create a new symphony. This because, if the relation of Hecht's suggestions to those that follow be in any way grounded, the dominant triune or Pythagorean threefold character of the original theme is in course of replacement by a numerical discontinuum of order $\geqq$ and generally < 5, but probably not essentially and always 3. The meaning of this will be clear, when it is allowed that for protanopes the number of color-processes could be $= 1$ or > 1, but not $= 2$,[4] for deuteratopes 2 or 3, and for normal polytopes, 3 or greater.[5] This is one consequence of the concept of closely overlapping curves—conforming to Hecht's conclusions, but admitting statistical variates. Mandelbaum and Mintz suggest:

> From a phylogenetic and from a photochemical point of view, the concept of closely overlapping curves is more probable than is that of the widely separated curves of classical formulation. Their differences in sensitivity may well be due to slight differences in their absorption spectra, for in the case of both visual purple and visual violet the spectral sensitivity is determined by the absorption spectrum. Such slight differences in spectral absorption could easily be accounted for by small molecular rearrangements, or the simple addition of a methyl or ethyl group.

What we wish to point out, as a mere suggestion for possible further prosecution by physiologists and biochemists, is that well-ordered and physico-chemically controlled modifications of the absorption spectrum exist in dyes of many types, which would permit the closely overlapping curves of the Hecht theory to arise for the same dye as well as by essential, though small, chemical modifications of a dye molecule. Such alterations can be determined by molecular aggregations of a reversible character, controlled by the parameters of the thermodynamic environment. We propose to group such variations under the general term, allelochromy,[6] and may mention two principal directions in which conditions for fulfilment of the closely overlapping trinity—or multeity—of sensitivity curves might be sought. These are (1) spectral absorption variation by dimerization[7] and (2) by heteropolymerization of dyes in lyotrope mesophase formation.[8] These are quite distinct processes, though liable to appear with the same dye molecules, and for the good reason that both depend upon the possibility of sterically unimpeded side-by-side parallel coherence, in the first case in pairs of two ions, in the second, in a species of one dimensional or filamentous quasi-crystallization of large numbers of like dye molecules acting as a unit.

Spectral variations in the first case can be produced by variation of concentration and medium. A pronouncedly amphipathic substance,[9] such as the nucleoprotein of nerve-fiber, should be ideal in respect of such control. *Per contra,* the other state of ordering also deserves consideration. While the striking spectral absorption of the mesophase of 1,1′-diethyl-2,2′-cyanine chloride, discovered by E. E. Jelley[10] and, independently, by G. Scheibe,[11] has concentrated attention on this narrow band type from symmetrical molecules, it deserves to be noted that with asymmetrical dye molecules of the cyanine dye family, co-operative spectra giving absorption curves of much broader form may be obtained, and, again, by small variations of the proportions of reversibly hetero-polymerized ions, allow controlled variation of the absorption.[12] In this case, with *two* not too dissimilar but isomorphous dye ions, A and B, *three* packets of A, AB and B could give curves of near overlap. The writer has commented elsewhere[12] on the analogies of the combinations such dye ions can make with proteins, with the spatial arrangements made probable for thymo-nucleic acid molecules.[13] The conditions by which, in these multi-molecular assemblages, excitation-conductance becomes possible, also would seem to deserve attention in connection with the theory of vision.

It is an interesting thought that while the widely separated curves of the classical trichromatic theory have well served the mimetic development of color photography, operation on the basis of such closely overlapping curves as those proposed by Hecht would probably have been technically impossible, or, in any case, impractical.

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PROPOSED UNIT FOR HIGH VACUUM

F. H. TOWNSEND[1] suggests a new unit for the measurement of vacuum which has the virtue of expressing increasing vacuum—decreasing pressure—in terms of

[4] Fractional values referring to statistical variations of the distributions of operative processes (1, 2, 3, 4 or 5) in rod and cone populations.

[5] Just as in multicolor printing, it could be a matter of economy *vs.* efficacy whether two, three or more components were employed. But, for vision, it is rather the (statistical) frequency of certain dye molecules in the populations of rods and cones.

[6] *Cf.* allelomorphy and signifying alternative or contrasting coloration.

[7] S. E. Sheppard and A. L. Geddes, *Am. Chem. Soc.*, 66: 1995, 1944, Part IV.

[8] S. E. Sheppard, *Reviews of Modern Physics*, 14: 303–340, 1942.

[9] S. E. Sheppard and A. L. Geddes, Amphipathic Character of Proteins and Certain Lyophile Colloids as Indicated by Absorption Spectra of Dyes, *Jour. Chem. Phys.*, 13, 63, 1945.

[10] E. E. Jelley, *Nature*, 138: 1009, 1936.

[11] G. Scheibe *et al.*, *Naturwiss.*, 25: 75, 1937.

[12] S. E. Sheppard, SCIENCE, 93: 42, 1941.

[13] K. Linderstrom-Lang, *Trans. Farad. Soc.*, 31: 324, 1935.

[1] *Nature*, 155: 545, 1945.

increasing positive numbers. At present we write 10^{-1}, 10^{-2}, 10^{-3}, . . . mm of mercury; or we use 10^{-3} mm, the micron, as the basic unit for measuring vacuum, and write 1, 0.1, 0.01, . . . , micron.

In Townsend's proposed system, the reciprocal of the negative power of 10, expressing pressure in millimeters of mercury, is multiplied by 10, thus resulting in positive, integral numbers of two figures. In this system, 10^{-1}, 10^{-2}, 10^{-3}, . . . , become 10, 20, 30, . . . vacuum units. This is similar to the method of expressing relative sound intensity levels, the reference level for vacuum being 1 mm. There is logic in using approximately 1 mm as the division point between pressure and vacuum. In its practical application, the range of values ordinarily used would lie between 10 and 70 vacuum units.

The suggestion appears practicable and logical. This note is written to bring it to the attention of American scientists and technologists who may not have access to *Nature.*

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THE OXIDATION OF BILIRUBIN BY PEROXIDASE

Peroxidase, in the presence of hydrogen peroxide, is known to oxidize phenols and aromatic amines and iodides. Milk peroxidase oxidizes nitrites and tryptophane.[1] Recently we have discovered that peroxidase oxidizes bilirubin to biliverdin. This reaction takes place in a narrow zone around pH 7.4.

It has been generally assumed that *in vivo* hemoglobin is broken down to biliverdin and that the biliverdin is then reduced more or less completely to bilirubin. However this may be, we wish to point out the possibility that bilirubin may be converted to biliverdin in the liver by action of peroxidase and peroxide. In 1934 Schreus and Carrie[2] observed that when liver brew was incubated with hemoglobin between pH 7 and 8, a blue-green pigment was formed. This was probably biliverdin. The formation of this substance was shown to be inhibited by catalase and favored when the digests were kept at 70°, at which temperature liver catalase was destroyed. We assume that the inhibitory effect of catalase was due to its destruction of hydrogen peroxide.

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[1] S. Thurlow, *Biochem. Jour.*, 19: 175, 1925.
[2] H. T. Schreus and C. Carrie, *Klin. Wochenschr.*, 13(2), 1670, 1934; *Med. Welt*, 9: 1135, 1935; quoted from *Chem. Abstracts*, 31, 6310, 1937.

THE IMPORTANCE OF DEGENERATIVE CHANGES IN LIVING ORGANISMS

Variations that reduce the amount and rate of growth in long-inbred lines of maize appear in the form of dwarf plants, narrow leaves, crooked stalks, reduced chlorophyll and plants that seem normal but are delayed in flowering and maturing. All the mutations so far observed are either neutral or disadvantageous to the organism. Unfavorable types such as these would be expected to be eliminated by natural competition, but when tested in hybrid combinations with the normal lines from which they originated, these degenerate individuals improve the performance of their offspring and definitely have advantage in survival. Increases over the normal, better parent range up to 104 per cent. in yield of grain, and up to 9 per cent. in height of stalk. This larger growth is made in less time.

Favorable mutations in plants and animals are extremely rare both under natural conditions and in the laboratory. The evidence indicates that they appear first in the heterozygous condition and segregate as unfavorable deviations from normal. Hereditary material is so highly developed and delicately balanced that changes of any kind usually result in a reduction of some kind. Ultimately these new alleles may be brought into equilibrium with the remaining gene complex in such a way as to promote better growth and survival. In this way evolution proceeds by first taking a step backward before going forward.

The fact that unfavorable characters appear so frequently and persist so long in many organisms indicates that they have survival value. These results, recently obtained and to be reported in detail, emphasize the need for caution before eliminating apparently degenerate individuals in plant and animal breeding practice as well as in any eugenic program.

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A REACTION OF ASCORBIC ACID WITH α-AMINO ACIDS

In Science of May 25, 1945, Koppanyi, Vivino and Veitch described a red color reaction of ascorbic acid with various α-amino acids. Somewhat over a year ago we observed the development of a bright red color on and in surgical catgut (mainly collagen) when immersed in ascorbic acid solutions, and we believe the same reaction as described by those authors to be involved.

When raw or processed (heat sterilized) plain catgut strands were immersed in ascorbic acid solutions of 50 mg per cent. or more, and stored at room temperature, the strands were uniformly red in three