximum resolution work is easily done with Vertical Illumination.

vi. X7 Huyghenian eyepiece yields all gen which an objective on the long tube (280mm) can provide and the Powell and Lealand binocular presents it best.

*it is a semi-apochromat and behaves perfectly as such, including some colour off focus as is proper.

Page 232

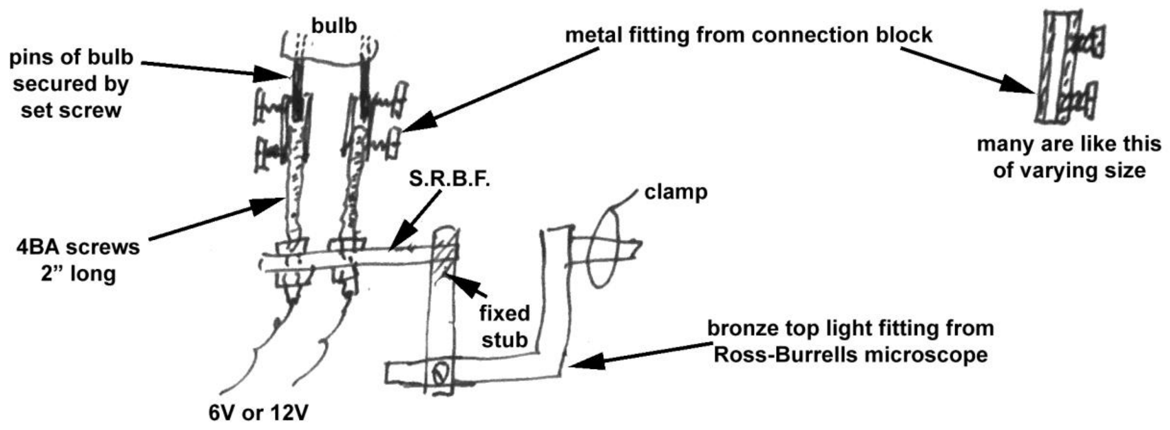


1st August 1978

Object of Experiment

To rebuild the Vertical Illumination illuminator in a smaller form using same Quartz Iodide lamp but different lamp mounting.

Apparatus:



Method:- By the above means the necessary flexibility for the lamp mounting is obtained from the 2" screws, and height adjustment from the depth into the sockets to which the bulb is inserted. A valve cap screwing can is rigged up around the bulb on a separate vertical screw leaving free air space around bulb. The whole is mounted on a clamp stand with ordinary stand clamps.

Conclusion. This is an improvement in that the bulb is easier to handle and the whole can be brought nearer the microscope leaving more room on the bench. It is also easier to adjust in height, and connections are more certain. First used with new Quartz Iodide bulb from Scotts, Wantage, 4th August 1978. OK. (no difficulty in getting bulb) (£2-45). A rheostat was added on base of Vertical Illumination system (low voltage) 4th August 1978.

Diatom rows examined for structure to date:-

Row A4 7th May

Row A5 21st May

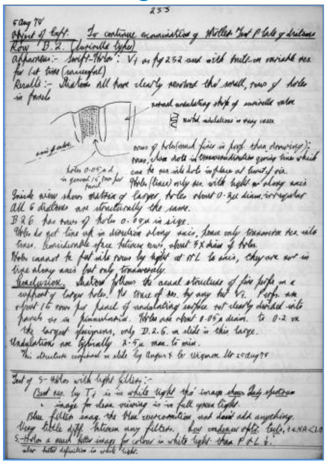
Row D6 22 May

Row B5 10th June

See notes in this book under above dates

Row B2 7th August
Row B1 20th August – 1st examination of small complicated row, all perforated some with window panels.

Page 233



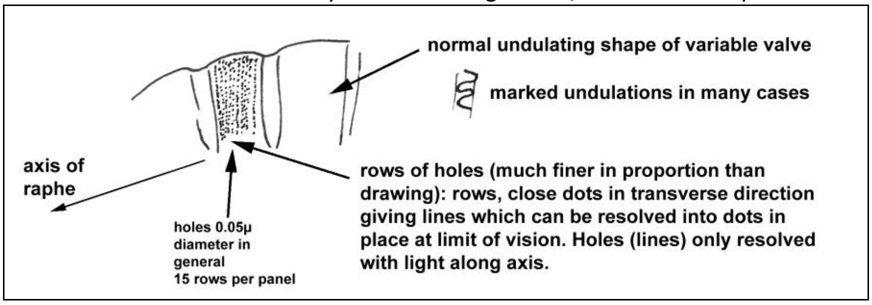
5th August 1978

Object of Experiment

To continue examination of Möller Test Plate of diatoms. Row B.2 (*Surirella* types)

Apparatus:- Swift-Holos, Vertical Illumination as page 232 used with built-on variable resistor for 1st time (successful)

Results:- Diatoms all now clearly resolved though small, row of holes in panels.

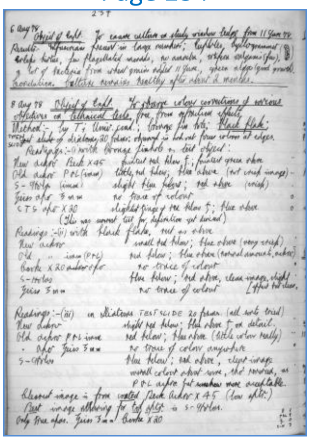


Inside view shows matrix of larger holes about 0.2µ diameter irregular. All 6 diatoms are structurally the same.
B.2.6. has rows of holes 0.08µ in size.
Holes do not line up in direction along axis, hence only transverse resolution into lines. Considerable space between rows about 3x diameter of holes.
Holes cannot be put into rows by light at right angle to axis, they are not in line along axis but only transversely.

Conclusion. Diatom follows the actual structure of fine perforations on a support of larger holes. No trace of resolution by any but Vertical Illumination. Perforations are about 15 rows per panel of undulating surface, not clearly divided into panels as in *Pinnularia*. Holes are about 0.05µ diameter to 0.2µ on the largest specimens, only B.2.6. on slide is this large.
Undulations are typically 2.5µ maximum to minimum.
This structure confirmed on slide by Angus and Co., Wigmore Street. 25th August 1978

Test of Swift-Holos with light filters:-
Best resolution by Transmitted Illumination is in white light though image shows secondary spectrum.
Best image for clean viewing is in full green light.
Blue filters exaggerate the blue over-correction and doesn't add anything.
Very little difference between any filters. Low condenser aperture tests, i.e. NA <1.0
Swift Holos a much better image for colour in white light than Powell and Lealand ⅛", also better definition in white light.

Page 234



6th August 1978

Object of Experiment

To examine culture on study window ledge from 11th June 1978

Results:- Infusorians present in large numbers; *Euplotes cyclogramma*, *Coleps hirtus*, few flagellated monads, no amoebae, *Rotifera vulgaris* (few), a lot of bacteria from wheat grains added 11th June, green algae (good growth)

Conclusion. Culture remains healthy after about 2 months.

8th August 1978

Object of Experiment

To observe colour corrections of various objectives on technical tests free from refraction effects

Method:- by Transmitted Illumination, Universal Condenser, bronze pin hole, black flake, Type slide of diatoms 20 forms, observed in and out of focus colours at edges.

Readings:-

i. With bronze pin hole as test object:
New achromat Beck x45 – faintest red below focus, faintest green above
Old achromat Powell and Lealand (immersion) – little red below, blue above (not crisp image)
Swift-Holos (immersion) – slight blue below, red above (crisp)
Zeiss apochromat 3mm – no trace of colour
CTS apochromat x20 – slightest tinge of red below focus, blue above
(This was severest test from definition yet devised)

Readings:-

ii. With black flake, rest as above
New Achromat – small red below, blue above (very crisp)
Old achromat immersion (Powell and Lealand) – red below, blue above (normal amounts, achromat)
Cooke x20 apochromat – no trace of colour
Swift-Holos – blue below, red above, clean image, slight effect but clear
Zeiss 3mm – no trace of colour

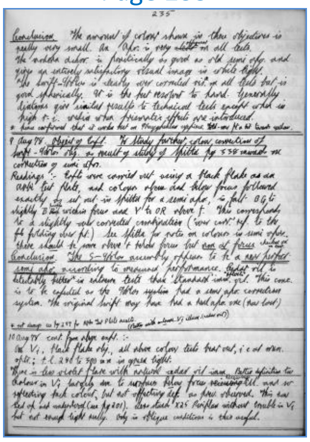
Readings:-

iii. On Diatoms test slide 20 forms (all sorts tried)
New achromat – slight red below, blue above focus on detail
Old achromat Powell and Lealand immersion – red below, blue above (little colour really)
Old apochromat Zeiss 3mm – no trace of colour anywhere
Swift-Holos – blue below, red above, clear image, overall colour about some, though reversed, as Powell and Lealand achromat, but somehow more acceptable.

Clearest image is from coated Beck Achromat c45 (low aperture)
Best image allowing for top aperture is Swift-Holos
Only true apochromats Zeiss 3mm and Cooke x20.

Conclusion. The amount of colour shown in this objective is really very small. An Apochromat is very different in all test. The modern Achromat is practically as good as old semi-apochromats and gives an entirely satisfactory visual image in white light.
The Swift-Holos is clearly over corrected vis.* in all tests but is good spherically. It is the best resolver to hand. Generally diatoms give similar results to technical tests except when in high Refractive Index media when prismatic effects are introduced.
*hence confirmed that it works best on Huyghenian eyepiece. Fold-over point a bit towards yellow.

Page 235



9th August 1978

Object of Experiment

To study further colour correction of Swift-Holos objective as result of study of Spitta page 338 onwards on correction of semi-apochromats.

Readings:- Experiments were carried out using a black flake as an Abbe test plate, and colours above and below focus followed exactly as set out in Spitta for a semi-apochromat, in fact Blue-green(BG) to slightly Blue-purple (BP) within focus and Yellow (Y) to orange (OR) above focus. This corresponds to a slightly colour corrected combination ('over correction' reference to the folding over point). See Spitta for notes on colours in semi-apochromats. There should be some above and below focus but none at focus. (Checked OK on test.)

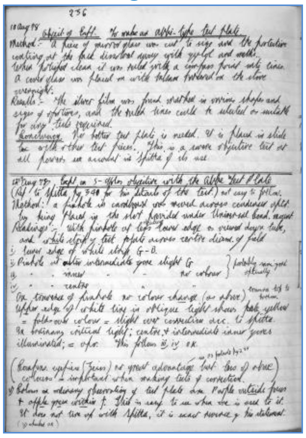
Conclusion. The Swift-Holos assembly appears to be a near perfect semi-apochromat, according to measured performance. Cedar oil is detectably better* in extreme tests than 'standard' immersion oil (Optoil). This conclusion is to be expected as the Holos ~~system~~ had a semi-apochromat correction system. The original Swift may have had a real apochromat one (now lost).
*not always. See page 237 for Abbe Test Plate results. (Better with extreme Vertical Illumination (Cedar Oil))

10th August 1978 (continued from above experiment)

On Vertical Illumination, black flake objective, all above colour tests bear out, i.e. at maximum aperture; tube length 280 to 300mm, in green light.

There is less violet flare with natural Cedar Oil immersion. Better definition too. Colour in Vertical illumination largely due to surfaces below focus receiving illumination and so reflecting back colour, but not affecting definition as previously observed. This now tied up and understood (see page 201) Lens stand x25 Periplan without trouble in Vertical illumination but not enough light really. Only in oblique conditions is this useful.

Page 236



10th August 1978

Object of Experiment

To make an Abbe-type test plate

Method:- A piece of mirror glass was cut to size and the protective coating at the back dissolved away with xylol and methylated spirit. When polished clean it was ruled with a compass point into lines. A cover glass was placed on with Balsam hardened on the stove overnight.

Results:- The silver film was found marked in various shapes and sizes of apertures, and the ruled lines could be selectable as suitable for any tests required.

Conclusion. No better test plate is needed. It is placed in slide box with other test pieces. This is a severe test at all powers, see account in Spitta, of its use.

~~12th~~ 13th September 1978

Experiment on Swift-Holos objective with the Abbe Test Plate

(Reference to Spitta page 340 for his details of the test) – not easy to follow.

Method:- A pinhole in cardboard was moved across condenser aperture by being placed in the slot provided under Universal Condenser mount.

Readings:- With pinhole at lens (objective) lower edge as viewed down tube, and while strip of test plate across centre diameter of field

i. Lower edge of white strip Green-Blue (G-B)
ii. Pinhole at outer intermediate zone slight Green (G)
iii. Pinhole at inner intermediate zone no colour (probably the same zone optically as ii.
iv. Pinhole at centre zone no colour

On traverse of pinhole no colour change (as above) – traverse top to bottom.

Upper edge of white line in oblique light shows pale yellow = fold-over colour = slight cover correction according to Spitta. In ordinary critical light; centre and intermediate inner zones illuminated; = Apochromat. This follows iii., iv. OK.

(Compensating eyepiece [Zeiss] no great advantage [see PS footnote page 238] but less of above colours = important when making tests of correction.)

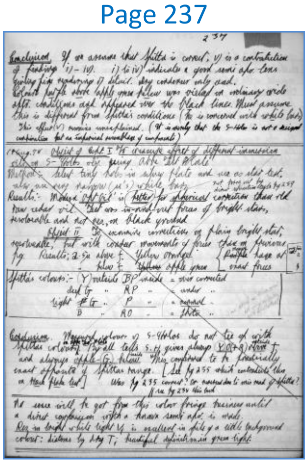
v. Colours on ordinary observation of test plate are Purple outside focus and apple-green within focus. (Checked OK) This is easy to see when one is used to it. It does not line up with Spitta, it is exact reverse and his statement….*(next page)*

Conclusion. If we assume that Spitta is correct, v. is a contradiction of findings i.-iv. i.-iv. Indicate a good semi-apochromat lens giving fine rendering of detail. Dry condenser only used.

Colours purple above apple-green below was viewed on ordinary wide aperture conditions and appeared over the black lines. Must assume this is different from Spitta's conditions. (He is concerned with white bars.)

This effect (v.) remains unexplained. (It is merely that the Swift-Holos is not a designed combination but an empirical assemblage of components.)

Page 237

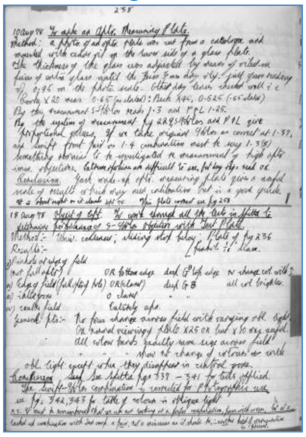


Transcribers Note: Here followed an experiment (14th August 1978) to measure effect of different immersion oils on Swift-Holes. The entire experiment has been crossed out and for this reason is not included here.

No sense will be got from this colour fringe business until a direct comparison with a known semi-apochromat is made.

Resolution in bright white light Vertical Illumination is excellent in spite of a little background colour; diatoms by Dry Transmitted Illumination beautiful in green light.

Page 238



10th August 1978

To make an aperture Measuring Plate

Method:- A photo of an aperture plate was cut from a catalogue and mounted with Cedar Oil on the lower side of a glass plate. The thickness of the glass was adjusted by means of oiled-on pieces of extra glass until the Zeiss 3mm dry objective just gave reading of 0.95 on the photo scale. Other dry lenses checked well i.e. Cooke x20 measured 0.65 (as stated); Beck x45, 0.625 (0.65 stated). By this measurement Swift-Holos reads 1.3 and Powell and Lealand 1.25. By the systems of measurement page 229, Swift-Holos and Powell and Lealand give proportional values. If we take original Holos as correct at 1.37, and Swift front pair as 1.4 combination must be say 1.3(8). Something remains to be investigated re. measurement of high aperture immersion objectives. Extreme apertures are difficult to see, but dry objectives read OK.

Conclusion. Gash made-up apertures measuring plate gives a useful scale of results which may need calibration but is a good guide. It is about right as it stands (September 1978) This plate correct, see page 250.

18th August 1978

Object of Experiment

To work through all the tests in Spitta to determine performance of Swift-Holos objective with Test Plate.

Method:- Universal Condenser, sliding stop below, Plate of page 236, pinhole $\frac{1}{16}$" diameter

Results:-

i. Pinhole at edge of field (not full aperture), Orange-Red bottom edge, deep Green-blue top edge, no change of colour with focus.
ii. Edge of field (full aperture of hole), Orange-Red(Claret) bottom edge, Deep Green-Blue top edge, all colours brighter
iii. Intermediate zone, Orange-claret bottom edge, deep Green-Blue top edge
iv. Centre field, entirely apochromatic

General points:- No focus change across field with varying oblique light. On normal viewing of plate x25 OK but x10 maximum usefulness. All colour bands exactly same size across field. All colour bands show no change of colours with oblique light except when they disappear in central zone.

Conclusion. See Spitta pages 337-341 for tests applied. The Swift-Holos combination is corrected for Photographic use, see pages 342, 343 for table of colours in oblique light.

P.S. It must be remembered that we are not looking at a proper computation, passable with errors, but on a lashed up combination with 2nd combination a pair, not a meniscus as it should be, therefore another kind of over-correction is present.

18th August 1978

Object of Experiment

To compare various objectives on the Test Plate

Method. As page 238 using test plate.

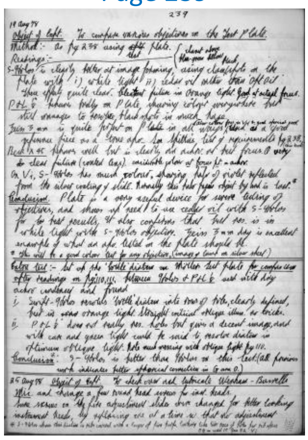
Readings:-

Swift-Holos, claret above, blue-green below, is clearly better at image forming, using close black dots on the plate with i. white light, ii. Cedar oil rather than 'Optoil'. These effects quite clear. Clearest picture in Orange light. Good at actual focus.

Powell and Lealand ⅛" behaves badly on Plate showing colour everywhere but still manages to resolve black spots in much haze.

Zeiss 3mm is quite perfect on Plate in all ways, also colour free in Vertical Illumination and good spherical correction. Used as a good reference piece as a true apochromat. See Spitta's list of requirements. Also see page 238 of this book.

Page 239



Beck x45 behaves well but is clearly an achromat at best focus. A very clear picture (coated lens), considerable colour at focus point – achromat.

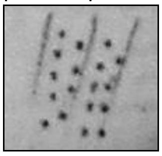
On Vertical illumination Swift-Holos has much colour, showing halo of violet reflected from the silver coating of slide. Normally this halo passes object by and is lost (This will be a good colour test for any objective [image of lamp on silver sheet])

Conclusion. Plate is very useful device for severe testing of objectives, and shows up need to use Cedar Oil with Swift-Holos for best results. It also confirms that best resolution is in white light with Swift-Holos objective. Zeiss 3mm dry is excellent example of what an apochromat tested on the plate should be.

Extra test:- Set up the 'bottle' diatom on Möller's Test Plate for comparison after readings on page 110, 111, between Holos and Powell and Lealand ⅛" used with dry achromatic condenser and found:

i. Swift-Holos resolves 'bottle' diatom into rows of holes, clearly defined, but in orange light. Straight critical oblique illumination, no tricks.
ii. Powell and Lealand does not really resolve holes but gives a decent image and with care and green light could be said to resolve diatoms in optimum oblique light. Note much messing with oblique light page 110.

Conclusion: Swift-Holos is better than Holos on this test (all previous work indicates spherical correction in Green and Orange) [Swift-Holos this diatom as ribs covered with a layer of five perforations looking like two rows of holes per rib space. Object glass used 10th January 1982 Vertical Illumination.



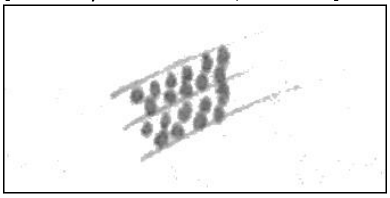
Check observation 5th **December 1982** at Beech Cottage

Same diatom: - Powell and Lealand: no resolution by Transmitted Illumination NA 1.0 or by Vertical Illumination however oblique.

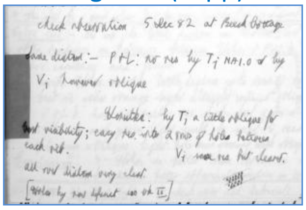
Koristka: by Transmitted Illumination a little oblique for best visibility; easy resolution into 2 rows of holes between each rib. Vertical Illumination some resolution but clearer.

All over diatom very clear.

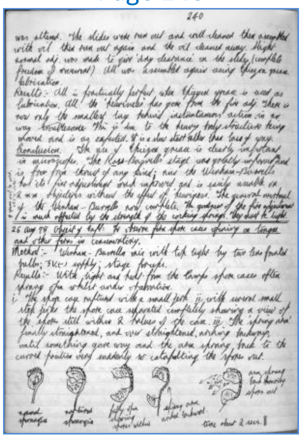
[Holos by now defunct, see Bk.II]



Page 239(supp)



Page 240



…was altered. The slides were run out and well cleaned then assembled with oil then run out again and the oil cleaned away. Slight normal adjustment was made to give 'dry clearance' in the slides (complete freedom of movement). All was assembled again using Apiezon grease lubrication.

Results:- All is practically perfect when Apiezon grease is used as lubrication. All the 'heaviness' has gone from the fine adjustment. There is now only the smallest lag behind instantaneous action, in no way troublesome. This is due to the heavy body structure being moved and is as expected. It is a slow start rather than loss of way.

Conclusion. The use of Apiezon grease is clearly important in microscopes. The Ross-Burrells stage was greatly improved and is free from thrust of any kind; now the Wenham-Burrells has its fine adjustment much improved and is easily usable on 2mm objectives without the effect of 'heaviness'. The general overhaul of the Wenham-Burrells now complete. The goodness of the fine adjustment is much affected by the strength of the cocking springs. They must be tight.

26th August 1978

Object of Experiment

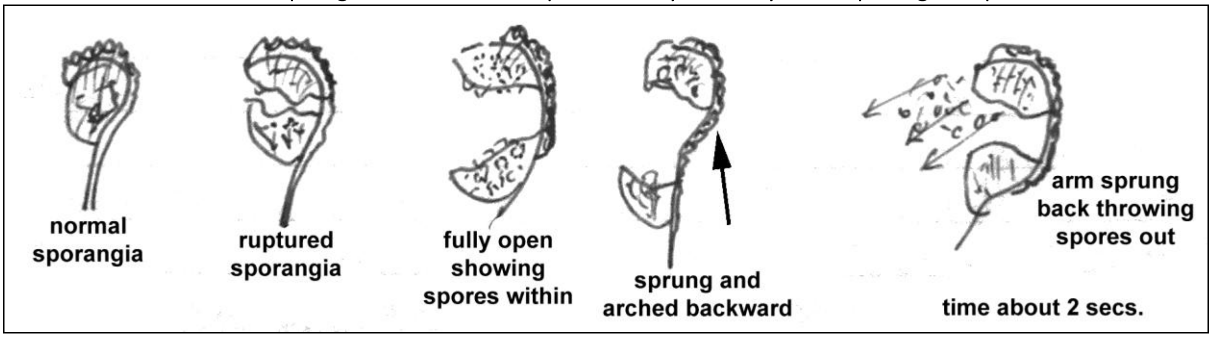
To observe fern spore cases spring on tongue (Harts Tongue?) and other ferns in conservatory.

Method:- Wenham-Burrells microscope with top light by two lens fronted bulbs; 3V(-) supply; stage forceps.

Results:- With light and heat from the lamps spore cases often sprang open whilst under observation.

i. The spore case ruptured with a small jerk.
ii. With several small step jerks the spore case separated completely showing a view of the spores still within 2 halves of the case

iii. The 'spring arm' finally straightened, and over straightened, arching backways, until something gave way and the arm sprang back to the curvet position very suddenly so catapulting the spores out.



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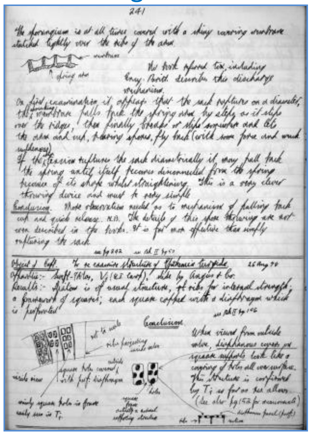
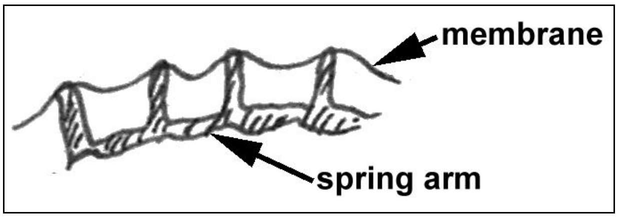
Page 241



The sporangium is at all times covered with a shiny membrane stretched lightly over the ribs of the arm.



No book, referred to, including Encyclopaedia Britannica describes this discharge mechanism.

On first examination it appears that the sack ruptures on a diameter, the shrinking membrane pulls back and the spring arm by steps as it slips over the ridges, then finally breaks or slips somewhere and lets the arm and cup, bearing spores, fly back (with some force and much suddenness).

If the skin tension ruptures the sack diametrically it may pull back the spring until itself becomes disconnected from the spring because of its shape whilst straightening. This is a very clever throwing device and must be very simple.

Conclusion. More observation needed as to mechanism of pulling back cup and quick release. NB. The details of this spore throwing are not even described in the books. It is far more effective than simply rupturing the sack.

See. Page 242. See Bk.II page 50.

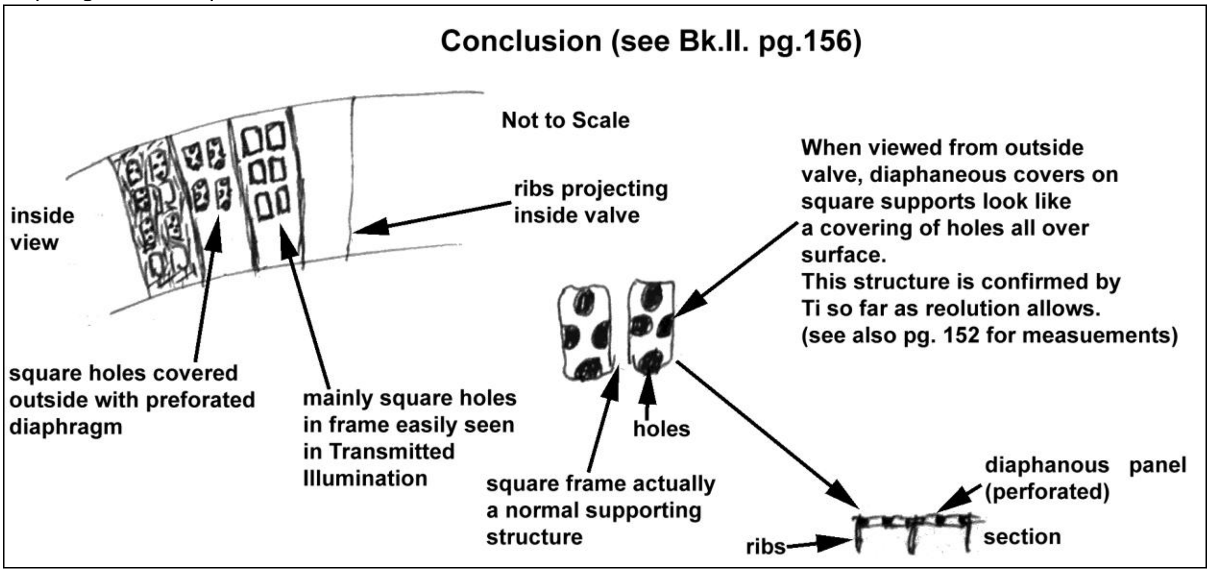
26th August 1978

Object of Experiment

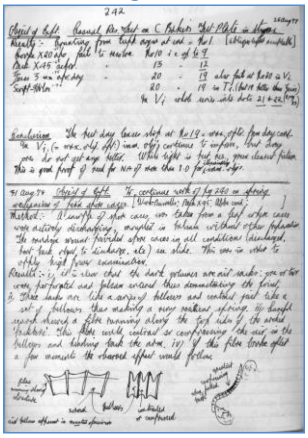
To re-examine structure of *Epithemia turgida*

Apparatus:- Swift-Holos, Vertical Illumination (Quartz Iodide lamp), slide by Angus & Co.

Results:- Diatom is of usual structure, ribs for internal strength, a framework of squares, each square capped with a diaphragm which is perforated.



Page 242



26th August 1978

Object of Experiment

Casual resolution test on C. Baker's Test Plate in Styrax

Results:- Counting from *Eupodicus argus* at end = No.1 (oblique light acceptable]

Cooke x20 apochromat (0.65) – Fails to resolve No.10 i.e. resolves up to 9

Beck x45 Achromat (0.65) fails to resolve 13 i.e. resolves up to 12

Zeiss 3mm apochromat, dry (0.95) fails to resolve 20 i.e. resolves up to 19 also fails at No.20. in Vertical Illumination.

Swift-Holos (1.3+) fails to resolve 20 i.e. resolves up to 19 in Transmitted Illumination (but 19 better than Zeiss). In Vertical Illumination whole series into dots 21 & 22 (easy 23)

Conclusion. The best dry lenses stop at No.19 = maximum aperture from dry condenser. In Vertical Illumination (=maximum objective aperture) immersion objectives continue to improve, but dry ones do not get any better. White light is best resolution, green clearest picture. This is good proof of need for NA more than 1.0 for illuminating immersion objectives.

Repairs to Zeiss Apo 6mm objective started again on 30th August 1978

[It did not look as good as expected on page 192.

It was decided to attempt to grind the middle lens of this combination lens (d) on page 182. This has its curves off proper axis due to rough repair job long ago without a rotating spindle.

1. Lens demounted and stuck on a turret (washer or nut) about $^3/_8$" Whitworth, which was about size to allow lens to sit in it correctly. Lens was stuck in with Evostick.
2. Nut and lens were stuck onto rotating grinding plate with Evostick and both moved about until reflection of a lamp (small) from lower surface stayed steady on rotation. All was then left to harden.
3. It was noted that the reflection from the upper surface wandered about a lot; this is the error. A card template was made as rough guide
4. A female tool was made of roofing pitch in a cork by pressing this onto the upper surface of the mounted lens when warmed by a candle.
5. When all had settled overnight, tool was worked over rotating lens by hand holding, with rouge and saliva.
6. 5 was unsatisfactory therefore a wood tool was made from a piece of ½ diameter dowel followed at the end by means of a convex bolt head worked into it with a hand drill (of roughly correct curve).
7. This rough tool was worked on the lens with 300 then 400 carborundum and soon became a good female as was known by the feel. About 1hr grinding was needed to bring error surface into axis with reference surface 2 above.
8. 500 carborundum was used, then finally rouge on the wood tool
9. Final polishing was by pitch tool 4 and rouge, ½hr from 8. Two reflections were nearly coincident except for wobble of grinding spindle. Decided to try lens. Dissolved off nut with methylated spirit.
10. Set up whole objective on Shadbolt turntable and balanced new lens in old bezel, and punched in with brush handle until all reflections were very nearly concentric. Sealed with shellac in bezel.
11. Some centring troubles, but polish OK. Test plate image sharp and black and white, though not right in centration of components.
12. Centring corrected, nearly coincidence of reflections. Left ot harden.

(see page 244)

31st August 1978

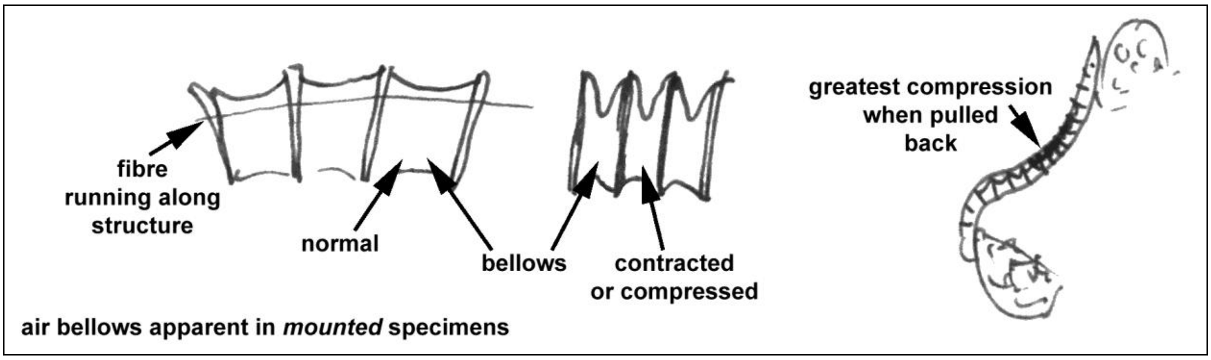
Object of Experiment

To continue work of page 240 on spring mechanism of fern spore cases. [Wenham-Burrells: Beck x45: Abbe condenser]

Method:- A sample of spore cases was taken from a leaf where cases were actively discharging, mounted in Balsam without other preparation. The random mount provided spore cases in all conditions (discharged, bent back about to discharge, etc.) see slide. This was in order to apply high power examination.

Results:-

i. It is clear that the dark volumes are air sacks: one or two were perforated and Balsam entered thus demonstrating the point
ii. These sacks are like a series of bellows and contract just like a set of bellows thus making a very resilient spring
iii. Careful search showed a fibre running along the top sides of the arched 'backbone'. This fibre could contract so compressing the air in to bellows and bending back the arm
iv. If this fibre broke after a few moments the observed effect would follow.



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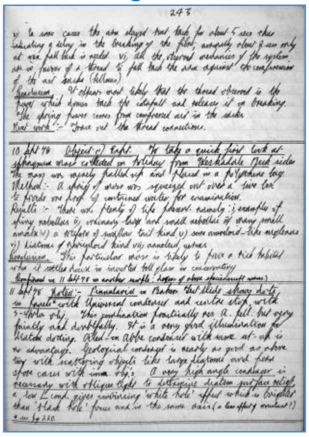
Page 243



v. In some cases the arm stayed bent back for about 5 seconds thus indicating a delay in the breaking of the fibre; normally about 2 seconds only at maximum pull back is needed.

vi. All the observed mechanics of the system are in favour of a thread to pull back the arm against the compression of the air sacks (bellows).

Conclusion. It appears most likely that the thread observed is the power which draws back the catapult and releases it on breaking. The spring power comes from compressed sir in the sacks.

Next work:- Trace out the thread connections.

10th September 1978

Object of Experiment

To take a quick first look at sphagnum moss collected on holiday from Keskadale Beck sides.

The moss was merely pulled up and placed in a polythene bag.

Method:- A sprig of moss was squeezed out over a live box to provide one drop of contained water for examination.

Results:- There was plenty of life present, namely i. examples of spiny *nebellas*, ii. Ordinary large and small *nebellas*, iii. many small amoeba, iv. A rotifera of swallow tail kind, v. some amoeboid-like euglenas, vi. Diatoms of naviculoid kind, vii. Annelid worms.

Conclusion. This particular moss is likely to prove a rich habitat when it settles down in inverted bell glass in conservatory.

Confirmed on 11 September 1978 on another sample: dozens of above species (except worms).

11th September 1978

Noted: *Pinnularia* in Bakers Test slide shows dots in panels* with Universal condenser and centre stop, with Swift-Holos objective. This combination practically resolves *Amphipleura pellucida* but very faintly and doubtfully. It is a very good illumination for diatom dotting. Oiled-on Abbe condenser with same set-up is no advantage. Geological condenser is nearly as good as above two with scattering objects like large diatoms and fern spore cases with immersion objectives. A very high angle condenser is necessary with oblique light to determine diatom surface relief, a low angle condenser gives convincing 'white hole' effect which is brighter than 'black hole' focus and in the same axis (= lens effect of mountant?)

* See page 220.

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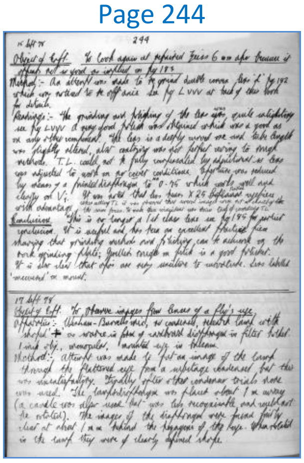


15th September 1978

Object of Experiment

To look again at repaired Zeiss 6mm Apochromat because it appears not so good as implied on page 183.

Method:- An attempt was made to re-grind double convex lens 'd' page 182 which was noticed to be off axis. See page LVVV at back of this book for details.

Readings:- The grinding and finishing of the lens was quite satisfactory see page LVVV. A very good polish was obtained which was as good as on any other component. The lens is a deeply curved one and tube length was slightly altered, also centring was not perfect owing to rough methods. Tube length could not be fully compensated by adjustment so lens was adjusted to work on no cover conditions. Aperture was reduced by means of a printed diaphragm to NA 0.75 which works well and clearly on Vertical Illumination. It was noted that bears x25 ~~Coplanar~~ Periplan eyepiece with advantage. When setting tube length it was observed that several images were not at exactly the same focus. To make them coincident was main task of correcting tube length.

Conclusion. This is no longer a 1st class lens see pg185 for earlier conclusion. It is useful and has been an excellent practice piece showing that grinding methods and polishing can be achieved on the rock grinding plate; Jeweller's rouge in pitch is a good polisher. It is also clear that apochromats are very sensitive to curvature. Lens labelled 'uncovered' on mount.

17th September 1978

Object of Experiment.

To observe images from lenses of a fly's eye.

Apparatus: Wenham-Burrells microscope, no condenser, research lamp with shaped -

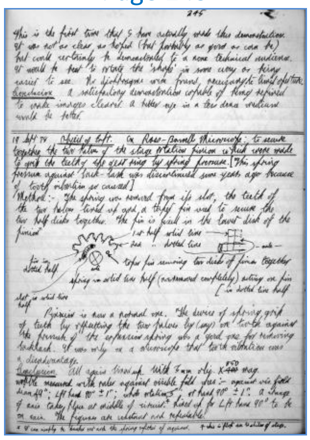
As source in form of cardboard diaphragm in filter holder; 1 inch objective, monocular, mounted eye in balsam.

Method:- Attempt was made to put an image of the lamp through the flattened eye from a substage condenser but this was unsatisfactory. Finally after other condenser trials none was used. The lamp and diaphragm was placed about 1 metre away (a candle was also used that was less recognisable and could not be rotated). The images of the diaphragm were found fairly clear at about 1mm behind the hexagons of the eye. When rotated in the lamp they were more of clearly defined shape. *(next page)*

This is the first time that I have actually made this demonstration. It was not as clear as hoped (but probably as good as can be) but could certainly be demonstrated to a non-technical audience. It would be best to rotate the 'shape' in some way or being easier to see. No diaphragms were found necessary to limit aperture.

Conclusion. A satisfactory demonstration capable of being refined to make image clearer. A better eye in a less dense medium would be better.

Page 245



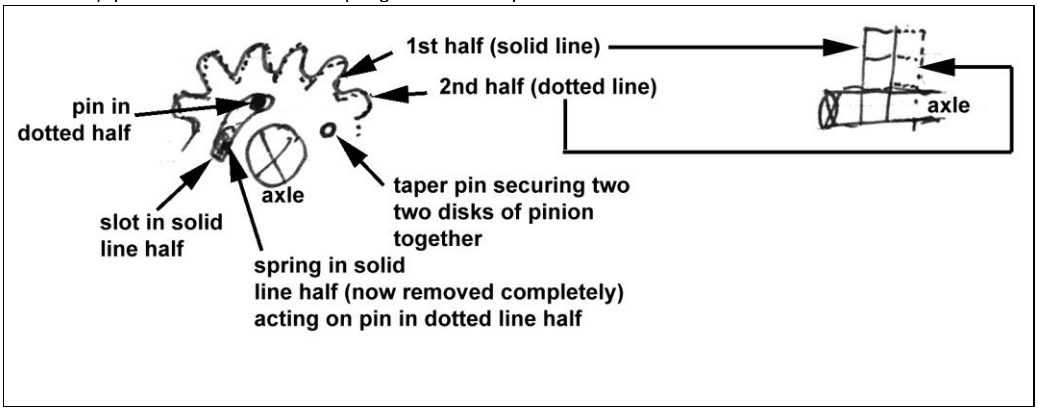
19th September 1978.

Object of Experiment

On Ross-Burrell Microscope: to secure together the two halves of the stage rotation pinion which were made to grip the teeth of the gear ring by spring pressure. [This spring pressure against back-lash was discontinued some years ago because of tooth vibration so caused.]

Method:- The spring was removed from its slot, the teeth of the two halves lined up and a taper pin used to secure the two half disks together. The pin is fixed in the lower disk of the pinion*.

*It can simply be knocked out and the spring re-fitted if required.



Pinion is now a normal one. The device of spring grip of teeth by offsetting the two halves by (say) one tooth against the pressure of the expansion spring was a good one for removing backlash. It was only on a microscope that tooth vibration was a disadvantage.

Conclusion. All again lined up. With 3mm objective x850 magnification wobble measured with ruler against visible field was:- against visible field diameter of 9"; left hand 90° ± 1"; whole rotation 3"; right hand 90° ± 1. A change of axis takes place at middle of circuit*. Lined up for left hand 90° to be on axis. The figures are constant and repeatable.

*this is 'flop' due to slides of stage.

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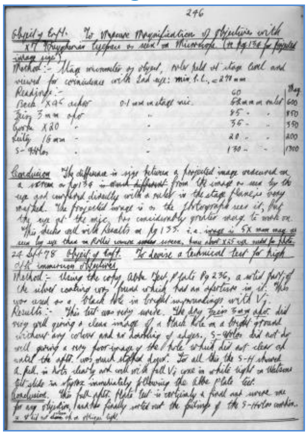


Object of Experiment

To measure magnification of objectives with x7 Huyghenian eyepiece as seen on microscope (re: page 134 for projected image size)

Method:- Stage micrometer as object, ruler held at stage level and viewed for coincidence with 2nd eyepiece; minimum tube length – 270mm

Readings:- (all at 0.1mm on stage micrometer)

Beck x45 achromat	60mm on ruler	x600
Zeiss 3mm apochromat	85mm on ruler	x850
Cooke x20 apochromat	35mm on ruler	x350
Leirz 16mm apochromat	20mm on ruler	x200
Swift-Holos apochromat	130mm on ruler	x1300

Conclusion. The difference in size between a projected image measured on a screen as page 134 from the image as seen by the eye and compared directly with a ruler in the stage plane is very marked. The projected image is as the photograph sees it; but the eye at the microscope has considerably greater magnification to work on. This checks well with results on page 133. i.e. image is 5x more magnified as seen by eye than on Rolleiflex camera screen, hence about c25 eyepiece needed for photo.

24th September 1978

Object of Experiment

To devise a technical test for high aperture immersion objectives

Method:- Using the copy Abbe Test plate page 236, a solid part of the silver coating was found which had an aperture in it. This was used as a black hole in bright surroundings with Vertical Illumination.

Results:- This test was very severe. The dry Zeiss 3mm apochromat did very well giving a clean image of a black hole on a bright ground without any colour and no doubling of edges. Swift-Holos did not do well giving a poor image of the hole which did not clear up until the aperture was much stepped down (It did not clean up on oblique light). For all this the Swift-Holos showed *Amphipleura pellucida* in dots clearly and well with full Vertical Illumination cone in white light on Watson's test slide in Styrax immediately following the Abbe plate test.

Conclusion. This full aperture plate test is certainly a final and severe one for any objective, and has finally sorted out the failings of the Swift-Holos combination.

25th September 1978

Object of Experiment

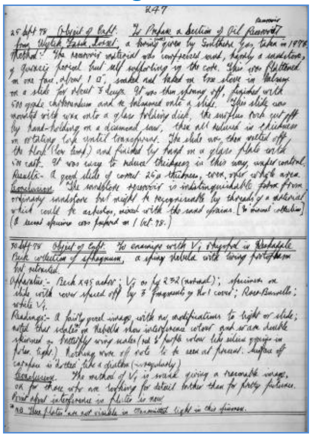
To prepare a section of Oil Reservoir from Wytch Farm, Dorset, a boring (core) by Southern Gas taken in 1978.

Method:- The reservoir material was compressed sand, hardly a sandstone, of Jurassic period but self-supporting in the core. This was flattened on one face about 1" square, soaked and baked on Esse stove in Balsam on a slide for about 3 days. It was then sprung off, finished with 500 grade carborundum and re-balsamed onto a slide. This slide was mounted with wax onto a glass holding disk, the surplus rock cut off by hand holding on a diamond saw, then all reduced in thickness on rotating lap until transparent. The slide was then melted off the block (low temperature) and finished by hand on a glass plate with 500 carborundum. It was easy to reduce thickness in this way, under control.

Results:- A good slide of correct 25µ thickness, even, over whole area,

Conclusion. The sandstone reservoir is indistinguishable from ordinary sandstone but might be recognisable by threads of a material which could be asbestos, mixed with the sand grains [in 'mineral' collection] (A second specimen was prepared on 1st October 1978)

Page 247



30th September 1978

Object of Experiment

To examine with Vertical Illumination rhizopod in Keskadale Beck collection of Sphagnum, a tiny *Nebella* with living protoplasm but retracted.

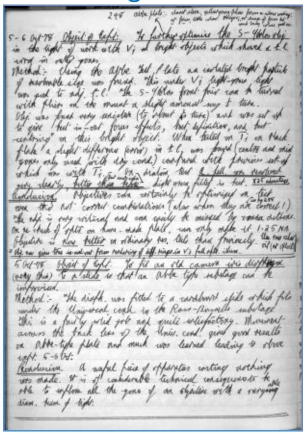
Apparatus:- Beck x45 achromat; Vertical Illumination as page 232 (normal); specimens on slide with cover spaced off by 3 fragments of No.1 cover; Ross-Burrells; white Vertical Illumination.

Readings:- A fairly good image with no modifications to light or slide; noted that scales* on *Nebella* show interference colour and so are double skinned as butterfly wing scales (red to purple colour like silica grains in polarised light). Nothing more of note to be seen at present. Surface of carapace is dotted like a diatom (irregularly).

Conclusion. The method of Vertical Illumination is sound giving a reasonable image, OK for those who are looking for detail rather than for pretty pictures. Point about interference in plates is new.

*NB. These plates are not visible in transmitted light in this specimen.

Page 248



5-6 October 1978

Object of Experiment

To further optimise the Swift-Holos objective in the light of work with Vertical Illumination on bright objects which showed a tube length error in outer zones. (Abbe plate: claret above, yellow green below focus on silver coating: at focus, little colour. Oblique Vertical Illumination no change of focus much secondary colours, good resolution.)

Method:- Using the Abbe Test Plate an isolated bright particle of resolvable size was found. This under Vertical Illumination light-green light was used to adjust tube length, The Swift-Holos front pair can be turned with pliers on the mount a slight amount say ½ turn.

Objective was found very sensitive (to about $\frac{1}{40}$ turn) and was set up to give best in-out focus effects, but definition, and best centring (objective now gives true in-and-out focus rendering of diffusion rings in Vertical Illumination, full aperture illumination) on this bright object. When tested on Transmitted Illumination on black flake a slight difference (error) in tube length was found (centre and mid zones only used with dry condenser) compared with previous set-up which was with Transmitted Illumination. On diatom test *Amphipleura pellucida* was resolved very clearly, better than before (best ever seen). Light green filter is best. X25 advantage.

Conclusion. Objectives can certainly be optimised on test even though not correct combinations (also when they are correct!) see page 285.

The adjustment is very critical and can easily be missed by coarse actions. On re-check of aperture on home-made plate, can only make it 1.25NA. Objective is now better in ordinary resolution tests than previously. Use raw Cedar Oil (not Optoil).

5th October 1978

Object of Experiment

To fit an old camera iris diaphragm (very thin) to a slide so that an Abbe type substage can be improvised.

Method:- The diaphragm was fitted to a cardboard slide which fits under the Universal condenser in the Ross-Burroughs substage. This is a fairly solid job and quite satisfactory. Movement across the back lens of the Universal Condenser gives good results on Abbe-type plate and much was learned leading to above experiment 5-6 October.

Conclusion. A useful piece of apparatus costing nothing was made. It is of considerable technical consequence to be able to explore all the zones of an objective with a variable diameter beam of light.

8th October 1978

Object of Experiment

Structure of Objectives.

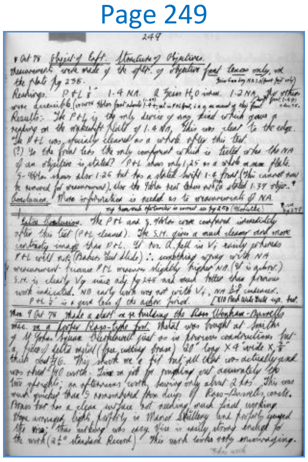
Measurements were made of the aperture of objective front lenses only on the plate page 238.

Readings:- Powell and Lealand $\frac{1}{8}$" 1.4NA, a Zeiss H2O immersion 1.2NA. No others were accessible (27th October 1978 Holos front admits 1.4+(1.43); mounted in Powell and Lealand front i.e. a re-mount of this front – Swift front 1.4(+) 6th December 1978.

Results:- The Powell and Lealand is the only device of any kind which gave a reading on the makeshift plate of 1.4NA. This was clear to the edge. The Powell and Lealand was specially cleaned as a whole after this test.

(?) Is the front lens the only component which is tested when the NA of an objective is stated? Powell and Lealand shows only 1.25 as a whole on the same plate. Swift-Holos shows also 1.25 but has a stated Swift 1.4 front (this cannot now be removed

Page 249



for measurement). Also the Holos rear lenses are from a stated 1.37 objective (see page 279).

Conclusion. More information is needed as to measurements of NA.

My home-made apertometer is correct – see page 250 (Koristka)

Extra Conclusion. The Powell and Lealand and Swift-Holos were compared immediately after this test (Powell and Lealand cleaned). The Swift-Holos gives a much clearer and more contrasty image than the Powell and Lealand. It resolves *Amphipleura pellucida* in Vertical Illumination easily whereas Powell and Lealand will not (Baker's Test Slide). Therefore something wrong with NA measurement because Powell and Lealand measures slightly higher NA (it is achromatic). Swift-Holos is clearly very good since adjustment (page 248) and much better than previous work indicated. NB. early work was not with Vertical Illumination, NA 1.0 condenser. Powell and Lealand ⅛" is a good lens of the achromat period. [x10 Beck Wide Field Eyepiece best]

Monday 9th October 1978

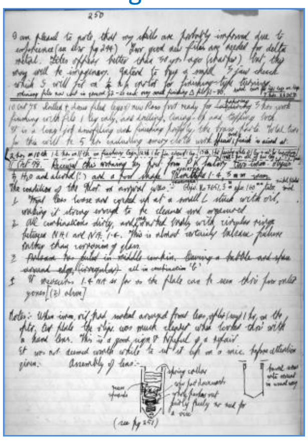
Made a start re-building the Wenham-Burrells microscope on a proper Ross-type Foot.

Metal was bought at Smiths of St. Johns Square, Clerkenwell, just as in previous construction, but a piece of Delta metal (free cutting brass) 20" long x 4' wide x $^3/_8$" thick cost £16. This shook me a bit but all that was actually used was about £10 worth. Time on job for roughing out accurately the two uprights; an afternoons work. Sawing only about 2 hours. This was much quicker than I remembered from days of Ross-Burrells construction. Brass bar has a clean surface not needing much final working. Have arrange lights properly in Manor scullery and properly secured the vice, thus working was easy. Vice is easily strong enough for the work (2½" standard Record). This work looks very encouraging.

(34 hours work)

(next page)

Page 250



I am pleased to note that my skills are probably improved due to experience (see also page 244). Two good new files are needed for delta metal. Files appear better than 30 years ago (sharper) but this may well be imaginary. Intend to buy a small 3 jaw chuck which I will fit on ¼hp motor for finishing-type turning.

Ordinary files now cost in general £2.20 each; very small finishing triangular file £1.30.

10th October 1978

Drilled and draw filed legs of new Ross ready for papering 3 hours work, finishing with file, 1 leg only, and drilling, lining-up and tapping both. It is a long job draw-filing and finishing properly the brass parts. Total time for this will be 5hrs excluding emery cloth work. Special, good finish is aimed at.

2hrs on 10th, 1½ hours on 11th on finishing legs.

12th 1 hour finishing edges of 1 leg.

13th 1 hour finishing whole of 1 leg and mount for lacquering.

18th 1½ hours for all of 2nd leg.

Total time on improved legs – 7 hours 26th October 1978.

Note: 20th October 1978

Time taken to prepare two Ross base legs for a new stand from purchased bar brass = 7 hours. Most time taken finishing to Ross standard for lacquering (lacquering not included in 7 hours). Draw file all surfaces finishing with fine triangular file; emery paper stuck on metal support for first cleaning; one broad sweep of emery on a wide supporting bar of hardwood for final 'grain'. Finish = Ross and Powell and Lealand in Oxford Museum. Actually, finish on Powell and Lealand "R.L." stand is not so good as mine.

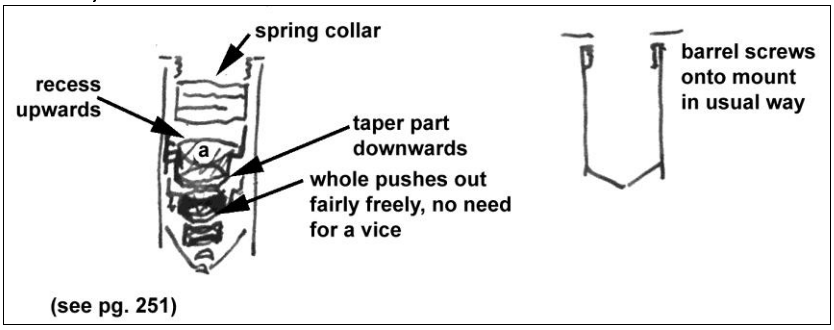
11th October 1978.

Received this morning by post from P. K. Sartory two immersion objectives, ⅐ water and alcohol(!) and a poor shape Koristka 1.4, 3mm immersion.

The condition of the Koristka on arrival was:- Objective No.3651, 3mm, apochromat, 160mm tube length, nickel plated barrel.

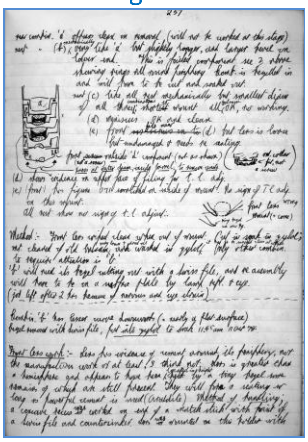
1. Front lens loose and cocked up at a small angle, stuck with oil, making it string enough to be cleaned and measured
2. All combinations dirty, and one marked badly with circular rings between NA 1 and NA 1.4. This is almost certainly Balsam failure rather than corrosion of glass.
3. ~~Balsam has failed in middle combination, leaving a bubble and space around edge (irregular), all in combination (b).~~
4. It measures 1.4NA so far as the plate can be seen through poor outer zones (2. Above)

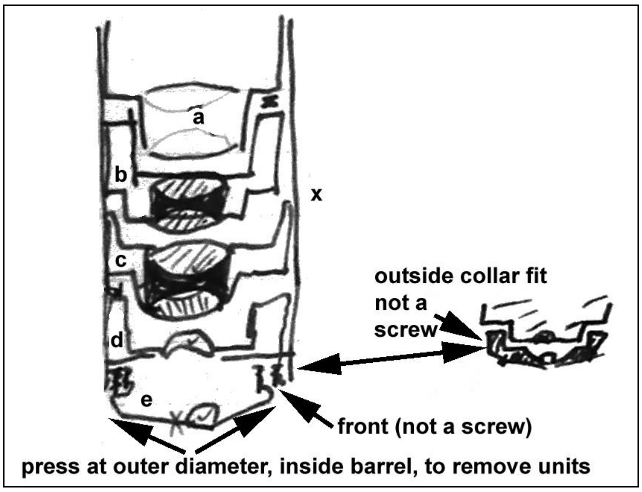
Notes:- When immersion oil had soaked around front lens, after (say) 1 hour on the aperture test plate the objective was much clearer when looked through with a hand lens. This is a good sign and hopeful of a repair.
It was not deemed worthwhile to set it up on a microscope before attention given.
Assembly of lens:-



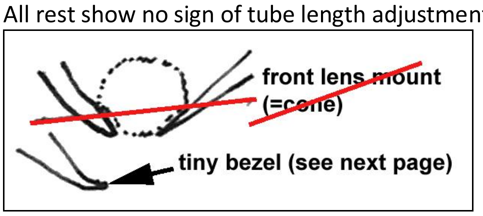
Rear combination 'a' appears clean on removal (will not be worked at this stage)
Next combination 'b' mechanically very like 'a' but slightly longer, and larger bevel on lower end. This is failed component, see 2. above, showing rings all round periphery. Combination is 'bezelled' in and will have to be cut and soaked out.
Next 'c' like all rest mechanically, but smallest diameter of all three combinations; shorter mount. All Balsam OK, no working.
'd' meniscus, OK and clean.
'e' front fits over 'd' but lens is loose but undamaged and needs re-seating.

Page 251





'd' shows evidence on upper face of filing for tube length adjustment.
'e' (front) has figure 071 scratched on inside of mount. No sign of tube length adjustment on this mount.
All rest show no sign of tube length adjustment.



Method:- Front lens wiped clean when out of mount. Put in soak in xylol. Mount cleared of old Balsam (very brown) and dried oil and washed in xylol (it had to be scraped clear at edges). Only other combination to require attention is 'b'. 'b' will need its bezel cutting out with a Swiss file, and re-assembly will have to be on a surface plate by lamp reflection and eye. (Job left after 2 hours because of nervousness and eye strain.) Combination 'b' has lesser curve downwards (= nearly flat surface). Bezel removed with Swiss file, put into xylol to soak, 11.45am 11th October 1978.

Front lens work:- Lens has evidence of cement around its periphery, not the manufacturers work or at least, I think not. Lens is greater than a hemisphere and appears to have been located in height by a tiny bezel some remains of which are still present. They will form a seating so long as powerful cement is used (Araldite).

Method of handling:- A concave recess was worked on end of a matchstick with point of a Swiss file and countersink. Lens was mounted on this holder with…*(next page)*

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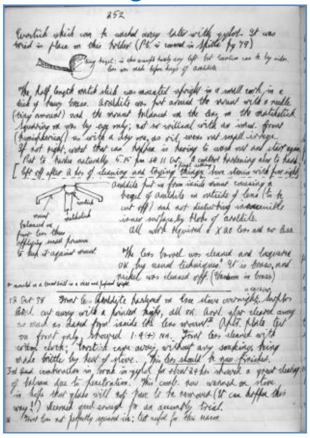
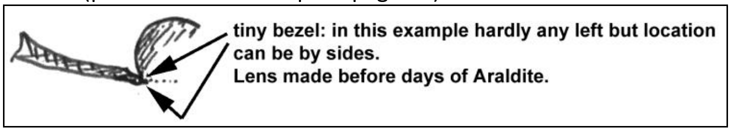
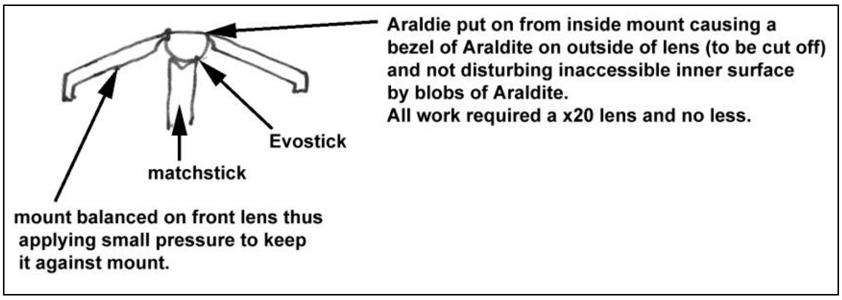


…Evostick which can be washed away later with xylol. It was tried in place on this holder. (point is covered in Spitta page 79)



The half-length matchstick was mounted upright in a small cork in a disk of heavy brass. Araldite was put around the mount with a needle (tiny amount) and the mount balanced on the lens on the matchstick. Squaring on was by eye only; not so critical with an immersion front (hemispherical) as with a dry one, as oil evens out small irregularities. If not right; worst that can happen is having to wash out and start again. Put to harden naturally 5.15pm 11th October. A control hardening also to hand. Left off after 2 hours of cleaning and trying things and final setting. Some strain with poor sight.



The lens barrel was cleaned and lacquered OK by usual techniques*. It is brass, and nickel was cleaned off (Handsome in brass)

*mounted on a breast drill in a vice and papered bright.

12th October 1978

Front lens Araldite hardened on Esse stove overnight (100th to 12th October). Surplus Araldite cut away with a pointed knife, all OK. Araldite also cleared away as much as dared from inside the lens mount*. Aperture plate test on front only, showed 1.4(+) NA. Front lens cleaned with cotton cloth; Evostick came away without any soaking, being made brittle by heat on stove. This lens should be now finished.

3rd combination in soak in xylol for about 24 hours showed a great clearing of Balsam due to penetration. This combination now warmed on stove in hope that glass will not have to be removed (it can happen this way!) Deemed good enough for an assembly trial.

*Front lens not perfectly squared in; test useful for this reason.

(next page)

After 3 hours heating on warm stove lens remained fairly clear but an air space appeared where xylol had penetrated then evaporated. Lens re-soaked for general examination by stacking up the components on the aperture plate. There was a limit of NA between 1.34 and 1.4 due to Araldite on the margin of the front lens. This was clearly visible and recognizable by looking at the back lens. More Araldite was removed from inside of mount with a needle by hand and on re-check aperture was 1.4. This is as far as one dare go so front was finally cleaned.

Lens was assembled but result was disappointing. Much disturbance from faulty "b", Decided this must be got out. Assembly was perfectly apochromatic.

'b' combination got out OK by heating gently on hot plate and punching out lenses with a cork pusher mounted on a nail head. Lens mount was rested in a nut so that lenses have clear push-out onto a piece of paper on hot plate. Left in xylol soak overnight. NB. 'b' lens with smallest curvature is downwards.

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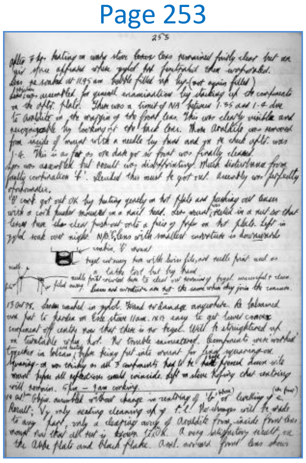
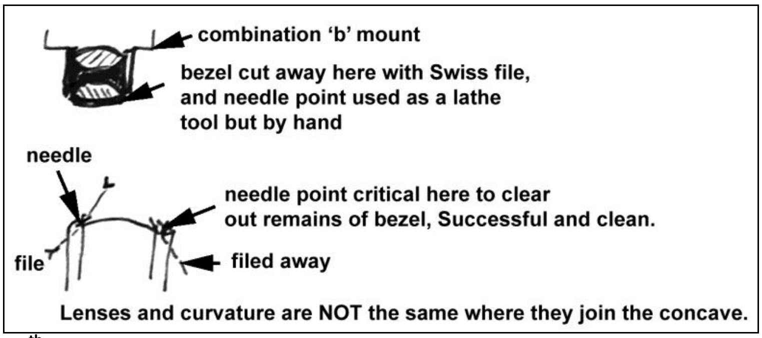




13th October 1978

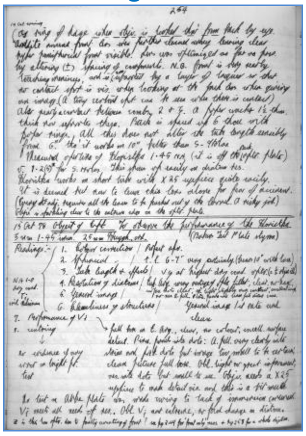
Lenses washed in xylol. Found no damage anywhere. Re-balsamed and put to harden on Esse stove 11am. NB. easy to get lower convex component off centre not that there is no bezel. Will be straightened up on turntable when hot. No trouble encountered. Components were 'worked' together in Balsam and heated before being put into mount for final squaring-on.

Squaring-on was tricky as all 3 components had to be hard pressed down into mount before all reflections would coincide. Left on stove hoping that centring will remain. 5pm-9am cooking.

19th October. pm. Objective assembled without change in centring of 'b' (above) or levelling of e (the front).

Result:- Very good, only a clearing up of tube length. No changes will be made to any part, only a clearing away of Araldite from inside front lens mount now that all rest is known to be OK. A very satisfactory result on the Abbe plate and black flake. Araldite around front lens shows…*(next page)*

Page 254



…as ring of haze when objective is looked through from back by eye.

14th October evening Araldite around front lens even further cleaned away leaving clear type hemispherical front visible. Lens was optimised as far as possible by altering (±) spacing of components. NB. front is very nearby leading meniscus, and is now separated by a layer of lacquer so that no contact spot is visible when looking at the back lens when giving an image. (A tiny central spot can be seen when there is contact.)

Also nearly a contact between combinations 2 and 3. A paper washer 1½ thou thick now separates these. Back is spaced up 6 thou with paper rings. All this does not alter the tube length sensibly from 6" though it works on 10" better than Swift-Holos.

Measured aperture of Koristka 1.45NA (it is off the Beck aperture plate) v. 1.2(5)* for Swift-Holos. This shows up easily on diatom resolution.

Koristka works on short tube with x25 eyepiece quite easily. It is deemed best now to leave this lens alone for fear of accident. (Every adjustment requires all the lenses to be pushed out of the barrel. A risky job.) Objective is sparkling clear to the extreme edge on the aperture plate.

15th October 1978

Object of Experiment

To observe the performance of the Koristka 3mm, 1.45 immersion, 25mm Huyghenian. (Baker's Test Plate in Styrax)

Readings:-

1. Colour Correction / Perfect Apochromat
2. Spherical correction / tube length 6-7" very certainly (bears 120"with loss)
3. Tube length and effects / very good at highest dry condenser aperture (=½ objective illuminated)
4. Resolution of diatoms / *Eupodiscus argus*, every vestige of aperture filled; clear, no haze
5. General image / surface dots clear, in green light slightly more contrast; excellent image, no resolution of *Amphipleura pellucida*. *Pinnularia* panels into lines full distinct cone.
6. Cleanliness of structure / General image 1st rate and clean
7. Performance of Vertical Illumination / full cone in *Epithemia argus*, clear, no colour, excellent surface detail. *Pinnularia* panels into dots. *Amphipleura pellucida* very clearly into striae and probably dots but image too small to be certain; clean picture, full bore. Oblique light no great improvement, resolved into dots but small to see. Objective needs a x25 eyepiece to make details visible and this is a bit much.

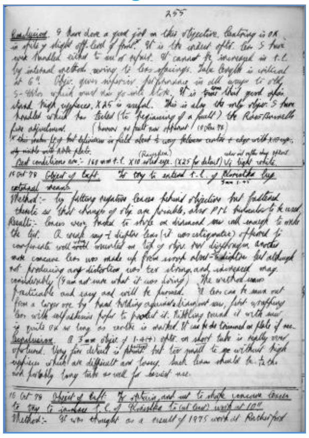
No test on Abbe plate was made owing to lack of immersion condenser.

Vertical illumination meets all needs of resolution. Oblique Vertical Illumination most extreme, no focal change on diatom.

*is this low aperture due to faulty mounting of front? See page 249 for ;front only' measurements and page 258 for a whole objective.

(next page)

Page 255



Conclusion. I have done a good job on this objective. Centring is OK in spite of slight off level of front*. It is the widest aperture lens I have ever handled either to use or repair. It cannot be increased in tube length by internal methods owing to lens spacings, Tube length is critical at 6". Objective gives superior performance in all ways to old Swift-Holos which must now go into store. It is true that good apochromats stand high eyepieces, x25 is useful. This is also the only objective I have handled which has tested (to beginning of a fault) the Ross-Burrells fine adjustment (however no fault now apparent 10th December 1978)

*~~this makes point of best definition about ½ way between centre and edge with x10 eye, only visible with Abbe plate.~~

Best conditions are:- 160mm tube length, x10 solid eye (x25 for detail) Vertical Illumination, white light.

15th October 1978

Object of Experiment.

To try to extend tube length of Koristka by external means.

Method:- by fitting negative lenses behind objective but fastened thereto so that changes of objective are possibly, also Powell and Lealand binocular to be used.

Results:- Lenses were hacked to shape on diamond saw well enough to make the test. A weak (say =1 dioptre lens (it was astigmatic) appeared to compensate well when mounted on top of slip. Rear diaphragm. Another more concave lens was made up from scrap about -⅓ dioptre but although not producing any distortion was too strong and increased magnification considerably (I am not sure what it was doing). The method seems practicable and easy and will be pursued. A lens can be sawn out from a larger one by hand holding against a diamond saw, first wrapping lens with self adhesive paper to protect it. Nibbling round it with a saw is quite OK so long as centre is marked. It can be trimmed on a plate if necessary.

Conclusion. A 3mm objective of 1.4(+) aperture in short tube is really over apertured. Very fine detail is present but too small to see without high eyepieces which are difficult and lossy. Such lenses should be 1.12ths and probably long tube as well for easiest use.

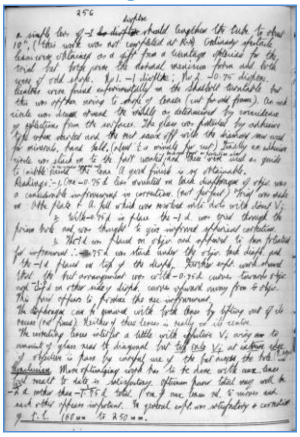
16th October 1978

Object of Experiment

To obtain and cut to shape concave lenses to try to increase tube length of Koristka to (at least) work at 10".

Method:- It was thought as a result of 1975 work at Rutherford…*(next page)*

Page 256



…a simple lens of -1 dioptre should lengthen the tube to about 10", (this work was not completed at Ruth.). Ordinary spectacle lenses were obtained as a gift from a Wantage optician for the trial but both were the normal meniscus form and both were of odd shape. No.1. -1 dioptre; No.2. -0.75 dioptre. Centres were found experimentally on the Shadbolt turntable but this was approximately owing to shape of lenses (cut for odd frames). An ink circle was drawn around the middle as determined by coincidence of reflections from the surfaces. The glass was protected by adhesive tape where wanted and the rest sawn off with the diamond saw used for minerals, hand held (about ½ a minute per cut). Finally an adhesive circle was stuck on to the part wanted, back and front as protection also, and these were used as guides to nibble round the lens (on the circular diamond saw). A good finish is so obtainable.

Readings:-

1. One -0.75 dioptre lens mounted in back diaphragm of objective was a considerable improvement in correction (not perfect). Trial was made on Abbe plate and *Amphipleura pellucida* which was resolved into dots with direct Vertical Illumination.
2. With -0.75 dioptre in place the -1 dioptre was tried through the prism hole and was thought to give improved spherical correction.
3. The -1 dioptre was placed on objective and appeared to have potential for improvement, therefore -0.75 dioptre was stuck under the objective back diaphragm and the -1 dioptre placed on top of the diaphragm. Further experiment work showed that the best arrangement was with -0.75 dioptre curves towards

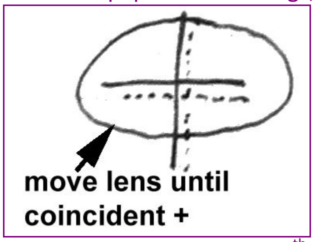
objective and -1.0 dioptre in other side of diaphragm curves upward away from objective. This pair appears to produce the necessary improvement.

The diaphragm can be removed with both lenses by lifting out of its recess (not fixed). Neither of these lenses is really on its centre.

The correcting lenses interfere a little with effective Vertical Illumination owing to amounts of glass near to diagonal but top rate Vertical Illumination at extreme edge of objective is possible by careful use of the bar across the hole (*Coscinodiscus argus* used).

Conclusion. More optimising work has to be done with auxiliary lens but result to date is satisfactory. Optimum power total may well be -½dioptre rather than -1.75 dioptre total. Position of auxiliary lens related to curves and each other appears important. In general experiment was satisfactory and correction of tube length 160mm to 250mm.

To find centre of double curved spectacle lens:-
Put '+' on paper about 2" legs; move lens about until arms of cross do not move as lens is rotated.



(method used successfully 4th April 1979 to cut meniscus)

Appendix note to page 256.
Auxiliary lenses increase magnification of objective a tiny amount. 1.4 Koristka objective stands higher eyepiece than $^1/_{12}$" Swift-Holos, therefore x10 against x7 is OK. Therefore magnification of two systems is about the same.
[total x25 needed for 160mm tube length and 3mm focal length ~ x10 for 2mm long tube]
See page LVVVI for correct method of finding centre of double curved lens.

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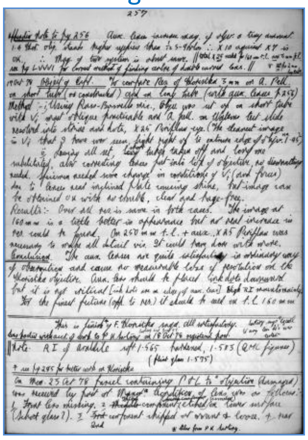


17th October 1978
Object of Experiment
To compare resolution of Koristka 3mm on *Amphipleura pellucida* on short tube (as constructed) and on long tube (with auxiliary lenses page 256)

Method:-

i. Using Ross-Burrells microscope, objective was set up on short tube with Vertical Illumination, most oblique practicable and *Amphipleura pellucida* on Watson's test slide. Resolved into striae and dots, x25 Periplan eyepiece (the cleanest image in Vertical Illumination that I have ever seen, light right up to extreme edge of objective NA 1.45)
ii. Leaving all set, short tube taken off and long one substituted, also correcting lenses put into top of objective, no dismantling needed. Specimen needed some change in conditions of Vertical Illumination (and focus) due to lenses near inclined plate causing shine, but image can be obtained OK with no trouble, clear and haze-free.

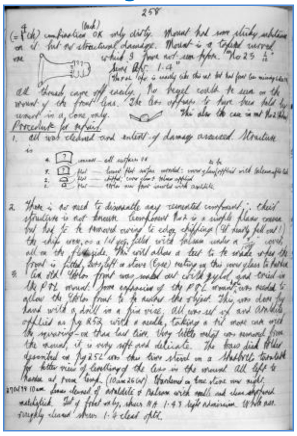
Results:- Overall resolution is same in both cases. The image at 160mm is a little better in appearance but no real increase in resolution could be found. On 250mm tube length and auxiliary, x25 Periplan was necessary to make all detail visible. It could have done with more.
Conclusion. The auxiliary lenses are quite satisfactory in ordinary way of observation and cause no measurable loss of resolution on the Koristka objective. Auxiliary lens should be placed 'ink dots' downwards but it is not critical [ink dots are on edge of auxiliary lens). High refractive index mounts mainly.
For the finest picture (opposed to resolution) it should be used on tube length 160mm.
This is finish of F. Koristka saga. All satisfactory.. Lens posted with account of work to P. K. Sartory on 18th October 1978 registered post. (Sartory died June 1983). Sartory says "equal to any lens he's ever tested".
See page 285 for better work on Koristka.

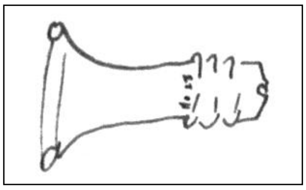
Note: Refractive index of Araldite – soft 1.565, hardened 1.583 (QMC figures). (flint glass 1.575)

On Monday 23rd October 1978 parcel containing Powell and Lealand 1.12” objective (damaged) was received by post at Manor (also form P. K. Sartory). Condition of lens was as follows:

1. Front lens missing
2. Third component corroded, etched on lower surface (Schott glass?)
3. 2nd component chipped at mount and loose
4. Rear…*(next page)*

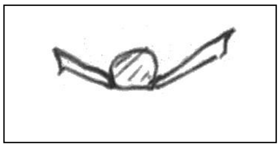
Page 258





…(4th) combination (back) OK only dirty. Mount had more sticky substance on it but no structural damage. Mount is a tapered curved one which I have not seen before. No.23 $\frac{1}{12}$” Semi-Apo. 1,4. (The Powell and Lealand apochromat is exactly like this mount but had front lens missing 6th December 1978)

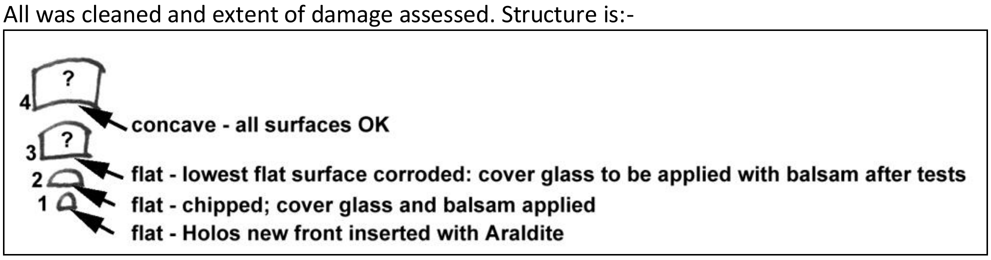
All threads came off easily. No bezel could be seen on the mount of the front lens. The lens appears to have been held by cement in a cone only.



This also the case in mount No.2 (below).

Procedure for repair.

1. All was cleaned and extent of damage assessed. Structure is:-



2. There is no need to dismantle any cemented component therefore their structure is not known. Component No.2 is a simple plano-convex but had to be removed owing to edge chipping (it nearly fell out!). The chips were, as a 1st go, filled with Balsam under a $^{7}/_{1000}$” cover, all on the flat side. This will allow a test to be made when the front is fitted. Lens left on stove (Esse) resting on this cover glass to harden.
3. An old Holos front was soaked out with xylol and tried in the Powell and Lealand mount. Some expansion of the Powell and Lealand mount hole was needed to allow the Holos front to be nearer the object. This was done by hand with a drill in a pin vice. All was set up and Araldite applied as page 252, with a needle, taking a bit more care with the squaring-on than last time. Very little metal was removed from the mount, it is very soft and delicate. The brass disk holder described on page 252 was this time stood on a Shadbolts turntable for better view of levelling the lens in the mount. All left to harden at room temperature (10am 26th October). Hardened on Esse stove over night.
4. 27th October 10am. Lens cleaned of Araldite and Balsam with needle and clean sharpened matchstick. Test of front only, shows NA 1.43 light admission. Whole assembly roughly cleaned shows 1.4 clear aperture.

(next page)

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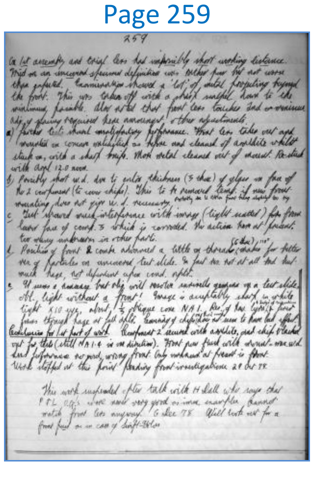


On 1st assembly and trial lens had impossibly short working distance. Tried on an uncovered specimen definition was rather poor but not worse than expected. Examination showed a ‘lot’ of metal projecting beyond the front. This was taken off with a sharp scalpel down to the minimum possible. Also noted that front lens touches 2nd meniscus. Adjustment of spacing required here amongst other adjustments.

a. Further tests showed unsatisfactory performance. Front lens taken out and mounted on concave matchstick as before and cleaned of araldite whilst stuck on, with a sharp knife. More metal cleaned out of mount. Re-stuck with Araldite. 12.00 noon.
b. Possibly short working distance due to extra thickness (3 thou) of glass on face of No.2. component (to cover chips). This to be removed temporarily if new front mounting does not give working distance necessary, Probably due to Holos front being slightly too big.
c. Test showed much interference with image (light matted) from lower face of component 3 which is corroded. No action here at present, too many unknowns in other parts.
d. Position of front 2 combinations advanced a little on threads (6 thou) 110°

makes for better resolution of particles on uncovered test slide. In fact resolution not at all bad but much haze, not dependent upon condenser aperture.

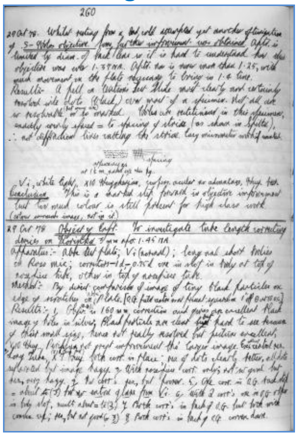
e. It seems a nonsense but objective will resolve *Surirella gemma* on a test slide, oblique light, without a front! Image is acceptable sharp in white light, x10 eyepiece, about ⅓ oblique cone NA1. Resolution of *Navicula lyra* and secondaries of *Triceratium* and finer forms through haze at full aperture. Covering of chips on No.2 component does not seem to have bad effect.

Conclusion for 1st part of work. Component 2 secured with Araldite, and chips blacked out for tests (still NA1.4 in one direction). Front now flush with mount – maximum working distance.

Lens performance no good, wrong front. Only unknown at present is front. Work stopped at this point pending front investigation. 29th October 1978.

This work suspended after talk with H. Dall (Horace Dall) who says that Powell and Lealand object glasses were never very good as immersion examples. Cannot match front lens anyway. 6th December 1978. Will look out for a front pair as in case of Swift-Holos.

Page 260

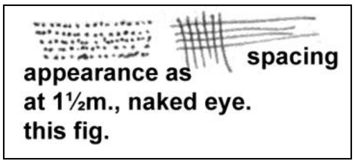


27th October 1978

Whilst resting from a bad cold attempted yet another optimization of Swift-Holos objective. Some further improvement was obtained.

Aperture is limited by diameter of back lens so it is hard to understand how this objective was ever 1.37NA. Aperture now is never more than 1.25, with much movement on the plate necessary to bring in 1.4 line.

Results. *Amphipleura pellucida* on Watson's Test Slide most clearly and certainly resolved into dots (black) over most of a specimen. Not all are so resolvable (but many are) or so marked. Holes are rectilinear in this specimen, exactly evenly spaced = to spacing of striae (as shown in Spitta), therefore not diffraction lines cutting the striae. Easy micrometer work if wanted.



Vertical Illumination, white light, x10 Huyghenian, compensating ocular no advantages. Huyghenian best.

Conclusion. This is a marked step forward in objective improvement but too much colour is still present for high class work. (colour surrounds image, not in it.)

29th October 1978

Object of Experiment

To Investigate tube length correcting devices on Koristka 3mm apochromat 1.45NA.

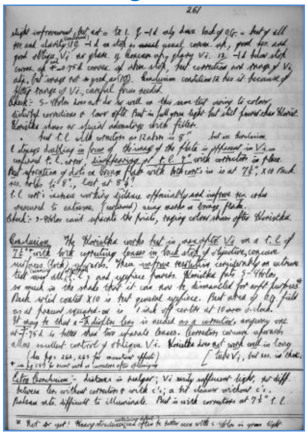
Apparatus:- Abbe test plate; Vertical Illumination (normal); long and short bodies on Ross microscope; correctors-1d,-0.75d, one in slot in body at top of nosepiece tube, other in top of nosepiece tube.

Method:- By direct comparison of image of tiny black particles on edge of scratches on 'Abbe' plate (object glass field centre is at present square in1[1] off 0 at 100.C.]

Results:-

1. Object glass is 160mm correction and gives an excellent black image of holes in silver, black particles are clear but hard to see because of their small size, hence not really resolved but picture excellent, x10 Huyghenian…Periplan not great improvement though larger image. Excellent central resolution
2. Long tube, x7 Huyghenian (x10 Beck test), both correctors in place; resolution of dots clearly better, all dots separated but image hazy
3. With nosepiece corrector only, not so good but resolution very hazy
4. No correctors, resolution, but poorer
5. One corrector in object glass back stop = about to 3 above, but no extra glare from Vertical Illumination
6. With 2 correctors, one in object glass other in body slot, results – to 3 above
7. Both correctors in back of object glass but both with convex up; resolution, but not good (- 3 above)
8. Both correctors in back of object glass, convex down…*(next page)*

Page 261



…slight improvement but not equal to 1

9. -1 dioptre only down back of object glass = best of all resolution and clarity (confirmed)
10. -1 dioptre on stop as usual, convex up, good resolution and good oblique Vertical Illumination, no glare
11. Concave up = glary Vertical Illumination
12. -1 dioptre below stop convex up and -0.75 dioptre convex up above stop, best correction and range of Vertical Illumination adjustment, but image not so good as 10.

Conclusion. Condition 12 has it because of better range of Vertical Illumination, careful focus needed.

Check:- Swift-Holos does not do so well on this same test owing to colour , disturbed corrections and lower aperture. Best in full green light but still poorer than Koristka. Koristka shows no special advantage with filters.

Koristka best tube length with correctors as 12 above is 8", but see conclusion.

A strange doubling in focus of the image of the plate is apparent in Vertical Illumination = confirmed tube length error, disappearing at tube length 7" with correctors in place.

Best separation of dots on bronze flake with both correctors in is at 7½", x10 Beck, resolution holds to 8", lost at 8¼".

Tube length correctors increase working distance appreciably and improve resolution when measured to extreme (confirmed) using marks on bronze flake.

Check:- Swift-Holos can't separate the points, raging colour shows after Koristka.

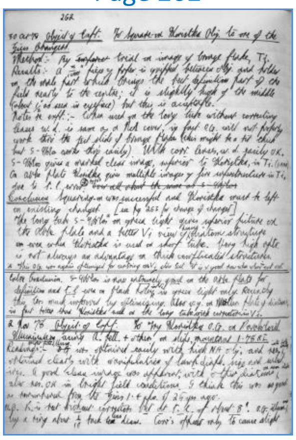
Conclusion. The Koristka works best in maximum aperture Vertical illumination on a tube length of 7½" with both correcting lenses in back stop of objective, concave surfaces (both) upwards. These improve resolution considerable on extreme test covering all appropriate tube lengths and eyepiece powers. Koristka puts Swift-Holos so much in the shade that it can now be dismantled for experimental purposes (see page 287 for recent work on correctors after optimising)[Not so yet! Heavy structures containing detail can often be better seen with Swift-Holos in green light.]. Beck solid coated x10 is best general eyepiece. Best area of object glass field as at present squared-on is 1 inch off centre at 10 o'clock.

It may be that a -½ dioptre lens is need as a corrector, anyway one at -1.75 dioptre is better than two separate lenses. Correctors concave upwards allow excellent control of oblique Vertical Illumination. Koristka does not work well in long tube Vertical Illumination, but resolution is there.

(See pages 262, 263 for mountant effects)

Extra Conclusion. Diatoms in Realgar; Vertical Illumination easily sufficient light, no difference between lens without correctors and with correctors; a bit cleaner without correctors. Balsam mounts difficult to illuminate. Best is with correctors at 7½" tube length.

Page 262



30th October 1978

Object of Experiment

To square-on Koristka Objective to one of the Zeiss changers

Method:-By trial on image of bronze flake, Transmitted Illumination.

Results:- a $^{3}/_{1000}$" piece of paper is gripped between objective and holder on the male part which brings the best definition part of the field nearly to the centre; it is slightly high of the middle (about ½" as seen in eyepiece) but this is acceptable.

Notes re: experiment:- When used on the long tube without correcting lenses working distance is same as a No.1. cover, in fact object glasses will not properly work through the test slide of bronze flake (this might be a bit thick but Swift-Holos gives a marked clear image, superior to Koristka, in Transmitted Illumination (1.0NA).

On Abbe plate Koristka gives multiple images of fine superstructure in Transmitted Illumination, due to tube length error (page 263), ~~overall about the same as Swift-Holos~~.

Conclusion. Squaring-on was successful and Koristka must be left on existing changer [see page 263 for change of changer].

The long tube Swift-Holos (This object glass was again optimised for centring on Vertical Illumination star test . It is very good now when colour is cut out.) in green light gives superior picture on the Abbe plate and a better Vertical Illumination view of heavy diatom structure even when Koristka is used on short tube. Very high aperture is not always an advantage in thick complicated structures.

Extra Conclusion. Swift-Holos is now extremely good on the Abbe plate for definition and tube length even on black holes in Vertical Illumination in green light only. Recently this lens much improved by optimising. Also very good on Möller's plate of diatoms, in fact better than Koristka used on the long tube with correctors in Vertical Illumination.

2nd November 1978

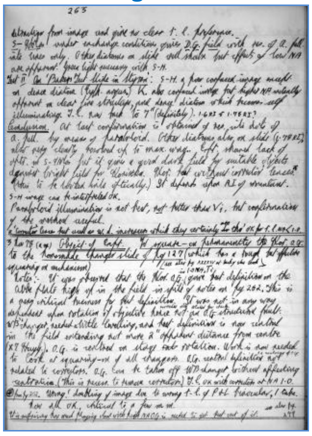
Object of Experiment

To try Koristka object glass on Paraboloid Illumination using *Amphipleura pellucida* and others on slide, mountant 1.78 refractive index.

Readings:- Bright illumination was obtained easily with high NA objective, and resolution obtained clearly with manipulation of lamp diaphragm, size and substage iris. A good clean image was apparent, with other diatoms on same slide also resolution OK in bright field conditions. I think this was as good as remembered from the Zeiss 1.4 apochromat of 25 years ago.

NB. Koristka is best without correctors but at tube length of about 8". Object glass illumination by a ring about $\frac{1}{10}$ of back lens diameter. Correctors appear only to cause slight…*(next page)*

Page 263



…detraction from image and give no clear tube length preference.

Swift-Holos under exchange conditions gives Dark Ground field with resolution of *Amphipleura pellucida* into lines only. Other diatoms on slide well shown but effects of low NA are apparent: Green light necessary with Swift-Holos.

Test II. On 'Bakers Test Slide in Styrax): Swift-Holos a poor confused-image except on dense diatoms (*Epith. Argus*). Koristka also confused image but higher NA instantly apparent on clear fine structure, and dense diatom which becomes self-illuminating. Tube Length now back to 7" (definitely) 1.61RI v. 1.75RI?

Conclusion. At last confirmation is obtained of resolution into dots of *Amphipleura pellucida* by means of paraboloid. Other diatoms also on slide (1.78 RI) also very clearly resolved up to maximum magnification. Experiment showed lack of aperture in Swift-Holos but it gives a good dark field for suitable objects against bright field for Koristka. Koristka best without 'corrector' lenses* (this to be looked into optically). It depends upon Refractive Index of mountant. Swift-Holos image can be re-interpreted. OK.

Paraboloid illumination is not best, not better than Vertical Illumination, but confirmation of the method useful.

*'Corrector' lenses best used as working distance increases which they certainly are though OK for tube length NA < 1.0.

3rd November 1978 (am)

Object of experiment.

To square-on permanently the Koristka object glass to the homemade changer slide of page 127 (which has a rough but effective squaring on mechanism) [see also page XXXXIV at back of the book]

Notes:- It was observed that the Koristka object glass in 1.0 NA, transmitted ill. Gave best definition on the Abbe plate high up in the field in spite of notes on page 262. This is a very critical business for best definition. It was not in any way dependent upon rotation of objective hence not an objective glass structural fault (corrector also rotated for check). WB's changer needed a little levelling, and best definition is now central in the field extending not more than 2" apparent distance from centre (x7 Huyghenian) Object glass is centred on stage rotation. Work is now needed to look at squaring-on of all changers. Object glass central definition i.e. centring of object glass not related to correctors. Object glass can be taken off WB changer without affecting centration (This is necessary to remove correctors). Tube Length OK with correctors at NA1.0.

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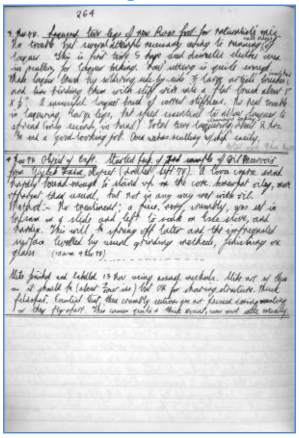
*from page 262. Wrong! Doubling of image due to wrong tube length of Powell and Lealand binocular, 1 tube.
Now all OK, critical to a few mm.
It is surprising how much playing about with high NA object glass is needed to get best out of it. (see also page 279)

Page 264



3rd November 1978

Lacquered two legs of new Ross foot for Naturalists' Microscope.

No trouble but several attempts necessary owing to running into ridges of lacquer. This is first time I have used domestic electric oven in scullery for lacquer baking. "Low" setting is quite enough. Make lacquer brush by soldering side-by-side 3 large artists brushes (camel hair) and binding them with stiff wire into a flat brush about 1" x ⅛". A successful lacquer brush of correct stiffness. No real trouble in lacquering large legs, but speed essential to allow lacquer to spread (only seconds in hand). Total time lacquering, cleaning and baking, about 2 hours. In end a good-looking job. Oven warms scullery workshop easily. Total work 9hrs page 250.

4th November 1978.

Object of Experiment.

Started Preparation of 2nd sample of Oil Reservoir from Wytch Farm, Dorset (drilled September 1978)

A loose coarse sand hardly bound enough to stand up on the core. Somewhat oily, more apparent than usual, but not in any way wet with oil.

Method:- No treatment; a piece, very crumbly, was set in Balsam on a slide and left to soak on Esse stove, and harden. This will be sprung off later and the impregnated surface levelled by usual grinding methods, finishing on glass (10am 4th November 1978)

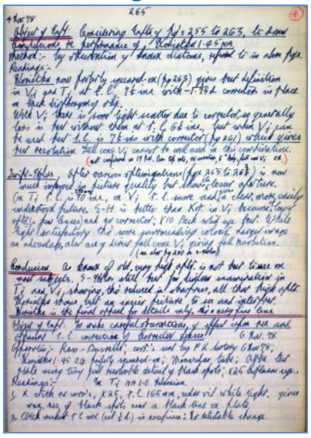
Slide finished and labelled 13th November using normal methods. Slide not so thin as it should be (about $^3/_{100}$ ins) but OK for showing structure. Much feldspar. Essential that these crumbly sections are not pressed during mounting or they fly apart. This causes quite a thick mount, cover must settle naturally.

4th November 1978

Object of Experiment

Considering Experiments of pages 255 to 263, to draw conclusions re. performance of Koristka 1.45NA.

Page 265



Method:- by illumination of known diatoms, referred to in above pages.

Readings:- Koristka now properly squared on (page 263) gives best definition in Vertical Illumination and Transmitted Illumination at tube length 7½ inches with -1.75 dioptre correctors in place on back diaphragm of objective.

With Vertical Illumination there is some light scatter due to corrector, so generally lens is best without them at tube length 6½ inches, but when Vertical illumination can be used best tube length is 7½ inches with corrector (page 261) which gives best resolution. Full cone Vertical Illumination cannot be well used on this combination. (not confirmed on 19th November, lens top rate, no correctors, 6" body, full cone Vertical Illumination, OK)

Swift-Holos. After various optimisations (pages 255 to 263) is now much improved in picture quality but shows its lesser aperture. On Transmitted Illumination tube length is 270mm, on Vertical Illumination tube length same and gives a clear more easily understood picture. Swift-Holos is better than Koristka in Vertical Illumination because of lower aperture (= few lenses) and no corrector; x10 Beck solid eyepiece best. White light satisfactory though some surrounding colour. Larger image an advantage, also use of direct full cone Vertical Illumination giving full resolution. (see also page 280 re. Swift-Holos)

Conclusion. As known of old, very high aperture is not best to use on most subjects. Swift-Holos still best for diatom examination in Transmitted Illumination and Vertical Illumination showing, though reduced in sharpness, all that high aperture. Koristka shows best an easier picture to see and interpret. Koristka is the final appeal for details only, though a very fine lens.

6th November 1978

Object of Experiment

To make careful observations of effect upon resolution and apparent tube length correction of corrector lenses.

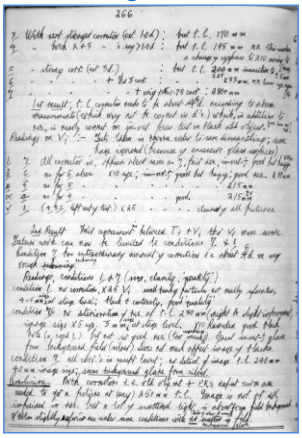
Apparatus:- Ross-Burrells, correctors sent by P. K. Sartory 6th November 1978, Koristka 1.45 object glass properly squared-on, monocular tube, Abbe test plate using tiny just resolvable detail of black spots, x25 coplanar eyepiece.

Readings:- In Transmitted Illumination NA1.0 Nelsonian

1. Koristka with no correctors, x25, tube length 165mm, Cedar Oil, white light, gives maximum resolution of black spots near a black line on plate.
2. With weakest tube length corrector (estimated ½ dioptre) in nosepiece. No detectable change.

(next page)

Page 266



1. With next stronger corrector (estimated 1.0 dioptre); best tube length 170mm
2. With both 2 and 3 correctors say > 1.0 dioptre; best tube length 195mm, NB. this involved a change of eyepiece to x10 owing to magnification.
3. With strong corrector (estimated 3 dioptre); best tube length 225mm insensitive to ± 5mm.
4. With strong corrector (estimated 3 dioptre) + No.3 Corrector; best tube length 233mm NB. Lower eyepiece again x6
5. With strong corrector (estimated 3 dioptre) + No.3 corrector + original 1.75 corrector; best tube length 280+mm

1st Result:

Tube length corrector needs to be about 6 dioptre according to above measurements (which may not be correct in dioptres) which in addition to resolution is nearly correct in-out focus test on black objects (NB. low resolution test)

Readings:- in Vertical Illumination – tests taken in reverse order to save dismantling; some haze ignored (because of excessive glass surfaces)

i. 7. All correctors in, appears about same as 7. Fair resolution, in-out-focus good but hazy, 280mm.
ii. 6. As for 6 above, x10 eyepiece, in-out-focus good but hazy, good resolution, 230mm
iii. 5. As for 5 above, x10 eyepiece, in-out-focus good but hazy, 215mm
iv. 4. As for 4 above, x10 eyepiece, in-out-focus good, 215mm ± 5mm
v. 1. (4,3,2 left out of test) x25, in-out-focus good, clearest of all pictures.

2nd Result:

Fair agreement is between Transmitted Illumination and Vertical Illumination, though Vertical Illumination more severe. Future work can now be limited to conditions 7 and 1.

Condition 7 has extraordinary amount of correction i.e. about 6 dioptre on my rough reckoning.

Readings, condition 1 and 7 (size, clarity, 'quality')

Condition 1, no correctors, x25 Vertical illumination, small bunch of particles not really separated 4-5mm size at stage level, black and contrasty, good quality

Condition 6, no deterioration of resolution at tube length 230mm (might be slight improvement) image size x6 eyepiece 3mm at stage level. X10 Ramsden good black hole (= condition 1) but not good resolution (too much eyepiece!). Great in-out-focus glare from background field (silver). Does not much affect image of blacks.

Condition 7. All correctors in except lowest, no deterioration of image, tube length 240mm, 4.0mm image size, same background glare from silver.

Conclusion. Both correctors i.e. old objective mounted and P. K. Sartory's deepest curve are needed to get a picture at (say) 250mm tube length. Image is not at all impaired in resolution but a lot of scattered light is about from field background. Swift-Holos slightly superior resolution under same conditions with no background glare in field (halo of colour on some)

6th November 1978 p.m.

Object of Experiment

To continue tube length experiments using Vertical Illumination on known diatoms.

Apparatus:- Ross-Burrells, dense diatoms on "type slide' by Baker, various correctors in nosepiece.

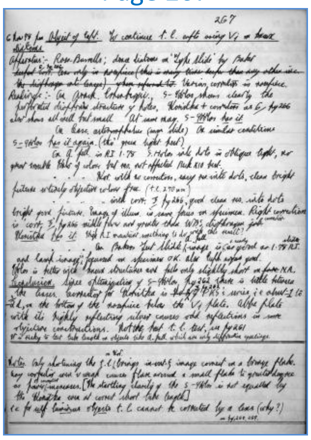
Readings:- On *Arach. Ehrenbergii*, Swift-Holos shows clearly the perforated diaphragm structure of holes, Koristka and correctors as 6. Page 266 also shows all well but small. At same magnification Swift-Holos has it.

On *Cosc. Asteromphalus* (same slide). On similar conditions Swift-Holos has it again (though green light best).

On *Amphipleura pellucida* in R.I. 1.78 Swift-Holos into dots in oblique light, no great trouble, halo of colour, but resolution not affected. Beck x10 best.

On *Amphipleura pellucida* in R.I. 1.78 Koristka with no correctors, easy resolution into dots, clean bright picture entirely objective colour free (tube length 270mm)

Page 267



On *Amphipleura pellucida* in R.I. 1.78 Koristka with correctors 3. Page 266, good clean resolution into dots, bright good picture. Image of illuminator in same focus in specimen. Right correction is corrector 3 page 266, middle power and greater than WB's diaphragm corrector. Koristka has it. High R.I. mountant something to do with result?

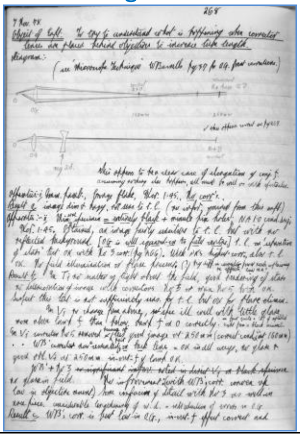
On Baker's test slide, *Amphipleura pellucida* image is very nearly as good as 1.78 Refractive Index slide and lamp image is focussed on specimen OK. Also *Eup. argus* good. Holos is better with known structures and falls only slightly short on NA.

Consclusion. Since optimisation of Swift-Holos page 262 there is little between the lenses. Corrector for Koristka is 3. Page 262 P. K. Sartory's series, i.e. about -1 to -½ dioptre, on the bottom of the nosepiece below the Vertical Illumination plate. Abbe plate with its highly reflecting silver causes odd reflections in some objective constructions.

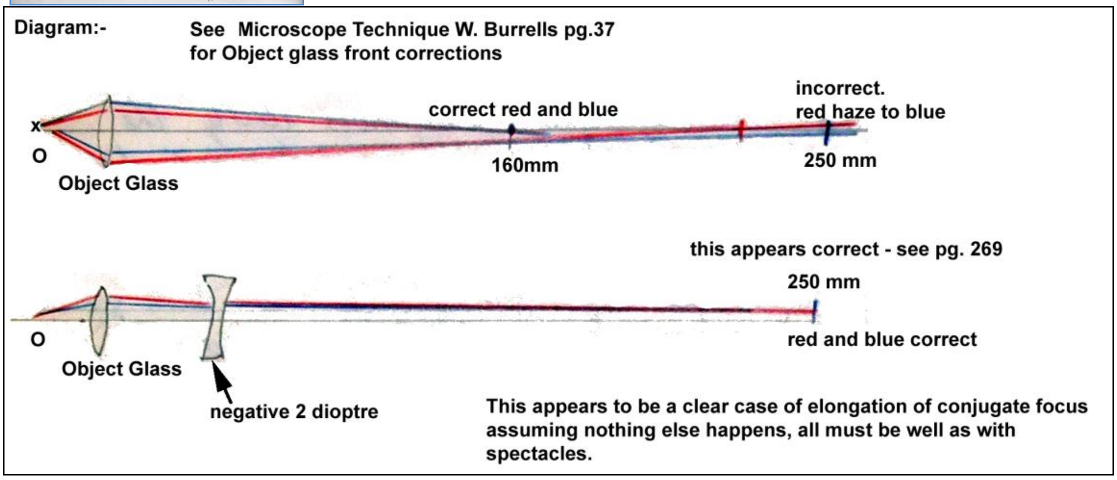
Not the best tube length test, see page 261. It is risky to test tube length on objects like *Amphipleura pellucida* which are only diffraction gratings.

Notes: Only shortening the tube length on Koristka brings out in-out-focus image correct on a bronze flake. Any corrector even very weak causes flare around a small flake to greater degree as power of corrector increases. [The startling clarity of the Swift-Holos is not equalled by the Koristka even at correct short tube length.]
i.e. for self luminous objects tube length cannot be corrected by a lens. (Why?) (see pages 268, 269)

Page 268



7th November 1978
Object of Experiment
To try to understand what is happening when corrector lenses are placed behind objectives to increase tube length.

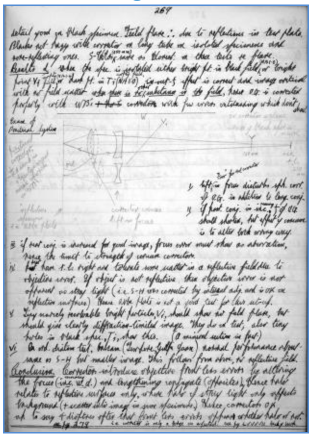


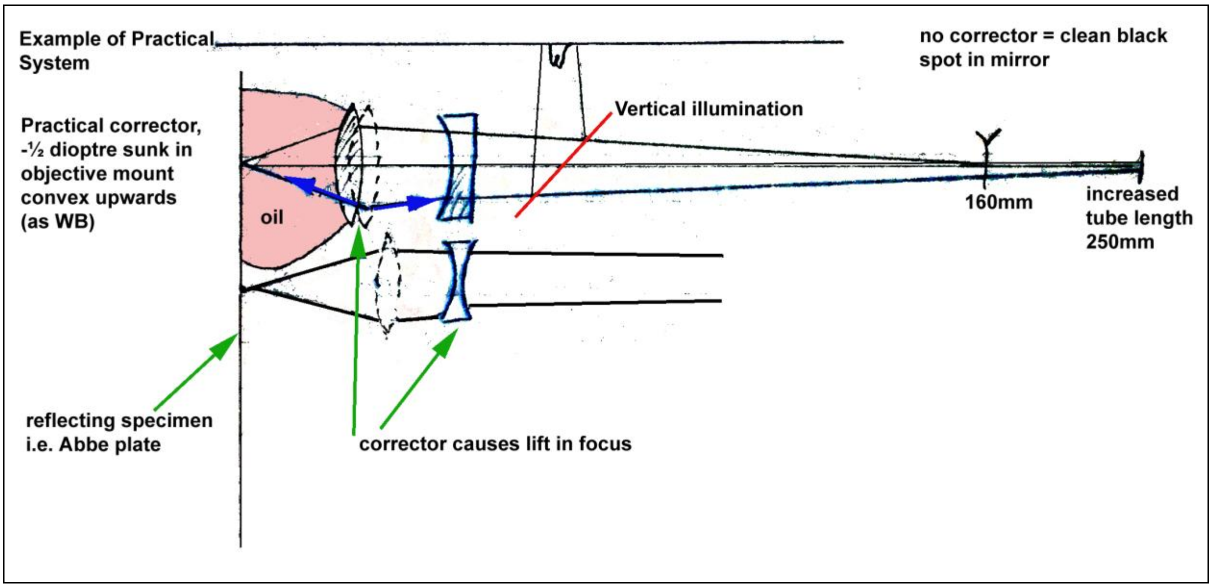
Apparatus (i):- Immersion Paraboloid, bronze flake, Koristka 1.45. No correctors.
Result (a):- image dim and hazy, not sensitive to tube length (no information gained from this experiment)
Apparatus (ii):- Mineral specimen – entirely black and minute pinholes; NA 1.0 condenser dry; Koristka 1.45. Obtained an image fairly sensitive to tube length but with no reflected background. [Object Glass is well squared-on to field centre] Tube length on 'separation of stars' test OK with No.3 corrector (page 266). With PKS higher corrector also tube length OK. No field illumination or flare present. (?) big difference in corrector power needs explaining re. effects, low NA?
Result (b):- In Transmitted Illumination no scatter of light about the field, good rendering of stars, no deterioration of image with correctors No. 3 or max No. 5, both OK.
Suspect this test is not sufficiently sensitive for tube length but OK for flare elimination.
In Vertical Illumination no change from above, specimen illuminated well with little glare, more above lamp focus than below, Lamp focussed on object correctly, in fact quite a lot of reflected light from a black mineral.
In Vertical Illumination corrector No. 5 removed because of less good image at 250mm (correct condition is at 160mm).
WB's corrector now a cemented pair on back lens – OK in all ways, no glare and good oblique Vertical Illumination at 250mm in-out-focus good, lamp OK.
WB's and No.3 ~~no significant improvement noted in direct Vertical Illumination on black specimen,~~ no glare in field. No improvement (with WB's corrector convex up low in objective mount). Some confusion of detail with No. 3 as well in nosepiece. Considerable lengthening of working distance and introduction of errors in object glass.
Result (c):- WB's corrector is best low in object glass, in-out-focus effect correct and…*(next page)*

…detail good in black specimen. Field flare therefore due to reflections in test plate. Blacks not hazy with corrector on long tube on isolated specimens and non-reflecting ones. Swift-Holos (250mm) same as Koristka in these tests re: flare.

Result (d): when the specimen is isolated either bright point in black field (NA 1.0) or bright point Vertical Illumination empty field (NA 1.4) or dark point in Transmitted Illumination (empty field NA1.0) in-out-focus effect is correct and image critical with no field scatter when there is no other substance in the field, hence object glass is corrected properly with WB's corrector with few errors outstanding which don't show.

Page 269



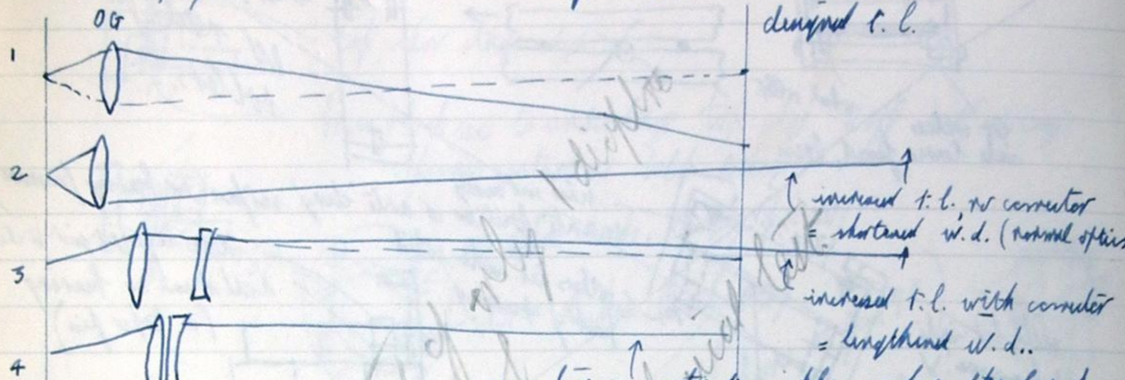


iii. If rear conjugate Is increased for good image, focus error must show as aberration, hence the limit to strength of concave correctors.
iv. Best have tube length right and tolerate some scatter in a reflective field due to objective error. If object is not reflective then objective error is not apparent as stray light (i.e. Swift-Holos was corrected by internal adjustment and is OK on reflective surfaces). Hence Abbe plate is not a good test for this set up.
v. Tiny scarcely resolvable bright particles, Vertical Illumination, should show no field flare, but should give clearly diffraction-limited image. They do in test; also tiny holes in black specimen, Transmitted Illumination, show this. (a mineral section in fact)
vi. An ordinary diatom test, Balsam (Tempére, Gulfe Juan) normal performance about same as Swift-Holos but smaller image. This follows from above, no reflective field.

Conclusion. Correctors introduce objective front lens errors by altering the focus (including increasing working distance) and lengthening conjugate (opposites). Hence halo relates to reflective surfaces only, where halo of stray light only affects background (and scatter into image in some specimens). Hence correctors OK up to say 4 dioptres, after that front lens errors appear whether halo or not. i.e. corrector is only a bodge as expected. See page LVVVVII at back of book.
See page 279.

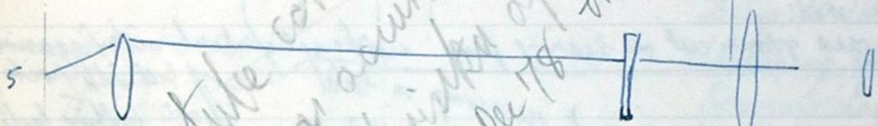
LVVVVII

Closer study of Tube Length Correctors from pg 269



corrector in contact simply weakens the lens by amount of $-f$ of corrector. This makes marked diff. to corrections of OG espec. on O.I.

Tube corrector only ... 6 Dec 78

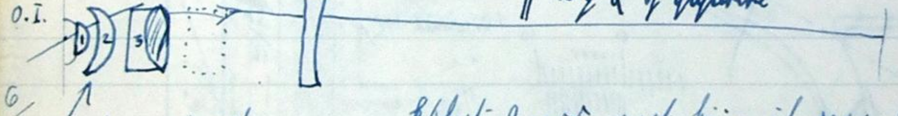


corr. near to field lens; no diff., only a little to the field lens curvature

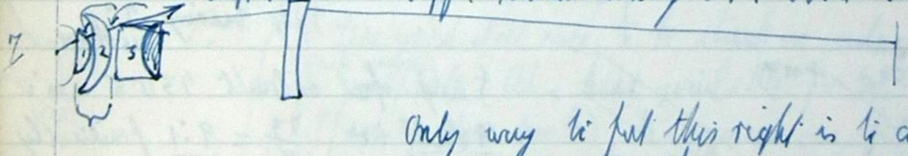
Max. effect appears to be 4, when corrector reduces curvature of back lens, but also alters f. l. of combination. // NB note wearing spectacle alters app. distance

Glass RI 1.5, 9/8" thickness raises image 3/8". t. l. 6" needed t l is 10" ∴ 4" to raise in space of 10 ins. accordingly 8" 1.5 RI liquid should do it.

// say 8" of glycerine



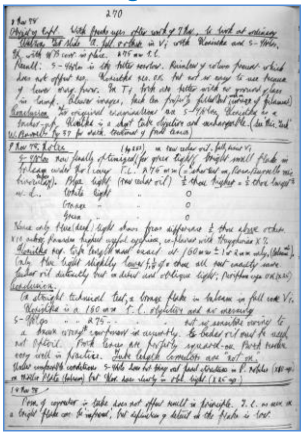
Effect of corr. must be:- if rear lens effectively red. in curve, f. l. of whole must increase (a weaker lens) but as all is fixed mechanically this must mean error. Diff's. between w. d. of 6 & 7 about 5 thous. = quite a lot.



Only way to put this right is to cause (1-2) & 3 to approach closer (= the needed correction anyway!) but there is not room, in fact a near contact in many objectives.

Hence only way is to increase optical path without lens = solid glass (2", dense) to 'lift up' image as in P&L compensator.

Page 270



8th November 1978

Object of Experiment

With fresh eyes after work of 7th November, to look at ordinary Watson Test Slide, *Amphipleura pellucida* and others in Vertical Illumination with Koristka and Swift-Holos, and with WB correctors in place, 275mm tube length.

Result:- Swift-Holos is the better resolver. Rainbow of colours present which does not affect resolution. Koristka resolution OK but not so easy to use because of lower magnifying power. In Transmitted Illumination both are better with no ground glass in lamp. Cleaner images, back lens properly filled (but with an image of filament).

Conclusion. For original examination use Swift-Holos. Koristka as a back-up. Koristka is a short tube objective and unchangeable (See 'Microscope Technique' W. Burrells page 37 for mathematical treatment of front lenses).

9th November 978

Notes

Swift-Holos now finally optimised (page 262) for green light, in raw Cedar Oil, full direct Vertical Illumination, bright small flake in Balsam under No.1. cover, Tube length 275mm (- shortest on Ross-Burrells microscope binocular tubes),

Blue light (raw Cedar Oil) ½ thou higher = ½ thou longer working distance

White light (raw Cedar Oil) 0 effect

Orange light (raw Cedar Oil) 0 effect

Green Light (raw Cedar Oil) 0 effect

Hence only blue (deep) light shows focus difference ½ thou above others. X10 achromat, Ramsden highest useful eyepiece, co-planar with Huyghenian x7.

Koristka requires tube length most exact at 160mm ± 1 or 2mm only (Balsam mount). Only the blue light slightly lower focus, $\frac{1}{18}$ of a thou, all rest exactly same.

Cedar oil distinctly best on direct and oblique light; Periplan eyepiece OK (x25).

Conclusion. On straight technical test, a bronze flake in Balsam in full cone Vertical Illumination, Koristka is a 160mm tube length objective and no messing

Swift-Holos is a 275mm tube length objective, not so sensitive owing to a known wrong component in assembly. Cedar oil must be used, not Optoil. Both lenses are properly squared-on. Both resolve very well in practice. Tube length correctors are 'not on'.

Under comfortable conditions Swift-Holos does not bring out panel structures in *P. nobilis* (x10 eyepiece) on Möller plate (balsam) but Koristka does clearly in oblique light (x25 eyepiece).

18th November 1978

Position of corrector in tube does not affect result in principle. Tube length as seen in a bright flake can be 'improved', but definition of detail in the flake is lost.

8th November 1978

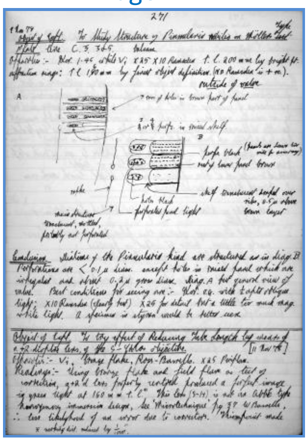
Object of Experiment.

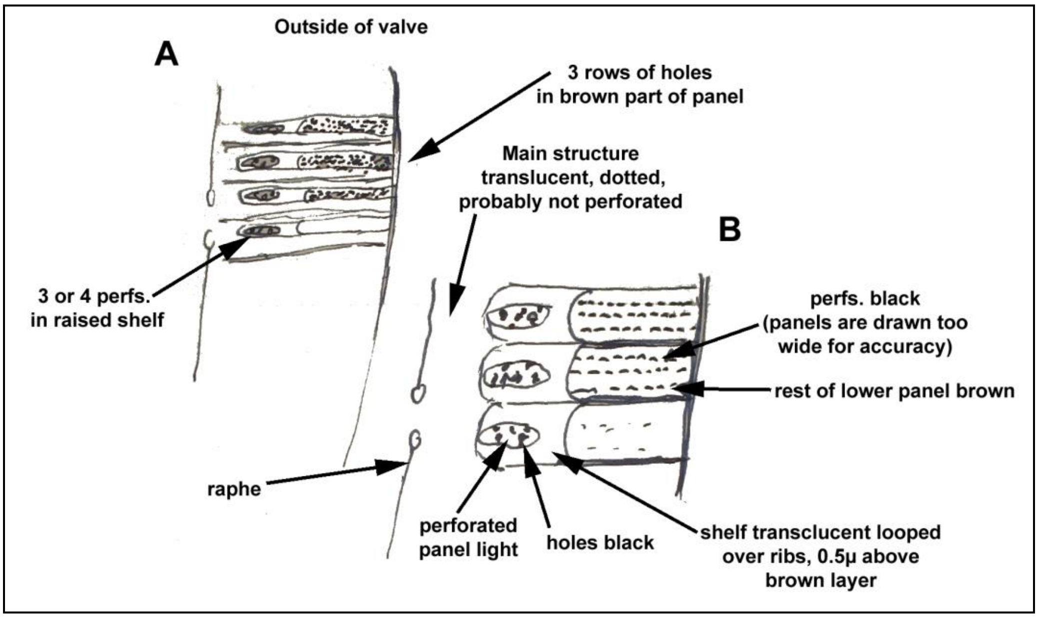
To Study Structure of *Pinnularia nobilis* on Möller's Type Test

Plate line C.3. 3 & 5. Balsam

Apparatus Koristka 1.45 white vertical illumination. X25 x10 Ramsden. tube length 200mm by bright light. diffraction rings: tube length 160mm by finest object definition (NB. Ramsden is positive.)

Page 271





Conclusion. Diatoms of the *Pinnularia* kind are structured as in diagram B. Perforations are < 0.1μ diameter except holes in raised panel which are irregular and about 0.2μ gross diameter. Diag. A. best general view of valve. Best conditions for seeing are:- Koristka object glass with ½ aperture. Oblique light; x10 Ramsden (clearly best) x25 for detail but a little too much mag. White light. A specimen in Styrax would be better seen.

11th November 1978

Object of Experiment

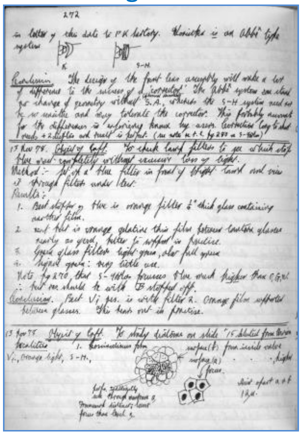
To try effect of Reducing Tube Length by means of a +2-dioptre lens, on the Swift-Holos objective.

Apparatus:- Vertical Illumination. Bronze flake, Ross-Burrells. X25 Periplan.

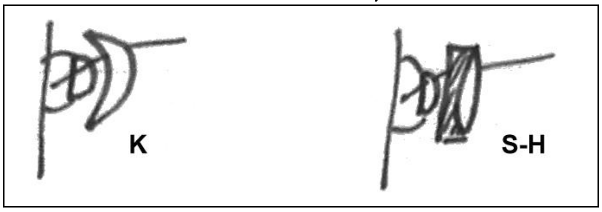
Readings:- Using bronze flake and field flare as test of correction, a +2-dioptre lens properly centred produced a perfect image in green light at 160mm. tube length*. This lens (S-H) is not an Abbe type homogenous immersion design, see Microtechnique page 37. W. Burrells, therefore less likelihood of an error due to correctors. This point made…*(next page)*

*working distance reduced by $^1/_{1000}$"

Page 272



…in letter of this date to P. K. Sartory. Koristka is an Abbe type system.



Conclusion. The design of the front lens assembly will make a lot of difference to the success of a 'corrector'. The Abbe system can stand no change of geometry without S.A., whereas the Swift-Holos system need not be so sensitive and may tolerate the corrector. This probably accounts for the differences in experience know by users. Correction long to short needs +2 dioptres and result is perfect. (see note re tube length page 280 on Swift-Holos.)

13th November 1978

Object of Experiment

To check lamp filters to see which stops blue most completely without excessive loss of light.

Method:- Set up a blue filter in front of bright lamp and view it through filters under test.

Results:-

1. Best stopper of blue is orange filter ¼" thick glass containing another film.
2. Next best is orange gelatine thin film between lantern glasses, nearly as good, better to support in practise.
3. Green glass filter, light green, also full green.
4. Signal green: very little use.

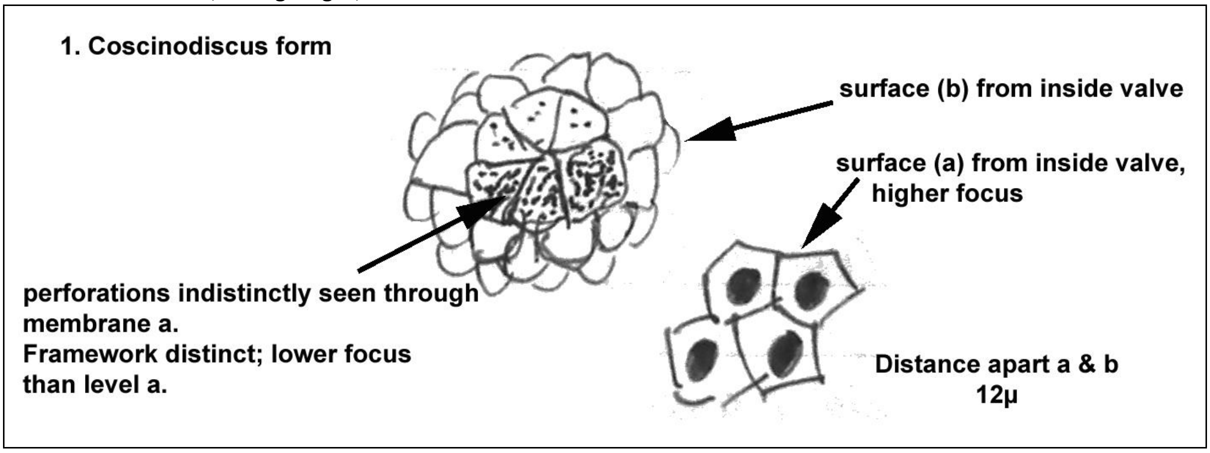
Note page 270 that Swift-Holos focuses blue much higher than O,G,W. therefore best resolution should be with B stopped off.

Conclusion. Best Vertical Illumination resolution is with filter 2. Orange film supported between glasses. This bears out in practise.

13th November 1978

Object of Experiment

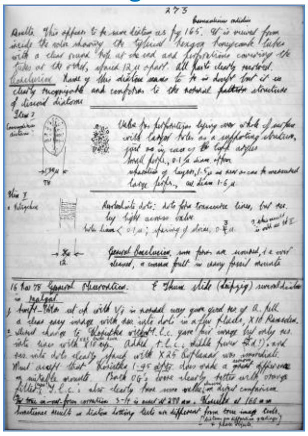
To study diatoms on slide "15 selected from Various localities".
Vertical Illumination, Orange Light, S-H.

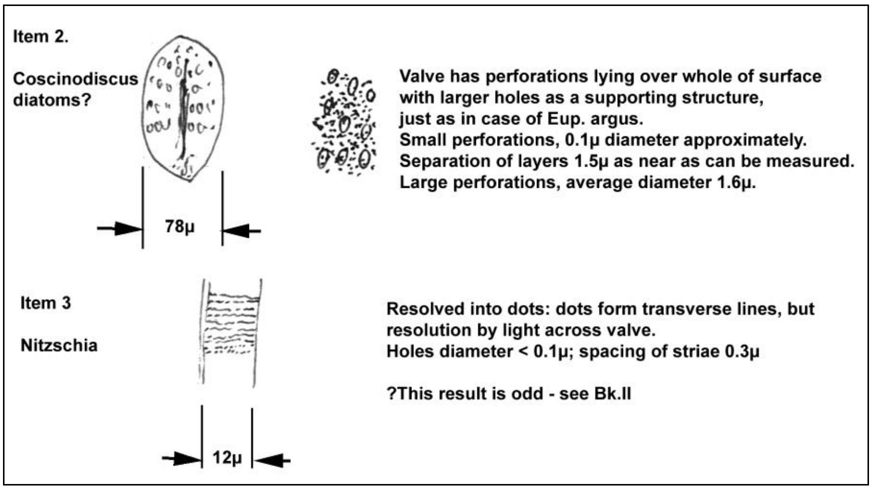


Results:- This appears to be same diatoms as page 165 (*Coscinodiscus radiatus*). It is viewed from inside the valve showing the typical hexagon honeycomb tubes with a clear round hole at the end and perforations covering the tubes at the other, spaced about 12µ apart. All parts clearly resolved.

Conclusion. Name of this diatom seem to be in doubt but it is clearly recognisable and conforms to the normal structure of discoid diatoms.

Page 273





General Conclusion. Some forms are scoured, i.e. over cleaned, a common fault in many fossil mounts.

16th March 1978

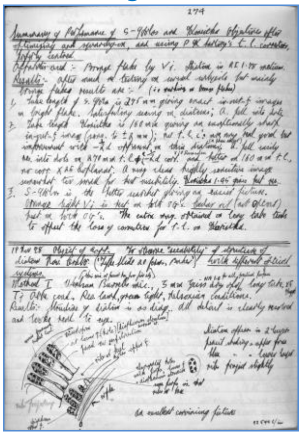
General Observation. E. Thum slide (Leipzig) several diatoms in Realgar.

1. Swift-Holos set up with Vertical Illumination in normal way gave good resolution of *Amphipleura pellucida*. A clear easy image with resolution into dots in a few places, x10 Ramsden.

2. Direct change to Koristka without tube length correction gave fair image but only resolved into lines with x10 eyepiece (x25 broke down). Added tube length correction; middle power (-½ dioptre), and resolution into dots clearly spaced with x25 Coplanar was immediate. Must accept that Koristka 1.45 aperture does make a serious difference on suitable mounts. Both object glasses were clearly better with orange filter (eyes?). Tube length correctors also clearly have some value observed on direct comparison.

For true in-out-focus correction Swift-Holos is exact at 270mm. Koristka at 160mm. Sometimes results on diatom dotting tests are different from true image tests [diatoms are diffraction gratings and phase effects].

Page 274

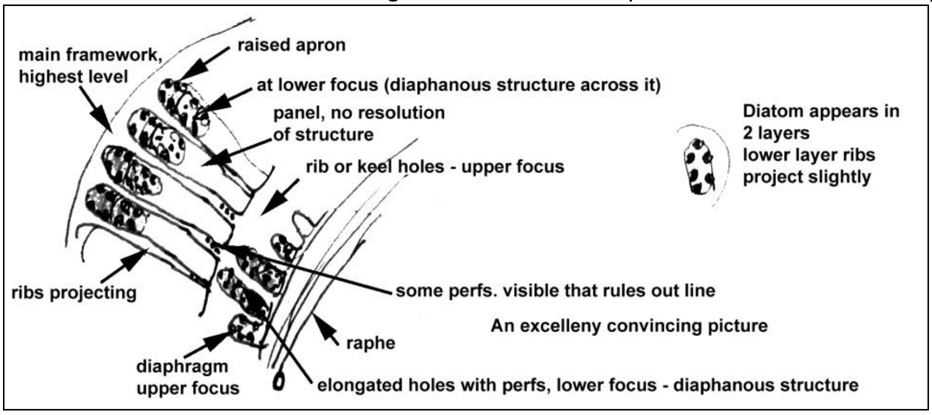


Summary of performance of Swift-Holos and Koristka Objective after optimizing and squaring-on, and using P. K. Sartory's tube length corrector, properly centred.
Apparatus used:- Bronze flake by Vertical Illumination. Diatom in RI 1.78 medium
Results:- After much re-testing on usual subjects but mainly bronze flakes (i.e. marking on bronze flakes) results are:-

1. Tube length of Swift-Holos is 275mm giving exact in-out-f images on bright flake. Satisfactory seeing on diatoms; *Amphipleura pellucida* into dots.
2. Tube length Koristka is 160mm giving an exceptionally sharp in-out-f image (sensitive to ± 2mm); no tube length corrector; are any real good but improvement with ½d apparent on thin diatoms (a phase object). *Amphipleura pellucida* easily resolved into dots on 270mm tube length and a ½d correction, x10 Ramsden and better on 160mm tube length, no correction, x25 Coplanar. A very clear highly sensitive image somewhat too small for best visibility. Koristka 1.45 gives best resolution.

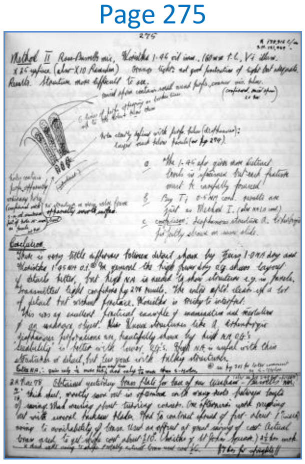
Swift-Holos is the better searcher giving an easier picture. Orange light Vertical Illumination is best on both object glasses. Cedar oil (not Optoil) best on both objective glasses. The extra magnification obtain on long tube tends to offset the loss of correction for tube length on Koristka.

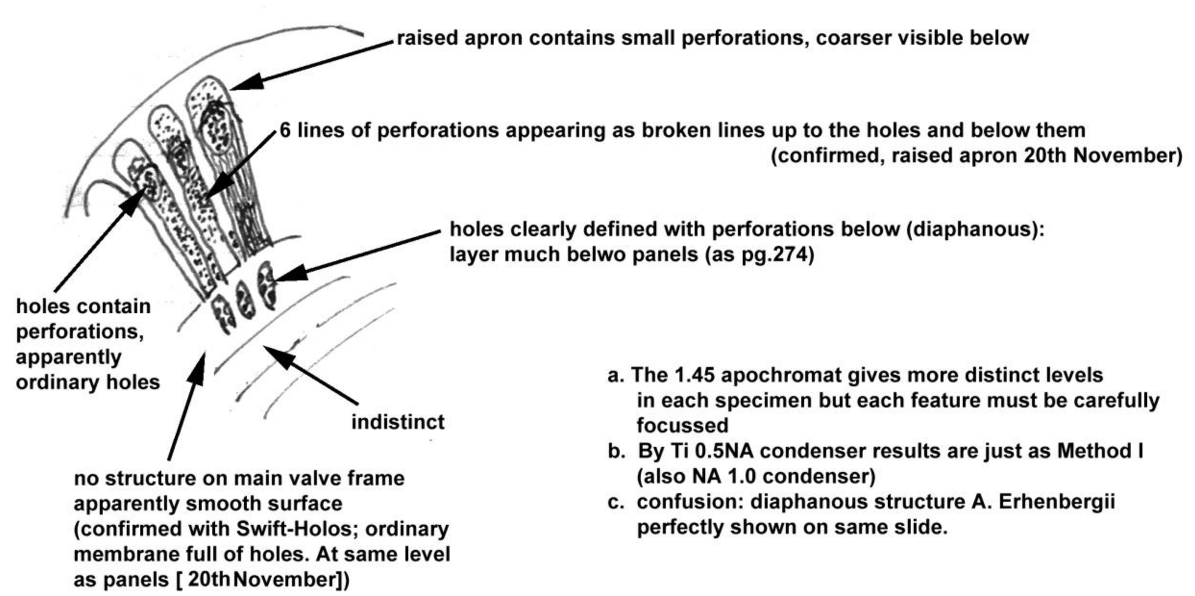
19th November 1978.
Object of Experiment
To observe 'seeability' of structure of diatom *Navicula crabro* (Type slide 20 forms, Baker), with different optical systems.
Method I. Wenham-Burrells Microscope (this microscope at present has poor fine adjustment), 3mm Zeiss NA 1.0 dry objective for all practical surfaces, long tube, x5 Huyghenian., Transmitted Illumination Abbe Condenser, Research lamp, green light, Nelsonian conditions.
Results:- Structure of diatom is as diagram. All detail is clearly resolved and looks real to eye.



Method II: Ross-Burrells microscope, Koristka 1.45 oil immersion, 160mm tube length, Vertical Illumination, x25 eyepiece (also x10 Ramsden), Orange light, not good penetration of light but adequate.
Results:- Structure more difficult to see.

Page 275





Conclusion. There is very little difference between detail shown by Zeiss 1.0 NA dry and Koristka 1.45 NA oil immersion*. In general the high power dry object glass shows layout of details better, but high NA is need to show structure e.g. in panels. Transmitted light confirms page 274 results. The extra aperture clears up a lot of detail but without practice. Koristka is tricky to interpret. This was an excellent practical example of examination and resolution of an unknown object. Known structures like *A. Ehrenbergii* diaphanous perforations are beautifully shown by high NA object glasses. 'Seeability' is better with low object glasses. High NA is useful with thin structures or detail, but less good with bulky structures.

Extra NA: gives only ⅓ more resolution than dry lens, and only 1.10 more than Swift-Holos.

*see page 301 for later comments re. Swift-Holos.

22nd November 1978

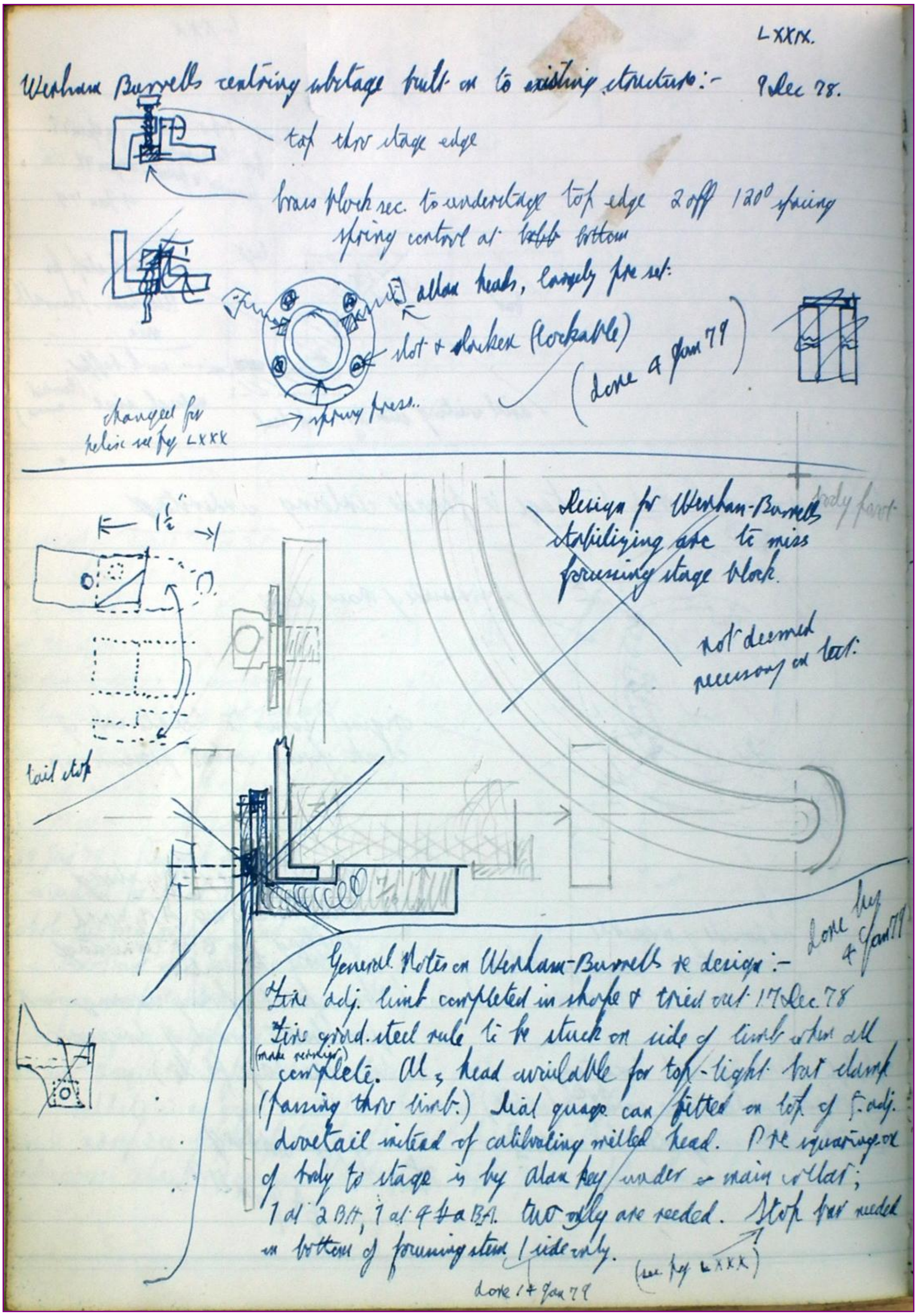
Obtained yesterday brass plate for base of new Wenham-Burrells microscope (also see page 249 for uprights)

$^{7}/_{16}$" thick sheet, mostly sawn out in afternoon with many rests between bouts of sawing. Much messing about turning corners. One afternoons work roughing out with several hacksaw blades. Had to contract spread of foot about 1" width owing to availability of brass. Used an offcut at great saving of cost. Actual brass used to get shape cost about £10* (Smiths of St. John's Square). 2½ hours work.

*Much waste owing to shape. Probably actual brass used cost £6.

7 hours for uprights.

(next page)



LXXIX.

Wenham Burrells centring substage built on to existing structure:- 9 Dec 78.

top thro' stage edge

brass block rec. to understage top edge 2 off 120° spacing
spring control at bottom

allen heads, largely pre set:

slot + slacken (lockable)

(done 4 Jan 79)

spring press.

changed for release see fig LXXX

1½

Design for Wenham-Burrells stabilizing arc to miss focussing stage block.

body part

not deemed necessary on test.

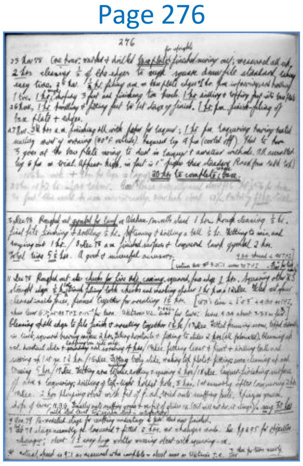
tail stop

General Notes on Wenham-Burrells re design:-
Fine adj. limb completed in shape & tried out 17 Dec. 78
Fine grad. steel rule to be stuck on side of limb when all complete. (make retaining) Al. head available for top-light bar clamp (passing thro limb.) Dial gauge can fitted on top of f. adj. dovetail instead of calibrating milled head. P.re squaring of body to stage is by allen key under main collar; 1 at 2 BA, 1 at 4 BA. two only are needed. Stop bar needed in bottom of focussing stem 1 side only.
(see fig LXXX)

done 1 Jan 79

done key 4 Jan 79

Page 276



23rd November 1978

One hour marked and drilled base plate for upright, finished sawing out; measured all up. 2hrs cleaning ½ of the edges to rough square draw file standard, taking easy time.

25th November 1978

½ hour filing a.m. on base plate edges plus 1 hour p.m. improving and bevelling 1 toe. 1 hour rough shaping 3 feet and finishing toe levels. 1 hour drilling and tapping feet into base plate.

26th November 1978

1 hour bevelling and fitting feet to 1st stage of finish. 1 hour p.m. finish-filing of base plate and edges.

27th November 1978

3½ hours a.m. finishing all with paper for lacquer. 1 hour p.m. lacquering having heated scullery most of morning (30°F outside). Lacquered by 4 p.m. (cooled off). Had to have 3 goes at the base plate owing to dust in lacquer and amateur methods.

All assembled by 6 p.m. on trial. Appears high, in fact is 1" higher than standard Ross (from table top).

11½ hours work plus 9 hours for legs – (say) 20 hours to complete whole base.

20 hours at £2 per hour – £40 labour. Cost of brass actually used about £16. Total £56 for base. In fact this would be more commercially. Overheads about 50%. Probably £100 total.

3rd December 1978.

Roughed out gimbal for lamp on Wenham-Burrells stand 1 hour. Rough cleaning ½ hour. Final file finishing and drilling ½ hour. Softening and drilling a ball ½ hour. Fitting to microscope and trying out 1 hour.

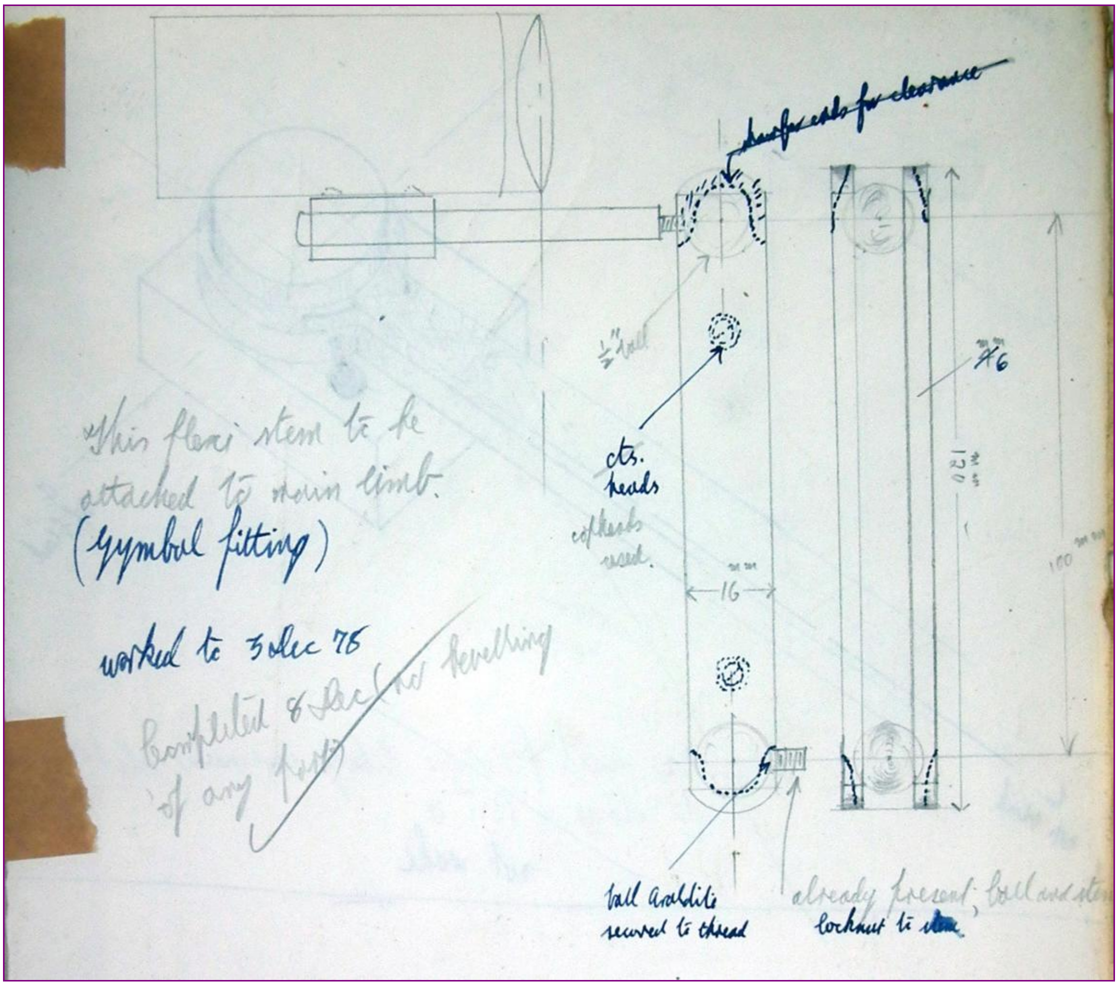
8th December 1978 a.m.

Finished surfaces and lacquered lamp gimbal 2 hours.

Total time 5½ hours. A Good successful accessory.

[4BA thread is 40TP]

[Watsons lever 3.25:1, screw 70 T.P.I. = $^4/_{1000}$" for turn nearly]



[Transcribers Note: remainder of this page relates to later dates and has been included in the appropriate position below.]

5th December 1978

Re-built parts of Wenham-Burrells microscope on proper Ross base (see pages 249, 275, 276) as obtained by measurement of old engravings.

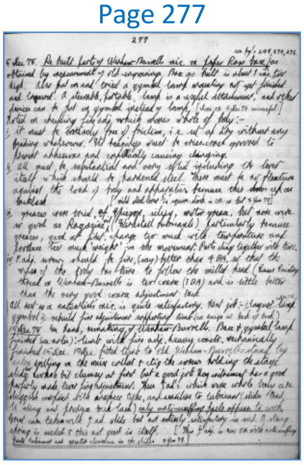
Base as built is about 1 inch too high. Also put on and tried a gimbal lamp mounting not yet finished and lacquered. A steerable, portable lamp is a useful attachment, and other devices can be put on gimbal instead of lamp. [Done OK 8th December 1978. Successful]

Noted on checking fine adjustment which moves whole of body:-

i. It must be entirely free of friction, i.e. set up dry without any binding whatsoever. It's bearings must be criss-cross grooved to prevent adhesions and capillarity causing clinging.

ii. All must be substantial and very solid including the lever itself which should be hardened steel. There must be no flexure against the load of body and apparatus, because this shows up as backlash. [mild steel lever $^5/_{16}$" square stock is OK on test 3rd January 1979]

Page 277

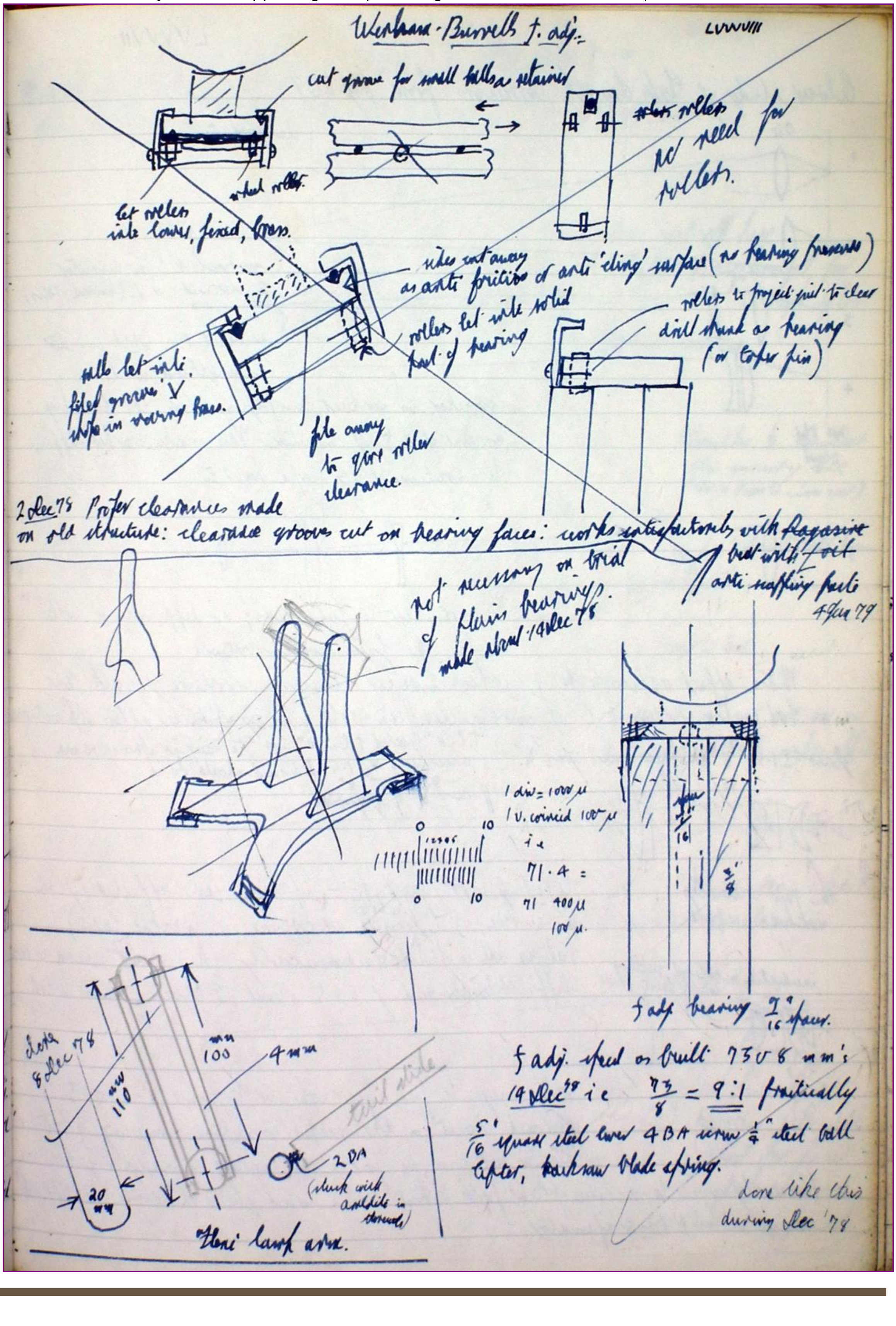


iii. Greases were tried Apiezon, silicon, motor grease, but none so good as Ragasine oil (Kirkstall Lubricants) particularly because greases, good at first, change too much with temperature and produce too much 'weight' in the movement. Parts cling together with time.

iv. Fine adjustment screws should be fine, (say) better than 4BA so that the mass of the body has time to follow the milled head (existing thread on Wenham-Burrells is too coarse (1BA) and is little better than the very good coarse adjustment rack)

All rest as a naturalists' microscope is quite satisfactory. Next job:-

i. Lacquer (8th December OK) lamp gimbal
ii. Rebuild fine adjustment supporting limb (see design at back of book - below)



11th December (originally on page 276)
Roughed out the cheeks for fine adjustment casing squared face edge – 1 hour. Squaring other 3 straight edges ½ hour Finish filing both cheeks and marking spacer – 1 hour p.m.

12th December (originally on page 276)
Filed out spacer, cleaned inside faces, pinned together for sweating 1½ hours [WB's lever is ½ by 3" + 4BA 40TPI, thus lever 6:1 at 40 TPI 0.15" per turn. Watson's vertical lever 0.046" per turn: hence 4BA about 3.3x as fast (actual speed is 9:1 as measured when complete – about same as Watson's fine adjustment 3.1000 thou per turn nearly)]
Clearing up all edges to file finish and sweating together 1½ hours.

13th December 1978 (originally on page 276)
Fitted focussing screw, tapped oddments in limb, squared bearing surface – 2 hours. Filing dovetails and fitting to slides 2 hours (all fabricated). Cleaning up external dovetail slides and lapping one side only and screwing 4 hours.

14th December 1978 (originally on page 276)
Fitting lever and pivot, and drilling ball and setting up 1st go 1½ hours.

15th December 1978 (originally on page 276)
Fitting body slide, making top plate and fitting, some cleaning up and truing 5 hours

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15th December 1978
In hand, remaking of Wenham-Burrells. Base and gimbal lamp finished (see notes): limb with fine adjustment heavy construction, mechanically finished 15th December. 17th December fitted limb to old Wenham-Burrells stand by extra drilling on the main collar and casting. The screws holding the stage slide bar look a bit clumsy at first but a good job. New instrument has a good properly made lever fine adjustment. These focus adjusters which move whole body are sluggish compared with nosepiece type, and sensitive to lubricant (slides tend to cling and produce backlash), only anti-scuffing paste appears to work. Great care taken with focus adjustment slide but not entirely satisfactory in end. A strong spring is needed and this not good in itself. [This focus adjustor is now OK with anti-scuffing paste lubricant and grater clearance in the slides – 3rd January 1979]

17th December 1978 (originally on page 276)
Fitting arm to existing microscope, drilling and squaring 2 hours

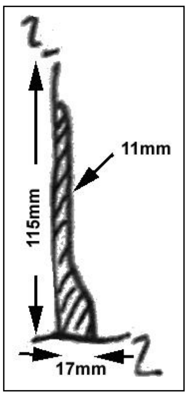
18th December 1978 (originally on page 276)
Lacquer finishing surface of arm and lacquering; drilling of top-light holder hole, 3 hours. 1st assembly after lacquering 2 hours.

19th December 1978 (originally on page 276)
2 hours playing about with fit of fine adjustment, tried anti-scuffing paste. Apiezon grease, shape of lever no bloody good (mild steel lever $^5/_{16}$" square stock is satisfactory). Finally anti-scuffing grease and re-fit of slider OK (Oil will not do it, it clings).
Say 30 hours.

3rd January 1979 (originally on page 276)
Re-modelled stage for centring understage – 4 hours, this now finished.

3rd February 1979 (originally on page 276)
Stage assembly re-lacquered and fitted 2 hours. No changes made. See page 295 for objective changer. About 1½ easy days mostly messing about with squaring – OK.

12th April 1979
Decided to add corner brackets to Ross stand as improving greatly the long-legged appearance of the stand when used inclined to a great degree.
Cost of material nil, all in hand.
Time: To saw out and roughly shape on 11th April - 1½ hours. To finish and fit for securing with Araldite on 12th April - 1½ hours. No trouble, lacquering not yet done.
(This work in bright brass very satisfying.)



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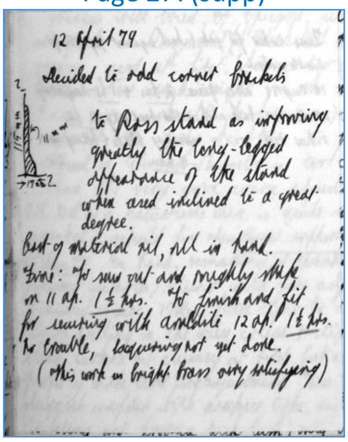
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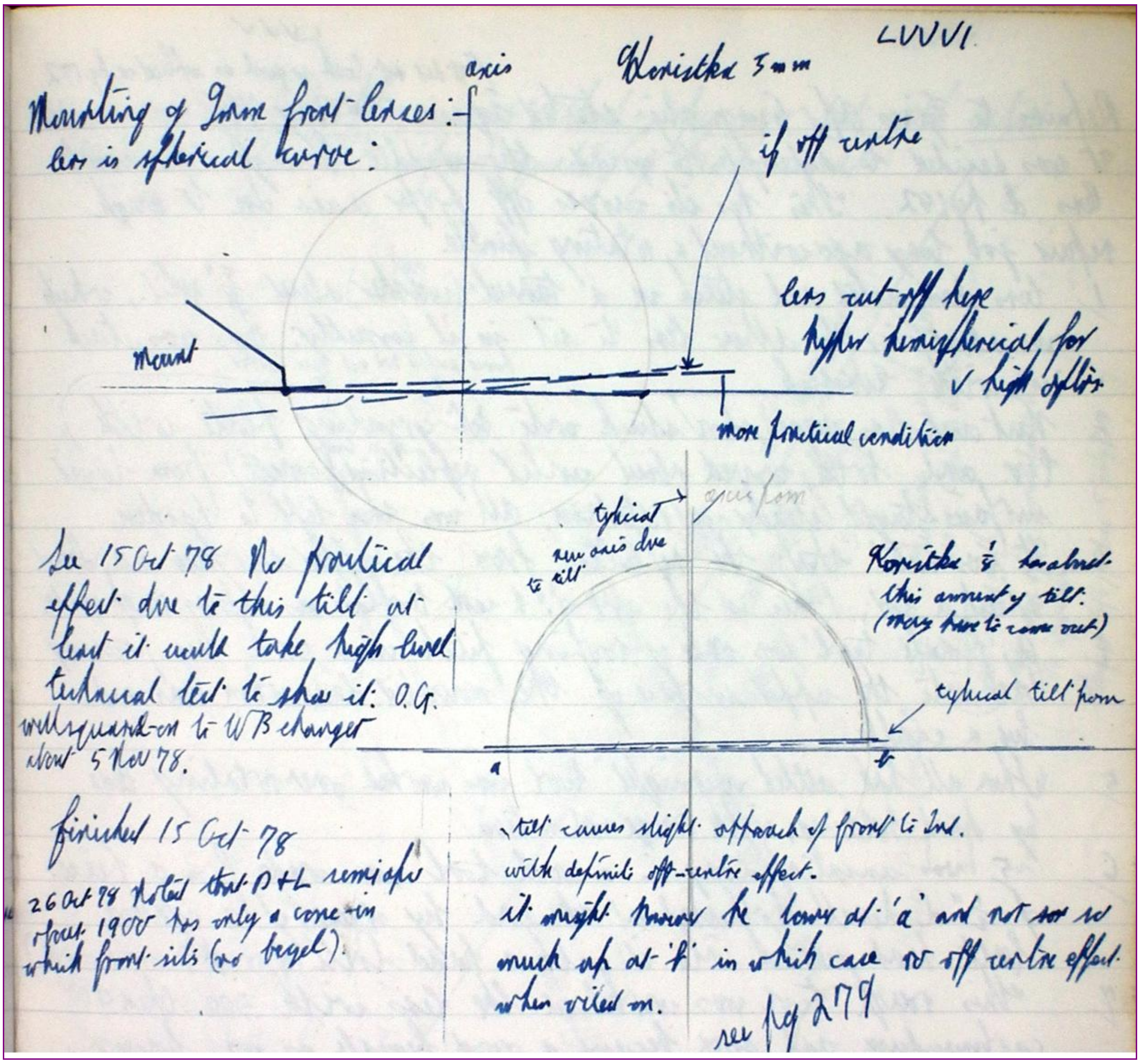

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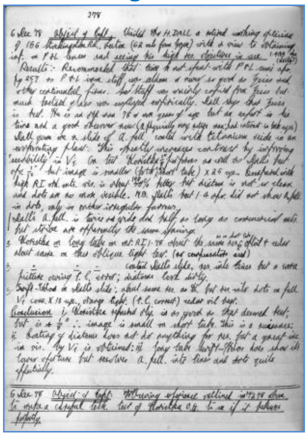


6th December 1978

Object of Experiment

Visited Mr. H. Dall a retired working optician of 166 Stockington Road, Luton (62 miles from Grove) with a view to obtaining information on Powell and Leland Lenses and seeing his high resolution objectives (1.40NA apochromat. Leitz?) in use.

Results:- Recommended that time be not spent with Powell and Lealand semi apochromat page 257 as Powell and Lealand immersion stuff was seldom or never so good as Zeiss and other continental firms. Stuff was mainly copied from Zeiss but much bastard glass was employed empirically. Dall says that Zeiss is best. He is an old man 78 or more years of age but an expert in his time and a good observer now (a physically active mad, had cataract in both eyes). Dall gave me a slide of *Amphipleura pellucida* coated with titanium oxide in an evaporating plant. This greatly increases contrast by improving 'seeability' in Vertical Illumination. On test Koristka ⅛" performs as well as Dall's best apochromat $\frac{1}{12}$" but image is smaller (both 0.4s short tube) x25 eyepiece. Compared with high RI ordinary mounts visibility is about 100% better but diatom is not so clean and dots no more visible. NB. Dall's best 1.4 apochromat did not show *Amphipleura pellucida* in dots, only in rather irregular furrows.

Dall's *Amphipleura pellucida* is twice as wide and half as long as commercial mounts but striae are apparently the same spacing.

a. Koristka on long tube on mount R.I. 1.78 about the same resolution as on short tube, Optoil and Cedar Oil about same on this oblique light test (no compensators used)
b. Koristka on long tube on coated Dall's slide, resolution into lines but a worse picture owing to tube length error, diatoms look dirty.
c. Swift-Holos on Dall's slide; about same resolution as Koristka but resolution into dots on full Vertical Illumination cone, x10 eyepiece, orange light (tube length correct) Cedar Oil best.

Conclusion.

i. Koristka repaired objective is as good as that deemed best but is ⅛” therefore image is small on short tube. This is a nuisance.
ii. Coating of diatoms does not do anything for resolution but a great increase in visibility by Vertical Illumination is obtained
iii. Long tube Swift-Holos does show its lower aperture but resolves *Amphipleura pellucida* into lines and dots quite effectively.

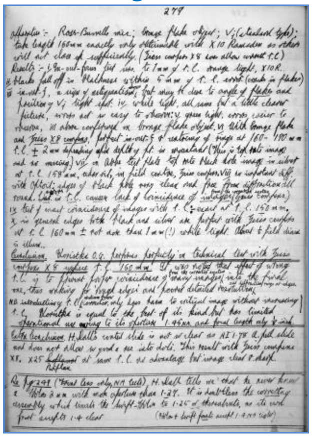
6th December 1978

Object of Experiment

Following experience outline in page 278 above to make a careful technical test of Koristka object glass to see if it behaves properly.

(next page)

Page 279



Apparatus:- Ross-Burrells microscope, bronze flake object, vertical illumination (standard type), tube length 160mm exactly only obtainable with x10 Ramsden eyepiece as others will not close up sufficiently (Zeiss compensating x8 does allow correct tube length).

Results:-

i. In-out-focus test sensitive to 1mm of tube length, orange light, x10 Ramsden
ii. Blacks fall off in blackness within 5mm of tube length error (cracks in flakes)
iii. In-out-focus, a sign of astigmatism shows but may be due to angle of flakes and position of Vertical Illumination light spot
iv. White light, all same but a little clearer picture, errors not as easy to observe
v. Green light, errors easier to observe, iii. above confirmed on bronze flake object
vi. With bronze flake and Zeiss x8 compensating eyepiece, perfect in-out-focus and centring of rings at 160-170mm tube length ± 2mm depending upon depth of point in mountant (this is top rate image and no messing!)
vii. On Abbe test plate top rate black hole image in silver at tube length 158mm, Cedar Oil, in field centre, Zeiss compensating eyepiece
viii. No important difference with Optoil, edges of black hole very clear and free from diffraction all round. Errors in tube length cause lack of coincidence of images from the correction system, Zeiss compensating eyepiece.
ix. Test of exact coincidence of images with tube length – exact at tube length 150mm
x. In general edges both black and silver are perfect with Zeiss compensating eyepiece at tube length 160mm =/- not more than 1mm(!), white light. About ½ field diameter is illuminated.

Conclusion. Koristka object glass performs perfectly in technical test with Zeiss compensating x8 eyepiece, tube length 160mm. It was noted that effect of wrong tube length is to prevent proper coincidence of many images from the corrector system into the final one, thus making for ‘rough edges’ and poorer detailed resolution and diffraction rings at edges.

NB. Introducing tube length medium power corrector only does harm to critical image without increasing tube length. Koristka is equal to the best of its kind but has limited operational use owing to its aperture 1.45 NA and focal length only ⅛”.

Extra Conclusion. H. Dall’s coated slide is not so clear as R.I. 1.78 *Amphipleura pellucida* slide and does not allow so good a resolution into dots. This result with Zeiss compensating x8. X25 Periplan at same tube length no advantage but image clear and sharp.

RE. Page 249 (Front lens only, NA tests)

H. Dall tells me that he never knew a Holos 2mm with more aperture than 1.27. It is doubtless the correcting assembly which limits the Swift-Holos to 1.25 or thereabouts, as its own front accepts 1.4 clear. (Holos and Swift fronts accept 1.4 NA light)

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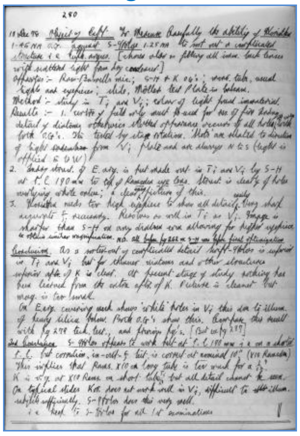

18th December 1978

Object of Experiment

To measure carefully the ability of Koristka 1.45NA object glass against Swift-Holos 1.25NA, to sort out a complicated structure in *Eup. argus* [chosen also as filling all immersion back lenses with scattered light from dry condenser]

Apparatus:- Ross-Burrells microscope, Swift-Holos and Koristka object glasses, monocular tube, usual lights and eyepieces, slide – Möller's test plate in Balsam.

Method:- Study in Transmitted Illumination and Vertical Illumination, colour of light found immaterial.

Results:-

1. Centre of field only must be used for resolution of fine secondary detail of diatoms, otherwise slotted appearance occurs of all holes off centre with both object glasses. This tested by stage rotation. 'Slots' are related to direction of light from Vertical Illumination plate and are always North to South (light is applied East to West)
2. Secondary structure of *E. argus* is best made out in Transmitted Illumination and Vertical Illumination by Swift-Holos at tube length 190mm to top of Ramsden eye lens. Structure is clearly of holes overlying whole valve; a clear easy picture of this.
3. Koristka needs too high eyepiece to show all detail easily, Very sharp accurate focus is necessary. Resolves as well in Transmitted Illumination as Vertical Illumination. Image is sharper than Swift-Holos on any diatom even allowing for higher eyepiece to obtain similar magnification. NB. all before page 262 on Swift-Holos was before final optimisation.

Conclusion. As a sorter-out of complicated detail Swift-Holos is superior in Transmitted Illumination and Vertical Illumination, but for thinner diatoms and other structures inferior aperture of Koristka is clear. At present stage of study nothing has been learned from the extra aperture of Koristka. Picture is cleaner but magnification is too small.

On E. Argus covering mesh shows 'white' holes in Vertical Illumination, this due to illumination of heavy silica below. Both object glasses show this. Compare this result with page 279 technical test, and previous pages [but see page 287]

2nd Conclusion. Swift-Holos appears to work best at tube length 190mm i.e. on a shorter tube length but correction, in-out-focus test, is correct at nominal 10" (x10 Ramsden).

This implies that Ramsden x10 on long tube is too much for a $^1/_{12}$". Koristka is very good at x10 Ramsden on short tube in Transmitted Illumination, but all detail cannot be seen. On typical slides Koristka does not work well in Vertical Illumination, difficult to illuminate subjects sufficiently. Swift-Holos does this very well. i.e. keep to Swift-Holos for all 1st examinations.

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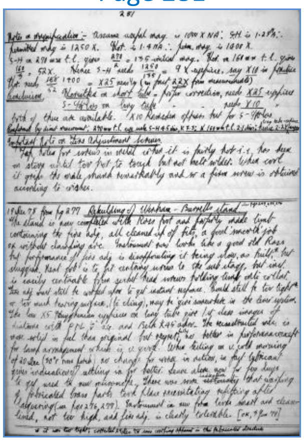

Notes on Magnification.

Assume useful magnification is 1000 x NA:

Swift-Holos is 1.25NA therefore permitted magnification is 1250x.

Koristka is 1.4NA therefore permitted magnification is 1400x.

Swift-Holos on 270mm tube length gives $^{270}/_2 = 135$ initial magnification.

Koristka on 160mm tube length gives $^{160}/_3 = 52$x.

Hence Swift-Holos needs $^{1250}/_{135} = 9$x eyepiece, say x10 in practice.

Koristka need $^{1400}/_{52} =$ x25 nearly (in fact 22x from measurements)

Conclusion. Koristka on short tube = proper correction, needs x25 eyepiece. Swift-Holos on long tube = proper correction needs x10 eyepiece. Both of these are available. X10 Ramsden appears best for Swift-Holos.

Confirmed by direct measurement: 270 mm tube length, eye scale Swift-Holos 4.5 divisions, Koristka 3.3 divisions. Koristka 160mm tube length 2.1 divisions; hence 2.2x long tube eyepiece.

Important note on Fine adjustment screws.

Tap holes for screws in metal when it is fairly hot, i.e. has been on stove until too hot to tough but not melt solder. When cool it grips the male shank remarkably and so a firm screw is obtained according to wishes.

19th December 1978 – from page 277

Rebuilding of Wenham-Burrells stand (also see pages 249, 299, 276,)

The stand is now completed with Ross foot and properly made limb containing the fine adjustment, all cleaned up of bits, a good 'smooth' job, OK without clamping arc. Instrument now looks like a good old Ross but performance of fine adjustment is disappointing, it being slow, as built (it was too tight, corrected 29th December 1978 some warping apparent in this fabricated structure), but sluggish. Next job is to fir centring screws to the sub stage, but instrument is easily centred from socket head screws holding limp onto collar. Fine adjustment must still be worked upon to get instant response. Could still be too tight, or too much bearing surface, (to cling), mat be 'give' somewhere in the lever system. The low x5 Huyghenian eyepieces on long tube give 1st class images of diatoms with Powell and Lealand ⅛" object glass and Beck x45 achromat. The reconstructed microscope is more solid in feel than original, but regretfully no better in performance, except for lamp attachment which is very good. When testing on very cold morning of 20th December (30°F room porch) no change for worse in action, in fact lubricant gives indication of settling in for better. Leave alone now for few days to get used to new microscope. There was some indication that warping of fabricated brass parts took place necessitating refitting after lacquering (see page 276, 277). Instrument in new form looks smart and clean-lined, not too high, and fine adjustment is clearly tolerable. [OK, 3rd January 1979].

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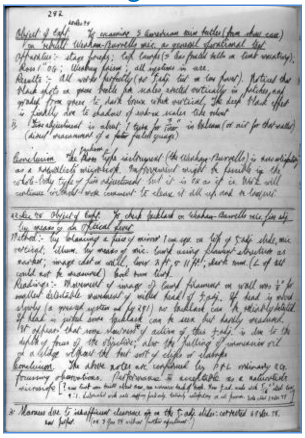

20th December 1978

Object of Experiment

To examine S. American rain beetles (from show case) on rebuilt Wenham-Burrells microscope. A general operation test.

Apparatus:- Stage forceps, top lamps (3 lens fronted bulbs on limb mounting), Ross 1" object glass, Wenham prism, all systems in use.

Results:- All works perfectly (no fine adjustment in low power). Noticed that black spots on green beetle are scales erected vertically in patches, and graded from green to dark brown when vertical. The deep black effect is finally due to shadow of end-on scales like velvet.

Fine adjustment is about 1 turn for $^{3}/_{1000}$" in Balsam (or air for that matter) (direct measurement of a feeler gauge)

Conclusion. The Jackson type instrument (the Wenham-Burrells) is now satisfactory as a naturalists' microscope. Improvement might be possible in the whole-body type of fine adjustment but it is OK as it is. Work will continue without more comment to clean it all up and re-lacquer.

22nd December 1978

Object of Experiment

To check backlash on Wenham-Burrells microscope fine adjustment by means of an optical lever.

Method:- by balancing a piece of mirror 1 cm square on top of fine adjustment slide, microscope vertical, illumination by means of microscope lamp using filament structure as marker, image cast on wall, lever 2ft v. 11ft, dark room (angle of tilt could not be measured). Cool room temperature.

Readings:- Movement of image of lamp filament on wall was ⅛" for smallest detectable movement of milled head of fine adjustment. If head is moved slowly (a greased system as page 281) no backlash can be reliably detected. If head is jerked some backlash can be seen but hardly measured. It appears that some slowness (slowness due to insufficient clearance on the fine adjustment slides: corrected 29th December 1978, now perfect [OK 3rd January 1979 without further adjustment]) if action of this fine adjustment is due to the depth of focus of the objective; also the 'pulling' of immersion oil on a stage without the best sort of clips or clamps.

Conclusion. The above notes are confirmed by Powell and Lealand ordinary object glass focussing observations. Performance is acceptable as a naturalists' microscope [? New limb was built about now, see LVVVVIII back of book [Transcribers Note: included with page 277 in this version]. New fine adjustment made with $^{5}/_{16}$" steel lever (:1 lubricated with anti-scuffing paste only. Entirely satisfactory OK all powers. Note added 28th December 1979)

22nd December 1978

Object of Experiment

To try to improve visibility of diatoms by optical means, ref. QMC Journal, December 1978 Vol.33., F.A.S. Sterrenburg. Polarised light

Apparatus:- Ross-Burrells microscope; polarised light, straight, white, Research Lamp 12V Projector Quartz Iodide, Swift-Holos and Koristka object glasses; Slide '*Amphipleura pellucida*' NBS RI 1.78, Universal Condenser, Transmitted Illumination, no diffuser.

Readings:-

i. With straight Transmitted Illumination Nelsonian, no resolution of *Amphipleura pellucida* by the object glass. With ordinary polarised light as for geology intense level, a good visible image but no resolution with Swift-Holos 1.25. Direct swap to Koristka (with WB's corrector in place) instant resolution into dots looking like a dark ground image and quite the best I have seen, dots properly on the valve, no oblique light, x7 Huyghenian. On change back to ordinary light, no resolution. [Specimen stated to be 40 lines in 10µ = 4 lines

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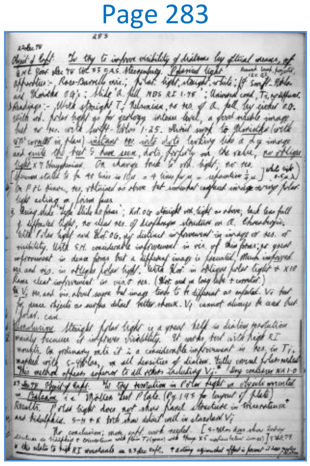

per µ = separation ¼µ (white light 0.5µ wavelength)]
On Powell and Lealand binocular resolution obtained as above but somewhat confused image owing to polarised light acting on prism faces.

ii. Using slide 'Type slide 20 forms' Koristka object glass straight ordinary light as above, back lens full of diffracted light, no clear resolution of diaphragm structure on *A. ehrenbergii*. With polarised light and Koristka object glass, no distinct improvement in image or resolution or visibility. With Swift-Holos considerable improvement in resolution of thin forms; no great improvement in dense forms but a different image is presented. Much improved resolution and visibility in oblique polarised light. With Koristka in oblique polarised light and x10 Ramsden clear improvement in visibility and resolution (Koristka used in long tube and corrector).
In Vertical Illumination resolution and visibility about same but image tens to be different as expected. Vertical Illumination best for dense objects as surface detail better shown. Vertical Illumination cannot always be used but polar can.

Conclusion. Straight polarised light is a great help in diatom resolution mainly because it improves visibility. It works best with high RI mounts. On ordinary mounts it is a considerable improvement in resolution in Transmitted Illumination, marked with Swift-Holos, on all densities of diatom. Fully crossed polars needed. This method appears superior to all others including Vertical Illumination. (this relates to high Refractive Index mountants, see 23rd December experiment. Dry condenser NA 1.0.

23rd December 1978
Object of Experiment
To try resolution in polarised light on objects mounted in balsam. i.e. Möller's Test Plate (page 193 for layout of plate)
Results:- Polarised light does not show panel structure in *Triceratium* (a strong azimuth effect is present, it does resolve diatom) and *Biddulphia*. Swift-Holos and Koristka both show detail well in standard Vertical Illumination.
No conclusion; more experimental work needed. [Swift-Holos does show secondary structure in *Biddulphia* and *Triceratium* with plain Transmitted Illumination (green) with Huyghenian x5 eyepiece (clear image) 5th February 1979]

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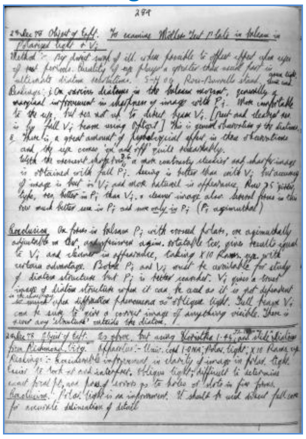

23rd December 1978
Object of Experiment
To examine Möller's Test Plate in Balsam in polarised light and Vertical Illumination.
Method:- By direct swap of illumination where possible to offset effect upon eyes of rest periods. Quality of eye plays a greater than usual part in ultimate diatom resolutions. Swift-Holos object glass, Ross-Burrells stand, Universal condenser, green light.
Readings:-

i. On various diatoms in the Balsam mount, generally a marginal improvement in sharpness of image with Pi. More comfortable to the eye, but resolution not up to direct beam Vertical Illumination [best and cleanest resolution is by full Vertical Illumination beam using Optoil]. This is general observation of the diatoms

ii. There is a great amount of psychological effect in these two observations and the eye comes 'on' and 'off' quite remarkably.
With the crescent shape row D.6. a more 'contrasty' steadier and sharper image is obtained with full Pi. Seeing is better than with Vertical illumination but accuracy of image is best in Vertical Illumination and more natural in appearance. Row D.5 'girder' type, resolution better in Pi than Vertical Illumination, a cleaner image also. Several forms in this row much better seen in Pi and some only in Pi (Pi azimuthal).

Conclusion. On forms in Balsam Pi with crossed polars, are azimuthally adjustable on test, and specimen azimuth rotatable too, gives results equal to Vertical Illumination and cleaner in appearance, taking x10 Ramsden eyepiece with certain advantage. Both Pi and Vertical Illumination must be available for study of diatom structure but Pi is better searcher. Vertical Illumination gives a truer image of diatom structure when it can be used as it is not dependent in the same way upon diffraction phenomena as is oblique light. Full beam Vertical Illumination can be sure to give a correct image of anything visible. There is never any 'structure' outside the diatom.

24th December 1978
Object of Experiment
As above, but using Koristka 1.45, tube length 180mm and slide 'Diatoms from Richmond, Virginia'.
Apparatus:- Universal Condenser 1.0NA, polarised light, x10 Ramsden eyepiece.

Readings:- Considerable improvement in clarity of image in polarised light. Easier to look at and interpret. Oblique light, difficult to determine exact focal point, and possibility of errors as to holes or slots in fine forms.

Conclusion. Polarised light is an improvement. It should be used direct full cone for accurate delineation of detail.

25th December 1978 pm

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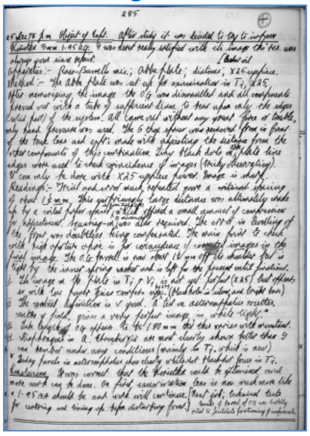

Object of Experiment

After study it was decided to try to improve Koristka 3mm 1.45 object glass.

I was never really satisfied with its image though resolution was always good since repair.

Apparatus:- Ross-Burrells microscope; Abbe plate, diatoms, x25 eyepiece

Method:- The Abbe plate was set up for examination in Transmitted Illumination, x25.

After memorising the image the object glass was dismantled and all components pressed out with a tube of sufficient diameter to bear upon only the edges (solid part) of the system. All came out without any great force or trouble, only hand pressure was used. The 6 thou spacer was removed from in front of the back lens and experiments made with adjusting the distance from the other components of this combination. Tiny black dots on Abbe plate line edges were used to check coincidence of images (tricky observation). It can only be done with x25 eyepiece power. Image is sharp.

Readings:- Trial and error much repeated gave a spacing of about 1½mm. This surprisingly large distance was ultimately made up by a coiled paper spacer that offered a small amount of compression for adjustment. Squaring-on to microscope was also required. The error in levelling of the front was doubtless being compensated. The main point to check with high aperture apochromats is for coincidence of corrected images in the final image. The object glass barrel is now about 1½mm off its shoulder but is tight by the inner spring washer and is left for the present until finalised.

i. The image on the plate in Transmitted Illumination and Vertical Illumination is not yet perfect (x25) but appears so with low power Zeiss compensating eyepieces (page 279) (black holes in silver, and bright bars)
ii. The central definition is very good. A test on *Asteromphalus* rosettes centre of field gives a very perfect image in white light. (Secondary panels in *Asteromphalus* show clearly white dot, black dot focus in Transmitted Illumination.)
iii. Tube length if object glass appears to be 180mm though this varies with mountant.
iv. Diaphragms in *Arachnoidiscus ehrenbergii* are most clearly shown better than I can remember under any conditions (mainly in Transmitted Illumination, which is new)

Conclusion. It was correct that the Koristka could be optimised and more work can be done. On first examination lens is now much more like a 1.45NA should be and work will continue [Next job, technical tests for centring and lining up before disturbing front]. Inside of barrel of object glass was lightly oiled to facilitate positioning of components.

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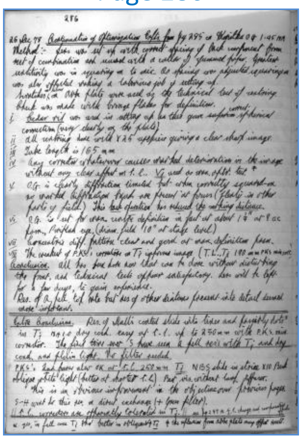

26th December 1978

Continuation of optimisation experiments from page 285 on Koristka object glass 1.45NA.

Method:- Lens was set up with correct spacing of back component from rest of combination and secured with a collar of gummed paper. Greater sensitivity was in squaring on to microscope. As spacing was adjusted squaring-on was also affected making a laborious job of setting up.

Scratches on silver on Abbe plate were used as the technical test of centring. Check was made with bronze flakes for definition.

i. Cedar oil was used in setting up as this gave correct spherical correction (very clearly on the plate)
ii. All centring done with x25 eyepiece giving a clear sharp image
iii. Tube length is 165mm
iv. Any corrector whatsoever causes marked deterioration in the image without any clear effect on tube length. Vertical illumination used as maximum aperture test (the reflection from Abbe plate may affect result)
v. Object glass is clearly diffraction limited but when correctly squared-on no marked diffraction bands are present at focus (plenty in other parts of field). This back operation has reduced the working distance.
vi. Object glass is set for maximum centre definition in fact at about 1¼" at 9 o'clock position, Periplan eyepiece (diameter field 10" at stage level)
vii. Concentric diffusion pattern clear and good at maximum definition position

viii. The weakest of P. K. Sartory's correctors in Transmitted Illumination improves image (tube length, Transmitted Illumination, 190mm P. K. Sartory's minimum corrector)

Conclusion. All has been done now that can be done without disturbing the front, and technical tests appear satisfactory. Lens will be left for a few days, to gain experience.

Resolution of *Amphipleura pellucida* top rate but resolution of other diatoms present into detail deemed more important.

Extra Conclusion. Resolution of Dall's coated slide into lines and possibly dots (yes, in full cone Transmitted Illumination though better in oblique Transmitted Illumination) in Transmitted Illumination NA 1.0 dry condenser easy at tube length up to 230mm with P. K. Sartory's minimum corrector. The first time ever I have seen *Amphipleura pellucida* resolved with Transmitted Illumination and dry condenser and plain light. No filter needed.

P. K. Sartory's 2nd power also OK at tube length 250mm, Transmitted Illumination, NBS slide in Styrax, x10 beck, oblique white light (better at shorter tube length). Best visibility without lamp diffuser.

This is an obvious improvement in the objective over previous page. Swift-Holos won't do this resolving on direct exchange (+ green filter).

Tube length correctors are apparently tolerated in Transmitted Illumination. See page 297 tube length change and compensation effects.

27th December 1978

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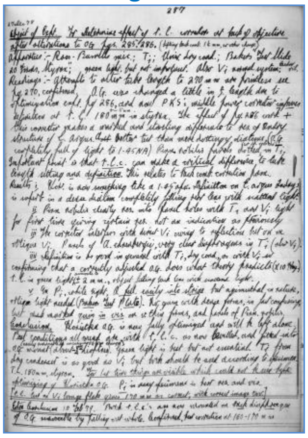


Object of Experiment

To determine effect of tube length correctors at back of objective after alteration to object glass – pages 285, 286 (lifting back combination 1½mm, no other change)

Apparatus:- Ross-Burrells microscope, Transmitted Illumination, Universal Dry condenser, 'Baker's Test slide 20 forms, Styrax', green light, but not important. Also Vertical Illumination normal system, Cedar Oil

Readings:- Attempts to alter tube length to 270mm are pointless, see page 270, confirmed. Object glass was changed a little in focal length due to optimization experiment page 286, and now P. K. Sartory's middle power corrector improves definition at tube length 180mm ± 5mm in Styrax. The effect of page 286 work and this corrector makes a marked and startling difference to resolution of secondary structure of *E. argus*. A better test than mere dotting of diatoms, (Object glass completely full of light to 1.45NA) *Pinnularia nobilis* panels dotted (not all over) do in Transmitted Illumination. Important point is that tube length correction can make a critical difference to tube length setting and definition. This relates to back combination correction position.

Results:-

i. Koristka is now something like a 1.45 apochromat. Definition in *E. argus* secondaries is superb in a dense diatom, completely filling rear lens with scattered light.

ii. *Pinnularia nobilis* clearly resolved into panel holes with Transmitted Illumination and Vertical Illumination light for first time giving certain resolution not an indication as previously

iii. The corrector interferes with direct Vertical illumination owing to reflection but on oblique Vertical Illumination panels of *A. ehrenbergii* very clear diaphragms in Transmitted Illumination (also Vertical Illumination).

iv. Definition is as good in general with Transmitted Illumination dry condenser, as with Vertical Illumination so confirming that a correctly adjusted object glass does what theory predicts (x10) tube length in green light accurate to ± 2mm, object filling back lens without scattered light.

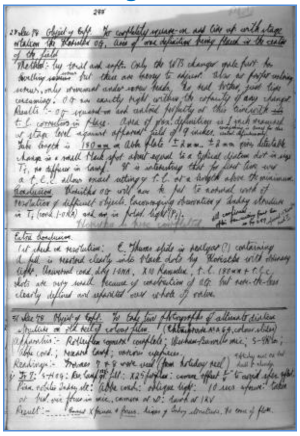
v. In Pi, white light, *Amhipleura pellucida* easily into striae but azimuthal in nature, oblique light needed (Baker's test plate). No gain with dense forms, in fact confusing, but marked gain in visibility on very thin forms, and panels of *Pinnularia nobilis*.

Conclusion. Koristka object glass is now fully optimised and will be left alone. Best conditions all round are with tube length corrector as now levelled, and fitted into object glass mount [easily removable by unscrewing object glass] (about -2 dioptres). Green light is best but not essential. Transmitted Illumination from dry condenser is as good as Vertical Illumination but both should be used according to specimen. Tube length 180mm Styrax. For 1st time things are visible which could not be seen before optimising of Koristka object glass. Pi in many specimens is best resolution and visibility.

[Tube length test on Vertical Illumination bronze flake gives 170mm as correct, with correct image to.]

Extra Conclusion 10th February 1979. Both tube length correctors are now mounted on back diaphragm of object glass removable by pulling out whole. Confirmed, best correction at 160-170mm.

Page 288



27th December 1978

Object of Experiment

To completely square-on and line up with stage rotation the Koristka object glass. Area of maximum definition being placed in the centre of the field.

Method:- by trial and experiment. Only the WB changer male part has levelling screws but these are messy to adjust. Also no proper centring screws, only movement under screw heads. No real bother, just time consuming. Object glass now exactly right within the capacity of any changer.

Results:- Object glass squared on and centred perfectly at this time with tube length correctors in place. Area of maximum definition is 1 inch measured at stage level against apparent field of 9 inches (everything is tuned for this central definition only). Tube length is 180mm on Abbe plate ± 2mm. ± 2mm gives detectable change is small black spot about equal to a typical diatom dot in size. Transmitted Illumination, no diffuser in lamp. It is interesting that for first time ever a tube length corrector allows exact setting of tube length at a length above the minimum.

Conclusion. Koristka object glass will now be put to normal work of resolution of difficult objects. Encouraging observation of secondary structure in Transmitted Illumination (condenser 1.0NA) and in polarised light (Pi)

All confirmed after re-seating of front lens as page 297.

Confirmed 15th March 1979 Bk.II.

Koristka is here completed.

Extra Conclusion. 1st check on resolution: E. Thum's slide in Realgar(?) containing *Amphipleura pellucida* is resolved clearly into black dots by Koristka with ordinary light. Universal condenser dry 1.0NA, x10 Ramsden, tube length 180mm and tube length corrector. Dots are very small because of construction of object glass but none-the-less clearly defined and separated over whole of valve.

31st December 1978

Object of Experiment

To take two photographs of ultimate diatom structure on old reel of colour film. (Ektachrome ASA64, colour slides)

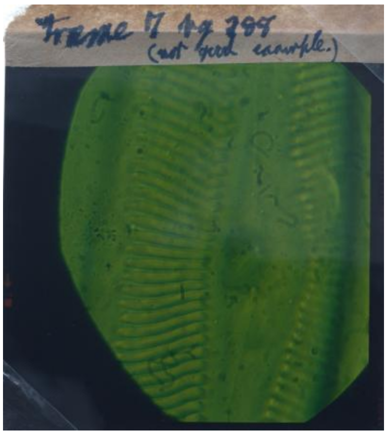
Apparatus:- Rolleiflex camera complete, Wenham-Burrells microscope, Swift-Holos, Abbe condenser, research lamp, various eyepieces.

Readings:- Frames 7 and 8 were used (from holiday reel) (Holiday reel OK but dull and cloudy)

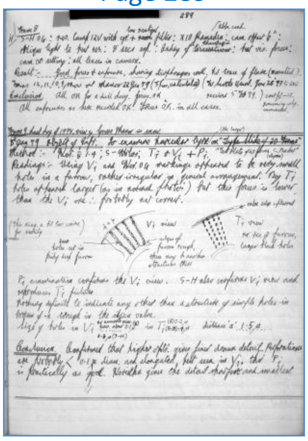
i. Frame 7. Swift-Holos object glass, research lamp 12V with green filter, x25 Periplan, camera offset ⅛" to avoid spherical reflection. *Pinnularia nobilis* secondary mount, Abbe condenser, oblique light, 10 seconds exposure, taken at best visible focus in microscope, camera at infinity, lamp at 12V.
   Result:- Correct exposure and focus. Signs of secondary structure. No trace of flare.

(next page)

Frame 7



Page 289



ii. Swift-Holos, research lamp 12V with green and low neutral filter, x10 Ramsden, Abbe condenser, camera offset ⅛", oblique light to best resolution; 8 second exposure, secondary of *Arachnoidiscus Ehrenbergii*; best visible focus, camera infinity setting, all lenses in camera.

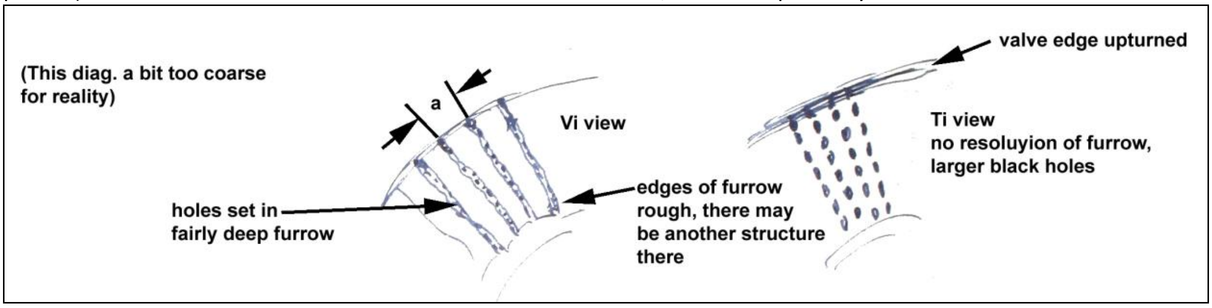
Result:- Good focus and exposure, showing diaphragms well. No trace of flare (mounted)

Frames 9,10,11,12 Snow at Manor 22nd January 1979 (3 fine, calculator) (To Scotts Wantage 24th January 1979 – received 5th February 1979 – cost £1.12 processing only, un-mounted))

Conclusion. All OK for a dull day. Focus OK.

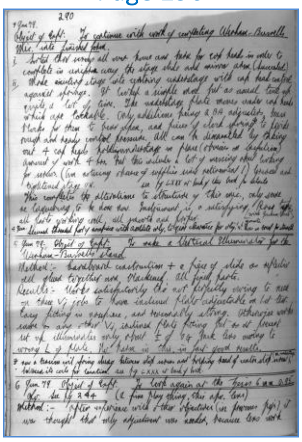
All exposures as here recorded OK. Focus OK in all cases.
(Frame 9. Last day of 1978 showing Grove Manor in snow.

2nd January 1979.
Object of Experiment
To examine *Navicula lyra* on "Test plate 20 forms C. Baker"
Method:- Koristka ⅛" 1.4, Swift-Holos, Transmitted Illumination and Vertical Illumination and Pi.
Readings:- Using Vertical Illumination and Koristka object glass markings appeared to be very small holes in a furrow, rather irregular in general arrangement. By Transmitted Illumination holes appeared larger (as in normal photos) but this focus is lower that the Vertical Illumination one, therefore probably not correct.



Pi examination confirms the Vertical Illumination View. Swift-Holos confirms Vertical Illumination and reproduces Transmitted Illumination picture.
Nothing definite to indicate any other than a structure of simple holes in bottom of a trough in the silica valve.
Size of holes in Vertical Illumination – no accurate means possible about 0.1µ (Koristka), 0.3µ (Swift-Holos), in Transmitted Illumination 0.2µ (Koristka), 0.4µ (Swift-Holos), distance 'a' 1.5µ.
Conclusion. Confirmed that higher aperture gives finer drawn detail. Perforations are probably < 0.1µ diameter and elongated, best seen in Vertical Illumination, though Pi is practically as good. Koristka gives the detail sharpest and smallest.

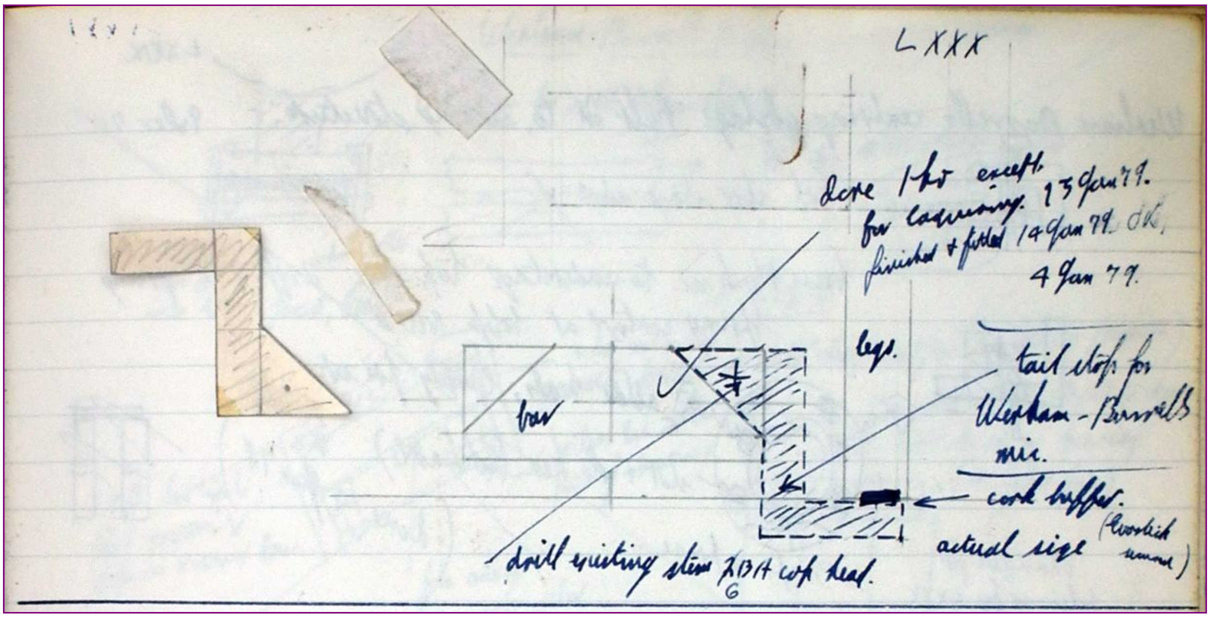
Page 290

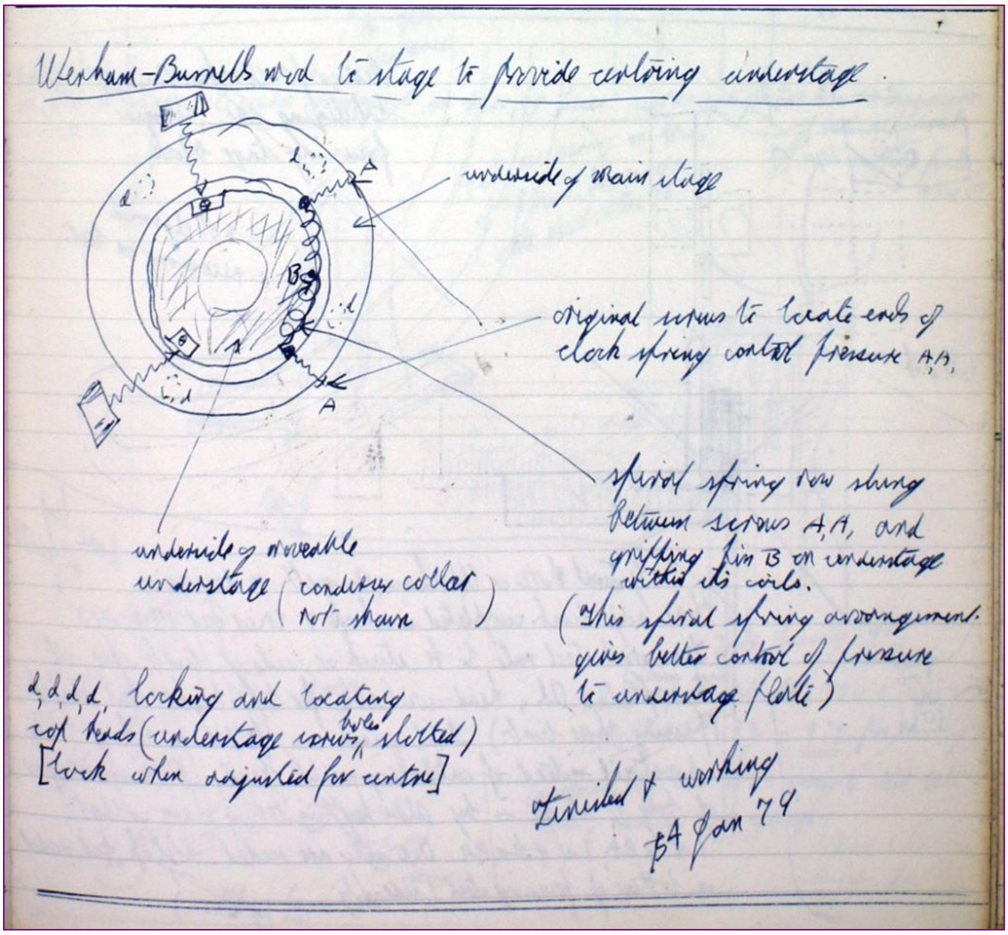


3rd January 1979
To continue with work of completing Wenham-Burrells Microscope into finished form.

i. Sorted through screws all over house and barn for cap heads in order to complete in uniform way the stage slide and mirror arm. (Succeeded)
ii. Made existing stage into centring understage with cap head control against springs. It looked a simple modification but as usual took up quite a lot of time. The understage plate moves under cap heads which are lockable. Only additions being 2BA adjusters, brass blocks for them to bear upon, and pieces of clock spring (now a tension coil spring between stop screws and holding head of centre stop screw [in substage] between its coils for location. See page LXXX at back of book.) to provide rough and ready control pressure. All can be dismantled by taking out 4 cap heads holding understage in place (obvious on inspection). Amount of work 4 hours, but this includes a lot of messing about looking for screws. (Am noticing absence of supplies since retirement!) Greased and tightened stage OK. (see page LXXX at back of this book for details- reproduced below)
iii. This completes the alterations to structure of this microscope, only some re-lacquering to be done now. Instrument is a satisfying Ross-type with Jackson limb. All parts working well, all smooth and proper.

4th January. Secured threaded part of nosepiece with Araldite only, to give clearance for objectives. Mounts now on trial for strength.





5th January 1979

Object of Experiment

To make a Vertical Illuminator for the Wenham-Burrells stand.

Method:- Cardboard construction and a piece of slide as reflector, all glued together and blackened. All fixed parts.

Results:- Works satisfactorily though not perfectly owing to need on these Vertical Illumination jobs to have inclined plate adjustable on 1st test. Easy fitting in nosepieces, and reasonably strong. Otherwise works same as any other Vertical Illumination inclined plate fitting but as at present set up illuminated only about ½ of object glass back lens owing to wrong angle of plate. No harm in this, in fact good results.

6th January 1979

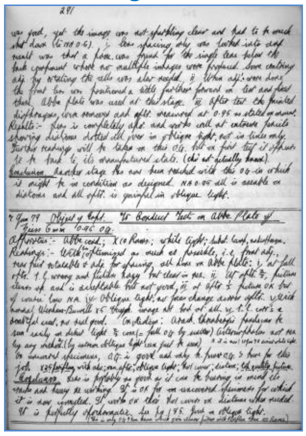
Object of Experiment

To look again at the Zeiss 6mm 0.95 apochromat. See page 244.

(A fine plaything, this apochromat lens.)

Method:- After experience with other objectives (in previous pages) it was thought that only adjustment was needed, because lens works…*(next page)*

Page 291



…was good, yet the image was not sparkling clear and had to be much shut down (to NA 0.6)

i. Lens spacing only was looked into and result was that a position was found for the single lens below the back component where no multiple images were produced. Some centring adjustment by rotating the cells was also needed.

ii. When adjustments were done the front lens was positioned a little further forward on test and fixed there. Abbe plate was used at this stage.

iii. After test the painted diaphragms were removed and aperture measured at 0.95 as stated on mount.

Results:- Lens is completely apochromat and works well at extreme pencils showing diatoms dotted all over in oblique light, not in lines only. Further readings will be taken on this object glass but on first test it appears to be back to its manufactured state (though not actually known).

Conclusion. Another stage has now been reached with this object glass in which it might be in condition as designed. NA 0.95 all is useable on diatoms and all aperture is gainful in oblique light.

7th January 1979.

Object of Experiment

To conduct tests on Abbe Plate of Zeiss 6mm 0.95 object glass.

Apparatus:- Abbe condenser, x10 Ramsden, white light, substage lamp, no diaphragm.

Readings:- With lens optimised as much as possible i.e. front adjusted, rear pair rotatable and adjusted for spacing, all done on Abbe Plate.

i. At full aperture tube length wrong and picture hazy but clear in resolution

ii. At aperture ⅔, picture clears up and is acceptable but not good

iii. At aperture ½ picture OK but of course low NA

iv. Oblique light, no focus change across aperture

v. With normal Wenham-Burrells x5 Huyghenian, image not bad at all

vi. Tube length correctors a doubtful asset, no real good.

On diatom: *Arachnoidiscus Ehrenbergii* panels can be seen easily on direct light ⅔ cone (-full object glass by scatter). *Asteromphalus* not resolved by any method [It is now! 10th June 1979 – direct white light] (by extreme oblique light can just be seen)

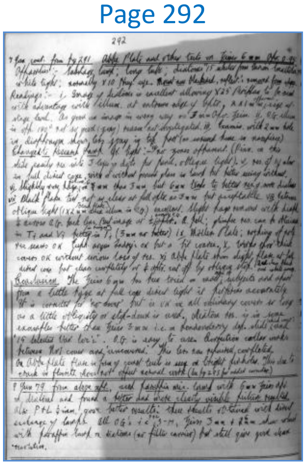
On uncovered specimens object glass is good and only high power object glass I have for this job. X29 Periplan with advantage; maximum aperture, oblique light, No.1 cover, diatom, top quality picture.

Conclusion. Lens is probably as good as it can be bearing in mind its cracks and heavy re-working. It is OK for uncovered specimens for which it is now corrected. It works OK through No.1. covers OK diatoms when needed. It is perfectly apochromatic. See page 185. Good in oblique light.

(This is only object glass I have known which gives clearer picture with Periplan than x10 Ramsden.)

(next page)

Page 292



7th January 1979 (continued from page 291.)

Abbe plate and other tests on Zeiss 6mm apochromat 0.95

Apparatus:- Substage lamp, long tube, diatoms "15 selected from various localities", white light, normally x10 Huyghenian eyepiece, mount now blackened; removed from edges.

Readings:-

i. Image of diatoms is excellent allowing x25 Periplan to be used with advantage with illumination at extreme edge of aperture, 2 x 1mm apparent size at stage level. As good an image in every way as Zeiss 3mm apochromat

ii. Object glass illumination in opposite 180° not so good (zoney), reason not investigated

iii. Examination with 2mm hole in diaphragm shows lens zoney in top part (as screwed home in nosepiece)

Changed to research lamp, green light.

iv. No zones apparent (*Pinnularia* on this slide easily resolved into 3 lines of dots per panel, oblique light)
v. Resolution of iv. also in full direct cone, with or without ground glass in lamp but better seeing without
vi. Slightly more haze, full cone on 6mm than 3mm but 6mm tends to better resolution of some diatoms
vii. Black flake test not so clear at full aperture as 3mm but acceptable
viii. Extreme oblique light (1 x 2mm black flake area illuminated in object glass) excellent. Slight haze removed with diaphragm ¼ across object glass back lens. Best image at ½ across object glass. *Amphipleura pellucida*, glimpse resolution can be obtained in Transmitted Illumination and Vertical Illumination. Better in Realgar in Transmitted Illumination (2mm no better(
ix. Möller's plate, nothing of note, resolution seems OK. *Eup. Argus* secondaries OK but a bit coarse
x. Works through thick covers OK without serious loss of resolution
xi. Abbe plate shows slight flare at full direct core but clears completely at ¼ aperture cut off by oblique stop. 2nd class black and white image

Conclusion. The Zeiss 6mm has been tried in most types of subjects and apart from a little haze at full cone direct light it performs accurately. It is corrected for 'no cover' but is OK on all ordinary covers so long as a little obliquity or stop-down is used. Diatom resolution is in some examples better than Zeiss 3mm, i.e. in Londonderry deposit slide (thick cover) and '15 selected various localities". Object glass is easy to use. Correction collar works between No.1 cover and uncovered. This lens no repaired, completed. On Abbe plate flare in form of comet tails is seen on bright pinholes. This due to crack in fluorite. Does not affect normal work. (see page 293 for added corrector)

9th January 1979

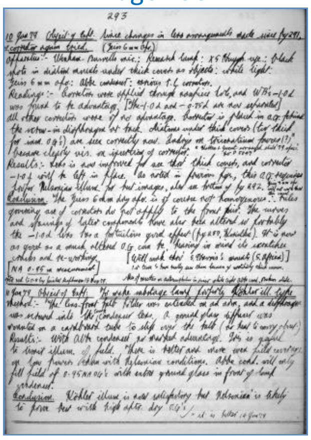
From above experiment, used paraffin microscope lamp with 6mm Zeiss apochromat on diatoms and found a better and more clearly visible picture resulted. Also Powell and Lealand ⅛ immersion gave better results: these results obtained with direct exchange of lamps. All object glasses i.e. Powell and Lealand, Swift-Holos, Zeiss 3mm and 6mm show colour with paraffin lamp on diatoms (no filter carrier) but still give good clean resolution.

10th January 1979

Object of Experiment

Since changes in lens arrangements made since page 291, tube length corrector again tried. Zeiss 6mm apochromat.

Page 293



Apparatus:- Wenham-Burrells microscope, research lamp, x5 Huyghenian eyepiece, black spots in diatom mounts under thick covers as objects, white light, Zeiss 6mm apochromat, Abbe condenser, various tube length correctors.

Readings:- Correctors were applied through nosepiece hole, and WB's -1.0 dioptre was found to be advantage (the -1.0 dioptre and -0.75 dioptre are now separated) All other correctors were of no advantage. Corrector is placed in object glass behind the screw-in diaphragms at back. Diatoms under thick covers (too thick for immersion object glasses) are seen correctly now. Secondaries on *Triceratium favus*(?) [Flatters and Garnett arranged slide 79 species No.P5047] became clearly visible on insertion of corrector.

Results:- Lens is now improved for use through thick covers, and corrector -1.0 dioptre will be left in place. As notes in previous pages, this object glass requires proper Nelsonian illumination for best images, also see bottom of page 292. Zeiss 3mm apochromat will not work through this cover.

Conclusion. The Zeiss 6mm dry apochromat is of course not homogenous therefore rules governing use of correctors do not apply to the front pair. The curves and spacings of later components have also been altered so probably the -1.0 dioptre lens has a fortuitous good effect (page 287 Koristka). It is now as good as a much altered object glass can be, bearing in mind its scratches, cracks and re-working.

[Will work through S. Harris' mounts (S. Africa). 1st time I have actually seen them because of wretchedly thick cover.]

[NA 0.95 in measurement]

Aperture reduced to 0.8 by painted diaphragm 16th May 1979.

Resolution of rosettes on *Asteromphalus* in direct white light, Abbe condenser. Baker's slide.

11th January 1979

Object of Experiment

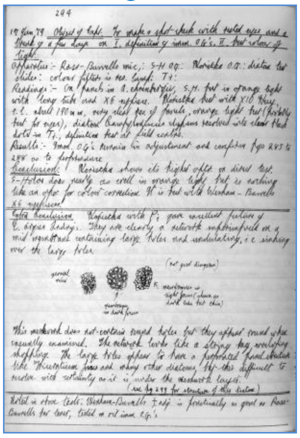
To make substage lamp properly Köhler illumination type.

Method:- The lens front bulb holder was extended on an arm, and a diaphragm was crewed into the lamp condenser lens. A ground glass diffuser was mounted on a cardboard tube to slip over the bulb (no heat to worry about).

Results:- With Abbe condenser no marked advantage. Iris is useful to limit illumination of field. There is better and more even field coverage on low powers than with Nelsonian conditions. Abbe condenser will only fill field of 0.95 object glasses with extra ground glass in from of lamp condenser.

Conclusion. Köhler illumination is now satisfactory but Nelsonian (it is better – 15th January 1979) is likely to prove best with high aperture dry object glasses.

Page 294



17th January 1979

Object of Experiment

To make a spot check with rested eyes and a break of a few days on I, definition of immersion object glasses. II. Best colour of light.

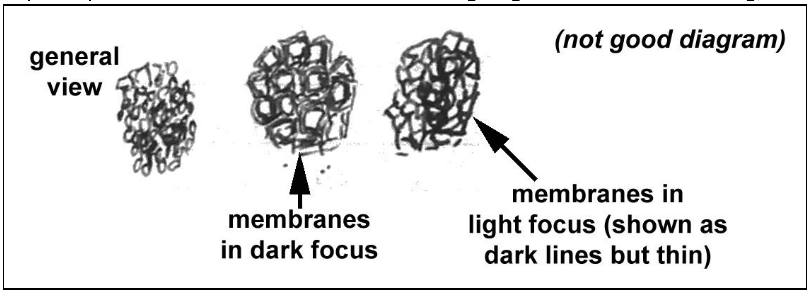
Apparatus:- Ross-Burrells microscope; Swift-Holos Object glass; Koristka object glass; diatom test slides; colour filters is research lamp; Transmitted Illumination.

Readings:- On panels in *Arachnoidiscus Ehrenbergii*, Swift-Holos put in orange light with long tube and x6 eyepiece. Koristka but with x10 Huyghenian, tube length about 190mm, very clear resolution of panels, orange light best (probably best for eyes), diatom *Campylodiscus clypeus* resolved into clear black dots in Transmitted Illumination, definition best at field centre.

Results: Immersion Object glasses remain in adjustment and confirm pages 285 to 288 as to performance.

Conclusion. Koristka shows its higher aperture on direct test. Swift-Holos does nearly as well in orange light but is nothing like an apochromat for colour correction. It is best with Wenham-Burrells x6 eyepieces.

Extra conclusion. Koristka with Pi gave excellent picture of *E. argus* secondaries. They are clearly a network superimposed on a mid membrane containing large holes and undulating, i.e. sinking over the large holes.

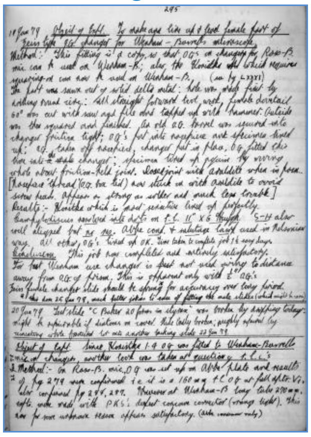


This membrane does not contain round holes but they appear round when casually examined. The network looks like a string bag enveloping shopping. The large holes appear to have a perforated panel structure like *Triceratium* forms and many other diatoms, but this difficult to resolve with certainty as it is under the meshwork layer.

(see page 299 for structure of this diatom)

Noted in above tests: Wenham-Burrells fine adjustment is practically as good as Ross-Burrells bar lever, test on oil immersion object glasses.

Page 295



18th January 1979

Object of Experiment

To make and line and level female part of Zeiss type object changer for Wenham-Burrells microscope.

Method: - This fitting is a copy, so that object glasses on changers for Ross-Burrells microscope can be used on Wenham-Burrells; also the Koristka which requires squaring-on can now be used on Wenham-Burrells (see page LXXXI)

The part was sawn out of solid delta metal: hole was made first by drilling round circle. All straight forward tool work, female dovetail 60° was cut with saw and file and tapped up with hammer. Outside was then squared and finished. An old object glass barrel was secured into changer, friction tight; object glasses put into nosepiece and specimen lined up; object glass taken off nosepiece, changer put in place, object glass fitted this time into the male changer; specimen lined up again by moving whole about friction held joint. Dosed joint with Araldite when in position. [Nosepiece 'thread')object glass box lid) now stuck on with Araldite to avoid screw heads. Appears as strong as solder and much less trouble.]

Results:- Koristka, which is most sensitive, lined up perfectly.

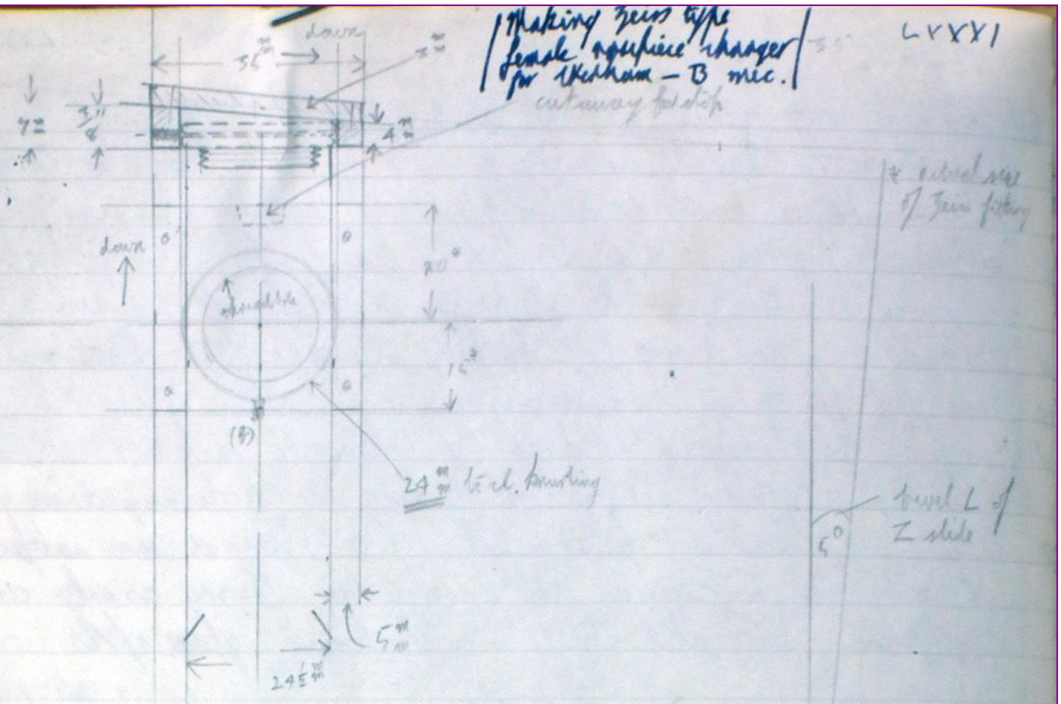
Campylodicus resolved into dots on tube length 11", x6 Huyghenian eyepiece. Swift-Holos also well aligned but no resolution. Abbe condenser and substage lamp used in Nelsonian way. All other object glasses lined up OK. Time taken to complete job 1½ easy days.

Conclusion. This job now completed and entirely satisfactory. For best Wenham use changer is not used owing to distance away from object glass of prism. This is apparent only with ½" object glasses.

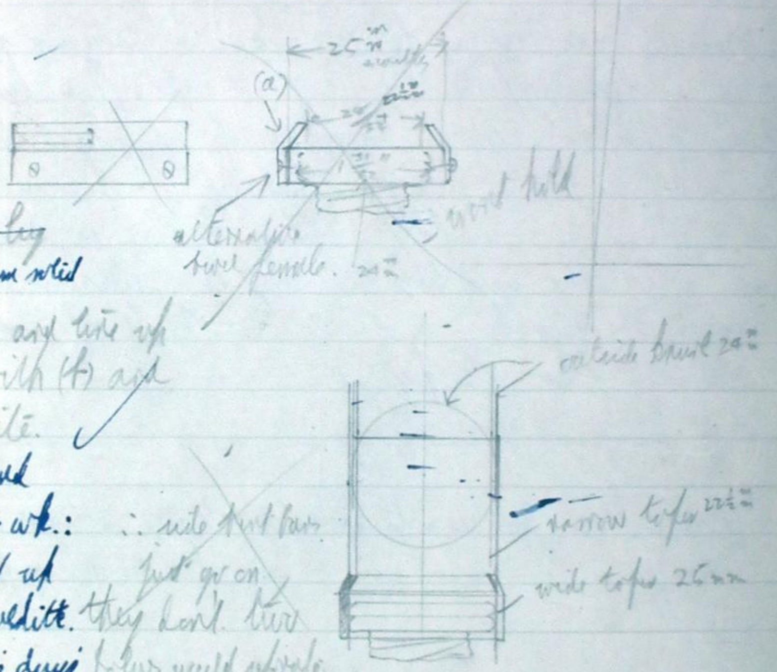
Zeiss female changer slide should be sprung (this done 25th January 1979, much better job as to ease of fitting the male slides [which might be worn]) for accuracy over long period.

(Making Zeiss type female nosepiece changer for Wenham – B mic.)

LXXXI



Method:– 1 drill hole for knurled collar first
2 square up to bevel & thickness
3 ~~make side of slide (a) by bending in vise~~ cut from solid
4 fit a male OG slide and line up on mic. 5 lock with (4) and secure with araldite.



19 Jan 79 Roughed out and marked for trial 2½ hr wk.: whole cut from solid, lined up on Wen.-Burr. mic. with araldite. Just one comfortable winter's day's work inc. waiting for At. to set.

20 Jan. Lacquered & finished OK (only a fair job)

Araldite is as good as solder for most brass parts. Female part screws into nosepiece tight up to proper vert. posn. without adjustment. If it becomes slack (does not fetch up in right place) fit a washer.

20th January 1979

Test Slide "C. Baker 20 forms in Styrax" was broken by dropping today. Might be repairable if diatoms on cover. Slide badly broken; roughly repaired by cementing whole fractured lot onto another backing slide – 22nd January 1979.

On 21st January 1979 (actually on page 296)

Koristka was demounted and front reset more accurately and with greater working distance. Mounts of front and No.2 combination cleared of lacquer, so restoring separation of front pair. No other change. Working distance improved, front further forward. No change of method from page 252 re. seating of front, but great care taken with levelling.

22nd January 1979

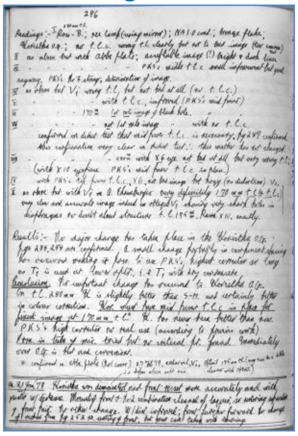
Object of Experiment

Since Koristka 1.4 object glass was fitted to Wenham-Burrells microscope on changers, another look was taken at question of tube length correctors.

Method:- On Ross-Burrells microscope object glass was set up on Abbe plate and results of page 279 were confirmed i.e. it is a 160mm tube length object glass at full aperture. Vertical Illumination also confirmed page 288, 287. However at Wenham-Burrells long tube 270mm, experiments were made with P. K. Sartory's defective concave corrector (orange light). This now for some unknown reason appears satisfactory. (Abbe condenser only.)

(next page)

Page 296



Readings:-

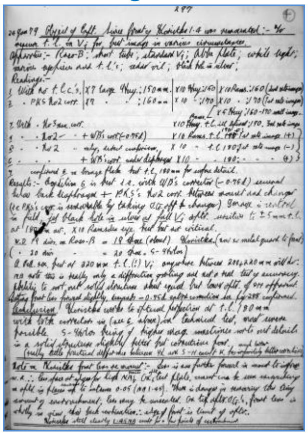
i. Ross-Burrells, 250mm tube length, research lamp (using mirror), NA 1.0 condenser, bronze flake, Koristka object glass, no tube length correctors, wrong tube length clearly but not too bad an image (too coarse test)
ii. As above but with Abbe plate, acceptable image(!), bright and dark lines
iii. As above but with Abbe plate, P. K. Sartory's middle tube length corrector, small improvement but good anyway. P. K. Sartory's No.3 strong, deterioration of image
iv. As above but Vertical Illumination, wrong tube length but not bad at all (no tube length corrector)
v. As above but Vertical Illumination with tube length corrector, improved (P. K. Sartory's mid power)
vi. As above but Vertical Illumination 170mm 1st rate image of black hole (P. K. Sartory's mid power)
vii. As above but Vertical Illumination 170mm not 1st rate image of black hole, with no tube length corrector. Confirmed on direct test that mid power tube length corrector is necessary, page 287 confirmed. This confirmation very clear on direct test, therefore this matter has not changed.
viii. As above but Vertical Illumination 280mm with x6 eyepiece, not bad at all, but very wrong tube length (with x10 eyepiece, P. K. Sartory's mid power tube length corrector in place)
ix. With P. K. Sartory's top power tube length corrector, x6, not bad image, but hazy (no distortion, Vertical illumination
x. As above but with Vertical Illumination on *Arachnoidiscus Ehrenbergii*, very definitely 170mm tube length (plus tube length corrector), very clear and accurate image indeed in oblique Vertical Illumination showing very sharp holes in diaphragms, no doubt about structure, tube length 175mm, Ramsden x10, exactly

Results:- No major change has taken place in the Koristka object glass pages 286, 288 are confirmed. A small change probably in component spacing has occurred making it possible to use P. K. Sartory's highest corrector so long as Transmitted Illumination is used at lower aperture, i.e. Transmitted Illumination with dry condensers.

Conclusion. Not important change has occurred to Koristka object glass. On tube length 280mm Koristka is slightly better than Swift-Holos and certainly better in colour correction. Koristka must have mid power tube length corrector in place for finest image at 170mm tube length (confirmed on Abbe plate [No.1 cover] 27th February 1979, Cedar Oil, Vertical Illumination, Optoil, 175 mm tube length [may now be a little cleaner with Optoil]). Koristka has never been better than now. P. K. Sartory's high corrector no real use (according to previous work). Position in tube of microscope tried but no critical point found. Immediately over object glass is best and convenient.

24th January 1979

Page 297



Object of Experiment

Since front of Koristka 1.4 was remounted:- To measure tube length on Vertical Illumination for best image in various circumstances.

Apparatus:- Ross-Burrells, short tube, standard Vertical Illumination, Abbe plate, white light, various eyepieces and tube lengths, Cedar Oil, black hole in silver.

Readings:-

1.	With no tube length correctors	X7 large Huyghenian; 150mm tube length	X10 Huyghenian; 150mm tube length	X10 Ramsden; 160mm tube length (2nd rate images)
2.	With P. K. Sartory's No.2 corrector	X7 large Huyghenian; 160mm tube length	X10 Huyghenian; 170mm tube length	X10 Ramsden; 170mm tube length (1st rate images) X5 Huyghenian; 160-170mm tube length (small images)
3.	With P. K. Sartory's No.3 (maximum) corrector			X10 Ramsden; tube length ill-defined; 190mm (3rd rate images)
4.	With P. K. Sartory's No.2 corrector and WB's corrector (-0.75 dioptre)			X10 Ramsden; tube length 190mm ± (1st rate images [+])
5.	With P. K. Sartory's No.2 only, direct comparison with 4.			X10 Ramsden; tube length 180mm (1st rate images [-])
6.	With P. K. Sartory's No.2 corrector and WB's corrector under diaphragm			X10 Ramsden; tube length 180mm (1st rate images [+])
7.	Confirmed 6. In bronze flake but tube length 180mm for surface detail.			

Results:- Condition 6. is best. i.e. with WB's corrector (-0.75 dioptre) secured below back diaphragm and P. K. Sartory's No. 3 corrector between mount and changer (i.e. P. K. Sartory's corrector is removable by taking object glass off changer). Image is central in field, jet black hole in silver at full Vertical Illumination aperture sensitive to =/- 5mm tube length at 180mm average, x10 Ramsden eyepiece best but not critical.

Working distance – 19 divisions on Ross-Burrells = 19 thou (about). Koristka (now no metal guard on front)

Working distance - 20 divisions on Ross-Burrells – 20 thou (Swift-Holos)

Amphipleura pellucida resolution best at 220mm tube length(!) Vertical illumination, anywhere between 200 and 220mm will do. NB. note this is really only a diffraction grating and not a real test of accuracy. Ability to sort out solid structure about equal but lower aperture of Swift-Holos apparent. Setting front lens forward slightly demands -0.75 dioptre extra correction. See page 288 confirmed.

Conclusion. Koristka works to optical perfection at tube length 180mm with both correctors in (see 6. Above) on technical test, most severe possible. Swift-Holos being of higher magnification sometimes sorts out details in a solid structure slightly better but corrections poor.

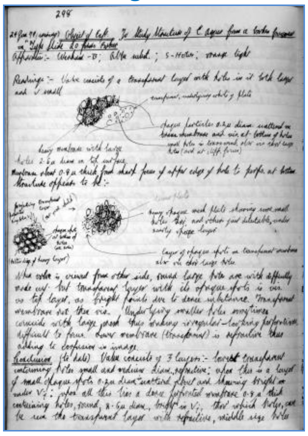
(really little practical difference between Koristka and Swift-Holos except Koristka has much better corrections.)

Note on Koristka front lens re-mount.

Lens is now further forward in mount to improve working distance, therefore less space as edges for high NA pencils. On aperture test plate, cement can be seen encroaching on aperture in places inwards to extreme 0.05 (NA 1,45). There is danger in removing this tiny amount of encroachment; lens may be unseated. On top aperture object glass front lens is wholly in view, through back combination, therefore edge of front lens is limit of aperture.

Koristka still clearly 1.45NA except for a few points of encroachment.

Page 298



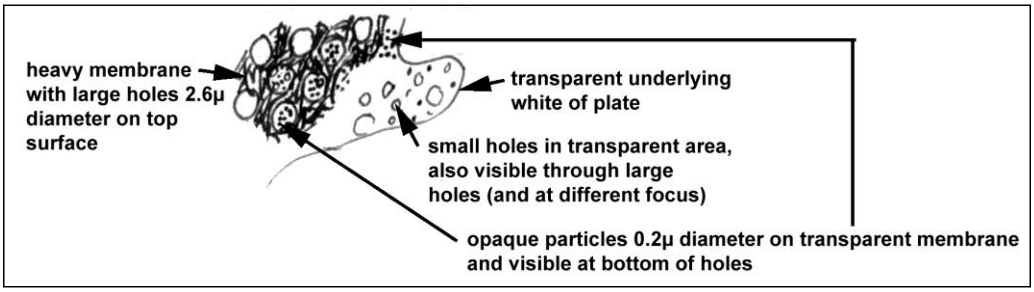
24th January 1979 (evening)

Object of Experiment

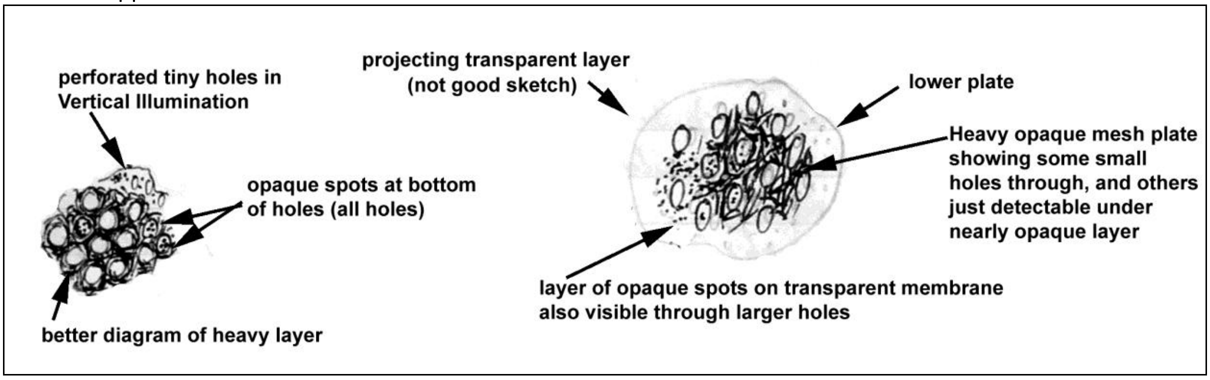
To study structure of *C. argus* from a broken fragment on "Type slide 20 forms Baker'

Apparatus:- Wenham-Burrells, Abbe substage, Swift-Holos, orange light

Readings:- Valve consists of a transparent layer with holes in it both larger and very small.



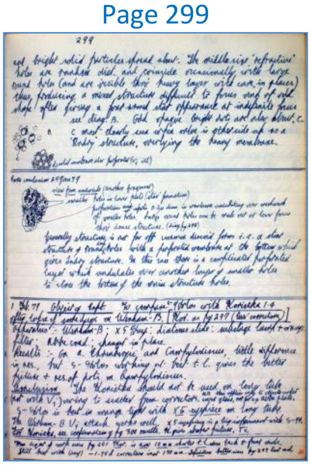
Membrane about 0.8µ thick from sharp focus of upper edge of hole to perforations at bottom.
Structure appears to be:



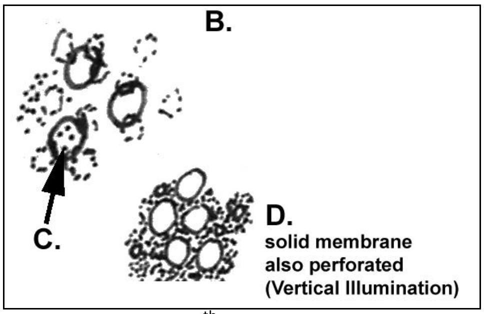
Whole valve is viewed from other side, round large holes are with difficulty made out but transparent layer with its opaque spots is visible as top layer, as bright points due to dense substance. Transparent membrane not then visible. Underlying smaller holes sometimes coincide with large mesh thus making irregular-looking perforations difficult to focus. Lower membrane (transparent) is refractive thus adding to confusion in image.

Conclusion. (to date) Valve consists of 3 layers:- lowest transparent containing holes small and medium diameter, refractive. Upon this is a layer of small opaque dots 0.2µ diameter is scattered about and showing bright under Vertical Illumination. Upon all this lies a dense perforated membrane 0.8µ thick containing holes, round 2.6µ diameter, bright in Vertical illumination, through which holes, can be seen the transparent layer with refractive middle size holes…*(next page)*

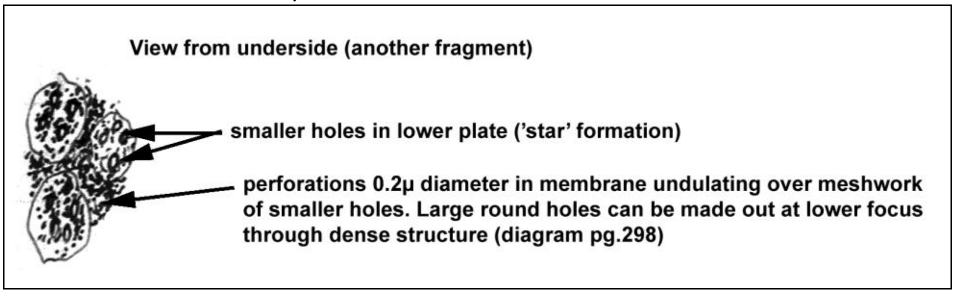
Page 299



…and bright solid particles spread about. The middle size 'refractive' holes are random distribution and coincide occasionally with large round holes (and are visible through heavy layer with care, in places) thus producing a mixed structure difficult to focus and of odd shape often giving a four armed star appearance at indefinite focus, see diagram B. Odd opaque bright dots are also about, C. C most clearly seen when valve is other side up as a 'secondary' structure, overlying the heavy membrane.



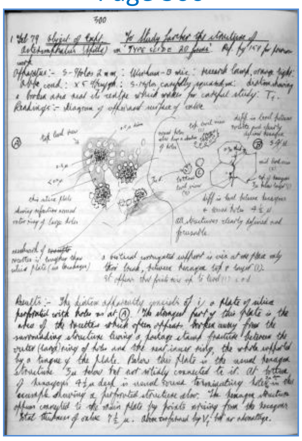
Extra conclusion 25th January 1979



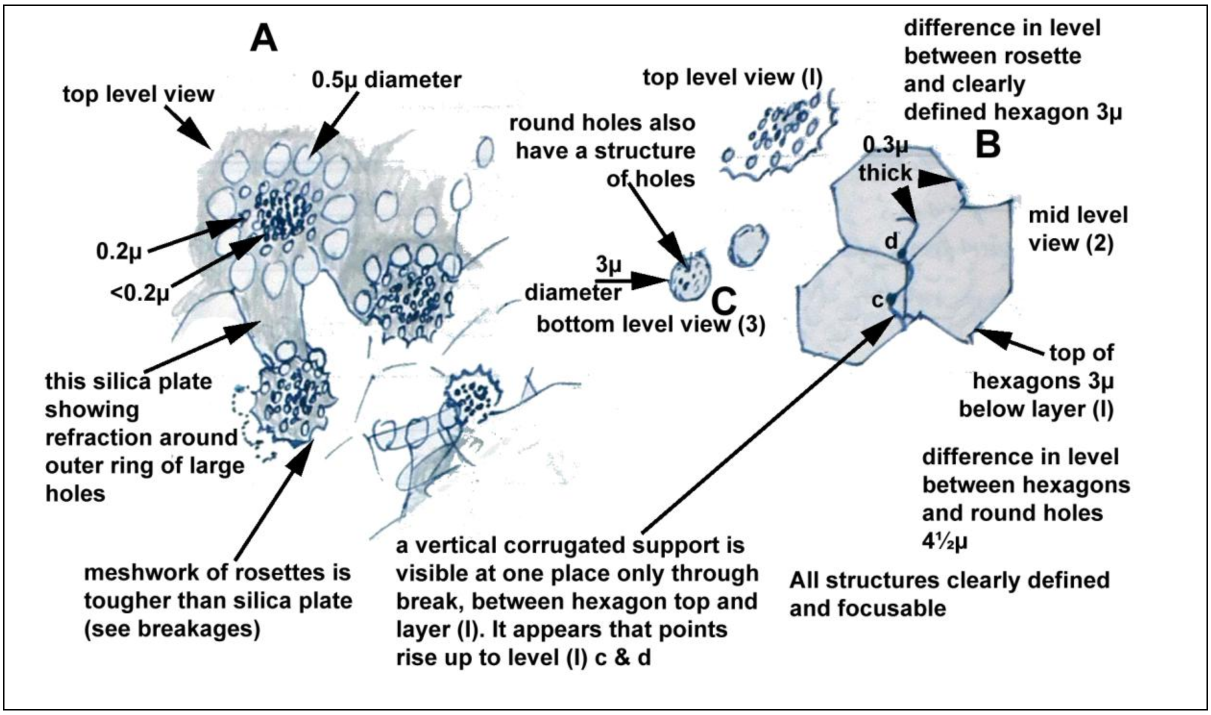
Generally structure is not far off common discoid forms i.e. a stout structure of round deep holes with a perforated membrane at the bottom which gives secondary structure. In this case there is a complicated perforated layer which undulates over another layer of smaller holes to close the bottom of the main structure holes.

1st February 1979
Object of Experiment
To compare Swift=Holos with Koristka 1.4 after lapse of some days on Wenham-Burrells (Koristka as page 297 [two correctors])
Apparatus:- Wenham-Burrells, x5 Huyghenian, diatoms slide, substage lamp and orange filter, Abbe condenser, changer in place.
Results:- On *Arachnoidiscus Ehrenbergii* and *Campylodiscus*, little difference in resolution, but Swift-Holos working at best tube length gives the better picture and resolution of dots on *Campylodiscus*.
Conclusion. The Koristka should not be used on long tube (nor with Vertical Illumination) owing to scatter from correctors. NB. this applies only to objects under cover glass, not for e.g. Abbe plate.
Swift-Holos is best in orange light with x5 eyepiece on long tube.
The Wenham-Burrells Vertical Illumination works well. X5 eyepiece is a big improvement with Swift-Holos.
For Koristka, see confirmation of page 300 results. Koristka gives sharper picture in Transmitted Illumination.
The digest of work since page 271. Koristka is now 10mm shorter tube length including back and front correctors. Still best with (say) -1.75diopter correctors in at 170mm. Definition better sine page 297 last used.

Page 300



1st February 1979
Object of Experiment
To study the structure of *Asteromphalus* (Spitta) on 'Type Slide 20 forms'
Ref. page 159 for previous work
Apparatus:- Swift-Holos 2mm, Wenham-Burrells microscope, research lamp, orange light, Abbe condenser, x5 Huyghenian, Swift Holos carefully squared-on; diatom showing a broken area near its centre which makes for carful study, Transmitted Illumination.
Readings:-
Diagram of uppermost surface of valve.



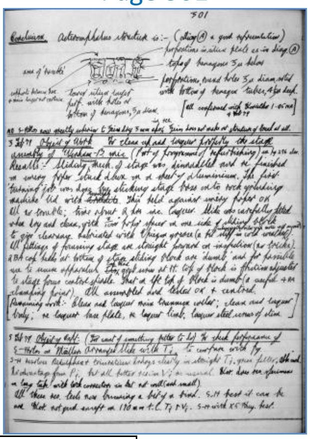
Results:- The diatom apparently consists of

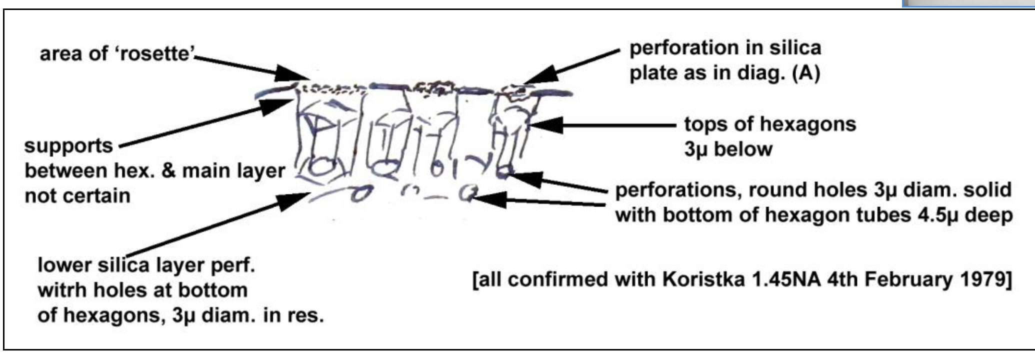
i. A plate of silica perforated with holes as at A. The strongest part of this plate is the area of rosettes which often appears broken away from the surrounding structure leaving a postage stamp fracture between the outer (large) ring of holes and the neat inner ring, the whole supported by a tongue of the plate. Below this plate is the usual hexagon structure 3µ below but not solidly connected to it. At bottom of hexagons 4½µ deep is usual round terminating holes 3µ diameter in this example showing a perforated structure also. The hexagon structure appears connected to the main plate by points arising from the hexagons. Total thickness of valve 7½µ. Above confirmed by Vertical Illumination, but no advantage.

(next page)

Conclusion. *Asteromphalus* structure is: (Diagram A - a good representation)

Page 301





NB. Swift-Holos now greatly superior to Zeiss 3mm apochromat in resolution. Zeiss does not make out structure of break at all.

3rd February 1979

Object of Work

To clean up and lacquer properly the stage assembly of Wenham-Burrells microscope. (Part of programme of refurbishing) see page 276 also.

Results:- Sliding focussing mechanism of stage was dismantled and re-finished on emery paper stuck down on a sheet of aluminium. The first 'turning' job was done by sticking stage boss onto rock grinding machine lid with Evostick. This held against emery paper OK. All no trouble; time about 2 hours including lacquering. Slide was carefully fitted when dry and clean, with $^{3}/_{1000}$" paper spacer on one side of sliding block to give clearance. Lubricated with Apiezon grease (a bit stiff in cold weather [subsequently oiled with motor oil as well]).

All fittings of focussing stage are straight forward on inspection (no tricks). 2BA cap heads at bottom of stage sliding block are 'dumb' and for possible use to secure apparatus. Cap head grub screw at right top of block is friction adjuster to stage focus control spindle. That on left top of block is dumb (a useful 4BA clamping point). All assembled and tested OK and centred.

Remaining work:- Clean and lacquer main trunnion collar; clean and lacquer body; re-lacquer base plate, re-lacquer limb, lacquer steel screws of stem.

5th February 1979

Object of Experiment

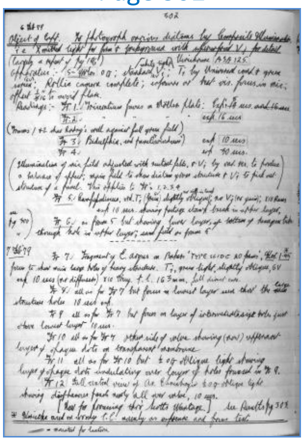
(For want of something better to do) To check performance of Swift-Holos on Möller's Arranged Slide with Transmitted Illumination. To compare with pg…..

Swift-Holos resolves *Biddulphia* and *Triceratium* secondaries clearly in straight Transmitted Illumination, green filter, Abbe condenser.

No advantage from Pi, but all better resolution in Vertical Illumination, as usual. Holos does resolve specimens on long tube with both correctors in but not well (and small).

All these resolution tests now becoming a bit of a bind. Swift-Holos best it can be. Koristka not good except on 170mm tube length Transmitted Illumination and Vertical Illumination. Swift-Holos with x5 Huyghenian best.

Page 302



6th February 1978

Object of Experiment

To photograph various diatoms by composite illumination i.e. transmitted light for form and background with superimposed Vertical Illumination for detail.

(largely a report of page 196)

Apparatus:- Swift-Holos object glass; standard Vertical Illumination 12V white light, Verichrome ASA125, Transmitted Illumination (6V) by Universal condenser and green screen, Rolleiflex camera complete, exposures or best visible focus in microscope, offset $^{1}/_{16}$" to avoid flare.

Readings:-

Frame 1. *Triceratium favus* on Möller's Plate: Exposure 8 seconds

Frame 2. *Triceratium favus* on Möller's Plate: Exposure 16 seconds [Mounted for Lantern]

(Frames 1 and 2 show secondaries well against full green field)

Frame 3. *Biddulphia*, end panel ('windows'): exposure 10 seconds [Mounted for Lantern]

Frame 4. *Biddulphia,* end panel ('windows'): exposure 30 seconds

(Illumination of microscope field adjusted with neutral filters, and Vertical Illumination, by variable resistor to produce a balance of effect; main field to show diatom gross structure and Vertical Illumination to pick out structure of a panel. This applies to Frames 1, 2, 3, 4)

Frame 5. *Campylodiscus,* ordinary Transmitted Illumination 6V (green) slightly oblique, no diffuser in lamp, no Vertical Illumination (no gain), x10 Ramsden: exposure 10 seconds, showing postage stamp break in upper layer. [Mounted for Lantern]

Frame 6. As Frame 5. but showing lower layer, of hexagon tube through hole in upper layer; same field as Frame 5. (see page 300) [Mounted for Lantern]

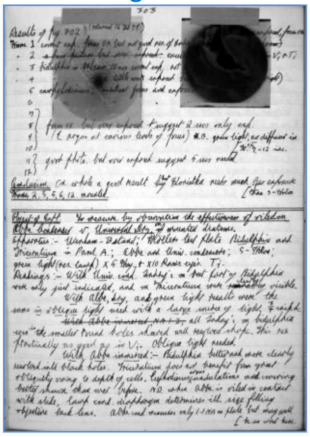
7th February 1979

Frame 7. Fragment of *E. argus* on Baker's 'Type Slide 20 forms', Koristka 1.45 (Koristka used on wrong tube length mainly as exposure and focus test), focus to show main large holes of heavy structure. Transmitted Illumination, green light, slightly oblique, 6V: exposure 10 seconds (no diffuser), x10 Huyghenian, tube length 163mm, full direct cone.

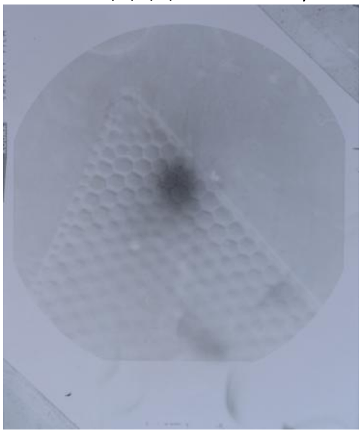
Frame 8. All as for Frame 7. but focus on lowest layer seen through the large structure holes: exposure 10 seconds.

Frame 9. All as for Frame 7. but focus on layer of intermediate size holes just above lowest layer. 10 seconds.
Frame 10. All as for Frame 7. Other side of valve showing (now) uppermost layer of opaque dots on transparent membrane.
Frame 11. All as for Frame 10. But ½ object glass oblique light showing layer of opaque dots undulating over layer of holes focussed in Frame 9.
Frame 12. Full central view of *Arachnoidiscus Ehrenbergii* ½ object glass oblique light showing diaphanous panels nearly all over valve. 10 seconds. [Mounted for Lantern]
[Now for processing through Scotts, Wantage]
See results page 303.
(next page)

Page 303

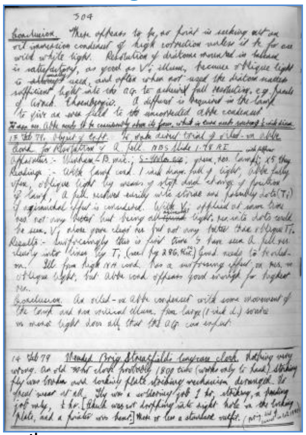


Results of page 302 (returned 16th February 1979)
Frame 1. Correct exposure, focus OK but not good resolution of secondaries ~~(*Biddulphia* in balsam)~~ A little under exposed, focus OK
Frame 2. ~~A fair picture but over exposed~~. Excellent micrograph, good resolution in Vertical Illumination and Transmitted Illumination.
Frame 3. *Biddulphia* in Balsam 10 seconds correct exposure. Not good resolution but focus OK.
Frame 4. *Biddulphia* in Balsam. A little over exposed, but not bad (20 seconds about right)
Frame 5. *Campylodiscus*, excellent focus and exposure
Frame 6. *Campylodiscus*, excellent focus and exposure
Frames 7,8,9,10. Focus OK, but over exposed, suggest 2 seconds only exposure. (E. Argus at various levels of focus) NB. green light, no diffuser in f5.6 (7-12 inclusive)
Frames 11, 12. Good photo, but over exposed, suggest 5 seconds needed.
Conclusion. On whole a good result but Koristka needs much less exposure than Swift-Holos. Frames 2,3,5,6,12 mounted)



Object of Experiment
To measure by observation the effectiveness of oiled-on Abbe condenser versus Universal dry on mounted diatoms.
Apparatus:- Wenham- Burrells stand, Möller's Test Plate, *Biddulphia* and *Triceratium* in Panel A, Abbe and Universal Condensers, Swift-Holos, green light (research lamp), x5 Huyghenian and x10 Ramsden eyepieces, Transmitted Illumination.
Readings:- With Universal condenser secondaries on best part of *Biddulphia* were only just indicated, and on *Triceratium* were clearly visible.
With Abbe dry condenser and green light results were the same in oblique light used with a large source of light, ¾ inch diameter.
All secondaries on *Biddulphia* even in the smaller round holes showed well resolved shape. This resolution practically as good as in Vertical Illumination. Oblique light needed.
With Abbe immersed:- *Biddulphia* better and more clearly resolved into black holes. *Triceratium* does not benefit from great obliquity owing to depth of cells. *Eupodiscus argus* undulations and covering better shown than ever before. NB. When Abbe is oiled in contact with slide, lamp condenser diaphragm determines illumination size filling objective back lens. Abbe condenser measures only 1.1NA on plate, but may well be an error here).
(next page)

Page 304



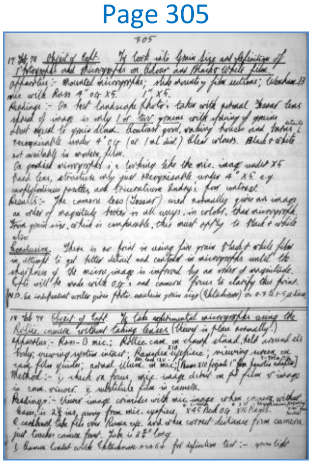
Conclusion. There appears to be no point in seeking out an immersion condenser of high correction unless it be for use with white light. Resolution of diatoms mounted in Balsam is satisfactory, as good as Vertical Illumination, because oblique light is usually used, and often when not used the diatom scatters sufficient light into the object glass to achieve full resolution, e.g. panels of *Arachnoidiscus Ehrnenbergii*. A diffuser is required in the lamp to give an even field to the uncorrected Abbe condenser.
For maximum resolution Abbe needs to be considerably above its focus, which in turn needs source of ½ inch diameter.

13th February 1979
Object of Experiment
To make direct trial of oiled-on Abbe condenser for resolution of *Amphipleura pellucida*. NB.S. Slide 1.78 Refractive Index.
Apparatus:- Wenham-Burrells microscope; Swift-Holos object glass; green, research lamp with diffuser; x5 Huyghenian eyepiece
Readings:- With lamp condenser 1 inch diameter full of light; Abbe fully open, oblique light by means of stop and change of position of lamp, *Amphipleura pellucida* resolved easily into striae and possibly dots (Transmitted Illumination) if azimuthal effect is considered. With Vertical Illumination applied at same time resolution not any better but being all azimuth light resolution into dots could be seen. Vertical Illumination alone gave clear resolution but not any better than oblique Transmitted Illumination.
Results:- Surprisingly this is first time I have seen *Amphipleura pellucida* resolved clearly into lines by Transmitted Illumination (see page 286 Koristka object glass). Condenser needs to be oiled on. Illumination from high NA condenser has a surprising effect on resolution in oblique light, but Abbe condenser appears good enough for highest resolution.
Conclusion. An oiled on Abbe condenser with some movement of the lamp and non-critical illumination from large (1 inch diameter) source in mono light does all that the object glass can expect.

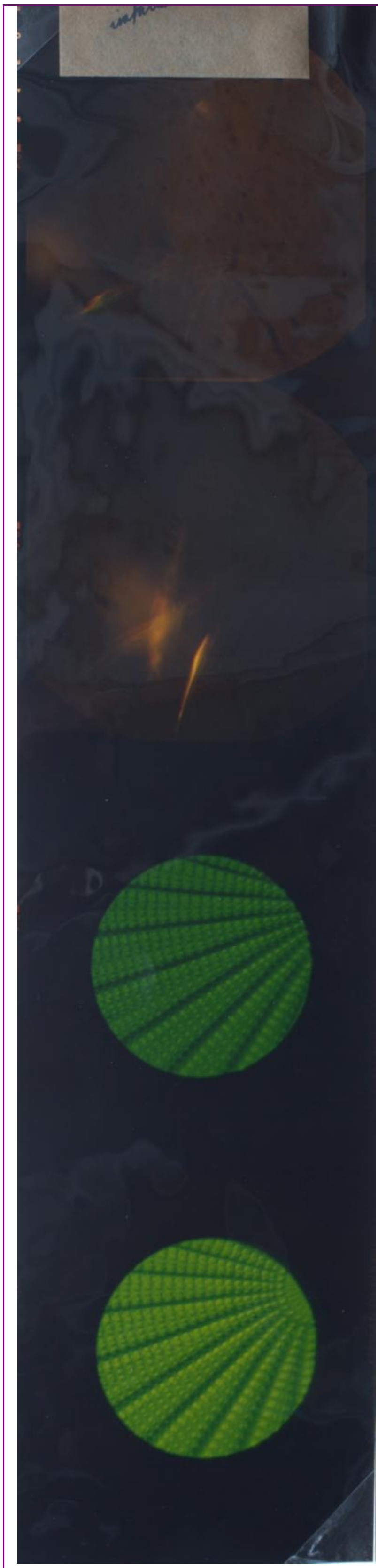
14th February 1979
Mended Brigadier Streatfield's long case clock.
Nothing very wrong. An old 30hr clock probably 1800 time (works only to hand). Striking fly was broken and locking plate striking mechanism deranged. No great wear at all. Fly was a soldering job 1hr, striking, a bending job only, ½hr [Check was not dropping into right hole on the locking plate, and a pointer was bent.] More or less standard outfit. [Brigadier died of cancer in late 1980].

17th February 1979
Object of Experiment
To look into grain size and definition of photographs and micrographs on Colour and Black and White film.

Page 305

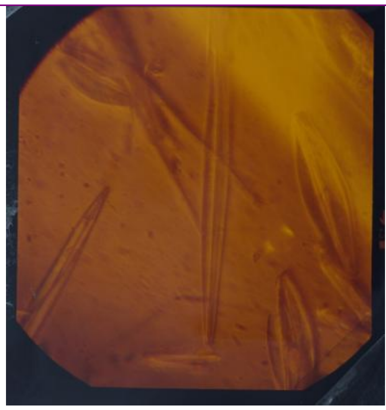


Apparatus:- Mounted micrographs; slide mounts of film sections; Wenham-Burrells microscope with Ross 4" object glass x5. 1" x5.
Readings:- On best landscape photos taken with normal Tessar lens spread of image is only 1 or two grains with spacing of grains about equal to grain diameter. Contrast good, making houses and barns details recognisable under 4" object glass (at 1 mile distance). Clear colours. Black and White not available in modern film.
On goodish micrographs i.e. looking like the microscope image under x5 hand lens, structure only just recognisable under 4" x5 e.g. *Campylodiscus* rosettes, and *Triceratium* secondaries, poor contrast.
Results:- The camera lens (Tessar) used normally gives an image an order of magnitude better in all ways, in colour, than micrograph. From grain size, which is comparable, this must apply to Black and White also.
Conclusion. There is no point in using fine grain Black and White film in attempt to get better detail and contrast in micrographs until the sharpness of the micro image is improved by an order of magnitude. Experiments will be made with object glasses and camera focus to clarify this point.
NB. An independent writer gives photo emulsion grain size (Ektachrome) as 0.3 to 1.5µ diameter.



Experimental exposure (improved later

Mostly experimental exposures (improved later)



17th February 1979 (page LXXXII from back of book)

Experiment planned with camera without lenses. (see page 305 for grain observations)

i. Lenses removed by straight screwing out, no problems, filter also taken out. The lenses shutter mechanism in place and working, also viewing system.
ii. Put ground glass on film guides and compare focus, camera without lenses and viewing system. All at infinity focus. On microscope of course (done OK)
iii. Arrive at some calibration by marking viewing system knob (main focus) (not necessary)
iv. Take test frames of secondary structure = most sensitive feature

v. Take film out of camera in dark by taking off back and re-winding after say 6 frames, not more, or backing may be deranged on film.
vi. Replace all lenses, not filter, and expose again on same subject. Probably lens in camera will make little difference as only centre of system is ever used. This will eliminate glare spots.

18th February 1979 (also page 305)

vii. Re. iii. above, microscope best visual focus = same as focus on film (no lenses) at distance of 2 inches from eyepiece, top lens to camera from surface (green light, a bronze flake object), Huyghenian x10, projecting 0.85 inches from Panolin adapter, Ramsden x10 projecting 1" from Panolin adapter (Ramsden eyepiece has spots in lenses)

Method of working:- simply obtain best visual focus on microscope and substitute camera with shading tube 2" away from eyepiece. Check with camera viewer if required. This all done, no troubles.
See results of film run, page 306.

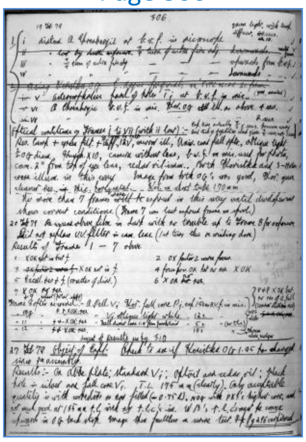
[Transcribers Note: Not sure where the below fits in.]
10. focus and exposure OK, good resolution into lines (*Amphipleura pellucida*) Vertical illumination oblique light 12 seconds Koristka. (NBS mount)
11. focus and exposure OK, good resolution into lines (*Amphipleura pellucida*) full direct cone from paraboloid 5 seconds (NBS mount) [Northern Biological Supplies]
12. focus and exposure OK, good resolution into lines (*Amphipleura pellucida*) full direct cone from paraboloid 10 seconds (Realgar mount)
Conclusion. Working Rolleiflex camera without lenses is no advantage. Koristka is a much better taking lens than Swift-Holos. Exposure now OK according to this book details.
Frames 5, 10, 11 mounted permanently.
The Koristka object glass is not properly in focus for transmitted light (to be checked) [it is with camera lenses in place]

18th February 1979
Object of Experiment
To take experimental micrographs using the Rolleiflex camera without taking lenses (Viewer in place normally).
Apparatus:- Ross-Burrells microscope; Rolleiflex camera in clamp stand, held around its body; viewing system intact; Ramsden eyepiece x10; viewing screen on camera film guides; normal illumination (Research lamp 12V); [Ramsden x10 projects 1" from Panolin adapter]; Swift-Holos object glass.
Method:
i. Check on focus, microscope image direct on film viewer, image on camera viewer
ii. Substitute film in camera

Readings:- View image coincides with microscope image when camera without lenses is 2 inches away from microscope eyepiece with x45 Beck object glass and x10 Ramsden eyepiece. With Swift-Holos and x10 Huyghenian 0.94" from microscope.
A cardboard tube fits over Ramsden eyepiece and when correct distance from camera just touches camera front. Tube is 2¾" long.
1. Camera loaded with Ektachrome ASA64 for definition test:- green light.

(next page)

Page 306



19th February 1979
i. Diatom *A. Ehrenbergii* at best visual focus in microscope, green light, with lamp diffuser, 10 seconds
ii. Wasted frame
iii. Diatom ¾ turn of extra fine focus, upwards from best visual focus
iv. Diatom ¾ turn of extra fine focus, downwards from best visual focus
v. *Asteromphalus* panel of holes, Transmitted Illumination at vest visual focus in microscope (good, mounted)
vi. *A. Ehrenbergii* best visual focus in microscope Koristka object glass, illuminated as above, 4 seconds
vii. *A. Ehrenbergii* best visual focus in microscope Koristka object glass, illuminated as above, 2 seconds

Optical conditions of frames i. to vii (with ii. lost) – Exposure time actually $^{3}/_{2}$x seconds because every 2nd turn of regulator clock gives $^{3}/_{2}$ seconds, not 1 second. Research lamp and green filter and diffuser, 12V, mirror illuminator, Universal condenser full aperture, oblique light, ½ object glass diameter, Huyghenian x10, camera without lens, best visual focus on microscope used for photo, camera 2" from top of eye lens, Cedar Oil immersion. Both Koristka and Swift-Holos were illuminated in this way. Image from both object glasses was good, Koristka gave cleaner resolution, microscope horizontal. Koristka on short tube 170mm.
No more than 7 frames were exposed in this way until development shows correct conditions (Frame 7 was last exposed frame on spool)
20th February 1979. Re-wound above film in dark with no trouble up to Frame 8 for exposure. Did not replace U.V. filter in camera lens (1st time this re-winding done).
Results of Frames 1-7 above.
1. Exposure OK. Not in best focus
2. Over exposed factor 2 worse focus

3. Exposure OK, not in focus
4. Focus possibly OK but no resolution. Exposure OK
5. Excellent resolution and focus (rosettes of diatom)
6. Exposure OK, no resolution
7. Exposure OK, no resolution

Frame 8 and 9 after re-wind – *Amphipleura pellucida* Vertical Illumination. Koristka full cone Pi, exposure 15 seconds, best visual focus in microscope (8 and 9 OK but no resolution of *Amphipleura pellucida*) NBS slide

Frame 10. Focus and exposure OK resolved *Amphipleura pellucida* Vertical Illumination oblique light, white. 12 seconds. NBS slide.

Frame 11. Focus and exposure OK resolved *Amphipleura pellucida* full direct cone 1.4 from paraboloid. 5 seconds. (no tube length correctors) NBS slide.

Frame 12. Focus and exposure OK resolved *Amphipleura pellucida* full direct cone 1.4 from paraboloid. 10 seconds. (no tube length correctors) Thum's slide, Realgar

---

27th February 1979

Object of Experiment

Check to see if Koristka object glass 1.45 has changed since re-assembly.

Results:- On Abbe plate, standard Vertical Illumination, Optoil and Cedar Oil, black hole in silver and full cone Vertical Illumination. Tube length 175mm (clearly). Only acceptable quality is with correctors as now fitted (-0.75 dioptre. No bloody good with P. K. Sartory's highest corrector and not much good at 165mm tube length with no tube length correctors in. WB's tube length correctors must be convex upwards in object glass back stop. Image then faultless in same test. Page 296 confirmed.

28th February 1978

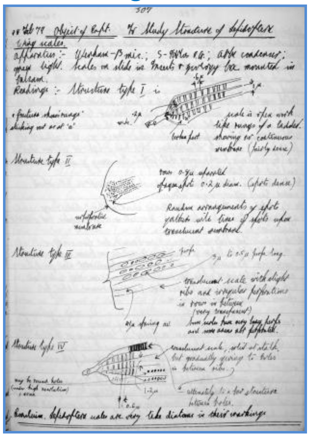
Object of Experiment

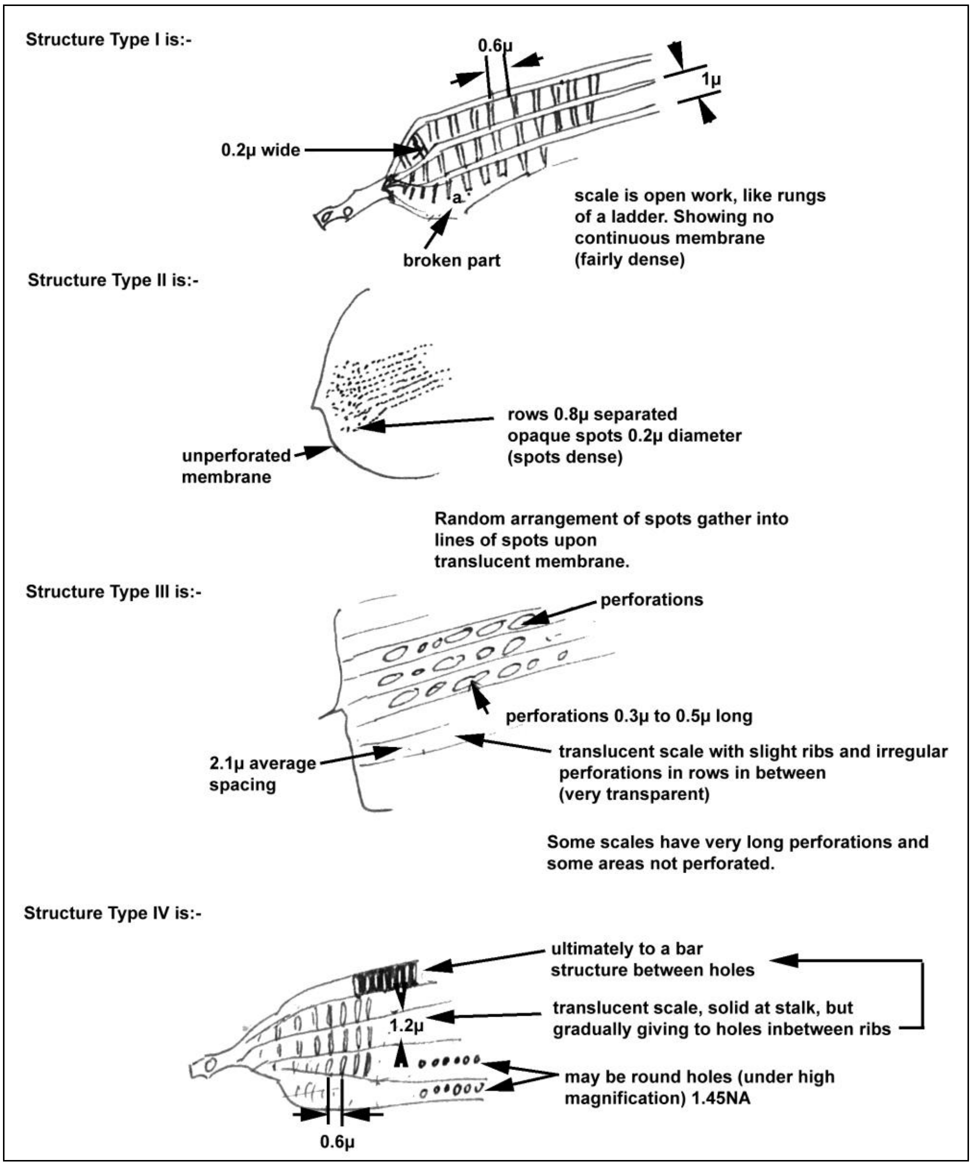
To study structure of Lepidoptera Wing Scales

Apparatus:- Wenham-Burrells microscope; Swift-Holos object glass; Abbe condenser; green light. Scales on slide in Insects and Geology box mounted in Balsam.

Readings:-

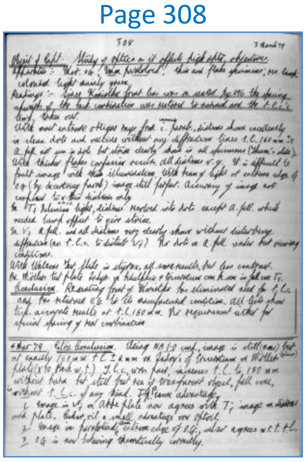
Page 307





Conclusion. Lepidoptera scales are very like diatoms in their markings.

Page 308



3rd March 1979

Object of Experiment

Study of Optics as it affects high aperture objectives

Apparatus:- Koristka object glass, immersion paraboloid, thin and thick flake specimens, research lamp, coloured light (mainly green)

Readings:- Since Koristka from lens was re-seated (page 296) the spacing upwards of the back combination was restored to normal and the tube length correctors temporarily taken out.

With most extreme oblique rays from immersion paraboloid diatoms shown excellently in clean dots and outline without an diffraction lines, tube length 150,, ± 5.

Amphipleura pellucida not seen in dots but striae clearly shown in all specimens (Thum slide). With thicker flakes confusion occurs. All diatoms very good. It is difficult to fault image with this illumination. With beam of light at extreme edge of object glass (by decentring paraboloid) image still perfect. Accuracy of image not confined to NA 1.0 thin diatoms only.

In Transmitted Illumination Nelsonian light, diatoms resolved into dots except *Amphipleura pellucida* which needed lamp offset to give striae.

In Vertical Illumination *Amphipleura pellucida* and all diatoms very clearly shown without disturbing diffraction (no tube length correction to disturb Vertical Illumination). No dots on *Amphipleura pellucida* under best viewing conditions.

With Watson's Test Slide in Styrax, all same results but less contrast. On Möller's Test Plate secondaries on *Biddulphia* and *Triceratium* can be seen in full cone Transmitted Illumination.

Conclusion. Re-seating front of Koristka has eliminated need for tube length correction and has returned object glass to its manufactured condition. All tests show technically accurate results at tube length 160mm. No requirement for special spacing of rear combination.

4th March 1979

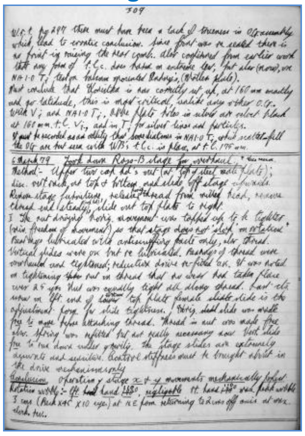
Extra Conclusion.

Using NA 1.0 condenser, image is still (now) best at exactly 160mm tube length +/1 2mm on secondaries of *Triceratium* on Möller's (balsam) plate (x10 Beck wide field) Tube length correctors, WB's pair, increases tube length to 180mm without haze but still best resolution of transparent object, full cone, is without tube length correctors of any kind. Paraboloid illumination some advantage.

1. Image in Vertical Illumination on Abbe plate now agrees with Transmitted Illumination image on diatoms and plate. Cedar oil a small advantage over Optoil.
2. Image in paraboloid illumination extreme edge of object glass also agrees with respect to tube length.
3. Object glass is now behaving theoretically correctly.

(next page)

Page 309



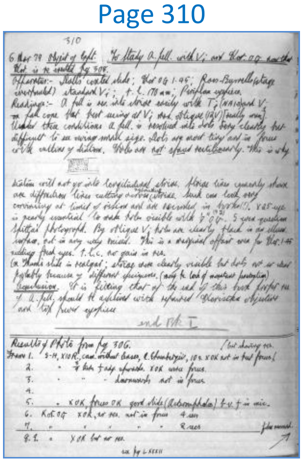
With reference to page 297 there must have been a lack of trueness in object glass assembly which lead to erratic conclusion. Since front was re-seated there is no point in raising the rear combination. Also confirmed from earlier work that any form of tube length correction does harm on extreme test, but also (now), on NA 1.0 Transmitted Illumination test on Balsam mounted Secondaries (Möller plate).
Must conclude that Koristka is now correctly set up, at 160mm exactly and no latitude, this is most critical, unlike any other object glass.
With Vi and NA1.0 Transmitted Illumination, Abbe Plate holes in silver are velvet black at 160mm tube length Vertical Illumination, and in Transmitted Illumination for silver lines and particles. That some diatoms in NA 1.0 Transmitted Illumination which scatter-fill the object glass are best seen with WB's tube length corrector in place, at tube length 175mm.

6th March 1979

Took down Ross-Burrells stage for overhaul (slop on rotation)

Method:- Upper two cap heads out (at top of steel plate); disconnect vertical rack at top and bottom and slide off stage upwards. Remove stage furniture, release horizontal thread from milled head, remove thread end, steady cap head, slide out top plate to right.
The nut driving horizontal movement was tapped up to be lighter (minimum freedom of movement) so that stage does not 'slop' on rotation. Bearings lubricated with anti-scuffing paste only, also thread. Vertical slides were OK but re-lubricated. Bearings of thread were overhauled and tightened; reduction drive re-fitted OK. It was noted on tightening nut in thread that no wear had taken place over 25 years. Nut was equally tight all along thread. Last its screw on left end of bottom top plate female slide is the adjustment position for slide tightness. Horizontal slide was made 'free to move' before attaching thread. Thread in nut was made free also. Spring was re-fitted but not really necessary now. Vertical slide free to run down under gravity. The stage slides are extremely accurate and sensitive. Control stiffness must be brought about in the drive mechanisms only.
Conclusion. Operation of stage x and y movements mechanically perfect. Rotation wobble: left hand 110°, negligible, right hand 110° maximum peak wobble 3cms (Beck x45, x10 eyepiece) at NE from returning to 2cms off axis at maximum clockwise revolution.

Page 310



6th March 1979

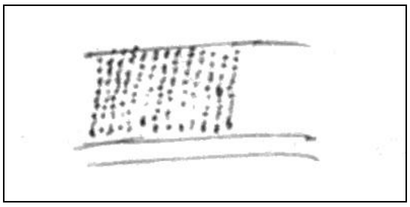
Object of Experiment

To study *Amphipleura pellucida* with Vertical Illumination and Koristka object glass now that Koristka is re-erected (page 308)

Apparatus:- Dall's coated slide; Koristka object glass 1.45; Ross-Burrells (stage overhauled), standard Vertical Illumination; tube length 170mm; Periplan eyepiece.

Readings:- *Amphipleura pellucida* is resolved into striae easily with Transmitted Illumination (NA 1.0) and Vertical Illumination on full cone but best seeing at Vertical Illumination maximum oblique (12V) [really maximum].

Under these conditions *Amphipleura pellucida* is resolved into dots very clearly but difficult to see owing small size. Dots are most tiny and in focus with outline of diatom. Holes are not spaced rectilinearly. This is why diatoms will not go into longitudinal striae.



Striae lines commonly shown are diffraction lines cutting across azimuthall striae. Such can look very convincing at limit of vision and are recorded in books(!). x25 eyepiece is nearly essential to make holes visible with ⅛" object glass. I even question Spitta's photograph. By oblique Vertical Illumination holes are clearly black in an illuminated surface, not in any way raised. This is a marginal affair even for Koristka 1.45 needing fresh eyes. Tube length correction no gain in resolution.
On Thum's slide in Realgar; striae more clearly visible but dots not so clear probably because of different specimens (may be lack of mountant penetration).
Conclusion. It is fitting that at the end of this book proper resolution of *Amphipleura pellucida* should be achieved with repaired Koristka objective and top power eyepiece.

End of Bk.I.

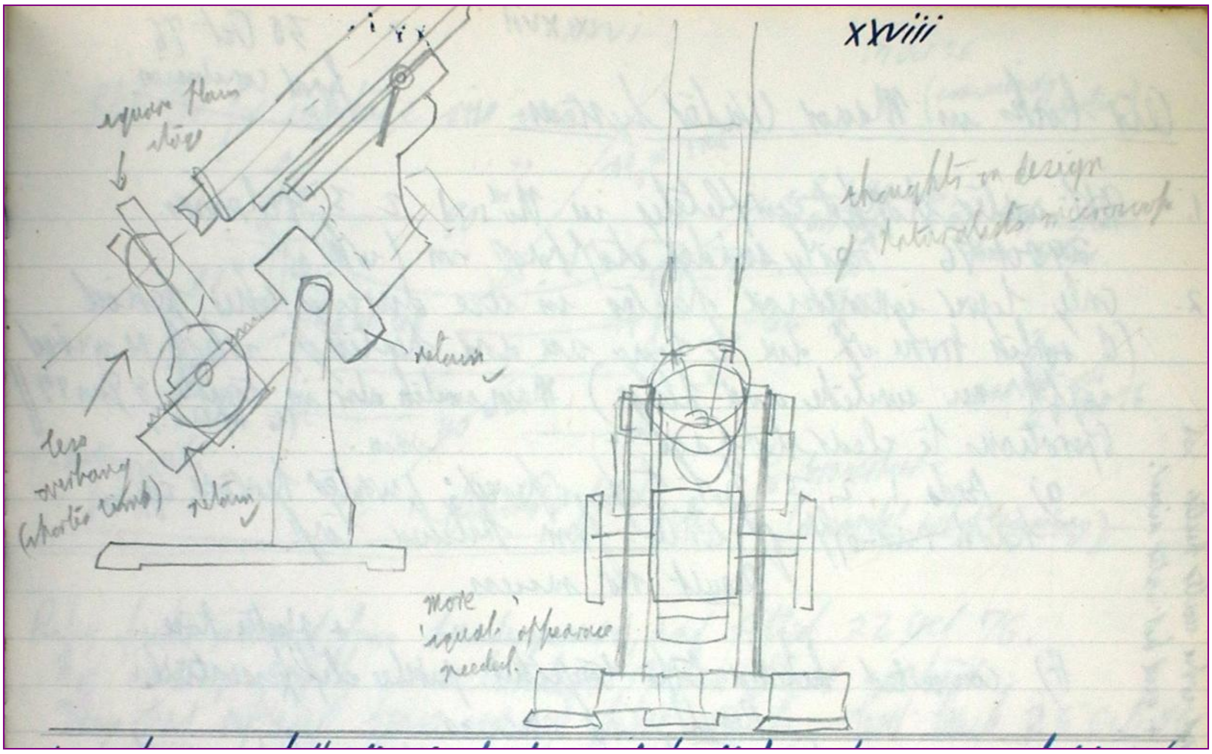
Results of Photo from page 306.
Frame 1. Swift-Holos, x10R, camera without lenses, *Cosinodiscus Ehrenbergii*. Exposure OK not in best focus, but showing resolution
Frame 2. Swift-Holos, x10R, ¾ turn fine adjustment upwards. Exposure OK, worse focus
Frame 3. Swift-Holos, x10R, ¾ turn fine adjustment downwards. Not in focus
Frame 4.
Frame 5. Swift-Holos, Exposure OK, focus OK, good slide (*Asteromphalus*) best visual focus in microscope
Frame 6. Koristka object glass. Exposure OK, no resolution, not in focus 4 seconds.
Frame 7. Koristka object glass. Exposure OK, no resolution, not in focus 2 seconds.
(Film removed)
Frame 8,9. Koristka object glass. Exposure OK but no resolution.
(see page LXXXII)

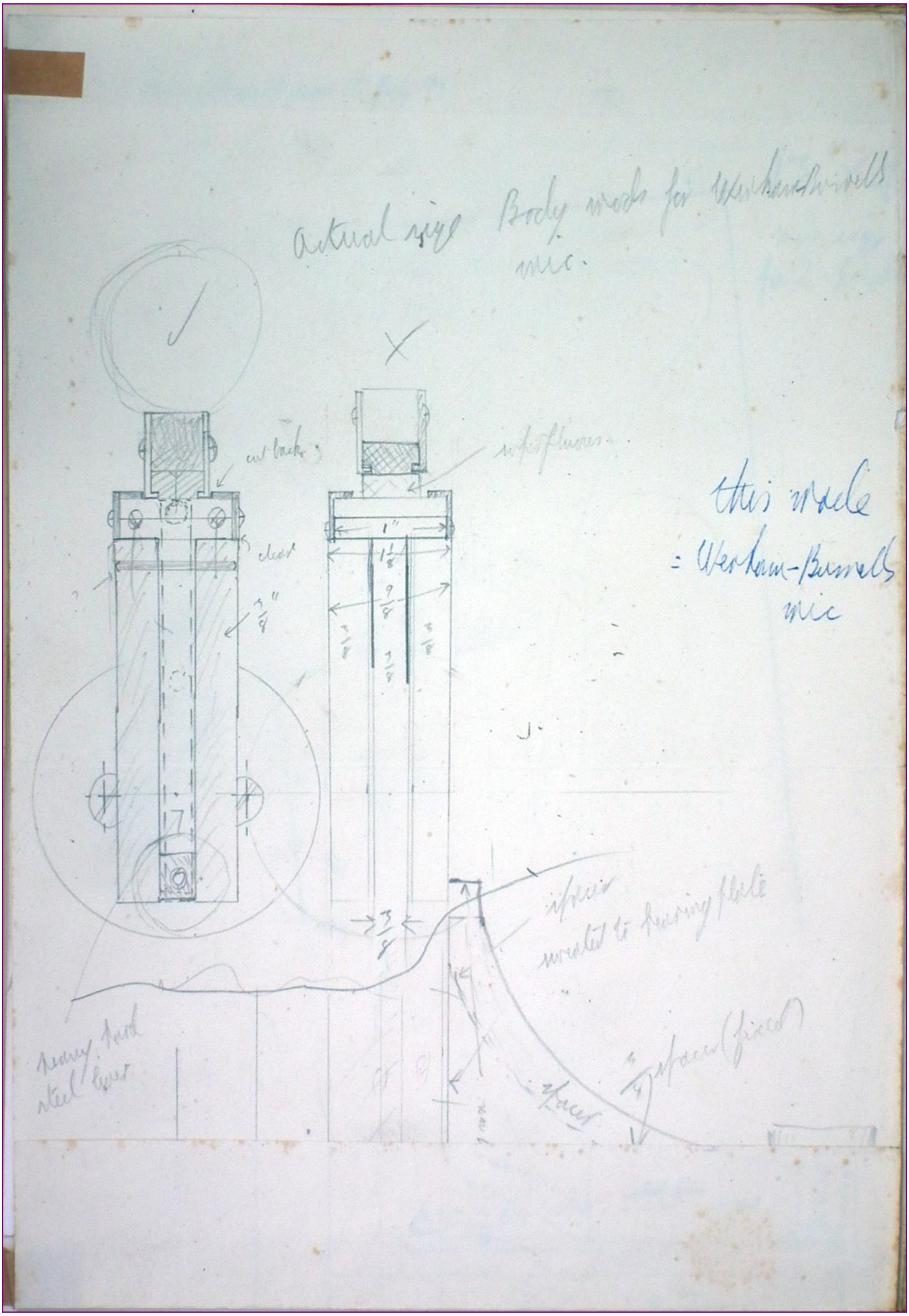
Miscellaneous un-dated notes from back of book.

Conan Doyle's Publications.
4 Vols. in one. Study in Scarlet, Sign of Four, Hound of the Baskervilles, Valley of Fear.
6 Vols. in one. Ring and the Lamp, Pirates and Blue Water, Terror and Mystery, Twilight and the Unseen, Adventure and Medical Life, Tales of Long Ago.
5 Vols. in one. Lost World, The Land of Mist, The Poison Belt, When the World Screamed, The Refugees.
(Historical), The White company, Sir Nigel, Micah Clark.
(Napoleonic Stories), Uncle Bernac, Adventure of Gerard, Exploits of Brigadier Gerard, The Great Shadow.
Sherlock Holmes. The Complete Short Stories (Adventures, Memoirs, Return of, Last Bow, Case Book.

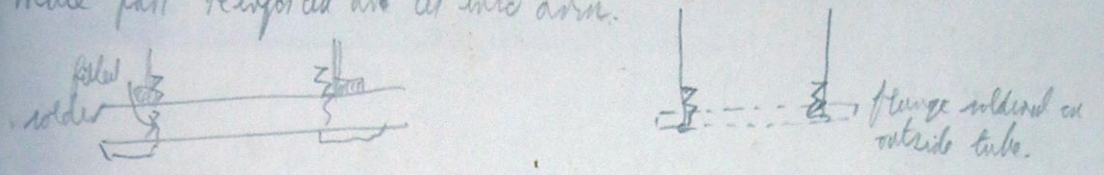
Preparation of Alum as done at Cleveland Alum Works at Hammersea & Boulby
Make pile of alum shale and brush wood sandwiches about 100ft high and 200ft square. Shale being bituminous will burn on its own when once started. FeS_2 (iron pyrites) in shale loses ½ S as SO_2 (sulphur dioxide) = FeS (iron sulphide). FeS absorbs H_2O from atmosphere = $FeSO_4.7H_2O$ (green vitriol). At high temperature in stack this oxidises to H_2SO_4 into alumina of the clay = sulphate of ammonia. This product steeped in H_2O and evaporated = sulphate of iron and alumina. These separated with carbonate of potash and piss. Again evaporated; alum crystallised at weaker concentration than iron salts; critical point tested by floating of a fresh egg. Liquor run off at this point leaving alum crystals. See sample of alum from Hammersea works from the Hammersea House (the old alum master's residence, now a farm). There was still a house on beach near workings in time of my maternal grandfather, born 1845. Local ceremony still 'recalls' collection of piss for this above purpose. A piss tank was a real thing.

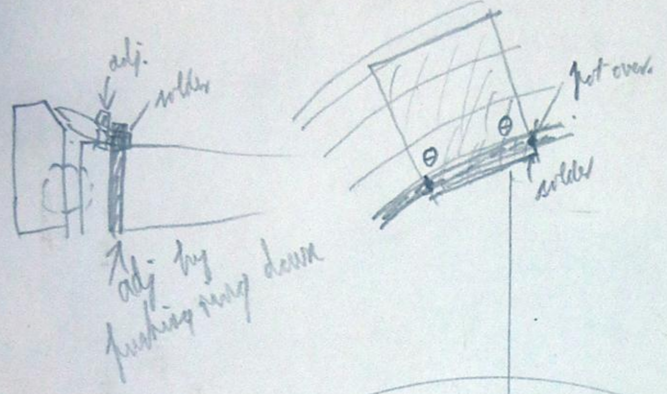
Ross-Burrells and Wenham-Burrells Technical Drawings and templates



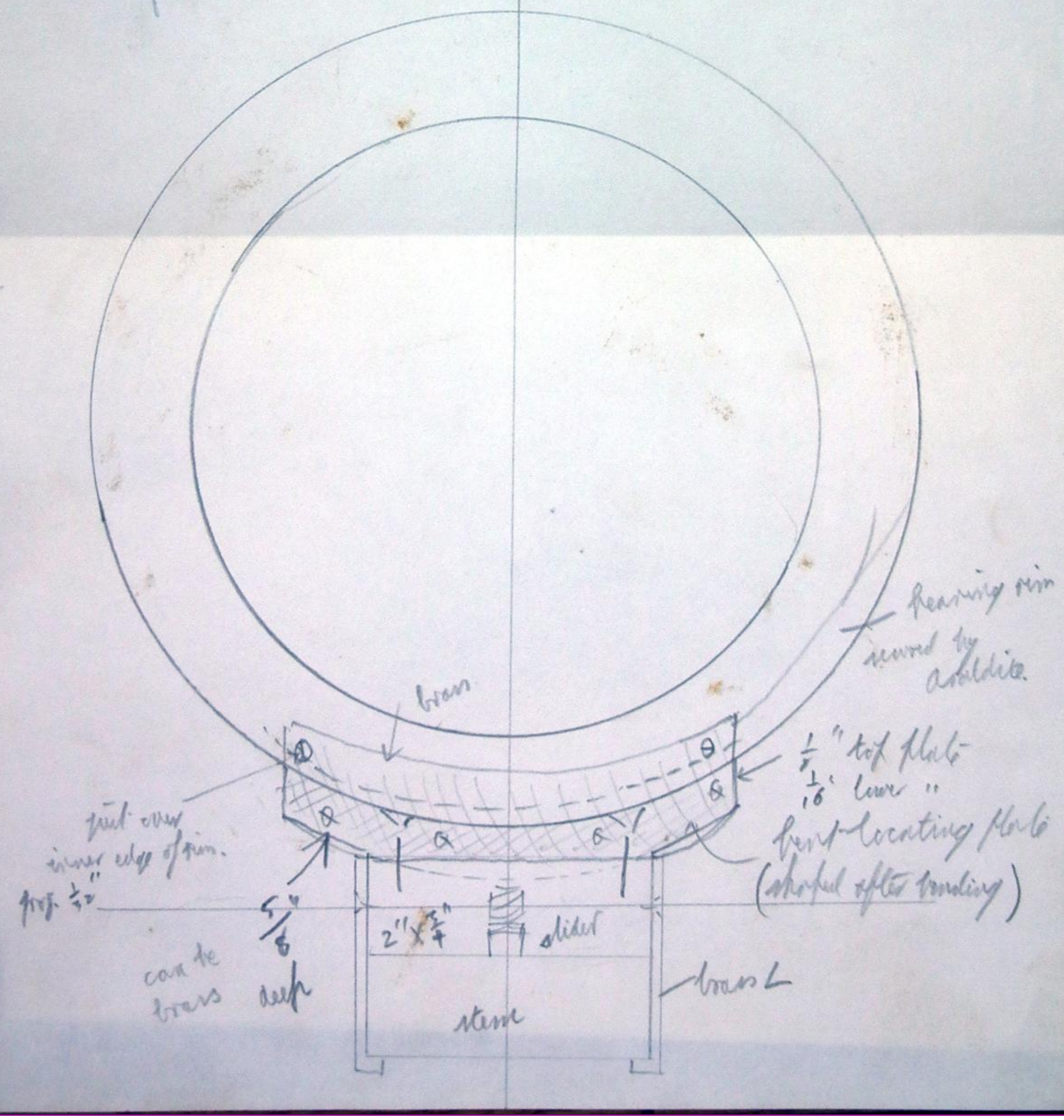

actual size
mic
cut back
clear
this made
= Wertam-Burrells
mic
heavy hard
steel lever

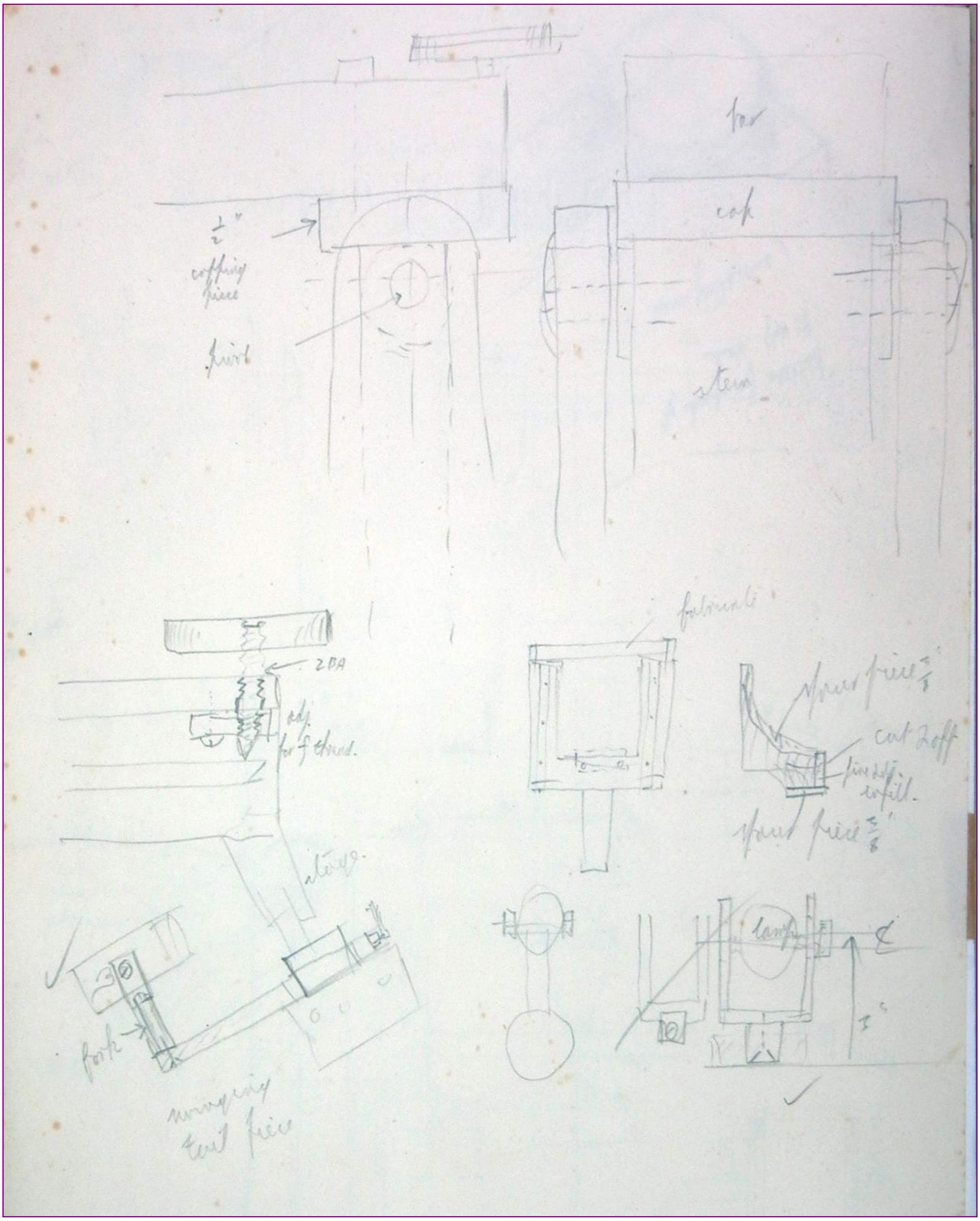
Ross body screw = fishpot can be'd with hole already there let into end of tube and 'solidified' with solder.
Make fast reinforced and let into arm.



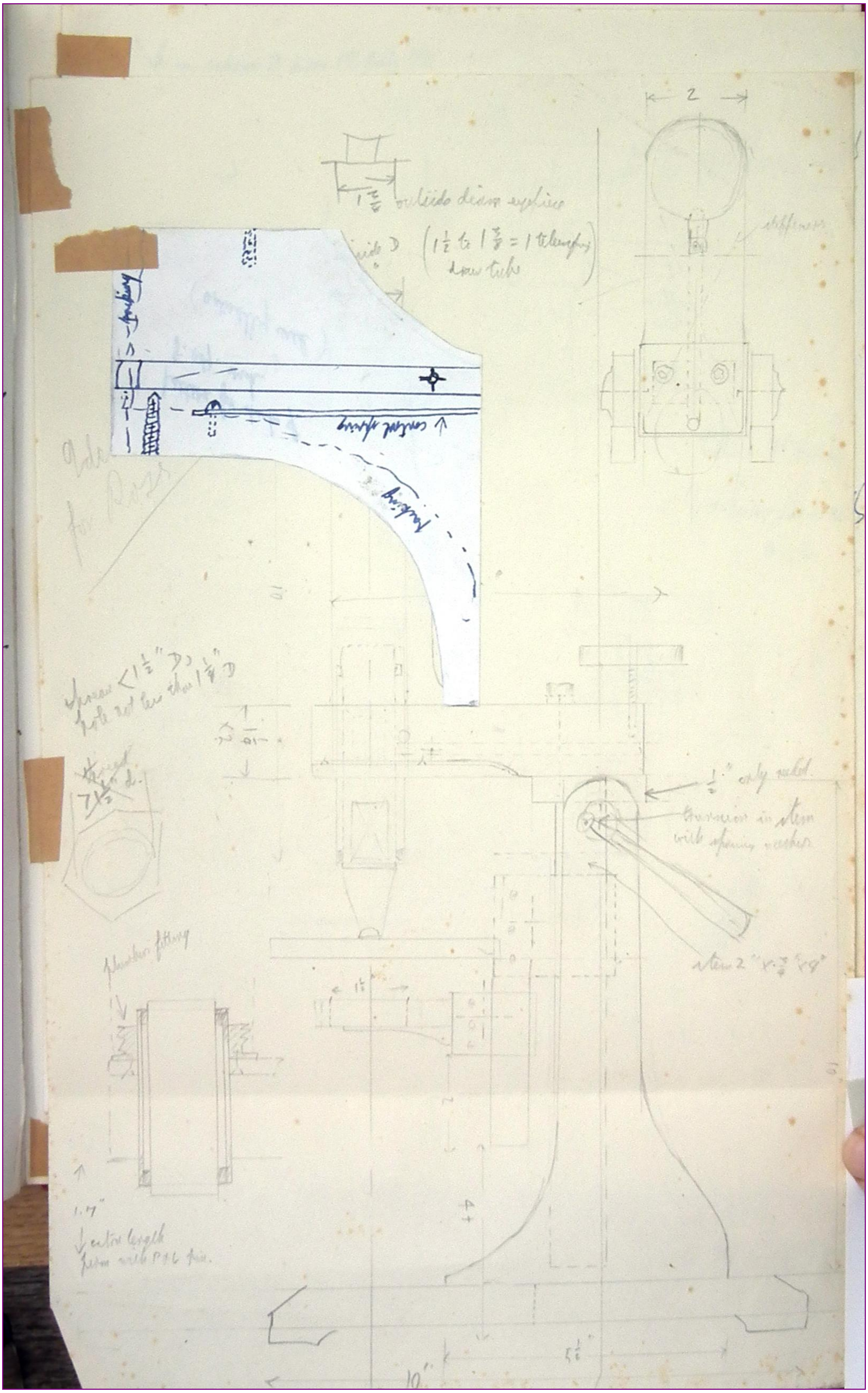


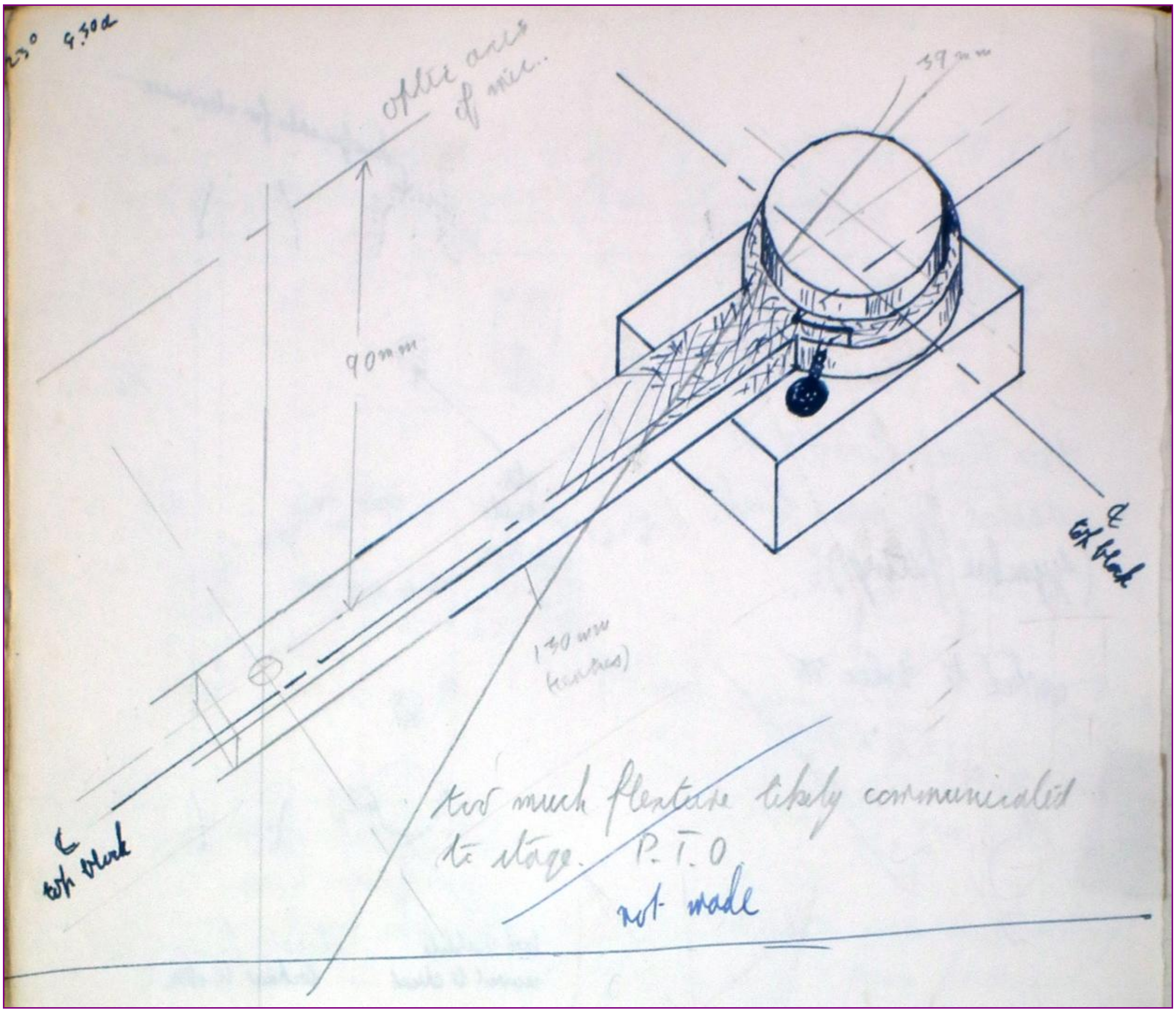
Idea only
Not made





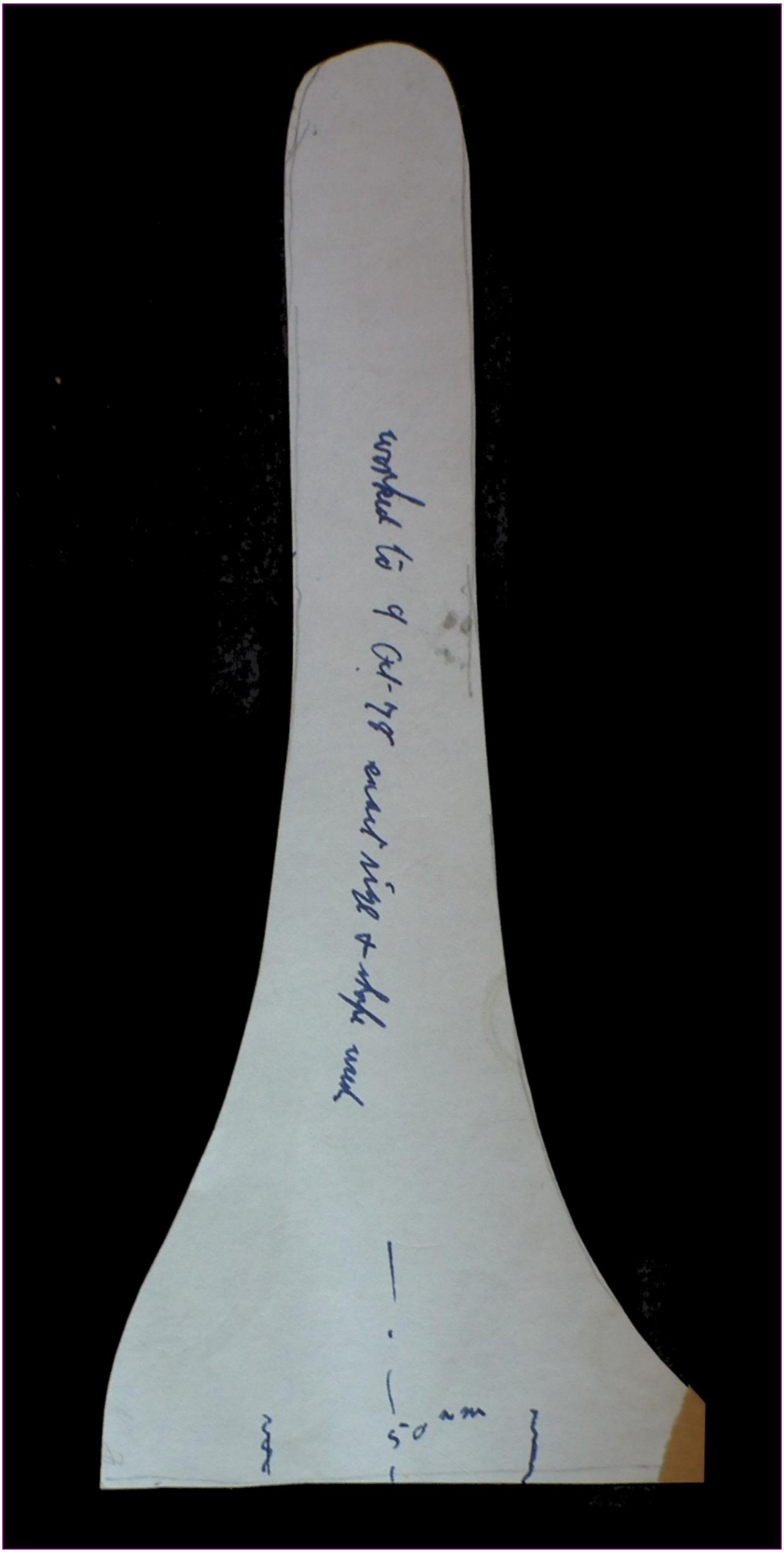
½"
capping piece
pivot
bar
cap
stem
2BA
adj
for f thread.
stage
fork
swinging end piece
fabricate
spare piece ⅝"
cut 2 off
spare piece ⅝"
lamp
1"


2
outside diam eyepiece
draw tube
stiffeners
packing
contact spring
packing
1/2" only needed
Trunnion in stem with spring washer
stem 2"
plumbers fitting
1.7"
entire length
10"
4

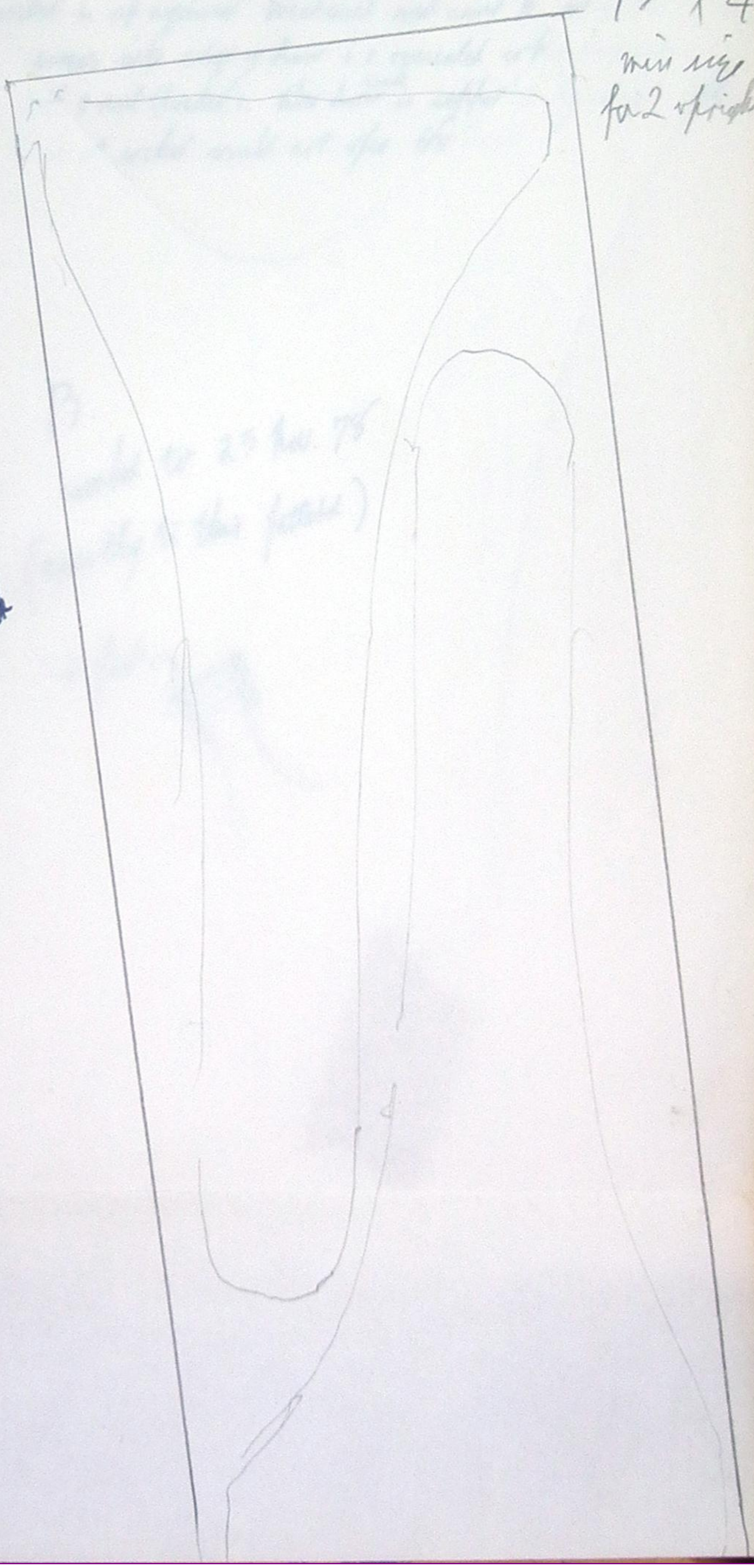

23° 4.30d
optic axis of micr.
39 mm
90 mm
130 mm (centres)
℄ of block
℄ of block
too much flexture likely communicated to stage. P.T.O
not made


B.
worked to 23 Nov. 78
(exactly to this pattern)
+ feet.


A
See pattern B.
(similar)
22 Nov 78
worked top but slightly
reduced in width as ↑
owing to economy in brass.
(an offcut was used)
7/10 thick used.
feet were fitted to make up
size
secured
6 BA from
below


worked to 9 Oct-78 exact size & shape used
5.0 cm

13" X 4½
min size
for 2 uprights



cut out complete
20 Oct 78
see pattern at back
of book

APPENDIX A

1975

= First entry (green)
= Experiment Entry (orange)

(Highlighted dates shown in bold; Feb 18 = first entry, all others = experiment entries.)

February

Mo	Tu	We	Th	Fr	Sa	Su
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	**18**	19	20	21	22	**23**
24	25	26	27	28		

3:◑ 11:● 19:◐ 26:○

March

Mo	Tu	We	Th	Fr	Sa	Su
					1	2
3	**4**	5	6	7	8	9
10	11	**12**	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

4:◑ 12:● 20:◐ 27:○

April

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	5	6
7	**8**	9	10	11	12	**13**
14	15	16	17	**18**	19	20
21	22	23	24	25	26	27
28	29	30				

3:◑ 11:● 19:◐ 25:○

May

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	**18**
19	20	21	**22**	**23**	24	25
26	27	28	29	**30**	31	

3:◑ 11:● 18:◐ 25:○

June

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	**6**	7	8
9	10	11	12	13	14	**15**
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

2:◑ 9:● 16:◐ 23:○

July

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	**5**	**6**
7	8	9	**10**	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

1:◑ 9:● 15:◐ 23:○ 31:◑

August

Mo	Tu	We	Th	Fr	Sa	Su
				1	**2**	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

7:● 14:◐ 21:○ 30:◑

September

Mo	Tu	We	Th	Fr	Sa	Su
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	**26**	27	28
29	**30**					

5:● 12:◐ 20:○ 28:◑

October

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

5:● 12:◐ 20:○ 27:◑

November

Mo	Tu	We	Th	Fr	Sa	Su
					1	2
3	4	**5**	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

3:● 10:◐ 18:○ 26:◑

December

Mo	Tu	We	Th	Fr	Sa	Su
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

3:● 10:◐ 18:○ 25:◑

1976

● = Experiment Entry

January

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

1:● 9:◐ 17:○ 23:◑ 31:●

February

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	**8**
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

8:◐ 15:○ 22:◑ 29:●

March

Mo	Tu	We	Th	Fr	Sa	Su
1	2	3	4	**5**	6	**7**
8	9	**10**	11	12	13	14
15	16	**17**	18	19	20	21
22	23	24	25	26	**27**	**28**
29	30	**31**				

9:◐ 16:○ 22:◑ 30:●

April

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	**8**	9	**10**	**11**
12	13	14	15	16	17	18
19	**20**	21	22	23	24	**25**
26	27	28	29	30		

7:◐ 14:○ 21:◑ 29:●

May

Mo	Tu	We	Th	Fr	Sa	Su
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

7:◐ 13:○ 20:◑ 29:●

June

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	**20**
21	22	23	24	25	26	**27**
28	29	30				

5:◐ 12:○ 19:◑ 27:●

July

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	8	9	10	**11**
12	**13**	14	**15**	**16**	**17**	18
19	20	**21**	22	**23**	24	25
26	27	28	29	30	31	

4:◐ 11:○ 19:◑ 27:●

August

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	8
9	10	11	12	13	**14**	15
16	17	**18**	19	20	**21**	22
23	24	25	26	27	**28**	29
30	31					

2:◐ 10:○ 18:◑ 25:●

September

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	**19**
20	21	22	23	24	25	**26**
27	28	**29**	**30**			

1:◐ 8:○ 16:◑ 23:● 30:◐

October

Mo	Tu	We	Th	Fr	Sa	Su
				1	2	3
4	5	6	**7**	8	**9**	10
11	**12**	**13**	14	15	16	**17**
18	**19**	20	21	22	23	24
25	26	27	28	29	30	31

8:○ 16:◑ 23:● 29:◐

November

Mo	Tu	We	Th	Fr	Sa	Su
1	2	**3**	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	**27**	**28**
29	**30**					

6:○ 14:◑ 21:● 28:◐

December

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	**10**	11	**12**
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	**28**	**29**	**30**	31		

6:○ 14:◑ 21:● 28:◐

1977

● = Experiment Entry (circled dates shown in **bold**)

January

Mo	Tu	We	Th	Fr	Sa	Su
					1	2
3	4	5	6	7	**8**	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	**29**	30
31						

5:○ 12:◑ 19:● 27:◐

February

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	5	**6**
7	8	9	**10**	11	**12**	13
14	15	16	17	18	19	20
21	22	23	24	25	26	**27**
28						

4:○ 11:◑ 18:● 26:◐

March

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	5	**6**
7	8	9	10	11	**12**	13
14	15	16	17	18	**19**	**20**
21	22	**23**	24	25	26	**27**
28	29	30	31			

5:○ 12:◑ 19:● 27:◐

April

Mo	Tu	We	Th	Fr	Sa	Su
				1	2	3
4	5	6	7	8	9	**10**
11	12	13	14	15	16	**17**
18	19	20	21	22	23	24
25	26	27	28	29	30	

4:○ 10:◑ 18:● 26:◐

May

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

3:○ 10:◑ 18:● 26:◐

June

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	10	11	**12**
13	**14**	15	16	17	**18**	19
20	21	22	23	24	25	26
27	28	29	30			

1:○ 8:◑ 16:● 24:◐

July

Mo	Tu	We	Th	Fr	Sa	Su
				1	2	3
4	5	6	**7**	8	**9**	10
11	12	13	14	15	16	**17**
18	19	20	21	**22**	23	**24**
25	26	**27**	28	**29**	30	**31**

1:○ 8:◑ 16:● 23:◐ 30:○

August

Mo	Tu	We	Th	Fr	Sa	Su
1	2	3	**4**	5	**6**	**7**
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	**30**	31				

6:◑ 14:● 22:◐ 28:○

September

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	**24**	25
26	27	28	29	30		

5:◑ 13:● 20:◐ 27:○

October

Mo	Tu	We	Th	Fr	Sa	Su
					1	**2**
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	**23**
24	25	26	**27**	**28**	29	**30**
31						

5:◑ 12:● 19:◐ 26:○

November

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	5	**6**
7	8	9	10	11	12	13
14	15	16	17	**18**	19	**20**
21	**22**	23	24	25	26	27
28	29	30				

4:◑ 11:● 17:◐ 25:○

December

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	**6**	7	**8**	9	**10**	11
12	13	14	15	16	**17**	18
19	20	21	**22**	23	24	**25**
26	**27**	**28**	**29**	30	31	

3:◑ 10:● 17:◐ 25:○

1978

● = Experiment Entry (circled dates shown in **bold**)

January

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	8
9	10	**11**	12	13	14	**15**
16	17	18	**19**	20	21	**22**
23	**24**	25	26	**27**	28	**29**
30	31					

2:◑ 9:● 16:◐ 24:○ 31:◑

February

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	**3**	4	**5**
6	**7**	8	9	10	11	12
13	14	**15**	**16**	**17**	**18**	**19**
20	21	**22**	**23**	24	25	26
27	**28**					

7:● 14:◐ 23:○

March

Mo	Tu	We	Th	Fr	Sa	Su
		1	**2**	**3**	4	**5**
6	7	8	9	10	**11**	**12**
13	14	**15**	16	17	**18**	**19**
20	21	**22**	23	**24**	**25**	**26**
27	**28**	**29**	30	31		

2:◑ 9:● 16:◐ 24:○ 31:◑

April

Mo	Tu	We	Th	Fr	Sa	Su
					1	**2**
3	**4**	5	**6**	7	**8**	**9**
10	11	**12**	**13**	14	15	16
17	18	19	**20**	21	**22**	23
24	25	**26**	27	**28**	29	30

7:● 15:◐ 23:○ 29:◑

May

Mo	Tu	We	Th	Fr	Sa	Su
1	2	**3**	4	5	**6**	**7**
8	9	10	**11**	12	13	**14**
15	**16**	**17**	**18**	**19**	20	**21**
22	23	**24**	25	26	27	28
29	30	**31**				

7:● 15:◐ 22:○ 29:◑

June

Mo	Tu	We	Th	Fr	Sa	Su
			1	**2**	3	**4**
5	6	**7**	8	9	**10**	**11**
12	13	**14**	**15**	16	17	18
19	20	21	**22**	**23**	24	25
26	27	28	29	30		

5:● 13:◐ 20:○ 27:◑

July

Mo	Tu	We	Th	Fr	Sa	Su
					1	**2**
3	4	**5**	**6**	**7**	**8**	9
10	11	12	**13**	**14**	15	16
17	18	19	20	**21**	**22**	**23**
24	25	26	27	28	29	**30**
31						

5:● 13:◐ 20:○ 26:◑

August

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	**5**	**6**
7	**8**	**9**	**10**	11	12	**13**
14	15	16	17	**18**	**19**	20
21	22	23	24	**25**	**26**	27
28	29	30	**31**			

4:● 11:◐ 18:○ 25:◑

September

Mo	Tu	We	Th	Fr	Sa	Su
				1	2	3
4	5	6	7	8	9	**10**
11	12	13	14	**15**	16	**17**
18	**19**	20	21	22	23	**24**
25	26	27	28	29	**30**	

2:● 10:◐ 16:○ 24:◑

October

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	**5**	**6**	7	**8**
9	**10**	**11**	**12**	**13**	14	**15**
16	**17**	18	19	20	21	22
23	24	25	26	**27**	28	**29**
30	31					

2:● 9:◐ 16:○ 24:◑ 31:●

November

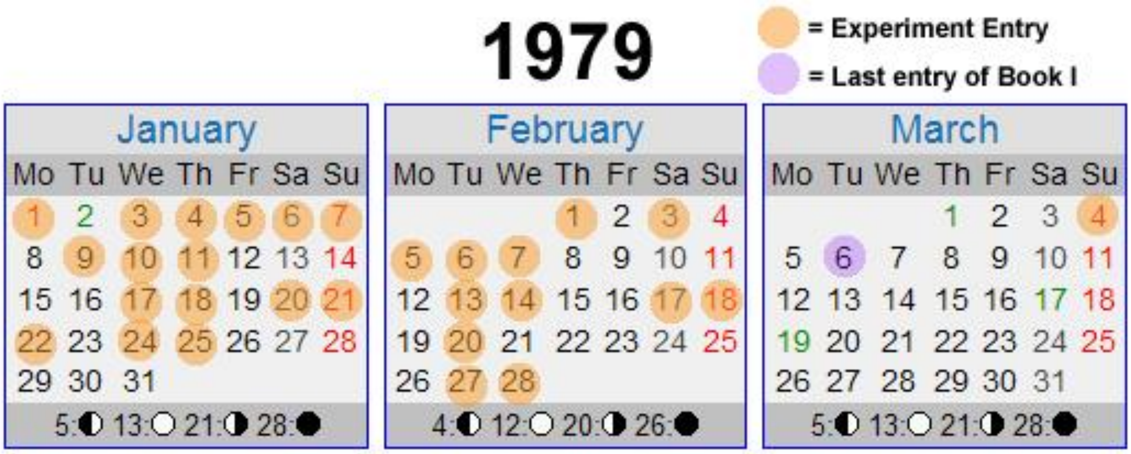
Mo	Tu	We	Th	Fr	Sa	Su
		1	**2**	**3**	**4**	5
6	**7**	**8**	**9**	10	**11**	12
13	14	15	**16**	17	**18**	**19**
20	21	**22**	**23**	24	25	26
27	28	29	30			

7:◐ 14:○ 22:◑ 30:●

December

Mo	Tu	We	Th	Fr	Sa	Su
				1	2	**3**
4	**5**	**6**	7	8	9	10
11	12	13	14	**15**	16	17
18	**19**	20	21	**22**	**23**	**24**
25	**26**	**27**	28	29	30	**31**

7:◐ 14:○ 22:◑ 29:●


1979
= Experiment Entry
= Last entry of Book I
January
February
March
Mo Tu We Th Fr Sa Su
5: 13: 21: 28:
4: 12: 20: 26:
5: 13: 21: 28:

APPENDIX B

Walter Burrells in RAF uniform (note Navigator wings)

Walter Burrells in mission dress (January 1942)

W. Burrells
(1920-1991)

BILL BURRELLS joined the Quekett in March 1938 and I first met him in the Autumn of 1945, still in RAF uniform but attending Gossip Meetings at Burlington House. I was a newcomer and quickly found him an enormously knowledgeable and helpful member who rapidly taught me the error of my ways when my exhibits were not up to the Club's high standards.

He had followed his father in to the Post Office from school and went to work at the research labs at Dollis Hill in physics and engineering. In a reserved occupation, he was eventually allowed to volunteer for service as a navigator with Bomber Command in 1941. After an extended series of missions over Germany he was transferred to teaching and lectured to young airmen until 1946 when he rejoined Dollis Hill. He became Secretary of the Club in 1949 and served until 1955 when he obtained a post at Harwell and joined the Rutherford Laboratory, working in health physics, chiefly on instrumentation, for the rest of his career.

Throughout this time his interest and activity in microscopy, though limited at times by service conditions of course, continued. In particular, with access to almost no tools he resurrected and modified an old Ross stand which he brought to the Club on many occasions. He had to make stage fittings to fit more modern condensers by wrapping thin metal in a spiral sandwich and sweating it together with solder; his filing and handwork were always to a very high standard so that things fitted as well as if they had been made by Ross! This stand was further modified over the years for special purposes and demonstrated in many guises. He made and fitted polarising apparatus of the Dick pattern and ultrafine adjustments to the mechanical stage so that he could centre very small individual crystals which he showed at Midlands Members meetings and the Annual Exhibition during its various stages of development. He also admired the Wenham binocular system and, when at Harwell, made metalised absorbtion plates to even out the intensity of the two beams.

426 *Obituaries*

When living at Rickmansworth, he became very interested in the rhizopoda and, with material available locally, collected and cultured many species for quite long periods on slides in moist chambers. He was particularly interested in observing feeding habits and found that, as he put it, 'they stopped feeding if exposed for long to light of wavelength much longer than mid-green!' He was always I think, more interested in the microscope as an instrument and, as far as I can remember, he never mentioned any major use of the microscope in his work. Indeed, when I was visiting him at work one day, he apologised for having to attend to a Research worker's problem. This involved looking at the graph he had produced, which was a straight line hopefully drawn through a scattering of points, and Bill telling the worker he would have to do the experiment again — more carefully! I ruefully remarked that in my biological field, I would have had to spend hours looking through the worker's slides before making any such comment and he remarked that 'that was the worst of being in an executive science'.

In 1961 his large (574 page) book, *Microscope Technique,* was published by Fountain press. It is a magnificent compendium, still of great value as a source of fundamentals, more sure in its treatment of the optical than the preparative aspects of microscopy. Sadly, he prepared a second edition which was never published due to a change in policy by Focal press (following the death of our Member, E. F. Linssen, who was their Scientific Editor.)

He had many interests outside both work and microscopy; he was a mountaineer and enjoyed an annual expedition for many years to Iceland with the public school's Exploration Society during which he made a long series of measurements showing that the country was 'splitting down the middle' as he put it. He lectured to many Societies and groups both on this and on matters microscopical during his years living in Oxfordshire. He served 15 years as a County Councillor for Grove and was on the Police Commission for which he received much praise locally.

He was very severely disabled by the treatment necessary in his last illness and survived 3½ years at home only due to the absolutely devoted care of his wife, Doris and her nursing helpers for which she has my utmost admiration.

M. V. Salmon.

Quekett Journal of Microscopy: VOLUME 37, 1993-1996, Part 5, Page 426

Walter Burrells b. 18th February 1920
BMD Birth, Walter Burrells, March 1920 Hapstead Vol.1a. pg.1367.
Mother's maiden name Turnbull
Doris Eveline Fillmore b. 2nd November 1920
BMD Birth, Doris E. Fillmore, December Quarter 1920 Hackney Vol.1b. pg.883.
Mother's maiden name - Bowman
BMD Marriage, Walter Burrells to Doris E. Fillmore, December Quarter 1945 Hendon Vol.3a. pg.1926A.
BMD Death, Walter Burrells, aged 71, February 1991 Henley Vol.20. pg.2775.
BMD Death, Doris Eveline Burrells, aged 75, November 1995 Poole D17E/4311D/298

Burrells, W. (Papers/Entries in the QMC Journal of Microscopy)

Reported items: modifications to the Powell & Lealand microscope (SERIES 4, VOLUME III, 1949-1953 Page 399)
Reported items: stability of instruments (SERIES 4, VOLUME III, 1949-1953 Page 497)
Microscope Technique. 1977 (SERIES 4, VOLUME X, 1976-1979 Page 396)
1950. The phase contrast system of microscopy (SERIES 4, VOLUME III, 1949-1953 Page 93)
1952. Notes on the binocular system of Powell and Lealand (SERIES 4, VOLUME III, 1949-1953 Page 380)
1955. The study of fresh water Rhizopods (SERIES 4, VOLUME IV, 1954-1957 Page 196)
1960a. The usefulness of sub-stage condensers (SERIES 4, VOLUME V, 1958-1961 Page 271)
1960b. Interpretation of the image of diatoms: a new method of illumination (SERIES 4, VOLUME V, 1958-1961 Page 320)

Elected a QMC member 8th March 1938
In the 1939 Membership lists @ 6 Tudor Close, Kingsbury, N.W.9.
In the 1948 Membership lists as Walter Burrells @ 52 Draycott Avenue, Northwick Park, Harrow, Middlesex (Stated interest – Rhizopods: Technical Microscopy: 'Brass and Glass')
In the 1962 Membership lists @ Icknield Way, Upton, Didcot, Berkshire
In the 1969 Membership lists @ The Manor, Grove, Wantage, Berkshire. Wantage 258.

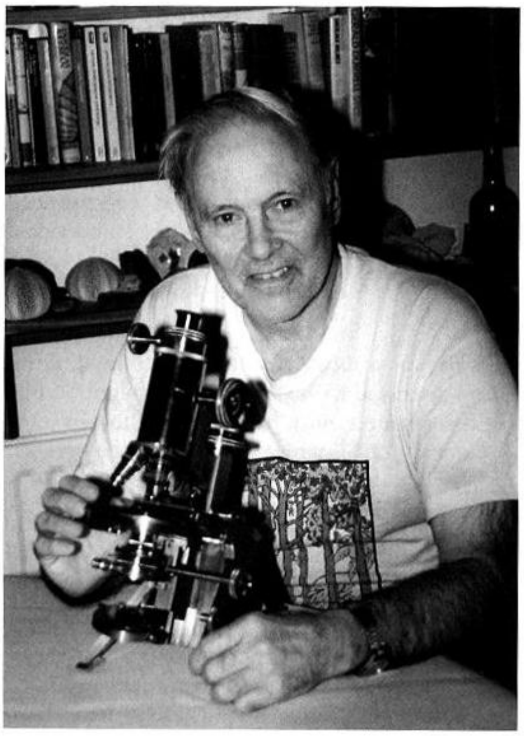
In the 1974 Membership lists @ The Manor, Grove, Wantage, Berkshire. Wantage 2258. (Stated interests General Microscopy, Microscope Construction, Microscope Optics, Petrology)

Author of:
Industrial Microscopy in Practice (Fountain Press 1961) [572 pages]
Microscope Technique: A Comprehensive Handbook for General and Applied Microscopy (Fountain Press 1977) [574 Pages] – Revised edition of ‘Industrial Microscopy’.

Photographed Upton Manor, Upton in 1968

APPENDIX C

Michael Vaughn Salmon: 1924–2007



Michael Vaughn Salmon was born on 29 July 1924, in Muswell Hill, north London. His unusual middle name was given after an ancient Welsh earl, a distant relative. He attended Harrow Weald Grammar School 1935–1942, gaining School Certificate and Higher School Certificate, before being awarded an open scholarship to St Mary's Medical School, from where he graduated in medicine in 1948.

He had a number of house appointments in London and Taplow, before being called up for National Service in October 1951: he was fortunate to be able to serve in the RAMC as a pathologist, finally rising to the rank of major in charge of the Western Command Laboratory in Chester. He was able to see all of the pathology from all serious cases worldwide during his National Service, and turned this to very good account in completing the work for his London MD degree in histopathology [awarded in 1953].

On demob the same year, he became a lecturer in the pathology department at St Mary's, from where he was able to spend some time attached to the Technical Optics Department at Imperial College working with B K Johnson among others. This allowed him to improve his understanding of the optics of microscopy, the better to drive his Baker interference microscope, and to understand the potential pitfalls of using it to inspect biological partly doubly-refractile objects.

In 1958 he went to the London Hospital Medical School as senior registrar in the department of pathology, and lecturer in neuropathology. Here he began work in electron microscopy, before moving to Smethwick in 1962, as Consultant Neuropathologist in the Midland Centre for Neuropathology and Neurosurgery: here he was able to commence his EM research on glial cells.

Quekett Journal of Microscopy: VOLUME 40, 2005-2008, Part 6, Page 536

He started to use a computer in the study of axon sheaths in 1971: the device had a total of 32K of memory for both data and program! On retirement in 1986 he was made an honorary senior lecturer of Birmingham Medical School.

He was a founder member of the Royal College of Pathologists in 1963, and was elected to its Fellowship in 1975.

Aside from his professional life, Michael started making stained section slides while still at school – and sold them to Gerrard and later to Watson. He was an able teacher of microscopical and photographic techniques throughout his life, working especially with the Quekett and at Regent Street Polytechnic in Margaret Harker's department of photography.

He joined the QMC in 1946, was soon on the committee, and helped to organise the first annual exhibition. He was President 1994–1997, having been elected to Honorary Membership in 1986, on the same day as John McArthur [of small microscope fame].

Michael joined the RMS in 1956, and served on its Council, and served also as one of its representatives on the BSI committee on microscopy standards. He taught some of its very earliest teaching courses.

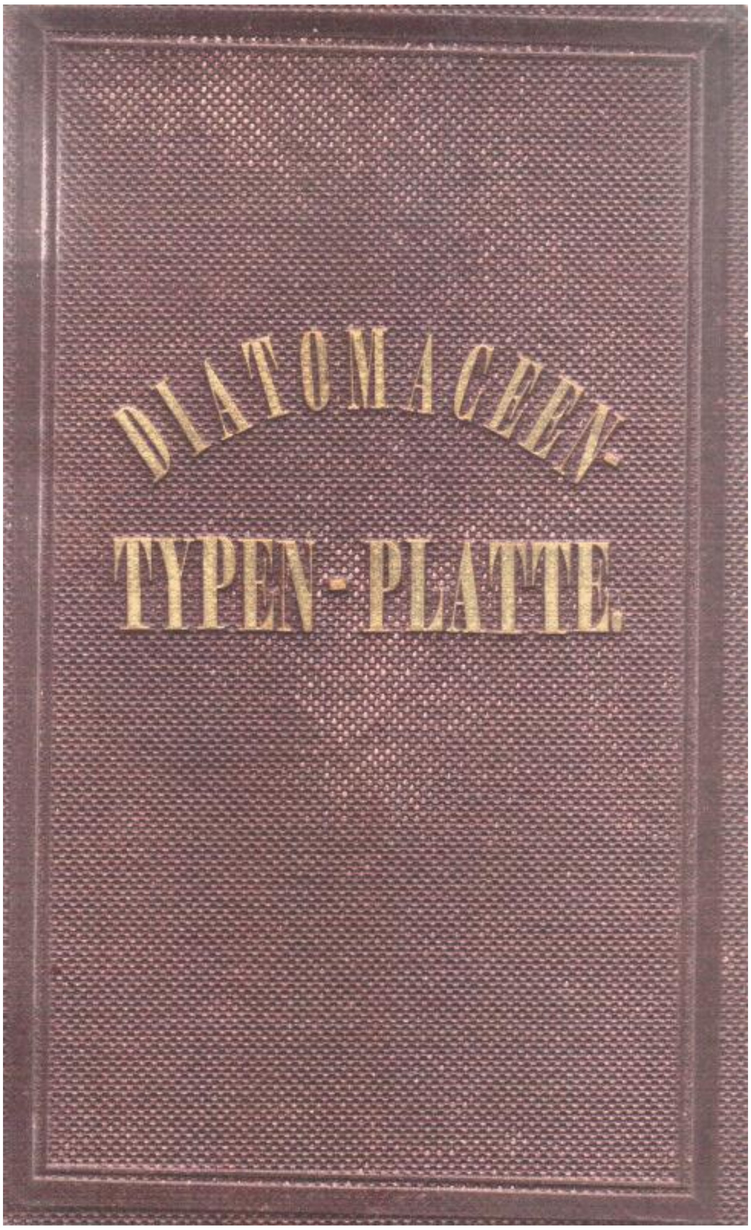
He wrote a number of papers for specialised neuropathological journals: the first was in *Brain* in 1964, and the last before retirement were in *Surgical Neurology* and in *Histopathology* in 1986. He hadn't written up any of his three Presidential Addresses for the Quekett journal by the time I became editor in the autumn of 1998: when I asked him urgently to do so, he was unwilling on the grounds that all were histochemical in character and would require full-colour illustrations which the Club could not then afford. He did, however, contribute two useful papers to the QJM, and two also to *The Microscope*.

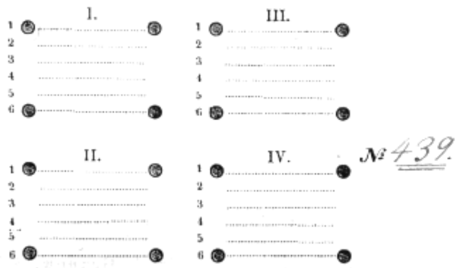
Michael had wide interests outside microscopy, as well as in pond life and Algae within it. I well remember a bank of Carousel projectors just inside his door at home, to be set up for multi-image projection on a large screen, the fading in and out all controlled by a computer program written on a BBC machine. He had much interest in sound recording, as I had myself at the time, and he operated a well-equipped workshop to make all manner of gadgets for his varied projects. We spent much time looking at each other's various machines whenever we exchanged visits!

He married Mary Claydon in July 1950: they had one daughter and three sons, one of whom died at age nineteen, and Mary sadly died in September 1969. Michael remarried in December 1971; his new wife Mary-Rose Taylor already had a son. Sadly, he had been unwell for some months when he died on 18 June 2007. We offer our sincere condolences to his surviving family.

Brian Bracegirdle

APPENDIX D





Diatomaceen-Typen-Platte.

Die Reihenfolge in diesem Präparat ist oben durch Skizze angedeutet. Die „Eupodiscus Argus" an den Ecken der Felder dienen nur zum Einschliessen derselben.

The succession of the objects on this slide is analogical to the above sketch. The corners of each square are marked by „Eupodiscus Argus" and accordingly not mentioned in the Catalogue.

La succession dans ce preparat est signifiée par l'esquisse ci-devant. Les „Eupodiscus Argus" servent seulement pour signifier la partion des quatres tableaux.

Verzeichniss der Diatomaceen,

nach den Bestimmungen des Herrn A. Grunow, Wien.

Catalogue of the Diatomaceae,

according to the classification of Mr. A. Grunow, Vienna.

Catalogue des Diatomacées,

suivant la Classification de Mr. A. Grunow, à Vienne.

Abkürzungen—Abbrevations—Abréviations:

Sw. = Süsswasser = fresh water = eau douce.
Seew. = Seewasser = marine = eau marine.
Brw. = Brackwasser = brakish water = eau saumâtre.
S. = Schaale = valve = ecaille.
OS. = Obere Schaale = upper valve = ecaille de dessu.
US. = Untere Schaale = under valve = ecaille de dessous.
H. = Hauptansicht = principal view = vue principal.
Th. = Theilungsact = act of binary subdivision = moment de division.

Epithemieae.

I. 1. 1. Epithemia turgida Kg. *S. Sw. Holstein.*
2. „ „ „ *H.*
3. „ „ „ *Th.*
4. „ granulata Kg. *Fossil. N.-Amerika.*
5. „ Westermannii Kg. *H. Brw. Mecklenburg.*
6. „ „ „ *Th.*
7. „ Hyndmannii Sm. *Fossil. Lüneburg.*
8. „ Sorex Kg. *Brw. Schleswig.*
9. „ gibba Kg. *S. Sw. Holstein.*
10. „ „ „ *H.*
11. „ ventrico-a Kg. *Brw. Schleswig.*
12. „ Zebra Kg. *S. Sw. Holstein.*
13. „ „ „ *H.*
14. „ constricta Sm. *S. Brw. Schleswig.*
15. „ „ „ *H.*
16. „ musculus Kg. *Seew. Upolu.*
17. „ Argus Sm. *S. Sw. Norwegen.*
18. „ „ „ *H.*
19. „ ocellata Kg. var. *Fossil. N.-Amerika.*
20. Eunotia incisa Greg. *Fossil. Norwegen.*
21. „ Formica Ehrbg. *Fossil. N.-Amerika.*
22. „ indica Grun. *Fossil. N.-Amerika.*
23. „ praerupta Ehrbg. *Fossil. N.-Amerika.*
24. „ tetraodon Ehrbg. *Fossil, Norwegen.*
25. „ „ var. diodon. *Fossil. Java.*
26. „ „ var. triodon. *Fossil. Norwegen.*
27. „ „ var. Diadema. *S. Fossil. Norwegen.*
28. „ „ „ „ *H.*

2. 1. Eunotia didyma Grun. *Ostindien.*
2. „ Kurziana Grun. *Ostindien.*
3. „ undulata Ralfs. *S. Sw. Holstein.*
4. „ „ „ *H.*
5. „ „ „ *Th.*
6. „ Soleirolii (Kg.) *Sw. Sachsen.*
7. Ceratoneis lunaris (Ehrbg.) Grun. *Sw. Holstein.*
8. „ Arcus Kg. *Sw. Norwegen.*

Meridioneae.

9. Climacosphenia moniligera Ehrbg. *S. Seew. Afrika.*
10. „ „ „ *H.*

3. 1. Meridion circulare Ag. *S. Sw. Holstein.*
2. „ „ „ *H.*
3. „ „ „ *Th.*
4. „ „ „ var. *Sw. Holstein.*
5. „ constrictum Ralfs. *S. Sw. Holstein.*
6. „ „ „ *H.*
7. Licmophora capensis Grun. var. californica. *S. Seew. Californien.*
8. „ „ „ var. californica. *H.*
9. Sceptroneis gemmata Grun. *Fossil. Jütland.*

Diatomeae.

10. Diatoma vulgare Bory. *Sw. Franken.*
11. „ „ var. lineare Sm. *S. Sw. Holstein.*
12. „ „ „ „ „ *H.*
13. „ „ „ „ „ *Th.*
14. „ elongatum Kg. *Sw. Schweiz.*
15. Odontidium hiemale Kg. *S. Sw. Deutschland.*
16. „ „ „ *H.*
17. „ „ var. mesodon Grun. *S. Sw. Deutschland.*
18. „ „ „ „ „ *H.*
19. „ „ „ „ „ *Th.*

5

20. Odontidium hiemale var. glaciale (Kg.) *S. Sw. Norwegen.*
21. „ „ „ „ „ *H.*
22. Synedra splendens Kg. *S. Sw. Ostfriesland.*
23. „ „ „ *H.*
24. „ „ „ *Th.*
25. „ Ulna Ehr. *Sw. Portorico.*
26. „ pulchella Kg. var. *S. Seew. Norwegen.*
27. „ „ „ „ *H.*
28. „ affinis Kg. *Seew. Schleswig.*
29. „ tabulata Kg. *Seew. Holstein.*
30. „ capitata Ehrbg. *Sw. Holstein.*

4. 1. „ undulata Sm. *Seew. Holstein.*
2. „ crystallina Kg. *Seew. Holstein.*

5. 1. „ formosa Hantzsch. *Seew. Upolu.*
2. „ fulgens Sm. *Seew. Italien.*
3. Fragilaria virescens Ralfs. *Sw. Holstein.*
4. „ capucina Desm. *Sw. Holstein.*
5. „ Ungeriana Grun. *Sw. Cypern.*
6. „ sp. *Sw. Ostfriesland.*

Rhizosolenieae.

6. 1. Rhizosolenia styliformis M. Schulze. *Grönland.*
2. „ „ „ „ *Th.*

Tabellarieae.

II. I. 1. Diatomella Balfouriana Grev. *Sw. Mähren.*
2. Gomphogramma rupestre A. Braun. *Sw. Mähren.*
3. Tetracyclus lacustris Ralfs. *Fossil. Norwegen.*
4. Terpsinoë musica Ehrbg. *S. Sw. Portorico.*
5. „ „ „ *H.*
6. „ „ „ *Th.*
7. „ amerikana Bailey var. *S. Seew. Australien.*
8. „ „ „ „ *H.*

6

9. Tabellaria flocculosa Kg. *S. Sw. Holstein.*
10. „ „ „ *H.*
11. „ fenestrata Kg. *H. Sw. Holstein.*
12. Grammatophora marina (Kg.) Sm. *S. Seew. Gibraltar.*
13. „ „ „ „ *S.*
14. „ „ „ „ *H.*
15. „ oceanica Ehrbg. *Seew. N.-Amerika.*
16. „ angulosa Grev. var. *Seew. Califorien.*
17. Rhabdonema arcuatum Kg. *S. Seew. England.*
18. „ „ „ *H.*
19. „ minutum Kg. *Seew. Ostsee.*
20. „ adriaticum Kg. *Seew. Türkei.*
21. Climacosira mirifica Grun. *Seew. Japan.*
22. Striatella unipunctata Ag. *Seew. Frankreich.*

Surirelleae.

2. 1. Surirella biseriata Bréb. *Sw. Holstein.*
2. „ „ var. acuminata. *Fossil. Lüneburg.*
3. „ robusta Ehrbg. *Fossil. Norwegen.*
4. „ oblonga Ehrbg. *Fossil. N.-Amerika.*
5. „ nobilis Sm. var. *Fossil. N.-Amerika.*
6. „ slevicensis Grun. *Brw. Holstein.*

3. 1. „ linearis Sm. var. constricta. *S. Sw. Schweden.*
2. „ „ „ „ „ *H.*
3. „ norwegica Eul. n. sp. *S. Sw. Norwegen.*
4. „ „ „ „ „ *H.*
5. „ splendida Kg. *Sw. Holstein.*
6. „ „ var. *Fossil. Lüneburg.*
7. „ striatula Turp. *Brw. Schleswig.*
8. „ Gemma Ehrbg. *Brw. Ostfriesland.*
9. „ Patella Ehrbg. *Fossil. Franzensbad.*
10. „ Moelleriana Grun. n. sp. *Sw. Holstein.*
11. „ minuta Bréb. *Sw. Schleswig.*
12. „ ovalis Ehrbg. *Brw. Schleswig.*

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13. Surirella Brightwellii Sm. *Brw. Holstein.*
14. „ fastuosa Ehrbg. *Seew. S.-Amerika.*

4. 1. Campylodiscus noricus Ehrbg. *Sw. Oesterreich.*
2. „ latus Shadbolt. *Seew. Australien.*
3. „ Echineis Ehrbg. *Fossil. Australien.*
4. „ Clypeus Ehrbg. *Fossil. Eger.*
5. „ ornatus Grev. *Seew. Samoa.*
6. „ limbatus Bréb. *Seew. S.-Amerika.*
7. „ spiralis Sm. *S. Sw. Norwegen.*
8. „ „ „ *H.*
9. Cymatopleura Solea Sm. *S. Sw. Holstein.*
10. „ „ „ *H.*
11. „ elliptica Bréb. *Sw. Holstein.*
12. „ „ var. hibernica. *Fossil. Lüneburg.*
13. Euphyllodium spathulatum Shadbolt. *Seew. Australien.*
14. Podocystis adriatica Kg. *Seew. Italien.*

Nitzschieae.

5. 1. Nitzschia circumsuta (Bailey) Grun. *Fossil. Schweden.*
2. „ Formica Hantzsch. *Seew. S.-Amerika.*
3. „ hungarica Grun. *Brw. Schleswig.*
4. „ dubia Hantzsch. *Sw. Holstein.*
5. „ Amphioxys Sm. *S. Sw. Holstein.*
6. „ „ „ *H.*
7. „ „ „ *Th.*
8. „ scalaris (Ehrbg.) Sm. *Sw. Schweden.*
9. „ Sigma Sm. *Brw. Ostfriesland.*
10. „ sigmatella Greg. *Brw. Schleswig.*
11. „ linearis Sm. *Sw. Preussen.*
12. „ obtusa Sm. *Sw. Frankreich.*
13. „ sigmoidea Sm. *Sw. Schlesien.*
14. „ spectabilis (Ehrbg.) Ralfs. *Fossil. Franzensbad.*

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15. Stenopterobia anceps (Lewis) Bréb. *Fossil. N.-Ameriha.*
16. Homoeocladia Martiniana Ag. *Seew. Dalmatien.*

6. 1. Tryblionella Hantzschiana Grun. *Brw. Schleswig.*
2. „ Victoriae Grun. var. *Fossil. Australien.*
3. „ punctata Sm. *Brw. Jütland.*
4. „ acuminata Sm. *Seew. Ostfriesland.*
5. Denticula frigida Kg. *Sw. Sachsen.*

Amphipleureae.

6. Amphipleura pellucida Kg. *Sw. Oesterreich.*

Cocconeideae.

7. Campyloneis Grevillii var. Argus Grun. *Seew. Japan.*
8. „ regala var. parva Grun. *Seew. N.-Seeland.*
9. Orthoneis fimbriata (Brightwell) Grun. *Seew. Australien.*
10. „ splendida (Greg.) Grun. *Seew. Japan.*
11. Cocconeis Scutellum Ehrbg. *Seew. Holstein.*
12. „ „ var. stauroneiformis Sm. *Seew. Ostsee.*
13. „ Placentula Ehrbg. *Sw. Holstein.*
14. „ „ forma maxima. *Seew. Holstein.*
15. „ Pediculus Ehrbg. *Sw. Holstein.*
16. „ dirupta Greg. *OS. Seew. England.*
17. „ „ „ *US.*
18. „ pseudomarginata Greg. *Seew. Capri.*
19. „ „ var. tropica Grun. *Seew. Japan.*
20. „ pellucida Grun. *Seew. Japan.*
21. Mastogloia Braunii Grun. var. *S. Seew. Rügen.*
22. „ „ „ „ *H.*
23. „ „ „ „ *Th.*

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24. Mastogloia Meleagris Kg. var. *S. Brw. Tromsö.*
25. „ „ „ „ *H.*
26. „ marginulata Grun. var. *S. Seew. Australien.*
27. „ „ „ „ *H.*
28. „ exigua Lew. *Seew. Ostfriesland.*
29. „ Dansei Thw. *Fossil. Australien.*

Achnantheae.

III. 1. 1. Achnanthes subsessilis Kg. *OS. Seew. Holstein.*
2. „ „ „ *US.*
3. „ „ „ *H.*
4. „ brevipes Ag. *Seew. Frankreich.*
5. „ longipes Ag. *OS. Seew. Dalmatien.*
6. „ „ „ *US.*
7. „ „ „ *H.*
8. „ inflata Grun. *S. Fossil. Australien.*
9. „ „ „ *H.*
10. Cymbosira Agardhii Kg. *Seew. S.-Amerika.*
11. Achnanthidium flexellum Bréb. *OS. Sw. Holstein.*
12. „ „ „ *US.*
13. „ lanceolatum Bréb. *S. Sw. Holstein.*
14. „ „ „ *H.*
15. Rhoicosphenia curvata Grun. *Sw. Holstein.*
16. Rhoiconeis genuflexa (Kg.) Grun. *Seew. Afrika.*
17. Eupleuria pulchella Arnott. *Seew. New-Seeland.*
18. „ Telfairii Arnott. *Seew. Afrika.*
19. „ media Arnott. *OS. Seew. Californien.*
20. „ „ „ *US.*
21. „ „ „ *H.*

Cymbelleae.

2. 1. Cymbella Ehrenbergii Kg. *Fossil. N.-Amerika.*
2. „ heteropleura Ehr. *Fossil. Norwegen.*

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3. Cymbella amphicephala Nägl. *Sw. Holstein.*
4. „ cuspidata Kg. *Fossil. Lüneburg.*
5. „ Navicula Ehrbg. *Sw. Lappland.*
6. „ ventricosa Kg. *Sw. Schweiz.*
7. „ affinis Kg. var. *Sw. Holstein.*
8. „ helvetica Kg *Sw. Norwegen.*
9. „ gastroides Kg. *Fossil. Lüneburg.*
10. „ Kamtschatica Grun. *Fossil. Kamtschatka.*
11. Cocconema lanceolatum Ehrbg. *Sw. Holstein.*
12. „ Cistula Ehrbg. *Sw. Holstein.*
13. „ scotica Sm. *Sw. Deutschland.*
14. Encyonema paradoxum Kg. forma maxima. *Sw. St. Gallen.*
15. Amphora ovalis Kg. *Sw. Holstein.*
16. „ Proteus Greg. *S. Fossil. N.-Amerika.*
17. „ „ „ *H.*

Gomphonemeae.

18. Gomphonema acuminatum Ehrbg. var. coronatum. *S. Sw. Holstein.*
19. „ „ „ var. coronatum. *H.*
20. „ „ „ „ „ *Th.*
21. „ capitatum Ehrbg. *Sw. Holstein.*
22. „ robustum Grun. n. sp. *Sw. New-York.*
23. „ dichotomum Kg. *Sw. Holstein.*
24. „ „ var. trigibbum. Eul. *Sw. Norwegen.*
25. „ commune Rabh. *Sw. Holstein.*
26. „ geminatum Ag. *S. Sw. Schweden.*
27. „ „ „ *H.*
28. „ „ „ *Th.*

Naviculaceae.

3. 1. Navicula divergens Sm. var. *Fossil. Norwegen.*
2. „ „ „ „ *Fossil. Norwegen.*

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3. Navicula nobilis Kg. *Fossil. Preussen.*
4. „ viridis Kg. *Sw. Holstein.*
5. „ major Kg. *S. Sw. Holstein.*
6. „ „ „ *H.*
7. „ acuminata Sm. *Sw. Thüringen.*
8. „ hemiptera Kg. var. *Sw. Schweiz.*
9. „ Brebissonii Kg. *Sw. Holstein.*
10. „ lata Bréb. *S. Sw. Sächs. Schweiz.*
11. „ „ „ *H.*
12. „ foederata Grun. *Fossil. N.-Amerika.*
13. „ hebes Ralfs. *Fossil. Norwegen.*
14. „ borealis Kg. *Sw. Holstein.*
15. „ gibba Kg. *Sw. Holstein.*
16. „ „ „ var. *Sw. Holstein.*
17. „ mesolepta var. stauroneiformis Grun. *Sw. Holstein.*
18. „ interrupta Sm. *Sw. Holstein.*
19. „ oblonga Kg. *Sw. Holstein.*
20. „ peregrina (Ehrbg.?) Sm. *Seew. Kiel*
21. „ radiosa Kg. *Sw. Ungarn.*

4. 1. „ Lyra Ehrbg. *Seew. Holstein.*
2. „ „ „ var. *Seew. Holstein.*
3. „ „ „ var. *Seew. S.-Amerika.*
4. „ elliptica Kg. *Sw. Norwegen.*
5. „ didyma Kg. *Seew. Schleswig.*
6. „ Entomon Ehrbg. *Seew. Mittelmeer.*
7. „ quadrata Greg. *Seew. Holstein.*
8. „ crassa Greg. *Seew. Holstein.*
9. „ elegans Sm. *Brw. Tromsö.*
10. „ Firma Kg. *Sw. Holstein.*
11. „ „ var. affinis Ehrbg. *Sw. Holstein.*
12. „ „ var. amphirynchus Ehrbg. *Sw. Holstein.*
13. „ „ var. dilatata Ehrbg. *Fossil. N.-Amerika.*

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14. Navicula Firma var. latissima Ehrbg. *Fossil. N.-Amerika.*
15. „ „ var. Hitschcockii Ehrbg. *Fossil. N.-Amerika.*
16. „ permagna Bailey var. *Sw. Holstein.*
17. „ amphisbaena Kg. *Sw. Schlesien.*
18. „ „ var β Sm. *Brw. Schleswig.*
19. „ sphaerophora (Kg.?) Sm. *Sw. Holstein.*
20. „ slesvicensis Grun. *Sw. Holstein.*
21. „ Rheinhardtii Grun. *Sw. Holstein.*
22. „ retusa Bréb. *Seew. England.*
23. „ quinquenodis Grun. *Sw. Dresden.*
24. „ limosa Kg. *Sw. Holstein.*
25. „ sculpta Ehrbg. *Fossil. Eger.*
26. „ bohemica Ehrbg. *Fossil. Eger.*
27. „ serians Kg. *Sw. Holstein.*
28. „ ambigua (Ehrbg.) Sm. *Sw. Holstein.*
29. „ rhomboides Ehrbg. *Fossil. N.-Amerika.*
30. „ crassinervis Bréb. *Sw. Holstein.*

5. 1. Scoliopleura convexa Grun. *Seew. Frankreich.*
2. „ tumida (Bréb.) Rabh. *Brw. Schleswig.*
3. Pleurosigma balticum Sm. *Brw. Frankreich.*
4. „ attenuatum Sm. *Sw. Norwegen.*
5. „ Hippocampus Sm. *Brw. Schleswig.*
6. „ acuminatum (Kg.) Grun. *Sw. Holstein.*
7. „ rhombeum Grun. *Seew. Samoa.*
8. „ naviculaceum Bréb. *Seew. Samoa.*
9. „ strigosum Sm. *Seew. Helgoland.*
10. „ angulatum Sm. *Brw. Schleswig.*
11. „ quadratum Sm. *Brw. Frankreich.*
12. „ formosum Sm. *Seew. Samoa.*

6. 1. Pleurostaurum Frauenfeldianum Grun. *Fossil. Java.*
2. „ javanicum Grun. *Fossil. Java.*

3. Pleurostaurum acutum Rabh. var. *Fossil. N.-Amerika.*
4. Stauroneis Moelleriana Grun. n. sp. *Sw. Holstein.*
5. „ phoenicenteron Ehrbg. *Sw. Holstein.*
6. „ gracilis Ehrbg. *Sw. Holstein.*
7. Endosigma eximum (Thw.) Bréb. *Brw. Holstein.*
8. Endostaurum crucigerum (Sm.) Bréb. *S. Seew. Schleswig.*
9. „ „ „ „ *H.*
10. Colletonema vulgare Thw. *Sw. Holstein.*
11. Schizonema Grevillei Ag. *Seew. Schleswig.*
12. Doryphora Boeckii Sm. *Seew. Holstein.*
13. „ amphiceros Kütz. *Brw. Cuxhaven.*
14. Donkinia recta (Donk) Ralfs. *Seew. England.*
15. Toxonidea insignis Donk. *Seew. England.*
16. Amphiprora alata Kg. *S. Brw. Schleswig.*
17. „ „ „ *H.*
18. „ elegans Sm. *Seew. Holstein.*

Isthemieae.

IV. 1. 1. Isthmia enervis Ehrbg. *Seew. Nordsee.*
2. „ nervosa Ehrbg. *Seew. Californien.*

Biddulphieae.

3. Biddulphia pulchella Gray. *S. Seew. Tongatabu.*
4. „ „ „ *H.*
5. „ Roperiana Grev. *S. Seew. Australien.*
6. „ „ „ *H.*
7. „ aurita Bréb. *Peru-Guano.*
8. „ reticulata Roper. *Seew. Australien.*
9. „ Baileyii Roper. *Seew. Cuxhaven.*
10. „ Rhombus Sm. *Seew. Cuxhaven.*
11. Cerataulus turgidus Ehr. var. *Seew. Australien.*
12. „ Smithii Bréb. *Seew. Cuxhaven.*

2. 1. Euodia gibba Bail. var. *Fossil. Spanien.*
2. „ Frauenfeldii Grun. *Seew. Australien.*
3. Corinna elegans Heib. *S. Fossil. Jütland.*
4. „ „ „ *H.*
5. Triceratium Favus Ehrbg. *Seew. Holstein.*
6. „ fimbriatum Brightwell var. *Seew. Australien.*
7. „ alternans Ehr. *Peru-Guano.* —
8. „ striolatum Ehrbg. *Seew. Cuxhaven.*
9. „ antediluvianum Ehrbg. *Seew. Holstein.*
10. „ pentacrinus Wallich. *Seew. Australien.*
11. Trinacria Regina Heib. *Fossil. Jütland.*
12. „ excavata Heib. *Fossil. Jütland.*
13. Solium exculptum Heib. *S. Fossil. Jütland.*
14. „ „ „ *H.*

3. 1. Goniothecium danicum Grun. *Fossil. Jütland.*
2. Hemiaulus Polycystinorum Ehrbg. *Fossil. Barbados.*
3. „ alatus Grev. *Fossil. Barbados.*

Eupodisceae.

4. Actinocyclus Ralfsii Sm. *Seew. Cuxhaven.*
5. „ dubius Grun. *Fossil. Australien.*
6. Auliscus sculptus (Sm.) Ralfs. *Seew. Cuxhaven.*
7. „ macraeanus Grev. var. *Seew. Australien.*
8. Aulacodiscus Crux Ehrbg. *Peru-Guano.*
9. Eupodiscus Argus var. 5 app. *Seew. Cuxhaven.*
10. „ „ „ 4 app.
11. „ „ „ 3 app.
12. „ radiatus Bailey. *Seew. S.-Amerika.*

Melosireae.

4. 1. Odontodiscus subtilis (Ehrbg.) Grun. *Brw. Holstein.*
2. „ eccentricus Ehrbg. *Seew. Holstein.*
3. Systephania Diadema Ehrbg. *Fossil. N.-Amerika.*
4. „ Corona Ehrbg. *Fossil. N.-Amerika.*

5. Peristephania Eutycha Ehrbg. (?) *Fossil. Spanien.*
6. Stephanopyxis appendiculata Ehrbg *S. Fossil. Jütland.*
7. „ „ „ *H.*
8. Endyctia oceanica Ehrbg. *Peru-Guano.*
9. Arachnoidiscus ornatus Ehrbg. *Seew. Japan.*
10. Cestodiscus ovalis Ehrbg. *Fossil. Spanien.*
11. Coscinodiscus minor Ehrbg. var. *Fossil. Nankoori.*
12. „ radiatus Ehrbg. *Seew. Holstein.*
13. „ Oculus Iridis Ehrbg. *Fossil. Jütland.*

5. 1. Craspepodiscus Coscinodiscus Ehrbg. *Fossil. Nankoori.*
2. Actinoptychus Halionyx Grun. *Peru-Guano.*
3. „ splendens (Shadbolt) Ralfs. *Seew. Holstein.*
4. „ Heliopelta Grun. *Fossil. N.-Amerika.*
5. „ undulatus Ehrbg. *Seew. Holstein.*
6. „ areolatus Ehrbg. *Peru-Guano.*
7. Asteromphalus Ralfsianus (Norm.) Grun. *Peru-Guano.*
8. „ Arachne (Bréb.) *Peru-Guano.*
9. Stephanogonia danica Grun. *Fossil. Jütland.*
10. Stictodiscus angulatus Grun. *Fossil. Jütland.*
11. Pyxidicula cruciata Ehrbg. *Fossil. Jütland.*
12. Hyalodiscus stelliger Bailey. *Seew. Californien.*
13. „ subtilis Bailey. *Seew. Californien.*
14. Symbolophora Trinitatis Ehrbg. var. *Fossil. Jütland.*

6. 1. Discoplea sinensis Ehrbg. var. *Fossil. Australien.*
2. Podosira maculata Sm. *Seew. Holstein.*
3. „ nummuloides Ehrbg. var. *Seew. Australien.*
4. Cyclotella Meneghiniana Kg. *Sw. Holstein.*
5. „ minutula Kg. *Fossil. Lüneburg.*
6. „ affinis Grun. *Fossil. N.-Amerika.*
7. „ striata Grun. *Brw. Holstein.*

8. Cyclotella operculata var. maxima Grun. *Fossil. Hannover.*
9. „ Astrea Ehrbg. *Fossil. Lüneburg.*
10. „ „ var. Carconensis Eul. *Fossil. Californien.*
11. „ (Melosira) radiata Brightwell. *Seew. Californien.*
12. Orthosira solida Eul. *Fossil. Californien.*
13. Melosira Borrerii Grev. *S. Seew. Schleswig.*
14. „ „ „ *H.*
15. „ nummuloides Dillw. *Seew. Ostfriesland.*
16. „ crenulata Kg. *Sw. Holstein.*
17. „ distans Kg. *Fossil. Böhmen.*
18. „ varians Kg. *Sw. Holstein.*
19. „ punctata Kg. var. *Fossil. Hannover.*
20. „ arenaria Moore. *Sw.*
21. „ sulcata Kg. *S. Peru-Guano.*
22. „ „ „ *H.*

Chaetocereae.

23. Chaetoceras didymum Ehrbg. *Peru-Guano.*
24. Dicladia Capreolus Ehrbg. *Peru-Guano.*
25. Syndendrium Diadema Ehrbg. *Peru-Guano.*

Wedel in Holstein, März 1874.

J. D. MÖLLER, Präparator.

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Achnanthes brevipes	Ag.	Achnantheae	3.	I.	4.		Marine		Frankreich
Achnanthes inflata	Grun.	Achnantheae	3.	I.	8.	Valve		Fossil	Australien
Achnanthes inflata	Grun.	Achnantheae	3.	I.	9.	Principal-View			Australien
Achnanthes longipes	Ag.	Achnantheae	3.	I.	5.	O.Valve	Marine		Dalmatien
Achnanthes longipes	Ag.	Achnantheae	3.	I.	6.	U.Valve			Dalmatien
Achnanthes longipes	Ag.	Achnantheae	3.	I.	7.	Principal-View			Dalmatien
Achnanthes subsessilis	Kg.	Achnantheae	3.	I.	1.	O.Valve	Marine		Holstein
Achnanthes subsessilis	Kg.	Achnantheae	3.	I.	2.	U.Valve			Holstein
Achnanthes subsessilis	Kg.	Achnantheae	3.	I.	3.	Principal-View			Holstein
Achnathidium flexellum	Breb.	Achnantheae	3.	I.	11.	O.Valve	Freshwater		Holstein
Achnathidium flexellum	Breb.	Achnantheae	3.	I.	12.	U.Valve			Holstein
Achnathidium lanceolatum	Breb.	Achnantheae	3.	I.	13.	Valve	Freshwater		Holstein
Achnathidium lanceolatum	Breb.	Achnantheae	3.	I.	14.	Principal-View			Holstein
Actinocyclus dubius	Grun.	Eupodisceae	4.	III.	5.			Fossil	Australien
Actinocyclus Ralfsii	Sm.	Eupodisceae	4.	III.	4.		Marine		Cuxhaven
Actinoptychus areolatus	Ehrbg.	Melosireae	4.	V.	6.				Peru-Guano
Actinoptychus Halionyx	Grun.	Melosireae	4.	V.	2.				Peru-Guano
Actinoptychus Heliopelta	Grun.	Melosireae	4.	V.	4.			Fossil	N.-Amerika
Actinoptychus splendens	(Shadbolt) Ralfs	Melosireae	4.	V.	3.		Marine		Holstein
Actinoptychus undulatus	Ehrbg.	Melosireae	4.	V.	5.		Marine		Holstein
Amphipleura pellucida	Kg.	Amphipleureae	2.	VI.	6.		Freshwater		Oesterreich
Amphiprora alata	Kg.	Naviculaceae	3.	VI.	16.	Valve	Brackish		Schleswig
Amphiprora alata	Kg.	Naviculaceae	3.	VI.	17.	Principal-View			Schleswig
Amphiprora elegans	Sm.	Naviculaceae	3.	VI.	18.		Marine		Holstein
Amphora ovalis	Kg.	Cymbelleae	3.	II.	15.		Freshwater		Holstein
Amphora Proteus	Greg.	Cymbelleae	3.	II.	16.	Valve		Fossil	N.-Amerika
Amphora Proteus	Greg.	Cymbelleae	3.	II.	17.	Principal-View			N.-Amerika
Arachnoidiscus ornatus	Ehrbg.	Melosireae	4.	IV.	9.		Marine		Japan
Asteromphalus Arachne	(Breb.)	Melosireae	4.	V.	8.				Peru-Guano
Asteromphalus Ralfsianus	(Norm.) Grun.	Melosireae	4.	V.	7.				Peru-Guano
Aulacodiscus Crux	Ehrbg.	Eupodisceae	4.	III.	8.				Peru-Guano
Auliscus macraeanus	Grev. var.	Eupodisceae	4.	III.	7.		Marine		Cuxhaven
Auliscus sculptus	(Sm.) Ralfs	Eupodisceae	4.	III.	6.		Marine		Cuxhaven

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Biddulphia aurita	Breb	Biddulphieae	4.	I.	7.				Peru-Guano
Biddulphia Baileyii	Roper	Biddulphieae	4.	I.	9.		Marine		Cuxhaven
Biddulphia pulchella	Gray	Biddulphieae	4.	I.	3.	Valve	Marine		Tongatabu
Biddulphia pulchella	Gray	Biddulphieae	4.	I.	4.	Principal-View			Tongatabu
Biddulphia reticulata	Roper	Biddulphieae	4.	I.	8.		Marine		Australien
Biddulphia Rhombus	Sm.	Biddulphieae	4.	I.	10.		Marine		Cuzhaven
Biddulphia Roperiana	Grev.	Biddulphieae	4.	I.	5.	Valve	Marine		Australien
Biddulphia Roperiana	Grev.	Biddulphieae	4.	I.	6.	Principal-View			Australien
Campylodiscus Clypeus	Ehrbg.	Surirelleae	2.	IV.	4.			Fossil	Eger
Campylodiscus Echineis	Ehrbg.	Surirelleae	2.	IV.	3.			Fossil	Australien
Campylodiscus latus	Shadbolt	Surirelleae	2.	IV.	2.		Marine		Australien
Campylodiscus limbatus	Breb.	Surirelleae	2.	IV.	6.		Marine		S.-Amerika
Campylodiscus noricus	Ehrbg.	Surirelleae	2.	IV.	1.		Freshwater		Oesterreich
Campylodiscus ornatus	Grev.	Surirelleae	2.	IV.	5.		Marine		Samoa
Campylodiscus spiralis	Sm.	Surirelleae	2.	IV.	7.	Valve	Freshwater		Norwegen
Campylodiscus spiralis	Sm.	Surirelleae	2.	IV.	8.	Principal-View			Norwegen
Campyloneis Grevillii var. *Argus*	Grun.	Cocconeideae	2.	VI.	7.		Marine		Japan
Campyloneis regala var. *parva*	Grun.	Cocconeideae	2.	VI.	8.		Marine		N.-Seeland
Cerataulus Smithii	Breb.	Biddulphieae	4.	I.	12.		Marine		Cuxhaven
Cerataulus turgidus	Ehr. var.	Biddulphieae	4.	I.	11.		Marine		Australien
Ceratoneis Arcus	Kg.	Epithemieae	1.	II.	8.		Freshwater		Norwegen
Ceratoneis lunaris	(Ehrbg.) Grun.	Epithemieae	1.	II.	7.		Freshwater		Holstein
Cestodiscus ovalis	Ehrbg.	Melosireae	4.	IV.	10.			Fossil	Spanien
Chaetoceros didymum	Ehrbg.	Chaetocereae	4.	VI.	23.				Peru-Guano
Climacosira mirifica	Grun.	Tabellarieae	2.	I.	21.		Marine		Japan
Climacosphenia moniligera	Ehrbg.	Meridioneae	1.	II.	9.	Valve	Marine		Afrika
Climacosphenia moniligera	Ehrbg.	Meridioneae	1.	II.	10.	Principal-View			Afrika
Cocconeis dirupta	Greg.	Cocconeideae	2.	VI.	16.	O.Valve	Marine		England
Cocconeis dirupta	Greg.	Cocconeideae	2.	VI.	17.	U.Valve			England
Cocconeis Pediculus	Ehrbg.	Cocconeideae	2.	VI.	15.		Freshwater		Holstein
Cocconeis pellucida	Grun	Cocconeideae	2.	VI.	20.		Marine		Japan
Cocconeis Placentula	Ehrbg.	Cocconeideae	2.	VI.	13.		Freshwater		Holstein

Specie	**Authority**	**Family**	**Block**	**Row**	**Position in Row**	**View**	**Habitat**	**Fossil or Recent**	**Source**
Cocconeis Placentula forma maxima		Cocconeideae	2.	VI.	14.		Marine		Holstein
Cocconeis pseudomarginata	Greg.	Cocconeideae	2.	VI.	18.		Marine		Capri
Cocconeis pseudomarginata var. *tropica*	Grun.	Cocconeideae	2.	VI.	19.		Marine		Japan
Cocconeis Scutellum	Ehrbg.	Cocconeideae	2.	VI.	11.		Marine		Holstein
Cocconeis Scutellum var. *stauroneiformis*	Sm.	Cocconeideae	2.	VI.	12.		Marine		Ostsee
Cocconema Cistula	Ehrbg.	Cymbelleae	3.	II.	12.		Freshwater		Holstein
Cocconema lanceolatum	Ehrbg.	Cymbelleae	3.	II.	11.		Freshwater		Holstein
Cocconema scotica	Sm.	Cymbelleae	3.	II.	13.		Freshwater		Deutschland
Colletonema vulgare	Thw.	Naviculaceae	3.	VI.	10.		Freshwater		Holstein
Corrina elegans	Heib.	Biddulphieae	4.	II.	3.	Valve		Fossil	Jutland
Corrina elegans	Heib.	Biddulphieae	4.	II.	4.	Principal-View			Jutland
Coscinodiscus minor	Ehrbg. var.	Melosireae	4.	IV.	11.			Fossil	Nankoori
Coscinodiscus Oculus Iridis	Ehrbg.	Melosireae	4.	IV.	13.			Fossil	Jutland
Coscinodiscus radiatus	Ehrbg.	Melosireae	4.	IV.	12.		Marine		Holstein
Crapedodiscus Coscinodiscus	Ehrbg.	Melosireae	4.	V.	1.			Fossil	Nankoori
Cyclotella (Melosira) radiata	Brightwell	Melosireae	4.	VI.	11.		Marine		Californien
Cyclotella affinis	Grun.	Melosireae	4.	VI.	6.			Fossil	N.-Amerika
Cyclotella Astrea	Ehrbg.	Melosireae	4.	VI.	9.			Fossil	Luneburg
Cyclotella Astrea var. *Carconensis*	Eul.	Melosireae	4.	VI.	10.			Fossil	Californien
Cyclotella Meneghiniana	Kg.	Melosireae	4.	VI.	4.		Freshwater		Holstein
Cyclotella minutula	Kg.	Melosireae	4.	VI.	5.			Fossil	Luneburg
Cyclotella operculata var. *maxima*	Grun.	Melosireae	4.	VI.	8.			Fossil	Hannover
Cyclotella striata	Grun.	Melosireae	4.	VI.	7.		Brackish		Holstein
Cymatopleura elliptica	Breb.	Surirelleae	2.	IV.	11.		Freshwater		Holstein
Cymatopleura ellitptica var hibernica		Surirelleae	2.	IV.	12.			Fossil	Lunenurg
Cymatopleura Solea	Sm.	Surirelleae	2.	IV.	9.	Valve	Freshwater		Holstein
Cymatopleura Solea	Sm.	Surirelleae	2.	IV.	10.	Principal-View			Holstein
Cymbella affinis	Kg. var.	Cymbelleae	3.	II.	7.		Freshwater		Holstein
Cymbella amphicephala	Nagl.	Cymbelleae	3.	II.	3.		Freshwater		Holstein
Cymbella cuspidata	Kg.	Cymbelleae	3.	II.	4.			Fossil	Luneburg
Cymbella Ehrenbergii	Kg.	Cymbelleae	3.	II.	1.			Fossil	N.-Amerika

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Cymbella gastroides	Kg.	Cymbelleae	3.	II.	9.			Fossil	Luneburg
Cymbella helvetica	Kg.	Cymbelleae	3.	II.	8.		Freshwater		Norwegen
Cymbella heteropleura	Ehr.	Cymbelleae	3.	II.	2.			Fossil	Norwegen
Cymbella Kamtschatica	Grun.	Cymbelleae	3.	II.	10.			Fossil	Kamtschatka
Cymbella Navicula	Ehrbg.	Cymbelleae	3.	II.	5.		Freshwater		Lappland
Cymbella ventricosa	Kg.	Cymbelleae	3.	II.	6.		Freshwater		Schweiz
Cymbosira Agardhii	Kg.	Achnantheae	3.	I.	10.		Marine		S.-Amerika
Denticula frigida	Kg.	Nitzschieae	2.	VI.	5.		Freshwater		Sachsen
Diatoma elongatum	Kg.	Meridioneae	1.	III.	14.		Freshwater		Schweiz
Diatoma vulgare	Bory	Meridioneae	1.	III.	10.		Freshwater		Franken
Diatoma vulgare var. *lineare*	Sm.	Meridioneae	1.	III.	11.	Valve	Freshwater		Holstein
Diatoma vulgare var. *lineare*	H.	Meridioneae	1.	III.	12.				Holstein
Diatoma vulgare var. *lineare*	Th.	Meridioneae	1.	III.	13.				Holstein
Diatomella Balfouriana	Grev.	Tabellarieae	2.	I.	1.		Freshwater		Mahren
Dicladia Capreolus	Ehrbg.	Chaetocereae	4.	VI.	24.				Peru-Guano
Discoplea sinensis	Ehrbg. var.	Melosireae	4.	VI.	1.			Fossil	Jutland
Donkinia recta	(Donk.) Ralfs	Naviculaceae	3.	VI.	14.		Marine		England
Doryphora amphiceros	Kutz.	Naviculaceae	3.	VI.	13.		Brackish		Cuxhaven
Doryphora Boeckii	Sm.	Naviculaceae	3.	VI.	12.		Marine		Holstein
Encyonema paradoxum	Kg. forma maxima	Cymbelleae	3.	II.	14.		Freshwater		St. Gallen
Endosigma eximum	(Thw.) Breb.	Naviculaceae	3.	VI.	7.		Brackish		Holstein
Endostaurum crucigerum	(Sm.) Breb.	Naviculaceae	3.	VI.	8.	Valve	Marine		Schleswig
Endostaurum crucigerum	(Sm.) Breb.	Naviculaceae	3.	VI.	9.	Principal-View			Schleswig
Endyctia oceanica	Ehrbg.	Melosireae	4.	IV.	8.				Peru-Guano
Epithemia Argus	Sm.	Epithemieae	1.	I.	17.	Valve	Freshwater		Norwegen
Epithemia Argus	Sm.	Epithemieae	1.	I.	18.	Principal-View			Norwegen
Epithemia constricta	Sm.	Epithemieae	1.	I.	14.	Valve	Brackish		Schleswig
Epithemia constricta	Sm.	Epithemieae	1.	I.	15.	Principal-View			Schleswig
Epithemia gibba	Kg.	Epithemieae	1.	I.	9.	Valve	Freshwater		Holstein
Epithemia gibba	Kg.	Epithemieae	1.	I.	10.	Principal-View			Holstein
Epithemia granulata	Kg.	Epithemieae	1.	I.	4.			Fossil	N.-Amerika
Epithemia Hyndmannii	Sm.	Epithemieae	1.	I.	7.			Fossil	Luneburg
Epithemia musculus	Kg.	Epithemieae	1.	I.	16.		Marine		Upolu

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Epithemia ocellata var.	Kg.	Epithemieae	1.	I.	19.			Fossil	N.-Amerika
Epithemia Sorex	Kg.	Epithemieae	1.	I.	8.		Brackish		Schleswig
Epithemia turgida	Kg.	Epithemieae	1.	I.	1.	Valve	Freshwater		Holstein
Epithemia turgida	Kg.	Epithemieae	1.	I.	2.	Principal-View			Holstein
Epithemia turgida	Kg.	Epithemieae	1.	I.	3.	Binary-Subdivision			Holstein
Epithemia ventricosa	Kg.	Epithemieae	1.	I.	11.		Brackish		Schleswig
Epithemia Westermannii	Kg.	Epithemieae	1.	I.	5.	Principal-View	Brackish		Mecklenburg
Epithemia Westermannii	Kg.	Epithemieae	1.	I.	6.	Binary-Subdivision			Mecklenburg
Epithemia Zebra	Kg.	Epithemieae	1.	I.	12.	Valve	Freshwater		Holstein
Epithemia Zebra	Kg.	Epithemieae	1.	I.	13.	Principal-View			Holstein
Eunotia didyma	Grun.	Epithemieae	1.	II.	1.				Ostindien
Eunotia Formica	Ehrbg.	Epithemieae	1.	I.	21.			Fossil	M.-Amerika
Eunotia incisa	Greg.	Epithemieae	1.	I.	20.			Fossil	Norwegen
Eunotia indica	Grun.	Epithemieae	1.	I.	22.			Fossil	N.-Amerika
Eunotia Kurziana	Grun	Epithemieae	1.	II.	2.				Ostindien
Eunotia praerupta	Ehrbg.	Epithemieae	1.	I.	23.			Fossil	N.-Amerika
Eunotia Soleirolii	(Kg.)	Epithemieae	1.	II.	6.		Freshwater		Sachsen
Eunotia tetraodon	Ehrbg.	Epithemieae	1.	I.	24.			Fossil	Norwegen
Eunotia tetraodon var. *Diadema*		Epithemieae	1.	I.	27.	Valve		Fossil	Norwegen
Eunotia tetraodon var. *Diadema*		Epithemieae	1.	I.	28.	Principal-View			Norwegen
Eunotia tetraodon var. *diodon*		Epithemieae	1.	I.	25.			Fossil	Java
Eunotia tetraodon var. *triodon*		Epithemieae	1.	I.	26.			Fossil	Norwegen
Eunotia undulata	Ralfs	Epithemieae	1.	II.	3.	Valve	Freshwater		Holstein
Eunotia undulata	Ralfs	Epithemieae	1.	II.	4.	Principal-View			Holstein
Eunotia undulata	Ralfs	Epithemieae	1.	II.	5.	Binary-Subdivision			Holstein
Euodia Frauenfeldii	Grun.	Biddulphieae	4.	II.	2.		Marine		Australien
Euodia gibba	Bail. var.	Biddulphieae	4.	II.	1.			Fossil	Spanien
Euphyllodium spathulatum	Shadbolt	Surirelleae	2.	IV.	13.		Marine		Australien
Eupleuria media	Arnott	Achnantheae	3.	I.	19.	O.Valve	Marine		Californien
Eupleuria media	Arnott	Achnantheae	3.	I.	20.	U.Valve			Californien
Eupleuria media	Arnott	Achnantheae	3.	I.	21.	Principal-View			Californien
Eupleuria pulchella	Arnott	Achnantheae	3.	I.	17.		Marine		New-Seeland
Eupleuria Telfairii	Arnott	Achnantheae	3.	I.	18.		Marine		Afrika
Eupodiscus Argus var. *3 app.*		Eupodisceae	4.	III.	11.		Marine		Cuxhaven
Eupodiscus Argus var. *4 app.*		Eupodisceae	4.	III.	10.		Marine		Cuxhaven
Eupodiscus Argus var. *5 app.*		Eupodisceae	4.	III.	9.		Marine		Cuxhaven

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Eupodiscus radiatus	Bailey	Eupodisceae	4.	III.	12.		Marine		S.-Amerika
Fragilaria capucina	Desm.	Meridioneae	1.	V.	4.		Freshwater		Holstein
Fragilaria sp.		Meridioneae	1.	V.	6.		Freshwater		Ostfriesland
Fragilaria Ungeriana	Grun.	Meridioneae	1.	V.	5.		Freshwater		Cypern
Fragilaria virescens	Ralfs	Meridioneae	1.	V.	3.		Freshwater		Holstein
Gomphogramma rupestre	A.Braun	Tabellarieae	2.	I.	2.		Freshwater		Mahren
Gomphonema acuminatum	Ehrbg. var coronatum	Gomphonemeae	3.	II.	18.	Valve	Freshwater		Holstein
Gomphonema acuminatum	Ehrbg. var coronatum	Gomphonemeae	3.	II.	19.	Principal-View			Holstein
Gomphonema acuminatum	Ehrbg. var coronatum	Gomphonemeae	3.	II.	20.	Binary-Subdivision			Holstein
Gomphonema capitatum	Ehrbg.	Gomphonemeae	3.	II.	21.		Freshwater		Holstein
Gomphonema commune	Rabh.	Gomphonemeae	3.	II.	25.		Freshwater		Holstein
Gomphonema dichotomum	Kg.	Gomphonemeae	3.	II.	23.		Freshwater		Holstein
Gomphonema dichotomum var. *trigibbum*	Eul.	Gomphonemeae	3.	II.	24.		Freshwater		Norwegen
Gomphonema geminatum	Ag.	Gomphonemeae	3.	II.	26.	Valve	Freshwater		Schweden
Gomphonema geminatum	Ag.	Gomphonemeae	3.	II.	27.	Principal-View			Schweden
Gomphonema geminatum	Ag.	Gomphonemeae	3.	II.	28.	Binary-Subdivision			Schweden
Gomphonema robustum	Grun. n.sp.	Gomphonemeae	3.	II.	22.		Freshwater		New-York
Goniothecium danicum	Grun.	Biddulphieae	4.	III.	1.			Fossil	Jutland
Grammatophora angulosa	Grev. var.	Tabellarieae	2.	I.	16.		Marine		Califorien
Grammatophora marina	(Kg.)Sm.	Tabellarieae	2.	I.	12.	Valve	Marine		Gibraltar
Grammatophora marina	(Kg.)Sm.	Tabellarieae	2.	I.	13.	Valve			Gibraltar
Grammatophora marina	(Kg.)Sm.	Tabellarieae	2.	I.	14.	Principal-View			Gibraltar
Grammatophora oceanica	Ehrbg.	Tabellarieae	2.	I.	15.		Marine		N.-Amerika
Hemiaulus alatus	Grev.	Biddulphieae	4.	III.	3.			Fossil	Barbados
Hemiaulus Polycystinorum	Ehrbg.	Biddulphieae	4.	III.	2.			Fossil	Barbados
Homoeocladia Martiniana	Ag.	Nitzschieae	2.	V.	16.		Marine		Dalmatien
Hyalodiscus stelliger	Bailey	Melosireae	4.	V.	12.		Marine		Californien
Hyalodiscus subtilis	Bailey	Melosireae	4.	V.	13.		Marine		Californien
Isthmia enervis	Ehrbg.	Isthemieae	4.	I.	1.		Marine		Nordsee
Isthmia nervosa	Ehrbg.	Isthemieae	4.	I.	2.		Marine		Californien
Licmophora capensis	Grun. var. californica	Meridioneae	1.	III.	7.	Valve	Marine		Californien
Licmophora capensis	Grun. var. californica	Meridioneae	1.	III.	8.	Principal-View			Californien
Mastogloia Braunii	Grun. var.	Cocconeideae	2.	VI.	21.	Valve	Marine		Rugen

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Mastogloia Braunii	Grun. var.	Cocconeideae	2.	VI.	22.	Principal-View			Rugen
Mastogloia Braunii	Grun. var.	Cocconeideae	2.	VI.	23.	Binary-Subdivision			Rugen
Mastogloia Dansei	Thw.	Cocconeideae	2.	VI.	29.			Fossil	Australien
Mastogloia exigua	Lew.	Cocconeideae	2.	VI.	28.		Marine		Ostfriesland
Mastogloia marginulata	Grun. var.	Cocconeideae	2.	VI.	26.	Valve	Marine		Australien
Mastogloia marginulata	Grun. var.	Cocconeideae	2.	VI.	27.	Principal-View			Australien
Mastogloia Meleagris	Kg. var.	Cocconeideae	2.	VI.	24.	Valve	Brackish		Tromso
Mastogloia Meleagris	Kg. var.	Cocconeideae	2.	VI.	25.	Principal-View			Tromso
Melosira arenaria	Moore	Melosireae	4.	VI.	20.		Freshwater		
Melosira Borrerii	Grev.	Melosireae	4.	VI.	13.	Valve	Marine		Schleswig
Melosira Borrerii	Grev.	Melosireae	4.	VI.	14.	Principal-View			Schleswig
Melosira crenulata	Kg.	Melosireae	4.	VI.	16.		Freshwater		Holstein
Melosira distans	Kg.	Melosireae	4.	VI.	17.			Fossil	Bohmen
Melosira nummuloides	Dillw.	Melosireae	4.	VI.	15.		Marine		Ostfriesland
Melosira punctata	Kg. var.	Melosireae	4.	VI.	19.			Fossil	Hannover
Melosira sulcata	Kg.	Melosireae	4.	VI.	21.	Valve			Peru-Guano
Melosira sulcata	Kg.	Melosireae	4.	VI.	22.	Principal-View			
Melosira varians	Kg.	Melosireae	4.	VI.	18.		Freshwater		Holstein
Meridion circulare	Ag.	Meridioneae	1.	III.	1.	Valve	Freshwater		Holstein
Meridion circulare	Ag.	Meridioneae	1.	III.	2.	Principal-View			Holstein
Meridion circulare	Ag.	Meridioneae	1.	III.	3.	Binary-Subdivision			Holstein
Meridion circulare	Ag. var.	Meridioneae	1.	III.	4.		Freshwater		Holstein
Meridion constrictum	Ralfs	Meridioneae	1.	III.	5.	Valve	Freshwater		Holstein
Meridion constrictum	Ralfs	Meridioneae	1.	III.	6.	Principal-View			Holstein
Navicula acuminata	Sm.	Naviculaceae	3.	III.	7.		Freshwater		Thuringen
Navicula ambigua	(Ehrbg.) Sm.	Naviculaceae	3.	IV.	28.		Freshwater		Holstein
Navicula amphisbaena Kg.	Sw.	Naviculaceae	3.	IV.	17.		Schlesien		Holstein
Navicula amphisbaena var. β	Sm.	Naviculaceae	3.	IV.	18.		Brackish		Schleswig
Navicula bohemica	Ehrbg.	Naviculaceae	3.	IV.	26.			Fossil	Eger
Navicula borealis	Kg.	Naviculaceae	3.	III.	14.		Freshwater		Holstein
Navicula Brebissonii	Kg.	Naviculaceae	3.	III.	9.		Freshwater		Holstein
Navicula crassa	Greg.	Naviculaceae	3.	IV.	8.		Marine		Holstein
Navicula crassinervis	Breb.	Naviculaceae	3.	IV.	30.		Freshwater		Holstein
Navicula didyma	Kg.	Naviculaceae	3.	IV.	5.		Marine		Schleswig

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Navicula divergens	Sm. var.	Naviculaceae	3.	III.	1.			Fossil	Norwegen
Navicula divergens	Sm. var.	Naviculaceae	3.	III.	2.			Fossil	Norwegen
Navicula elegans	Sm.	Naviculaceae	3.	IV.	9.		Brackish		Tromso
Navicula elliptica	Kg.	Naviculaceae	3.	IV.	4.		Freshwater		Norwegen
Navicula Entomon	Ehrbg.	Naviculaceae	3.	IV.	6.		Marine		Mittelmeer
Navicula Firma	Kg.	Naviculaceae	3.	IV.	10.		Freshwater		Holstein
Navicula Firma var. *affinis*	Ehrbg.	Naviculaceae	3.	IV.	11.		Freshwater		Holstein
Navicula Firma var. *amphirynchus*	Ehrbg.	Naviculaceae	3.	IV.	12.		Freshwater		Holstein
Navicula Firma var. *dilatata*	Ehrbg.	Naviculaceae	3.	IV.	13.			Fossil	N.-Amerika
Navicula Firma var. *latissima*	Ehrbg.	Naviculaceae	3.	IV.	14.			Fossil	N.-Amerika
Navicula Firma var.Hitschcockii	Ehrbg.	Naviculaceae	3.	IV.	15.			Fossil	N.-Amerika
Navicula foederata	Grun.	Naviculaceae	3.	III.	12.			Fossil	N.-Amerika
Navicula gibba	Kg.	Naviculaceae	3.	III.	15.		Freshwater		Holstein
Navicula gibba	Kg. var.	Naviculaceae	3.	III.	16.		Freshwater		Holstein
Navicula hebes	Ralfs	Naviculaceae	3.	III.	13.			Fossil	Norwegen
Navicula hemiptera	Kg. var.	Naviculaceae	3.	III.	8.		Freshwater		Schweiz
Navicula interrupta	Sm.	Naviculaceae	3.	III.	18.		Freshwater		Holstein
Navicula lata	Breb.	Naviculaceae	3.	III.	10.	Valve	Freshwater Sachs		Schweiz
Navicula lata	Breb.	Naviculaceae	3.	III.	11.	Principal-View			Schweiz
Navicula limosa	Kg.	Naviculaceae	3.	IV.	24.		Freshwater		Holstein
Navicula Lyra	Ehrbg.	Naviculaceae	3.	IV.	1.		Marine		Holstein
Navicula Lyra	Ehrbg. var.	Naviculaceae	3.	IV.	2.		Marine		Holstein
Navicula Lyra	Ehrbg. var.	Naviculaceae	3.	IV.	3.		Marine		S.-Amerika
Navicula major	Kg.	Naviculaceae	3.	III.	5.	Valve	Freshwater		Holstein
Navicula major	Kg.	Naviculaceae	3.	III.	6.	Principal-View			Holstein
Navicula mesolepta var. *stauroneiformis*	Grun.	Naviculaceae	3.	III.	17.		Freshwater		Holstein
Navicula nobilis	Kg.	Naviculaceae	3.	III.	3.			Fossil	Preussen
Navicula oblonga	Kg.	Naviculaceae	3.	III.	19.		Freshwater		Holstein
Navicula peregrina	(Ehrbg.?) Sm.	Naviculaceae	3.	III.	20.		Marine		Kiel
Navicula permagna	Bailey var.	Naviculaceae	3.	IV.	16.		Freshwater		Holstein
Navicula quadrata	Greg.	Naviculaceae	3.	IV.	7.		Marine		Holstein
Navicula quinquenodis	Grun.	Naviculaceae	3.	IV.	23.		Freshwater		Dresden
Navicula radioa	Kg.	Naviculaceae	3.	III.	21.		Freshwater		Ungarn
Navicula retusa	Breb.	Naviculaceae	3.	IV.	22.		Marine		England
Navicula Rheinhardtii	Grun.	Naviculaceae	3.	IV.	21.		Freshwater		Holstein
Navicula rhomboides	Ehrbg.	Naviculaceae	3.	IV.	29.			Fossil	N.-Amerika
Navicula sculpta	Ehrbg.	Naviculaceae	3.	IV.	25.			Fossil	Eger
Navicula serians	Kg.	Naviculaceae	3.	IV.	27.		Freshwater		Holstein
Navicula slesvicensis	Grun.	Naviculaceae	3.	IV.	20.		Freshwater		Holstein

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Navicula sphaerophora	(Kg.?) Sm.	Naviculaceae	3.	IV.	19.		Freshwater		Holstein
Navicula viridis	Kg.	Naviculaceae	3.	III.	4.		Freshwater		Holstein
Nitzschia Amphioxys	Sm.	Nitzschieae	2.	V.	5.	Valve	Freshwater		Holstein
Nitzschia Amphioxys	Sm.	Nitzschieae	2.	V.	6.	Principal-View			Holstein
Nitzschia Amphioxys	Sm.	Nitzschieae	2.	V.	7.	Binary-Subdivision			Holstein
Nitzschia circumsuta	(Bailey) Grun.	Nitzschieae	2.	V.	1.			Fossil	Schweden
Nitzschia dubia	Hantzsch.	Nitzschieae	2.	V.	4.		Freshwater		Holstein
Nitzschia Formica	Hantzsch.	Nitzschieae	2.	V.	2.		Marine		S.-Amerika
Nitzschia hungarica	Grun.	Nitzschieae	2.	V.	3.		Brackish		Schleswig
Nitzschia linearis	Sm.	Nitzschieae	2.	V.	11.		Freshwater		Preussen
Nitzschia obtusa	Sm.	Nitzschieae	2.	V.	12.		Freshwater		Frankreich
Nitzschia scalaris	(Ehrbg.) Sm.	Nitzschieae	2.	V.	8.		Freshwater		Schweden
Nitzschia Sigma	Sm.	Nitzschieae	2.	V.	9.		Brackish		Ostfriesland
Nitzschia sigmatella	Greg.	Nitzschieae	2.	V.	10.		Brackish		Schleswig
Nitzschia sigmoidea	Sm.	Nitzschieae	2.	V.	13.		Freshwater		Schlesien
Nitzschia spectabilis	(Ehrbg.) Ralfs.	Nitzschieae	2.	V.	14.			Fossil	Franzensbad
Odontidium hiemale	Kg.	Meridioneae	1.	III.	15.	Valve	Freshwater		Deutschland
Odontidium hiemale	Kg.	Meridioneae	1.	III.	16.	Principal-View			Deutschland
Odontidium hiemale var. *glaciale*	(Kg.)	Meridioneae	1.	III.	20.	Valve	Freshwater		Norwegen
Odontidium hiemale var. *glaciale*	(Kg.)	Meridioneae	1.	III.	21.	Principal-View			Norwegen
Odontidium hiemale var. *mesdon*	Grun.	Meridioneae	1.	III.	17.	Valve	Freshwater		Deutschland
Odontidium hiemale var. *mesdon*	Grun.	Meridioneae	1.	III.	18.	Principal-View			Deutschland
Odontidium hiemale var. *mesdon*	Grun.	Meridioneae	1.	III.	19.	Binary-Subdivision			Deutschland
Odontodiscus eccentricus	Ehrbg.	Melosireae	4.	IV.	2.		Marine		Holstein
Odontodiscus subtilis	(Ehrbg.) Grun.	Melosireae	4.	IV.	1.		Brackish		Holstein
Orthoneis fimbriata	(Brightwell) Grun.	Cocconeideae	2.	VI.	9.		Marine		Australien
Orthoneis splendida	(Greg.) Grun.	Cocconeideae	2.	VI.	10.		Marine		Japan
Orthosira solida	Eul.	Melosireae	4.	VI.	12.			Fossil	Californien
Peristephania Eutycha	Ehrbg. (?)	Melosireae	4.	IV.	5.			Fossil	Spanien
Pleurosigma acuminatum	(Kg.) Grun.	Naviculaceae	3.	V.	6.		Freshwater		Holstein
Pleurosigma angulatum	Sm.	Naviculaceae	3.	V.	10.		Brackish		Schleswig
Pleurosigma attenuatum	Sm.	Naviculaceae	3.	V.	4.		Freshwater		Norwegen

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Pleurosigma balticum	Sm.	Naviculaceae	3.	V.	3.		Brackish		Frankreich
Pleurosigma formosum	Sm.	Naviculaceae	3.	V.	12.		Marine		Samoa
Pleurosigma Hippocampus	Sm.	Naviculaceae	3.	V.	5.		Brackish		Schleswig
Pleurosigma naviculaceum	Breb.	Naviculaceae	3.	V.	8.		Marine		Samoa
Pleurosigma quadratum	Sm.	Naviculaceae	3.	V.	11.		Brackish		Frankreich
Pleurosigma rhombeum	Grun.	Naviculaceae	3.	V.	7.		Marine		Samoa
Pleurosigma strigosum	Sm. Seew.	Naviculaceae	3.	V.	9.				Helgoland
Pleurostaurum acutum	Rabh. var.	Naviculaceae	3.	VI.	3.			Fossil	N.-Amerika
Pleurostaurum Frauenfeldianum	Grun.	Naviculaceae	3.	VI.	1.			Fossil	Java
Pleurostaurum javanicum	Grun.	Naviculaceae	3.	VI.	2.			Fossil	Java
Podocyctis adriatica	Kg.	Surirelleae	2.	IV.	14.		Marine		Italien
Podosira maculata	Sm.	Melosireae	4.	VI.	2.		Marine		Holstein
Podosira nummuloides	Ehrbg var.	Melosireae	4.	VI.	3.		Marine		Australien
Pyxidicula cruciata	Ehrbg.	Melosireae	4.	V.	11.			Fossil	Jutland
Rhabdonema adriaticum	Kg.	Tabellarieae	2.	I.	20.		Marine		Turkei
Rhabdonema arcuatum	Kg.	Tabellarieae	2.	I.	17.	Valve	Marine		England
Rhabdonema arcuatum	Kg.	Tabellarieae	2.	I.	18.	Principal-View			England
Rhabdonema minutum	Kg.	Tabellarieae	2.	I.	19.		Marine		Ostsee
Rhizosolenia styliformis	M.Schulze	Rhizosolenieae	1.	VI.	1.				Gronland
Rhizosolenia styliformis	M.Schulze	Rhizosolenieae	1.	VI.	2.	Binary-Subdivision			Gronland
Rhoiconeis genuflexa	(Kg.) Grun.	Achnantheae	3.	I.	16.		Marine		Afrika
Rhoicosphenia curvata	Grun.	Achnantheae	3.	I.	15.		Freshwater		Holstein
Sceptroneis gemmata	Grun.	Meridioneae	1.	III.	9.			Fossil	Jutland
Schizonema Grevillei	Ag.	Naviculaceae	3.	VI.	11.		Marine		Schleswig
Scoliopleura convexa	Grun.	Naviculaceae	3.	V.	1.		Marine		Frankreich
Scoliopleura tumida	(Breb.) Rabh.	Naviculaceae	3.	V.	2.		Brackish		Schleswig
Solium exculptum	Heib.	Biddulphieae	4.	II.	13.	Valve		Fossil	Jutland
Solium exculptum	Heib.	Biddulphieae	4.	II.	14.	Principal-View			Jutland
Stauroneis gracilis	Ehrbg.	Naviculaceae	3.	VI.	6.		Freshwater		Holstein
Stauroneis Moelleriana	Grun. n.sp.	Naviculaceae	3.	VI.	4.		Freshwater		Holstein
Stauroneis phoenicentron	Ehrbg.	Naviculaceae	3.	VI.	5.		Freshwater		Holstein
Stenopterobia anceps	(Lewis) Breb.	Nitzschieae	2.	V.	15.			Fossil	N.-Amerika

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Stephanogonia danica	Grun.	Melosireae	4.	V.	9.			Fossil	Jutland
Stephanopyxis appendiculata	Ehrbg.	Melosireae	4.	IV.	6.	Valve		Fossil	Jutland
Stephanopyxis appendiculata	Ehrbg.	Melosireae	4.	IV.	7.	Principal-View			Jutland
Stictodiscus angulatus	Grun.	Melosireae	4.	V.	10.			Fossil	Jutland
Striatella unipunctata	Ag.	Tabellarieae	2.	I.	22.		Marine		Frankreich
Surirella biseriata	Breb.	Surirelleae	2.	II.	1.		Freshwater		Holstein
Surirella biseriata var. *acuminata*		Surirelleae	2.	II.	2.			Fossil	Norwegen
Surirella Brightwellii	Sm.	Surirelleae	2.	III.	13.		Brackish		Holstein
Surirella fastuosa	Ehrbg.	Surirelleae	2.	III.	14.		Marine		S.-Amerika
Surirella Gemma	Ehrbg.	Surirelleae	2.	III.	8.		Brackish		Ostfriesland
Surirella linearis	Sm. var constricta	Surirelleae	2.	III.	1.	Valve	Freshwater		Schweden
Surirella linearis	Sm. var. constricta	Surirelleae	2.	III.	2.	Principal-View			Schweden
Surirella minuta	Breb.	Surirelleae	2.	III.	11.		Freshwater		Schleswig
Surirella Moelleriana	Grun. n.sp.	Surirelleae	2.	III.	10.		Freshwater		Holstein
Surirella nobilis	Sm. var.	Surirelleae	2.	II.	5.			Fossil	N.-Amerika
Surirella norwegica	Eul. n.sp.	Surirelleae	2.	III.	3.	Valve	Freshwater		Norwegen
Surirella norwegica	Eul. n.sp.	Surirelleae	2.	III.	4.	Principal-View			Norwegen
Surirella oblonga	Ehrbg.	Surirelleae	2.	II.	4.			Fossil	N.-Amerika
Surirella ovalis	Ehrbg.	Surirelleae	2.	III.	12.		Brackish		Schleswig
Surirella Patella	Ehrbg.	Surirelleae	2.	III.	9.			Fossil	Franzensbad
Surirella robusta	Ehrbg.	Surirelleae	2.	II.	3.			Fossil	Norwegen
Surirella sleviscensis	Grun.	Surirelleae	2.	II.	6.		Brackish		Holstein
Surirella splendida	Kg.	Surirelleae	2.	III.	5.		Freshwater		Holstein
Surirella splendida var.		Surirelleae	2.	III.	6.			Fossil	Luneburg
Surirella striatula	Turp.	Surirelleae	2.	III.	7.		Brackish		Schleswig
Symbolophora Trinitatis	Ehrbg. var.	Melosireae	4.	V.	14.			Fossil	Jutland
Syndendrium Diadema	Ehrbg.	Chaetocereae	4.	VI.	25.				Peru-Guano
Synedra affinis	Kg.	Meridioneae	1.	III.	28.		Marine		Schleiswig
Synedra capitata	Ehrbg.	Meridioneae	1.	III.	30.		Freshwater		Holstein
Synedra crystallina	Kg.	Meridioneae	1.	IV.	2.		Marine		Holstein
Synedra formosa	Hantzsch.	Meridioneae	1.	V.	1.		Marine		Upolu
Synedra fulgens	Sm.	Meridioneae	1.	V.	2.		Marine		Italien
Synedra pulchella	Kg. var.	Meridioneae	1.	III.	26.	Valve	Marine		Norwegen
Synedra pulchella	Kg. var.	Meridioneae	1.	III.	27.	Principal-View			Norwegen
Synedra splendens	Kg.	Meridioneae	1.	III.	22.	Valve	Freshwater		Ostfriesland
Synedra splendens	Kg.	Meridioneae	1.	III.	23.	Principal-View			Ostfriesland
Synedra splendens	Kg.	Meridioneae	1.	III.	24.	Binary-Subdivision			Ostfriesland
Synedra tabulata	Kg.	Meridioneae	1.	III.	29.		Marine		Holstein
Synedra Ulna	Ehr.	Meridioneae	1.	III.	25.		Freshwater		Portorico
Synedra undulata	Sm.	Meridioneae	1.	IV.	1.		Marine		Holstein

Specie	Authority	Family	Block	Row	Position in Row	View	Habitat	Fossil or Recent	Source
Systephania Corona	Ehrbg.	Melosireae	4.	IV.	4.			Fossil	N.-Amerika
Systephania Diadema	Ehrbg.	Melosireae	4.	IV.	3.			Fossil	N.-Amerika
Tabellaria fenestrata	Kg.	Tabellarieae	2.	I.	11.	Principal-View	Freshwater		Holstein
Tabellaria flocculosa	Kg.	Tabellarieae	2.	I.	9.	Valve	Freshwater		Holstein
Tabellaria flocculosa	Kg.	Tabellarieae	2.	I.	10.	Principal-View			Holstein
Terpsinoe amerikana	Bailey var.	Tabellarieae	2.	I.	7.	Valve	Marine		Australien
Terpsinoe amerikana	Bailey var.	Tabellarieae	2.	I.	8.	Principal-View			Australien
Terpsinoe musica	Ehrbg.	Tabellarieae	2.	I.	4.	Valve	Freshwater		Portorico
Terpsinoe musica	Ehrbg.	Tabellarieae	2.	I.	5.	Principal-View			Portorico
Terpsinoe musica	Ehrbg.	Tabellarieae	2.	I.	6.	Binary-Subdivision			Portorico
Tetracyclus lacustris	Ralfs.	Tabellarieae	2.	I.	3.			Fossil	Norwegen
Toxonoidea insignis	Donk.	Naviculaceae	3.	VI.	15.		Marine		England
Triceratium alternans	Ehr.	Biddulphieae	4.	II.	7.				Peru-Guano
Triceratium antediluvanum	Ehrbg.	Biddulphieae	4.	II.	9.		Marine		Holstein
Triceratium Favus	Ehrbg.	Biddulphieae	4.	II.	5.		Marine		Holstein
Triceratium fimbriatum	Brightwell var.	Biddulphieae	4.	II.	6.		Marine		Australien
Triceratium pentacrinus	Wallich	Biddulphieae	4.	II.	10.		Marine		Australien
Triceratium striolatum	Ehrbg.	Biddulphieae	4.	II.	8.		Marine		Cuxhaven
Trinacria excavata	Heib.	Biddulphieae	4.	II.	12.			Fossil	Jutland
Trinacria Regina	Heib.	Biddulphieae	4.	II.	11.			Fossil	Jutland
Tryblionella acuminata	Sm.	Nitzschieae	2.	VI.	4.		Marine		Ostfriesland
Tryblionella Hantzschiana	Grun.	Nitzschieae	2.	VI.	1.		Brackish		Schleswig
Tryblionella punctata	Sm.	Nitzschieae	2.	VI.	3.		Brackish		Jutland
Tryblionella Victoriae	Grun. var.	Nitzschieae	2.	VI.	2.			Fossil	Australien