photosensitive pigment with the same product of bleaching as *Argyropelecus* and *Bathylagus*. *Stomias atriventer* Garman (family Stomiatidae) and the unrelated *Lampanyctus mexicanus* Gilbert (family Myctophidae) both had $490_1$ pigments. Slightly different was an extract of *Melamphaes bispinosus* Gilbert (family Melamphaidae) with a light-sensitive $488_1$ pigment.

All the extracts showed surprisingly high concentrations of the photosensitive pigments. (In Fig. 1, curve 1, the optical density at 475 mμ was 0.562 in an extract made from two small eyes.) The fishes examined probably all have pure-rod retinas. With histological methods, Brauer (*7*) studied species of each genus reported here and found only rods in each of them. There is no direct evidence that the light-sensitive retinal pigments of these deep-sea fishes are visual pigments. This seems probable, however, in view of their characteristic shape, which agrees with Dartnall's nomogram, and their products of bleaching, which are indicative of retinene$_1$. Although the tendency of the retinal pigments to be shifted toward the blue end of the spectrum was common to all the deep-sea fishes studied, there is no systematic trend apparent from this preliminary survey. The extracted pigments differ from rhodopsins in their $\lambda_{max.}$ but not in their retinene. Their wavelengths of maximum absorption approach the photosensitive pigments of certain mammals which also have $\lambda_{max.}$ less than 500 mμ (*8*). Because of this continuous spread of retinene$_1$ pigments, the use of the term *chrysopsin* is confusing and therefore is not followed. The presence of a dual, light-sensitive pigment system in a pure-rod eye (*Bathylagus*), based on the single carotenoid retinene$_1$, is particularly interesting (*9*).

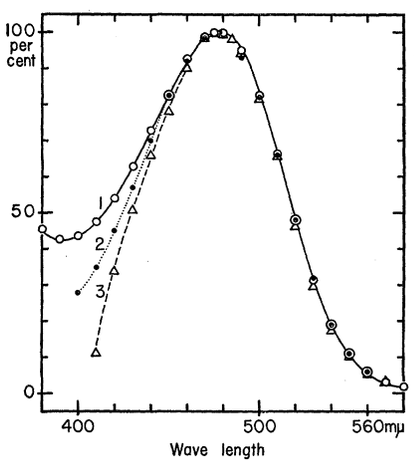


Fig. 1. Photosensitive pigment of *Argyropelecus affinis*. Curve 1, absorption spectrum of unbleached retinal extract (no significant absorption between 580 and 700 mμ); curve 2, constructed from Dartnall's nomogram, assuming a maximum at 478 mμ; curve 3, hydroxylamine experiment, difference spectrum (maximum change, 0.071 optical density units) after exposure of extract to yellow light (580 mμ).


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9. A detailed account of this investigation is in preparation.



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## Factors Affecting the Appearance of Picture Varnish

Among the factors that affect the appearance of a picture varnish of the spirit type, one might consider that the refractive index of the resin would play a major role. Refractive index has entered the literature regarding picture varnishes, yet I do not recall that its role has ever been demonstrated. There has certainly not been sufficient discussion of the subject to reach agreement on whether the refractive index should be low (*1*) or similar to that of aged linseed oil (linoxyn) (*2*). In seeking to develop new protective coatings for the artist and conservator, our laboratory gave consideration to this problem. This report presents reasons for believing that variations in the refractive index of the resin, within the range 1.43 to 1.54, play a relatively minor, if not negligible, role in determining the appearance of spirit varnishes on the surface of paintings. Particular attention is drawn to variations in appearance that are attributable to differences in the viscosity grades of the resin.

Fresnel's law relates the intensity of reflected light in terms of the angle of incidence and the refractive index. Under the restricted condition of perpendicular incidence, the Fresnel equation may be simplified to

$$I = \left(\frac{n-1}{n+1}\right)^2$$

where $I$ is the intensity of light of unit amplitude which is reflected and $n$ is the refractive index. With this equation, values as follows may be calculated: $n = 1.1$, 0.23 percent reflection; 1.3, 1.7 percent; 1.5, 4.0 percent; 1.7, 6.7 percent. These values are essentially those attained at angles of incidence up to about 40 deg.

The range of refractive indices in organic coatings applied in the conservation of art objects is limited and is perhaps no more than 0.17. Limitation is understandable if only atoms of carbon, hydrogen, and oxygen are to be used in building the molecules of durable thermoplastics. By calculations from the simplified Fresnel equation, it is estimated that a linoxyn film of refractive index 1.57 (near the upper limit) would reflect 4.9 percent of the incident light. A film of refractive index 1.467 (near the lower limit) would reflect 3.6 percent. If reflection at the varnish-oil interface is considered, application of a varnish of refractive index 1.57 would result in no reflection and application of one of refractive index 1.467 would result in less than 1-percent reflection.

Frequently, then, in picture varnish, we are concerned with absolute differences in reflection of no more than 1 or 2 percent. This is close to the limit of the sensitivity of the eye. Over a wide range of intensities, the relative threshold of just-perceptible-brightness is about 1 percent of the intensity level to which the eye is adjusted (*3*).

Regardless of the proportion of incident light which is reflected, one's impression of a surface is strongly influenced by the relative sharpness or diffuseness of the reflected light. Methods of expressing the distribution of the reflected light are aspects of "gloss" or "glossiness." Judd (*4*) lists five types, five ways of expressing gloss: specular gloss, contrast gloss, distinctness-of-image gloss, sheen, and bloom.

If one observes only the reflected light, the relative change from 3.6 to 4.9 percent is considerable. However, in viewing a painting, the eye is perhaps adjusted to the general level of illumination in the room. An absolute difference of 1 to 2 percent is frequently negligible in comparison with variations in diffuse reflection—that is, gloss. In their investigation of ceramic glazes, Dinsdale and Malkin (*5*) found that the measured and observed gloss did not follow in the order of increasing refractive index from 1.51 to 1.66.

Even with porous paint, experiment has demonstrated that the fluidity of a varnish at a given concentration of resin can play a greater role than refractive index in determining appearance. A lean paint of Bakelite polyvinyl acetate AYAT and ultramarine was prepared. The

Table 1. Color of lean polyvinyl acetate-ultramarine paint when varnished.

| Varnish resin | Solvent | Color | Viscosity grade (centipoise) | Refractive index of resin |
|---|---|---|---|---|
| Experimental polymethacrylate | Cycloparaffins | Light | 22 | 1.48 |
| Experimental polymethacrylate | Cycloparaffins | Dark | 8 | 1.48 |
| AW-2 | Cycloparaffins | Dark | 1.2 | 1.52 |
| Dammar | Turpentine | Dark | 1.3 | 1.53 |
| Bakelite polyvinyl acetate AYAB | Toluene | Dark | 9 | 1.467 |
| Bakelite polyvinyl acetate AYAT | Toluene | Light | 114 | 1.467 |
| Polyvinyl alcohol | Water | Light | ~400* | 1.51 |

* Value determined in water.

paint did not rub off when it was rubbed with the hand, and yet it was porous to the applied varnishes. When the coat of varnish had dried, the value of the blue was noted simply as "dark" or "light." Table 1 shows that varnishes prepared with resins of high viscosity grade apparently do not form an intimate contact with the paint, with the result that the color appears light irrespective of the refractive index. Practical applications immediately come to mind when one does not wish to darken colors in pastels and porous paints.

The truly outstanding difference between the properties of the traditional picture varnishes, dammar and mastic, and those of many proprietary polymers is not in their refractive indices, but in the viscosity of their solutions. In place of intrinsic viscosity, we have used the viscosity at 20 percent solids by weight in toluene at 70°F as a convenient measure to characterize resins, giving it the name "viscosity grade." A similar measurement has been used to classify chlorinated rubber (*6*). On this scale, dammar, mastic, and resin AW-2 (Badische Anilin und Soda Fabrik) have a viscosity grade between 1.2 and 1.3 centipoises (cp) whereas Bedacryl 122 X (I.C.I.) and Lucite 44 (du Pont) *n*-butyl polymethacrylate have values about 48. Compared with dammar resin, polymers of high viscosity grade resist flow at a relatively low concentration of solids. As the solvent evaporates beyond this point, the film tends to conform to the contours of the paint surface (*7*). In this manner, a varnish formulated with a resin of high viscosity grade tends to be less glossy than the dammar type, which is able to remain fluid, continuing to level itself, until much more of the solvent has departed.

Among museum authorities, interest in refractive index has centered about the appearance of coatings of polyvinyl acetate. The polymer long used in America, Bakelite vinyl resin AYAF (similar to the earlier Vinylite A), is one of relatively high (80 centipoises) viscosity grade. The formulation of Reid, originally presented by Stout and Gettens, (*8*) was tested in our laboratory and found to give poor distinctness-of-image gloss when it was sprayed on window glass, with the spray gun at a distance of 10 to 20 inches from the glass. In a control test, the gun emitted 35 to 70 ml of toluene per minute. Changes in formulation of the solvent markedly altered the gloss. This laboratory has for several years drawn the attention of museums to polyvinyl acetate polymers of 40- and 9-centipoise viscosity grade (*9, 10*).

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## Effect of Gibberellin on Cell Division in Hyoscyamus

Recently it has been shown that gibberellin, when it is applied to nonvernalized biennial *Hyoscyamus niger* will cause the formation of an elongate stem (*1*). Since the nonvernalized plant grows as a rosette—that is, without measurable internodes—it was suggested that the gibberellin caused an increase in the number of cells. This report presents direct evidence for an increase in cell division resulting from application of gibberellin to biennial *H. niger* (*2*).

Plants of *H. niger* (biennial, purple-flowered strain) were grown from seed in a greenhouse in which the temperature was not permitted to fall below 20°C and in which the photoperiod was maintained at 18 hours by supplementing natural light with artificial illumination. Crystalline gibberellin (*3*) was dissolved in glass-distilled water to which a small amount of a wetting agent (Tween 20) was added. The desired amount of gibberellin was applied at the base of a leaf as close to the apex as possible by means of a hypodermic syringe.

The apical region of the shoot (rosette) was prepared for microscopic examination by fixation in formalin, acetic acid, and 50-percent ethanol (5/5/90); dehydration in tertiary butanol; imbedding in Tissuemat (mp 56°C); longitudinal sectioning at 6 μ; and staining with safranin and fast green according to the procedures outlined by Johansen (*4*). Generally, ten sections per plant, comprising a median slice of 60-μ thickness through the apical region, were examined. Certain restrictions were imposed on this research; only meta-, ana-, and telophase division figures were counted, and only the shoot apex proper and that part of the subapical region which is enclosed by the provascular tissue were examined (see Fig. 1, top). During the period in which observations were made, there was no measurable change in shape and total volume of the subapical region; hence, the cell division counts refer to the same tissue volume.

In one experiment, plants were treated with 0.2 ml of a 25 mg/lit solution of gibberellin (equivalent to a dose of 5 μg per plant) while they were receiving continuous illumination. Illumination was supplied by fluorescent tubes (warm and cool white) yielding approximately 500 ft-ca at plant height, at 23 ± 2°C. In two other experiments, checking the 24-hour point, the plants were treated with gibberellin as described while maintained in greenhouse conditions (varying temperatures, 18-hour photoperiod). Since the results were substantially the same for all three experiments, the data are grouped together.

As can be seen from Table 1, there was no significant difference between the treated and control plants with respect to the number of division figures in the apical region. However, beginning between 12 and 18 hours after treatment, the number of divisions in the subapical region underwent a striking increase. In this region, a distinction was made between "longitudinal" and "transverse" division figures—that is, division figures the spindle axes of which form an angle of 0 to 45 deg or of 45 to 135 deg with the longitudinal axis of the plant (see Fig. 1, bottom). Table 1 shows that the increase relates mainly to the longitudinal ones; the differences in transverse