The microscope prism and the structure of the Produra [i.e. Podura] scale / by J.B. Reade.

(29.)

THE MICROSCOPE PRISM AND THE STRUCTURE OF THE PRODURA SCALE;

Being a Postcript to the Paper "On the Diatom Prism and Diatom Markings," read before the Royal Microscopical Society, June 9, 1869.

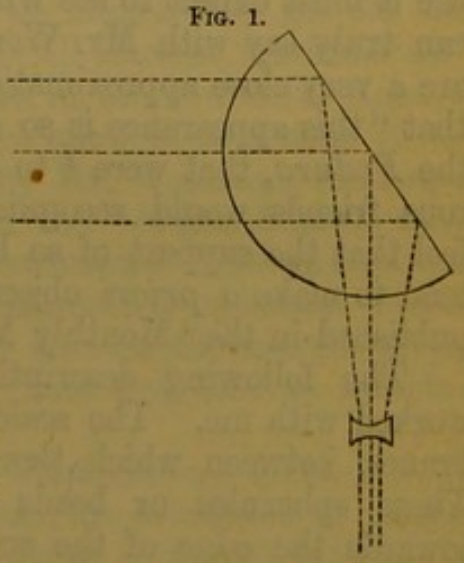
By the Rev. J. B. Reade, M.A., F.R.S.,

PRESIDENT OF THE ROYAL MICROSCOPICAL SOCIETY.

The paper on the Diatom Prism contained an account of the nature and effect of the illumination as illustrated by the development of Diatom Markings. These were new to me, and at none of our meetings, either public or private, had I ever seen any exposition of the surface of the valves which led to any definite and exact knowledge of the structure. In the short discussion on the paper, in which, by perhaps unavoidable circumstances, I was prevented from taking a part, it appeared that some microscopists had for years "considered the markings to be spherical." Here, no doubt, an erroneous method of illumination, though incapable of suppressing the whole of the truth, was yet insufficient to reveal "nothing but the truth," and hence Mr. Slack very naturally distrusts the usual mode of displaying diatom valves.

By breaking up a valve of *P. quadratum*, Mr. Wenham had obtained single spherules, and had also detached a line of spherules like a row of beads; but this most conclusive evidence still fails to convince some observers that the law of Diatom structure is established. It is more than probable, however, that their doubts will be set at rest by the single pencil of parallel light reflected from the equilateral prism.

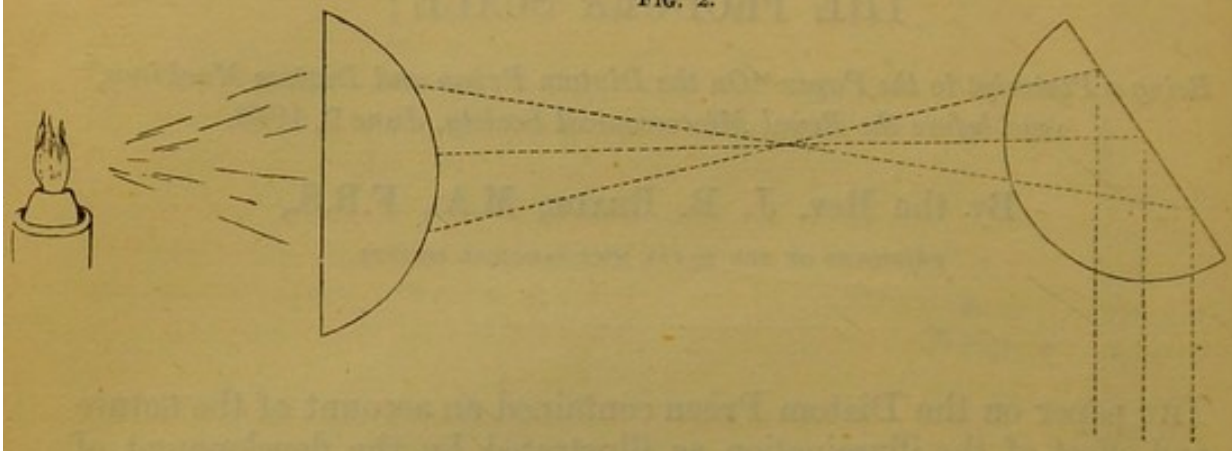
Fig. 1.



Since the paper was read, I have used the upper crown-glass hemisphere of the kettledrum as a Brewster's hemispherical prism, in which, says Brewster, the two convex surfaces are ground at the same time; and Mr. Ross made a deep double concave flint lens, which is so placed within the converging cone (Fig. 1) as to render the emergent rays both parallel and achromatic. In practice, however, I find it easier to obtain parallel light by placing the lower

hemisphere of the kettledrum, or any bull's-eye lens, between the lamp and the hemispherical prism (Fig. 2), and allowing the rays,

Fig. 2.



after crossing at the focus, to fall upon the plane surface of the prism. These diverging rays are just sufficiently shut up by the converging power of this prism as to be rendered parallel when reflected on the object under examination. Virtually, the point or source of light is in the principal focus of the prism, and the reflected rays are of course parallel. We thus obtain great intensity of illumination, which may be useful in the examination of certain structures, and the little vivid disc of light is easily thrown into the centre or on any part of the circumference of the field; but hitherto the plane prism has answered every requirement in the examinations I have made, and of these one of recent interest has been the scale of the *Podura*.

In the interpretation of this standard test object—the Podura scale—the value of parallel light from one source of light only will, I think, be admitted by all observers. But those who are about to use it must expect to see what they have never seen before; for I can truly say with Mr. Wenham, whose results on a dark ground are a very close approximation to my own results on a light ground, that "this appearance is so different from anything before seen in the *Podura*, that were I to exhibit it as such, not one of its numerous friends would recognize it." It is no slight satisfaction to feel that the support of so high an authority as Mr. Wenham will tend to make *a priori* objectors cautious. Mr. Wenham's paper is published in the 'Monthly Microscopical Journal' for July.

The following description is accepted by friends who have worked with me. The scale of the Podura consists of two membranes, between which there is a series of small solid spherules. These spherules or beads are often arranged in parallel rows towards the edge of the scale, and in the centre they are placed rather diamond-wise. Under a power of 12,000 linear, I have found 24 spherules in $\frac{1}{1000}$th of an inch on the 12-inch horizontal dia-

meter of the field and 6 on the vertical diameter. Hence, in the latter direction they are about $\frac{1}{6000}$th of an inch apart, and in the former, the interval being equal to a diameter of a spherule, they are about $\frac{1}{48000}$th of an inch apart. If now we could place a series of spherules in almost close contact on the vertical diameter, we should have parallel rows of about 48 spherules enclosed between the membranes as in a tube, and the membranes themselves would touch and be in close contact along the parallel intervals. Now let this close contact of the membranes continue, since in point of fact it really does exist on the scale, but remove the spherules we have supposed to be inserted. Then we have an empty space like the empty finger of a glove between spherule and spherule on the vertical diameter of the field. The sides of this tubular space cannot preserve their parallelism without the support of the supposed additional spherules, and therefore they tend to fall together, having the diameter of the existing spherule for the width of the tube close to the spherule, and thence tapering to a point just before a lower spherule is reached. Thus we have on the vertical 12-inch diameter, under a power of 12,000 linear, a set of 6 spherules at the top of 6 *hollow cones of membrane*, which may be shown as brilliant objects on a dark ground, while at the same time they naturally prevent the *direct* light of the usual achromatic condenser from passing through them. If this is the true interpretation, and I believe it to be so, it is a curious fact that simple darkness in the hollow cones—the absence of light and not the presence of shadow —supplies our skilled opticians with their best test in the shape of "a note of exclamation," having exquisite definition and *apparent* materiality. But if, instead of using direct light, we so place an equilateral prism as to throw a parallel beam of oblique light along the length of the scale, the shadow of the raised membrane which forms the hollow cone disappears, and we immediately get rid also of the interior darkness, and therefore of all trace of "exclamation" except that which almost naturally arises at the now novel sight of nothing but small spheres upon what we know to be a scale of the Podura! The object seems to be—as by Mr. Wenham's method it really is—illuminated from above, and the "*bright blue circular spots*" of Mr. Wenham are seen by transmitted light and natural shadows to stand out in full relief as distinct spherical bodies. These spherules may often be distinctly seen on the margin of the scale, and in more than one instance I have seen them as detached bodies near the scale.

Among the "variety of modes of illumination" alluded to by Mr. Beck, there are no doubt some which are calculated to mislead us; but the equilateral prism is a safe guide, and much information respecting the structure of the Podura scale may be readily gathered by throwing the parallel beam of light in various directions on

its surface. Most of the peculiar characteristics pointed out by Mr. Wenham become apparent, as well as the new features above described; and, notwithstanding the difference in our modes of examination, we come to the same conclusion that the markings are "not real spines," but "so incorporated with the membranes that separation cannot be effected."

The equilateral prism which I used in the first instance for supplying a single pencil of parallel light is 5 inches long with one-inch faces. It was made about thirty years ago of the well-known white sand which abounds in my old parish of Stone. I now use with equal effect and easier management much smaller prisms of an inch and even half-an-inch in length, with inch and half-inch faces. Mr. Ross has adapted these prisms to my microscope, mounted on a small arm with ball-and-socket joint. In a *popular instrument* the expensive luxuries of a mechanical sub-stage and elaborate condensers may be dispensed with, and the *Prism Microscope*, consisting of the body with its powers, a thin stage, and a two-inch equilateral prism, will look like a good working tool, and cannot fail to interpret the minute wonders of Creation to many intelligent admirers of Nature.

P.S.—July 21.—In consequence of a question just put to me by one of the early Fellows of our Society, the Rev. Charles Pritchard, between whom and myself the microscope was in years long gone bye a bond of union, I find it necessary to add a few additional remarks. The question is, "How does the *prism*, as such, effect the work better than a good plane surface?" Before answering the question I thought it better to examine the quantity and nature of the light which is reflected up the tube of the microscope from the left-hand plane face of the prism—an angle of the prism being towards the object on the stage—and the same light which passes through the same face of the prism and is totally reflected up the tube from the adjacent face or base of the prism, by turning the prism a little on its axis, the prism lying nearly under the vertical diameter of the stage. My report may "sound like a fable," but nevertheless the difference is marvellous. The whole light of the lamp totally reflected is not perceptibly altered either in nature or quantity, but the portion reflected from the face, and not entering the prism, is a *purely polarized beam!* As such I have used it in the examination of several suitable objects, passing it through selenite plates where necessary, and I prefer the results to any previously obtained by the direct light of a common Nicol's prism. Salicine and crystals generally, as well as fine vessels in animal and vegetable tissues, are seen in almost stereoscopic relief, in consequence of the shadows which are readily thrown by a slight

obliquity of the polarizing pencil. This obliquity may be extended to the bringing out the effect of polarized light even on a dark ground, and thus, as in the combination devised by Mr. Furze, heightening the solidity by the play of colours.

The plane prism may be used in other instruments as a polarizer, but it is satisfactory to find that the prism microscope is independent of extra appliances for producing polarized light.

I will only add, that when the sun itself is reflected from a surface of the prism, its disc being seen at the bottom of the tube, the phenomena of polarization, so easily exhibited, are brilliant in the extreme. The eye, also, is not fatigued by the brightness of this one component part of the sun's light; but the whole light totally reflected from an inner face of the prism would be intolerable. The brightness of the polarized beam may, however, be diminished to any extent by simply placing small pieces of white linen of different thicknesses between the prism and the sun.

The plane speculum of a Newtonian Telescope exhibits less polarization, both with daylight and lamplight, than the plane surface of an equilateral prism, but far too much to allow it to take the place of the prism which alone supplies a beam of pure unpolarized light at the angle of total reflection.

London: Printed by William Clowes & Sons, Stamford Street and Charing Cross.