for their visibility upon the difference in refractive index of the object and the material in which it is embedded. The greater this difference, the greater is the contrast in the object and the finer is the detail which can be resolved. Also, the higher the refractive index of the embedding material the greater is the depth of focus (penetration) of any objective lens.

If an object has a refractive index of 1.43 (air = 1) it becomes invisible when mounted in material of the same index. It becomes increasingly more contrasty (visible) as the surrounding substance has its index reduced, but the limit in this direction is 1 or a dry mount. Therefore, for this and some other reasons, dry mounts have never been satisfactory. As the refractive index of the surrounding medium is increased above 1.43 the object becomes more and more contrasty. A great deal of research has been conducted in the past to discover a material suitable for mounting purposes and of high index and there is a large literature on the subject. Many chemicals have been investigated and almost the entire series of natural gums, resins and alkaloids. Up to the present time, however, and except for special purposes the microscopist has been limited to two or three natural resins or mixtures of resins, the refractive index of which is very low. He is, therefore, greatly handicapped at the start of his effort, which, in most cases, is to see as much as he can with his microscope. Of the common mountants, Canada balsam has come into almost universal use because it can be procured easily, is chemically stable and is easily manipulated. Long ago it was pointed out that the exudation of the American sweet gum tree, *Liquidambar styraciflua*, was superior to balsam, but it has not come into general use. This resin is sometimes called "styrax," but it should not be confused with an oriental product of that name used in pharmacy. Its refractive index is 1.58; Canada balsam is 1.53.

Even the liquid amber is not sufficiently high for many objects; in fact, it is desirable to have a series of mounting mediums, one end having the maximum attainable refractive index.

After making exhaustive experiments in many directions the assistance of Mr. Paul Ruedrich was solicited and we began a line of search through the synthetic resins. One of particular promise has been discovered and is noted in our records as "A F S." It is composed of analine, formaldehyde and sulphur. A range of refractive index from 1.68 to almost 2.0 has been obtained and after two months' standing it appears to be entirely stable. The discovery was made on October 8, 1926. It is a well-known fact that substances closely related to this resin are the most stable in organic chemistry and have come into wide industrial use within recent years. It can not of course be definitely proved to be stable until after years of observation, but present indications are that it will be. Certainly it will keep unaltered for a period of months. This substance is a yellow resin which can be used in a thick viscous condition or thinned down with aniline or other solvents. It is used in the same manner as Canada balsam and does not offer some of the difficulties encountered with that substance. It may be hardened in the air, in an oven or with stronger heat. Although yellow in color it effectively transmits the apple-green rays for which most microscopic objectives are corrected.

A comparison of the utility of mounting mediums is afforded by the "index of visibility" which is the amount of difference between the refractive index of object mounted and that of the medium used. Thus, if the silica of diatoms be used for illustration, its index of refraction being 1.43, its index of visibility in Canada balsam becomes $1.53 - 1.43 = .10$. In liquid amber it is $1.52 - 1.43 = .15$. This means, practically, that 50 per cent. greater utility is obtained from a given microscope if the object be mounted in the latter. In this "A F S" synthetic resin the visibility becomes $1.68 - 1.43 = .25$, while in a solidified form it becomes $1.88 - 1.43 = .45$; all intervening values may be had. Thus a diatom in "A S F" becomes four and a half times or 450 per cent. more visible than it would be in Canada balsam. The same principles apply with all objects, either stained or unstained.

Likewise, increase in depth of focus being directly proportional to the index of refraction of the mounting medium, this factor, so important in photomicrography, becomes almost twice as great in "A F S" as in balsam.

From the optical properties of this material and its ease of manipulation I am forced to the belief that it will enable the human eye to see that which no eye has seen before.

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THE CULTURE MEDIUM FOR DROSOPHILA

Mr. M. Chino, my co-worker on *Drosophila* in our laboratory, has devised a culture medium for the fly which consists of: 100 gr. peeled banana, 100 gr. kôji,[1] 10 gr. agar-agar and 800 cc of water, with a very small quantity of powdered magic yeast added to the mixture. Kôji has to be soaked in water over

[1] Culture of *Aspergillus oryzae* on rice, used for fermenting rice for brewing saké and also for various other purposes in Japan.

night before being prepared for the food. This amount of food is sufficient for about 30 half-pint milk-bottles. We have been using this culture medium for the last few years, and find it quite satisfactory. In fact, it is practically just as good as the banana-agar food for *D. melanogaster* or *D. immigrans,* and is apparently better than the banana for *D. virilis.* The greatest advantage of the food is, however, that it is much cheaper than the banana food, costing only about one third of the latter in Kyoto at least. Thus, in Kyoto:

100 gr. kôji costs ca.	5.5 sen	
100 gr. peeled banana costs ca.	6 sen	(average cost of a year)
10 gr. agar-agar costs ca.	9 sen	
total	20.5 sen	
while, 800 gr. peeled banana costs ca.	48 sen	
16 gr. agar-agar costs ca.	12 sen	
total	60 sen	

We recommend this culture medium to the workers who can easily obtain kôji. We have not yet tried malt as a substitute for kôji, though it might be worth while trying.

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SPECIAL ARTICLES

ON THE ORIGIN OF SUN-SPOT VORTICES

IT is well known that sun spots are the visible manifestations of great cyclonic storms in the surface gases of the sun. It is also known that the gases carried around in the sun-spot vortices carry with them great electric charges, apparently of negative sign. In his estimate of the magnitude of the elements of a given sun spot, Carl Störmer[1] concluded that the negative charge over the sun spot area was equivalent to $5.5 \cdot 10^{15}$ electrons over each square centimeter.

The origin of these great cyclones and the source of the charges carried by the revolving gases have never been explained. The only known way by which such a charged area could be isolated upon a good conductor, such as the sun is supposed to be, is by electrostatic induction from a charge upon some other body in the vicinity of the conductor, and aside from this possibility the only conclusion possible in the present state of our knowledge is that the whole surface of the sun is charged to a potential as great, or nearly as great, as the sun-spot area.

There are other reasons for believing the sun to be charged to an enormous negative potential. It is known that the sun has a magnetic field many times as strong as the magnetic field of the earth, and the only known way in which such a field could be maintained is by electrical currents flowing around the sun, presumably caused by negative charges carried around by the sun's rotation.

Another argument for a negatively charged sun is the apparent impossibility of explaining the slight density of gases at the base of the solar corona except by electric repulsion. The corona has every appearance of a gaseous atmosphere several millions of miles in height, yet the gas pressure at its base has been estimated by astronomers as low as 10^{-13} atmosphere, a lower pressure than we are able to produce in our best air pump vacuum.

The explanation most frequently proposed for this low atmospheric pressure is that the coronal gases are supported by radiation pressure, though it has been shown that this assumption is impossible. According to careful measurements, the total radiation of the sun if it were completely absorbed would be capable of supporting a pressure of about 2.3 milligrams to the square centimeter near the sun's surface. The corona was photographed by Maunder[2] in 1898 to a height of at least five million miles above the sun's surface. In order to be supported by radiation pressure the total weight of a column of coronal gas five million miles high and one square centimeter in cross section could weigh only 2.3 milligrams on a body where gravitation is twenty-seven times as great as upon the earth, and provided it absorbed the total solar radiation.

But the solar radiation is only slightly absorbed by the corona. From measurements made on the brightness of the corona it seems to be about one eight-hundred-thousandth that of the sun. This must mean that all the light absorbed and re-emitted and all the light reflected in the corona is about one eight-hundred-thousandth of the total solar radiation.

Schwarzschild,[3] in a theoretical analysis of radiation pressure, showed that the pressure of sunlight upon particles of the dimensions of gas molecules would be insignificant as compared with the sun's gravitation attraction. He accordingly proposed the hypothesis that the solar corona consists of free electrons, and he calculated that such an atmosphere would reflect light of all wave-lengths with equal facility (which is not true of other gases) and that it would partly polarize the reflected light, both of which phenomena appear in the corona. The one objection

[1] *Astrophys. Jour.,* 43, 347 (1916).

[2] Arrhenius, "Kosmische Physik," p. 119.

[3] Sitzungsber, d. K. Bayer, Akad., Math.-Phys. Kl., 31, 293–338 (1901).