per cent. solution of $(NH_4)_2SO_4$ added. Evaporate to dryness on the water bath, dry in the oven and drive off slight excess of ammonium salts in the electric muffle at low heat, finally heating to dull redness. Take up in dil. HCl, digest on the water bath for an hour or more, filter and determine Na and K by Hilgard's methods. The $BaSO_4$, *after heating,* has little or no tendency to absorb Na and K. This, however, is not true in the cases of Ca and Mg.

Where the soils carry soluble salts ("white alkali" soils),[1] the soil in the percolator must first be leached free from these salts with pure water before being subjected to the $BaCl_2$ treatment, or, where percolation with water is slow as is the case with heavy soils, a separate analysis may be made for water soluble bases and these subsequently subtracted from those found in the $BaCl_2$ solutions.

In the case of acid soils (unsaturated with respect to bases), the amounts of replaceable H-ion may be determined in the $BaCl_2$ percolate by means of titrations as recommended by Gedroiz and recently modified by Joffe and McLean.[2]

Representative data, solubility determinations and certain other work leading up to the adoption of these methods is in press in the technical series of bulletins of the Arizona Agricultural Experiment Station.

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SPECIAL ARTICLES

ANALYSIS OF THE COLOR OF THE SKIN AND ITS SIGNIFICANCE

OUR complexions and the colors of the skin are dependent on a variety of causes. Recent experimentation by methods to be briefly described here indicates that these causes include (1) pigmentation, or melanin and (2) the character, amount, distribution and velocity of flow of the blood in the capillary bed in the skin. Normal blondes and brunettes differ in the amount of pigmentation only. It is said: "That the pigmentation of the skin bears some relation to health is well recognized. Tanned individuals are generally healthy. But whether the action is a direct or indirect one is unknown."[1] I have found, however, that the condition of tan per se, due to pigmentation, is not such an indicator because of the fact that the blood, by reason of the reflection of light from the capillaries in the surface of the skin, contributes its quota to the composite color of the skin as seen by the eye. The eye is a poor instrument for analyzing or resolving the constituents of color.

Tintometer methods for estimating and recording the color of the skin may be of value to the medical profession in the course of the treatment of diseases in which appreciable color changes occur in the skin, but they do not in any manner analyze the light reflected by the skin and therefore can not record skin color in terms of the three attributes of color, that is, brilliance, hue and saturation. Spectrophotometric analyses of the light reflected by the skin and the subsequent analysis of these data into the components of red, green and violet excitation values and relative luminosity on the basis of the noonday sun as a standard furnish the only scientific method for obtaining information on the rôle played by pigment and blood in the color of the skin. So far as I know, no work has previously been done on this subject. This paper is a preliminary report of my recent investigations.

Accurate determinations of the color of the skin in terms of spectral wavelengths and amounts, with the subsequent analysis of such data, are doubtless of decided value in cases of jaundice, cyanosis, polycythemia vera (in which capillary dilatation and increased cell volume play a part), Addison's disease, hemochromatosis and anemia.

The instrument employed in these investigations, which will be reported in detail elsewhere in medical literature, is the Keuffel and Esser color analyzer. Reflection curves from various portions of the fingers or hands may be obtained in terms of the reflection of light from a block of magnesium carbonate by placing the hand or fingers in the position ordinarily occupied by the second magnesium block. I have also built and adapted to this spectrophotometer an attachment whereby the face or arm may be used and reflection curves obtained.

Figure 1, curve 1, shows the spectral distribution of light reflected from the fingers of a normal blond; curve 2 gives similar data in a case of Addison's disease; curves 3 and 4 are from two cases of polycythemia vera. In each instance corresponding fingers and areas were used. The ordinates give the percentages of reflection, while the abscissae give the wavelengths as read on the drum of the spectrometer.

These data as plotted in Figure 1 (and other similar data) have been analyzed into percentages of red, green and violet color excitation values and relative luminosity with noonday sunlight as the standard, in the manner described in detail in the report of the

[1] Soils carrying "black alkali" must be treated differently. A discussion of this case will appear in the bulletin referred to later.

[2] "Colloidal Behavior of Soils and Soil Fertility: II. The Soil Complex Capable of Base Exchange and Soil Acidity." In *Soil Science,* vol. 21, no. 3, pp. 181–195 (1926).

[1] Matthews, "Physiological Chemistry," 4th ed., p. 711, 1925.

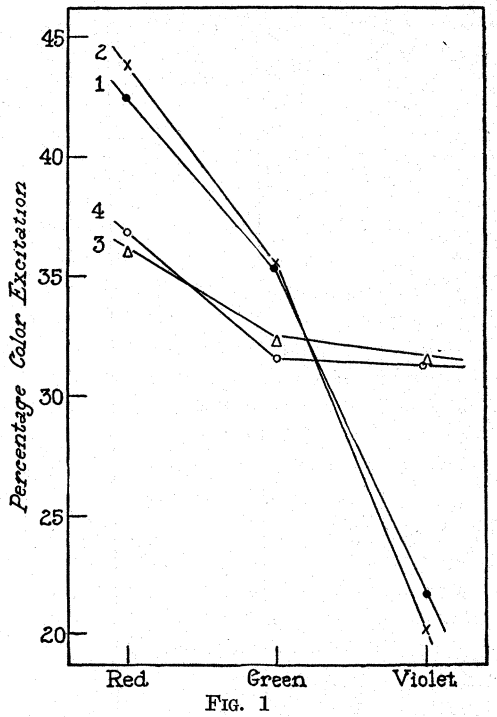

FIG. 1

Committee on Colorimetry of the Optical Society of America.[2] Figure 2 gives the percentages of the red, green and violet excitation values in the reflection of light from the skin in a case of (1) normal blond, (2) Addison's disease, (3) polycythemia vera and (4) marked polycythemia vera. Table 1 also gives the dominant wavelengths and purity in each of these cases. Table 2 contains the summated color excitation values of red, green and violet in each of the four conditions cited.

The following conclusions are drawn from the experimental work conducted thus far:

(1) The spectrophotometric method of analysis of skin color furnishes the basis for a relatively simple but bloodless method of depicting certain characteristics of the blood at the peripheral portions of the body.

[2] Troland, "Report of Committee on Colorimetry," *Journal of Optical Society of America*, Vol. vi, pp. 527–596, 1922.

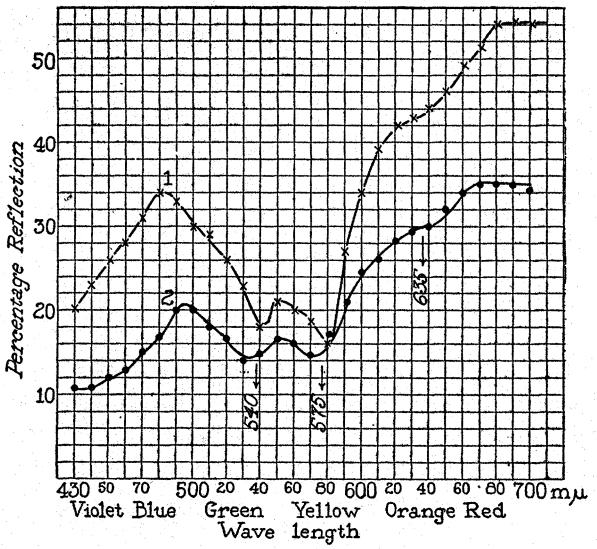

FIG. 2

(2) The spectrophotometric reflection curves show the presence (or absence in certain cases) of (a) hematin, (b) reduced hemoglobin, (c) oxyhemoglobin and possibly (d) methemoglobin in peripheral or surface tissues and blood.

(3) It is probable that the spectrophotometric data as obtained from the skin by reflection methods may be of value in determining certain physico-chemical characteristics of the blood.

(4) By spectrophotometric reflection curves and their subsequent analysis into fundamental red, green and violet excitation values, it is possible to differentiate between changes or variations in skin color due to (a) pigment content and (b) characteristics dependent on the amount, distribution or quality of the peripheral blood supply.

(5) Spectral analyses show that there is very close agreement in the values of the dominant wavelength, purity and percentages of red, green and violet in normal blondes and brunettes and in such pathologic conditions as Addison's disease. The dominant wavelength is practically 585 μ (nearly sodium yellow) in all instances.

TABLE 1

PERCENTAGE EXCITATION VALUES DETERMINED FROM THE SPECTROPHOTOMETRIC DATA ON THE SKIN OF NORMAL PERSONS AND IN CERTAIN DISEASES

Case	Curve (Fig. 1)	Classification	Red	Per cent. Green	Per cent. Violet	Dominant wavelength (μ)	Purity, per cent.
1	1	Normal blond	42.45	35.68	21.87	587	43
2	2	Addison's disease	43.90	35.70	20.40	580	50
3	3	Polycythemia vera	35.81	32.49	31.70	605	10
4	4	Polycythemia vera	36.90	31.60	31.50	640	10

TABLE 2

SUMMATIONS OF COLOR EXCITATION VALUES FROM THE SKIN OF NORMAL PERSONS AND IN CERTAIN DISEASES

Case	Classification	Total Red	Total Green	Total Violet
1	Normal blond	2600	2186	1340
2	Addison's disease	1412	1151	650
3	Polycythemia vera	1570	1425	1388
4	Polycythemia vera	1330	1141	1130

(6) In cases of polycythemia vera, the congestive stage of Raynaud's disease and allied conditions there are marked departures from the normal conditions in the values of the dominant wavelengths, purity and percentages of red, green and violet. In these diseases, in which there are generally marked disturbances in the quantity, quality and rates of flow of blood, the dominant wavelength is in the red (605 μ to 640 μ in my findings).

(7) Cyanosis is noticeable in various diseases. Spectrophotometric determinations and analyses in terms of monochromatic radiation show that the summated violet values are higher by percentage in comparison to similar summated values of the violet in normal subjects, and that there is a marked reduction in the summated values of the reds and greens in these diseases as compared with normal persons.

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CILIARY ACTIVITY OF THE OYSTER

IN a recent paper[1] Galtsoff describes an ingenious method for determining the rate and the amount of water passed through an oyster's gills. Since these experiments were conducted in a tank in the laboratory it is of interest to compare Galtsoff's findings with observations of oysters in their natural surroundings.

As was to be expected, following the work of Gray ('23)[2] on the effect of temperature upon ciliary movement in the gills of *Mytilus*, the rate of flow of water through the oyster was found to be a function of the temperature. Unlike Mytilus, however, the cilia of the oyster were seen to come to a standstill at 5° C. with no current produced below 7.6° C.

From examination of the stomach of oysters throughout the year I showed[3] that between 5.6° C. and 7.2° C. lies a "critical temperature" above which active feeding occurs and below which almost no food is taken. Round[4] showed no reduction in numbers of bacteria in oysters at 5° C. until after five days.

Oysters taken during the winter and early spring show active feeding in some individuals at a temperature of 5.6° C., or 2° below the figure given by Galtsoff as the minimum below which no current is produced. Since Galtsoff's observations were made upon oysters adjusted to summer temperatures it is evident that *Ostrea elongata* behaves much like the ctenophore *Mnemiopsis leidyi*[5] with respect to its temperature adjustments. With the slowly falling temperatures of autumn and early winter the oyster becomes adapted to a lower range of temperature, so that although there is a sharp decrease in ciliary movement below 5° C., activity does not entirely cease. Theories of hibernation[6] in the oyster are true therefore in only a relative sense as Round[4] has suggested.

The maximum amount of water filtered by a medium sized oyster was found by Galtsoff to be 3,000 cc. Using a different method[7] I found that when commencing active feeding after a period of closure, oysters three to four inches long may take in between five and six liters of water in an hour. Extended observations of oysters attached to a kymograph while living under natural conditions show that the rate of feeding in the oyster may be subject to wide variations independent of changes in temperature, turbidity, salinity and other environmental conditions. Feeding occurs, for example, much more actively on the flood than during the ebb tide.

Galtsoff found that his oysters living in the laboratory under controlled conditions kept their shells open an average of twenty hours each day. With oysters living under natural conditions, exposed to wide variations in temperature, turbidity, salinity and pH I found[7, 8] that out of each day the oyster remained closed for an average of four hours, most of this period of inactivity occurring at night. The agreement between Galtsoff's findings on oysters in the laboratory with mine on animals living under natural conditions indicates that the period of closure in the oyster represents a minimum of physiological inactivity determined by the needs of the organism. To quote an earlier statement of mine on this subject (7, p. 340), "the writer believes the evidence from all sources indicates that the periods of inactivity which occur under conditions favorable for feeding are to be looked upon as true rest periods."

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[1] SCIENCE, 63, No. 1626.
[2] Proc. Royal Soc., Ser. B., 95, No. 664.
[3] Rep. N. J. Expt. Sta., 1921, p. 293.
[4] Rep. R. I. Com. Shellfisheries for 1914.
[5] *Biol. Bull.*, 48, 92–111.
[6] Gorham, F. P., Rep. R. I. Com. Shellfisheries for 1910, and *J. Am. Publ. Health*, January, 1912.
[7] Rep. N. J. Expt. Sta. for 1920.
[8] Proc. Soc. Exp. Biol. and Med., 21, 91.