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INTER-SOCIETY COLOR COUNCIL

R. G. MACDONALD, SECRETARY
122 EAST 42ND ST., NEW YORK, N. Y.

INTER-SOCIETY COLOR COUNCIL

NEWS LETTER NO. 19

SEPTEMBER, 1937

I. H. Godlove, Editor

Charles Bittinger
Associate Editor for Art

D. B. Judd
Associate Editor for Science

NEW INDIVIDUAL MEMBERS

We take this opportunity of welcoming into the Council the following new members; who have been recently elected:

W. R. Koch, Wright Field, Dayton, Ohio
W. A. Lindberg, Chrysler Corporation, Detroit, Michigan

COLOR COUNCIL PLAN FOR NAMING COLORS

With regard to the plan for naming colors, which has been exemplified in earlier News Letters, we are informed that a vote has been taken on the extension and changes recommended in the report of the Problems Committee. Seventeen ballots were in favor of the proposals of the report, this being a majority in favor, with no votes contrary.

BOSTON COLOR GROUP

On May 16, 1937, the Boston group held its second dinner meeting at the Hotel Lennox, with Walter M. Scott as acting chairman, and S. Q. Duntley, of Massachusetts Institute of Technology as secretary. After Dr. Scott had recalled the visit of the Council Chairman, M. Rea Paul, at the previous dinner, when the latter explained the Council's purposes in fostering dinner groups in various parts of the country, he described the types of organization which had proved successful in Washington and Chicago, and asked for an expression of opinion on the form of organization best suited for the Boston group. Mrs. Elsie K. Chamberlain, of the Chamberlain School of Art, and Arthur W. Cornell, of Forbes Lithographing Company, both spoke in favor of an informal type of organization at least at the start. A similar expression was made by Professor Frank L. Allen, of Massachusetts Normal Art School, who made a remark interesting to us. He said that a notice of the present meeting had been put in a certain weekly news-letter, and a surprisingly large volume of inquiries for further information had immediately been received. This perhaps stimulated Professor Michael J. Zigler, of Wellesley College and Professor Arthur C. Hardy, of Massachusetts Institute of Technology, to consider the possibility of too large a group and to stress the value of slow growth as informality.

George E. Nerney, of Bay State Optical Co., supported this view by citing a similar organization of the plastic industries which failed because of too sudden growth. Orin E. Skinner, of the Connick Stained Glass Co., whose principal color interest is in its emotional effects, spoke in favor of continuance of the organization. Other persons who were present at the dinner were Mrs. Mollie Starks, of the Chamberlain School of Art; P. E. Gillingham, of Forves Lithographing Co., and E. H. Kroepel of Wadworth, Howland Paint Co. The group elected the two officers named above to serve for the ensuing year; and arrange to have the third dinner meeting during the first week of October.

It seems that eastern colorists prefer informality. Do we hear Chicago's comments?

ELECTION OF VOTING DELEGATES FOR THE INDIVIDUAL MEMBER GROUP

We are informed by the Chairman that the following individual members have been elected as the three voting delegates to represent the Council's individual members, their appointment to be effective at once:

Mrs. Elizabeth Burris-Meyer
Dr. Le Grand Hardy
Miss Dorothy Nickerson

THE COLORQUERY AND VISIONNAIRE

Question 8. What is the difference between the iridescent blues of the peacock and the non-iridescent blue of the bluejay?

Question 9. Why does a row of street lamps in a London fog seem redder and redder at increasing distances?

COLOR IN PAINTING THROUGHOUT THE AGES. III.

THE OLD STONE AGE

In the second article of this series we placed the earliest known art in Aurignacian times, which may be thought of as beginning roughly at 100,000 B.C., possibly somewhat earlier either in Europe or in Africa. The dawn artist was a member of the Aurignacian race, or to be more accurate, he possessed a form of the Aurignacian culture. For a long time it has been customary to regard the early Aurignacian as an intrusive culture which came to Europe from North Africa. This was because a very similar culture (we shall not confuse you with the name) is abundant there; and we have a very interesting book in our library, written in 1929, which rather confidently describes the Aurignacian homeland as Ethiopia. But L. S. B. Leakey, in his very fine book "Adam's Ancestors" (1935), gives the evidence that this culture slowly evolved from the contact of two other very dissimilar cultures which were those of two different races of man. To be sure, he also showed that exactly the same fusion of cultures occurred simultaneously in East Africa.

Incidentally, it may be remarked that the Mediterranean Sea must not be thought of as a great bar to contacts, passable only in ships, which the early people did not have. Instead, there were elevations and submersions of land at various early times which made of the Mediterranean a land-locked pair of lakes, with land birdges at the strait of Gibralter and between Italy and Tunis across Sicily. We will have occasion to describe these oscillations later, as also connections of the British Isles with the continent.

Ath this point we must interject a note on our datings. In the case of such a date as that above, it makes little difference whether we say 100,000 B. C. or 100,000 years ago; for the accuracy of our chronology does not justify the distinction in such archaic times. Consequently, up to the end of the Great Ice Age, that is, about 20,000 B. C., we shall not bother to subtract about 1900 years to correct to the calendar of the Christian era. Moreover, until we reach about 500 B C., for brevity we shall not generally append the "B.C.," instead merely putting the date figures in parenthesis.

The chronological frame, on which archeologists and anthropologists hang dates, is chiefly that of the four major glaciers of the Great Ice Age, which is the quaternary or Pleistocene age of the geologists, as well as certain minor glaciations or arrests in the thawing of the ice after the last great glaciation. In Africa, the corresponding periods were either wet (pluvial) or dry (interpluvial); and a geologist has worked out an interesting theory of the connections in arctic and tropical regions. Very serious discrepancies in the datings of the glaciers will be found in books on the Ice Age or Old Stone Age; and, since the cultures are dated by correlation to the geological data, the cultural chronology is marked by equally serious disagreements between authorities.

But we believe it worthwhile, as an aid to the memory and for clarity, to make use of a system of dating which we regard as fairly accurate relatively, if not absolutely. The basis of this system is as follows.

Glacial conditions were not identical in the Alps, in Scandinavia, in Britain and in America, the four places where the geology has been most completely worked out. But on the whole it had been found out that there were four main glacial periods between about (800,000) and (20,000). It was learned that each of the first three had two sub-maxima of cold, while the last one was triple. Also, that there was an extremely long period (about 200,000 years) between the two middle glaciations. A number of very interesting theories have been worked out to account for the alternating warm and cold periods;

and we can assure you that a reading of one of the many books on the Great Ice Age would repay you for your time. Here we shall say only that recently there have been worked out, from accurate astronomical data, calculations giving the variations in summer heat following variable solar activity. The effect of the planets or great stars, supposed to control the sun spots, is not by direct variation of temperature, but involved air currents, special storminess and increased snowfall in periods of increased solar activity. The calculated curve of summer sunshine gave three duplex and one triple minima in excellent agreement with the geological evidence; and the longest stretch of warmth between the middle two cold periods. This fine correspondence leads us to have considerable confidence in the calculated dates. We regret only that we have not the space to recite some of the excellent geological correlations with this computed data; for example, with the positions of the complex "terrace" system of certain German rivers. We regret also that we cannot discuss also the closely related theories of the origin of the continents, and of the "continal drifts", as of the Americas away from Europe and Africa. We will note only, in passing, the similarity of the Atlantic coastlines of the Americas to the west coasts of Europe and Africa; also the great similarity of geological data near the two coasts. Not to slight our western ocean, we note that geologists have theories which make the Pacific the scar left by the birth of the moon.

Since we cannot all be geologists and follow the injunction of the Book of Job (XII.8): "Speak to the earth, and it shall teach thee," we shall refer you, upon request, to the interesting books on these facts and theories. The boldest of the theorists has broken the earth's crust into bits and remoulded it by arranging the pieces, as in a gigantic picture puzzle,nearer to his hearts desire. Hereminds one of a figure in many Bantu dances, where the two partners turn back to back, bump, and part again. It is thrilling to think of this figure on a continental scale. Africa parts from America, then woos her mate back again in a later geological age.

To return to the Aurignacian artists, since their culture was due to the gradual fusion of two older ones long in contact, a definite date is meaningless. Qualifying terms, such as <u>basal</u>, <u>early</u> or <u>lower</u>, <u>middle</u>, <u>late</u> or <u>upper</u>, and <u>final</u> are often used to distinguish successive phases of a culture, since the remains (stone tools, pottery, etc.) of the cultures are found in superimposed layers. We follow Leakey in placing "Basal Aurignacian," both in Europe and East Africa, in a geological period which we (not Leakey) date roughly at (130,000); and "Lower Aurignacian" at (100,000) in East Africa and (60,000 or 50,000) in Europe. Following these, there wa a "middle Aurignacian" invasion of Europe at about (40,000) coming from Asia by way of the plateau of Iran and Palestine. Whereas one of the races whose culture fused to form the Aurignacian was of modern type (Homo sapiens), the bearers of the other older culture were of a different type supposed to have died out about the time of the last great glacier. The Lower Aurignacians were of modern type, and the Asiatic or middle Aurignacians were of the special variety of H. sapiens forming the great race called the "Cromagnon race". This is really a mixed or hybrid race; but it is regarded by ethnologists as being in many respects, as in its brain size, perhaps the greatest race which ever lived. Indeed, we shall have other occasions to note examples of this hybrid vigor, or "heterosis," resulting from cross-breeding of racial strains. Aurignacian man's greater intelligence and better weapons accounts for the disappearance of certain other cultures at this time. These cultures we shall not name at this moment; for we recall the story of the second installment of this serial, and we fear that you, hearing a long list of culture names, races and dates, may wish to "give up your place to Habbakuk".

It is unfortunate how complex has become, the last decade, the picture which we must paint. In 1925, the picture of the Old Stone Age was given fairly completely somewhat as follows:

Years B. C.	Culture	Races
12,000	Magdalenian	Cro-magnon
15,000	Solutrean	Cro-magnon; Brünn
20,000	Aurignacian	Cro-magnon, Grimaldi
35,000	Mousterian	Neanderthal
60,000	Acheulean	Unknown
75,000	Chellean	Unknown
200,0000	Eolithic or Pre-Chellean	Trinil, Heidelberg & Piltdown

This picture is now woefully incomplete, in the light of the knowledge transpiring in the succeeding decade. Moreover, it is even inaccurate. The above culture names survive; so also the names of the races (except that we have used Trinil for the race of the "missing link," Pithecanthropus erectus). But there is doubt whether the Brünn race differs essentially from the Cro-magnon; and doubt as to the negroid character of the Grimaldi race, which was formerly assumed. Finally the above dates must be very greatly enlarged.

Leakey, in "Adams Ancestors," after greatly simplifying the representation of the actual facts, as we have said most great painters do, found it necessary to use about 80 names to diagram only the cultures of the Old Stone Age. If he had listed those of the "mesolithic," "neolithic" (new stone), bronze and iron ages, which follow, a much larger number of names would have been required. Leakey accomplished part of the simplification to 80 culture names by lumping together all Europe, instead of treating separately the cultures of Central Europe, France, Great Britain, Italy and Scandinavia. He could neglect those of Crete and Greece, whose art flowered in the bronze and iron ages. East Africa was treated; but not South Africa, which was marked by some very interesting cultures.

We shall not risk boring you by giving now even a further condensed table of cultures. Very soon we shall say a lot about races. At the moment we shall add to the above list of old stone cultures only two very important names. These are, with probably more nearly correct dates:

Clactonian	(450,000 - 250,000)
Levalloisian	(250,000 - 50,000)

These cultures and the Mousterian are know as "flake cultures," as opposed to the Chellean and Acheulean, which are called "core cultures" from the type of stone implements which characterize them. It is easily seen that if a lump of flint is dealt blows in a suitable way to fashion a tool of a definite shape by knocking off flakes, what is left may be regarded as the core. The Chelleo-Acheulean hand-axe, for example, is a core tool. The Aurignacian cultures were characterized by blades, which are long, narrow flakes with more or less parellel sides, and gravers, which are generally made on flakes or blades. Different forms of stone knife blades characterize various special Aurignacian cultures. We shall have more to say of the cultures later; but for details a book on the Old Stone Age or pre-history should be consulted.

Some of the dates above seem very large, when we remember that our era began less than 2000 years ago. To make them seem less staggering, we propose to cite some which will dwarf them; for we promised to go back to the beginning of things. We are reminded of the viewpoint of Cratzer, astronomer to Henry VIII, whose portrait Holbein painted. After 30 years in England, he had scarce learned to speak any English, and his majesty asked the reason why. He replied: "I beseech your Highness to pardon me; what can a man learn in only 30 years?" Some vague connection recalls also the story of a painter's progress with the years. Don Juan Carreno, the favorite painter of Charles II of Spain, sat quietly through a criticism of a certain copy of Titian's St. Margaret. After all present had declared it execrable; Carreno quietly remarked: "It at least has the merit of showing that no man need despair of improving in art; for I painted it myself when I was a beginner."

The oldest rocks, the lifeless era, of this earth, go back about 1,750,000,000 years; the earliest plants, 1,250,000,000 years. Jelly-like animals appeared at 900,000,000; "primary" or "paleozoic" geological time and invertebrates at 450,000,000. Forests and fishes (vertebrates) followed at 300,000,000; amphibians soon after, and the "secondary" period and the age of reptiles and birds at 200,000,000 years. The last great geological division, the Cenozoic, the age of mammals, apes and man, is subdivided into the "Tertiary" and the "Quaternary." The tertiary period included the following epochs: The Eocene, 55,000,000; Oligocene, 36,000,000; Miocene, 17,000.000; and Pliocene, 13,000,000. The Quaternary epoch includes the Pleistocene, which is roughly coincident with the Great Ice Age, and Holocene or Recent time.

We cite these dry but stupendous figures, even though the ghost of Habbakuk haunts us, because we wish to place on man's family tree the Aurignacian, Magdalenian and later branches on which art flowered. We must climb upwards from the trunk, which branched first not when "apes became men" (for that would be an inaccurate statement), but when the anthropoid apes and the human family branced away from one another. From the common anthropoid-human stem the New World monkeys split off in the Eocene; the Old World monkeys at the very start of the Oligocene. Later, in the Oligocene, occurred the branching of the great apes and the human forms. In the Miocene, the anthropoids had advanced far toward the orang, chimpanzee and gorilla, and probably in some cases toward man. A Miocene form is the ancestor of the orang; another Miocene genus, called Sivapithecus, lies between the ancestor of the orang and the as yet undifferentiated gorilla-chimpanzee-human stock. The Miocene ancestor of these two apes is called Dryopithecus. It is a fossil genus of at least 6 species, varying much in size and details. Some of its species led to the gorilla, others to the chimpanzee, others between them. All of them show characters closely allying them to man.

Strictly, the facetious term the "missing link," if used at all, refers to the Oligocene-dated fork in the common stock which led to man and to the apes, rather than to a link in a straight chain between them. Perhaps there are known no fossil forms exactly at the fork of this Y. But forms very close to it are known. Probably the Trinil man is close on the human side. Close on the ape side should be placed some recent finds. In the Punjab of India, among the Sivalik foothills of the Himalayas, there was found a fossil genus, Palaeopithecus, so close to man that there was doubt originally whether he was man or ape. He was finally reclassified close to the chimpanzee. In 1924, at Taungs, Bechuanaland, South Africa, on the margin of the Kalahari desert, there was found a new genus, Australopithecus, with the most human-like anthropoid face yet known. It has also been classified between man and the chimpanzee, but in the chimpanzee-gorilla (or Dryopithecus) group, and closer to the apes than to man. This fossil was a six-year old "boy." But only last year, at Sterkfontein, in the Transvaal, there was found an adult form of the Taungs type. Though extinct, this form has a number of traits more human and less brutal than the surviving apes.

H. F. Osborn and other authorities believe that man's descent is to be traced from a primitive ape-like form more closely resembling the chimpanzee than man, but less specialized in ape-like habits than the orang. He regards the pre-human stock as terrestial in habit, yet seeking his food in trees and developing a tree-walking habit. He regards the uplands of Mongolia or Tibet as the birthplace of man. The stimulus to the development of many mammalian groups was known to be because of the wave of aridity which occurred in Oligocene time concurrently with the complete elevation ofthe great continental plateau. The mammals (and the apes) had to choose between the warm enervating forest-clad regions or the temporate but stimulating plateaus. In the elevated semi-arid upland environment the struggle for food was intense.

Hence reliance had to be put upon the invention of implements and weapons. Man's earliest flints served both these functions. The apes specialized in arboreal life; man chose to use his lower limbs for progression and freed his arms to hold food and flints.

Perhaps it is now the place to tell the story of an ape who tried to become a painter; for we are leading up to our subject painting. It is related that in 1302 the painter Buffalmacco was invited to paint the chapel of St. Catherine in the church of San Francesco at Assisi. His host, the good Bishop Guido, possessed a great ape, extraordinarily cunning, but most mischievous. This ape often gravely watched the painter at work, mingling pigments, handling tools, beating eggs for his medium, which was distemper. One Monday morning, the painter discovered his figures ruined, his vessels all heaped together, everything topsy-turvy. He concluded that some one, moved by jealousy, had wrought this havoc. But after a repetition of this catastrophy, and sore confusion, he suspected the ape, although the ape had been chained to a great log. He complained to the Bishop, who detailed six soldiers to stand watch, and to cut down, without mercy, the guilty culprit. The figures were again completed, and on one Saturday night the painter was hastily summoned. The new master, the ape, was on the scaffold; at once he had fallen upon the vases which held the pigments. mingled them all together, and, plunging the pencils into the mixture, had daubed over every figure. Apparently, during the first episode, he had not ceased till he had repainted the whole work with his own hand, besmirching all the physical representations of the saints, if not their characters. On this occasion, the soldiers and the deposed artist all stood watching the new master at work, all being convulsed with laughter, Buffalmacco most of all. At length, the latter betook himself to the Bishop, and said: "My lord, you desire to have your chapel painted on one fashion, but your ape chooses to have it done in another." Then, after relating the story, he added: "There was no need whatever for your lordship to send to foreign parts for a painter, since you had the master in your house. Perhaps he merely did not know how to mix paints; now that he has learned, he has no further need for help. I beg your permission to return to Florence." But the Bishop persuaded him to stay; and the story ends by relating that, since Buffalmacco had been picked for the job because both he and the Bishop were merry souls, the only punishment of the ape was being forced to remain in a wooden cage watching the other master at work. The leaps, flings and contortions of the animal then showed his rage.

INTER-SOCIETY COLOR COUNCIL

REPORT ON SURVEY OF TERMS, TESTS, AND PROBLEMS

SUBCOMMITTE IV (A.S.T.M.)

PROGRESS REPORT FEBRUARY 25, 1937

The committees of the American Society of Testing Materials are organized on the basis of the types of engineering materials to be considered, for example ferrous and non-ferrous metals, ceramic and similar materials, and miscellaneous materials such as coal, paint, textiles, etc. There are also committees for certain general testing methods such, for example, as spectroscopy. There is no committee on colorimetry nor does the spectroscopy committee concern itself with spectrophotometry as the physical basis of colorimetry.

An attempt has been made through other I.S.C.C. members of the A.S.T.M. and through the Society's indexes to collect data on color specifications and tests accepted as standards or as tentative standards by the Society. It can not be claimed that this survey is rigorously complete in substance or final in form. At the end of 1936 the Society issured its tri-annual volume of Standards and its annual volume of Tentative Standards. This report has not been revised to cover these latest publications.

It is clear even from a hasty survey that color is not one of the properties of engineering materials which has received extensive consideration. The industries represented in the Society which have done most are the paint and pigment (more generally the preservative coatings) industries, the petroleum industry, and the textile industry. Data with reference to textiles, however, are being reported to the Inter-Society Color Council through another channel, namely the American Association of Textile Chemists and Colorists.

The American Society for Testing Materials has formulated definitions of terms relating to paint specifications such as "color" (which reads in part "color is primarily a physiological sensation"), "tinting strength", "tint", "shade", "hue", and "tone".

The Society has a standard method of analysis of the color characteristics of paint in terms of fundamental physical units. This method recognizes spectrophotometry as basic and recommends fumed magnesium oxide as a standard reflecting surface but leaves the mode of illumination and viewing to be agreed on by the buyer and seller (of the paint). No mention is made of any method of converting the spectrophotometric data to an equivalent stimulus. The standard method for testing the mass color and tinting strength of dry color pigments is concerned chiefly with the procedure for preparing and mounting pastes in order to determine by visual inspection whether they are like the standard. There is a standard method for preparing shellac either in the form of solutions or films in order to determine by visual inspection whether it is like the standard. In the case of oleoresinous varnishes the standard method for clor provides for comparing visually the light transmitted through the varnish with that transmitted by a potassium bichromate solution of known concentration in sulfuric acid.

A color test from a wholly different industry may be mentioned here. The organic impurities in sand for concrete are tested by comparing the color of a supernatant alkaline solution with that of an alkaline solution of tannic acid of known concentration.

The above standard procedures have been accepted by the Society in final form. They are understood to be generally satisfactory and widely used with the exception of the spectrophotometric method. The specifications for pigments in general read "the mass color and character of the tint formed by mixture with white pigment shall be the same as, and the strength not less, that of a sample mutually agreed upon by buyer and seller". In general, in the pigment and finishes industries, as indicated by the Society's accepted standards, specification of color is by means of a physical standard, in most cases without any attempt to specify tolerances. The colors are surface colors. Tri-stimulus specifications are not used.

Turning now to the Society's tentative standards, there are tests for the color of lubricating oil and of petrolatum by means of the A.S.T.M. Union Colorimeter, a test for the color of refined petroleum oil by means of the Saybolt Chronometer and a tentative revision of the standard methods of testing electrical insulating oils which provides that the tentative color tests for lubricating oils be used. Both the A.S.T.M. Union colorimeter and the Saybolt chronometer depend on the visual matching in a divided field eyepiece of the oil with glass discs. The glass discs of the Union colorimeter are defined in terms of Lovibond units whereas in the case of the Saybolt chronometer they are defined in terms of trilinear coordinates calculated from spectral transmission data using the 1931 I.C.I. standard illuminant C. For both instruments the light is defined as substantially illuminant C.

These tentative tests for oils are reported to be used a good deal and to be satisfactory. Revision is not being considered. The method for determining the color of petrolatum is not equally satisfactory. The Lovibond tintometer is being considered for this purpose but the difficulty of standardizing and specifying tintometer glasses is recognized as an obstacle. The opinion has been expressed that color as an index of quality of petrolatum products has frequently been over emphasized and color as such is not usually an important property.

A tentative method for testing soluble nitrocellulose base solutions includes a color test which depends on comparing a bottle of the solution with a bottle containing a standard platinum-cobalt color solution or a standard caramel solution. The caramel solutions are used to extend the range, but the color is based on the platinum-cobalt standards.

It will be noted that unlike the accepted standards, the tentative standards of the Society include definitions based on spectrophotometry and the 1931 I.C.I. Standard Observer and Coordinate System.

Turning now to the question of unsolved problems, the writer is not authorized to request for the A.S.T.M. assistance in its program of work. It may be mentioned, however, that there is a subcommittee now active on the subject of gloss, particularly of preservative coatings. The work of this committee is not yet complete, but the attempt is being made to formulate definitions and recommend experimental procedures which will have the advantage of definiteness in dealing with this attribute of the appearance of surfaces.

There have been submitted to the Committee a number of definitions of terms and problems which are not in any sense official or representative of the American Society for Texting Materials. They are, I think, interesting to the Inter-Society Color Council as evidence of the usage of color terms and tests in industry unofficially. Most of the terms collected relate to the pigment, paint, plastics, and coated textile fields. Almost without exception in these industries color is specified by a material sample. The descriptive terms used are far from having any fixed or definite meaning. In particular, it may be noted that the term "bright" is very frequently used to indicate saturation as it is also frequently used to indicate brilliance. The term "hue" so well recognized among students of color appears to have little industrial use. "Saturation" in general is not clearly and explicitly recognized by industry as an attribute of color. In connection with colored materials the term "strength" is widely used and is economically a very important consideration.

The writer feels that when a color term is used in widely different senses and not consistently even by one individual, let alone one industry, then the recording of the variant meanings is of doubtful value. It certainly does not permit one to learn what any particular speaker or writer means to say. On the other hand, it is doubtful whether the I.S.C.C. or any other organization can force on industry a new vocabulary. It would appear, therefore, to the writer that an exhaustive study of non-official usage is hardly worth while and that usage in this field as in others will eventually be determined chiefly by the students and writers, particularly if it becomes evident that there are practical advantages in the improved vocabulary.

On the other hand, the standard specifications and tests such as those att empted by the A.S.T.M. represent a considered attempt by a number of conflicting interests to get together on a practically useful procedure. Such tests may admittedly lag behind the front of the procession in any rapidly developing scientific field, but will represent practical conservative opinion.

Unless, however, this subject is to be kept an open file, the report of this subcommittee may well be based on the 1936 Standards and Tentative Standards and brought to a close within the next six months.

THE COLORQUERY AND VISIONNAIRE

Question 8: What is the difference between the iridescent blues of the peacock and the non-iridescent blue of the bluejay?

Answer to 8: Writers on color commonly distinguish "structural colors" from the more familiar "pigment colors." Since structure of matter is involved in both cases, the distinction is somewhat arbitrary. Pigment colors are those supposed due to th- chemical nature of a light-absorbing material, the absorbers being the molecules. This ca , familiar in the colors of paints, dye solutions and dyed fabrics, solutions of copper, iron and other chemical salts, and many natural pigments, as of the chlorophyll of green plants, has been treated in the answer to question 1. Structural colors depend on, or are profoundly modified by, the geometrical arrangement of the parts of a material. This case includes the colors produced by means of prisms, diffraction gratings, thin films such as those of soap bubbles or oil on water, or the "light" scattering "particles of turbid media such as the suspended solids of milk. In all the "structural"cases, color is produced from materials which themselves may be (but are not necessarily) colorless; e.g., raindrops in the rainbow, pure mineral oil floating on water.

In bird feathers, it is commonly agreed that the reds, yellows and blacks are pigment or absorption colors. On the other hand, blues, whites and the so-called "metallic" or iridescent colors are structural. Practically all the non-metallic greens are structural blues combined with a pigment yellow. Iridescence is the rainbow-like play, of shifting character, which results when the point of view or the angle of illumination of the iridescent material is changed. There is some disagreement among authorities as to the causes of the structural colors of feathers, though illustrious names are associated with contradictory theories. Everyone admits that there is no blue pigment in non-metallic blue feathers, as those of the bluejay, bluebird, indigo bunting and kingfisher. Some structural colors have been carelessly described as"prismatic;" but those descriptions never explain where the prisms are, nor how they are arranged to give certain colors (blue, not reds nor yellows).

It was shown by Haecker and Meyer (1902) that the non-iridescent feather blues, as those of the bluejay, are of the type ("Tyndall blues") due to scattering of light, of the form we have already described, in answering question 6, for Irish blue eyes and blue sky. The scattering centers are the very fine air bubbles or pores in the outer layer of cells of the barbs of the feathers. It is the blue of turbid media. More recently, C.W. Mason has confirmed Haecker's work, and has found no other structural or pigment blue in non-iridescent feathers.

The iridescent colors of peacocks, pheasants, trogons, pigeons, ducks, grackles, and humming birds are characterized by their brilliancy and luster. The iridescence comes wholly from the barbules; the barbs are an opague, dark, dull brown and show no other colors. Iridescence is seen in light reflected from both surfaces; but only brown without iridescence is seen if the feather is between the eye and the light.

Structures similar to prisms, to diffraction gratings, and to thin plates have been offered to explain the iridescent colors; and Michelson (1911) was convinced that they were due to selective reflection from a pigment surface, the cause of the socalled "surface color" of many solid dye crystals, as those of magenta. An equally great name, Lord Rayleigh's (1919), is associated with a thin-film theory. Mason (1923), after examining all the possibilities, concluded that the iridescence is caused by thin laminae or films in the barbules, and found no other structural colors nor surface colors. We shall leave it to those interested in zoology (or is it comparative anatomy, histology or microscopy?) to look yp the details of the geometrical structures - responsible. On the other hand, we shall watch for an opportunity to discuss some of the properties of and distinguishing tests for the interference colors of thin films, surface and body colors due to selective reflection, diffraction effects and scattering effects. At the moment we shall state only the rudiments of the theory of interference and note the iridescent colors seen in the peacock's feathers. As we go from normal to grazing incidence of light, the typical color changes from greenish blue through purple to red. As we woudl expect, when the feather structure is swelled by immersion in certain organic liquids, the colors change; the sequence becomes; orange, green, blue, violet blue.

We will recall the appearance of a soap bubble when seen in white light. We see complicated bands of beautiful colors. If we use light of a single hue, we get only bands alternately of that hue and black. We attribute the black spaces to waves from the two sides of he bubble film interfering with or obliterating each other. The intensified chromatic color is due to the reinforcing action of two similar amplitudes. Reinforcement we suppose due to crest meeting crest; interference to crest superimposed on trough. The waves starting from the two different surfaces, separated by just the proper distance are in opposite phase; for one passes from denser to rarer, the other from rarer to denser, medium. If we make a fine wedge of air by separating two plane glass plates by a thin silk thread at one end, and view the reflected light successively in red and blue light, we see more blue bands than red bands. A little consideration will show that this is because the red rays have a longer wave length. We suspect, however, that the female pea fowl does not attempt to analyze, even so simply as we have, the causes of the peacock's gaudy colors.

Question 9: Why does a row of street lamps in a London fog seem redder and redder at increasing distances?

Answer to 9: In answering question 6, we noted that Rayleigh's scattering law describes the fact that red light is scattered only about a fifth as much as blue light having a wave length two-thirds as great, by particles whose diameters are of the order of magnitude of the wave length of light". The smoke particles in mixtures of fog and smoke are small enought to scatter blue light more effieiently than red. Scattering of light is a phenomenon which is best treated by considering the scattering particle as a source of secondary radiation. The amount of energy of the primary beam which is scattered in varic's directions varies in a complicated way which we will not describe; but one important result is that only a small portion of the scattered energy continues in the original direction of the beam. Therefore, since short wave light (roughly blue) is scattered more than long wave light, the residual beam remains richer in long (red) waves. The greater the thickness of scattering material of course the more complete this process is. Hence lamps at greater and greater distances, seen as separate beams because of perspective effects, appear richer and richer in long waves. That is, they are redder at increasing distances. Dismal London fogs can thus contribute a few spots of color.