hard, enlarged and nodular prostate gland becomes and remains soft and atrophic in the presence of the advancing neoplastic process elsewhere in the body. Clearly the prostatic tissue in bone marrow and lymph gland is located more strategically for its growth than in the original neoplastic site. Among possible causes of the failure cases are the production of significant quantities of androgen in extragonadal loci, as well as differences in the nature of original tumor. It has been established that varying, and at times, large, amounts of androgen are produced in the adrenal cortex of man; the adrenal androgens have been incompletely studied in prostatic cancer but obviously if significant amounts of androgens are produced in this region in certain patients, castration will effect incomplete regression of the tumor. It has been found that glandular types of prostatic cancer often but not always respond more favorably than undifferentiated tumors.

The urinary excretion of hormones in prostatic cancer has been studied.[33] The 17-ketosteroid excretion is reduced in amount as compared with vigorous young men, but not more so than in normal males of the same age group; following orchiectomy there is a decrease in their level followed in several weeks by a rise greater than the pre-operative values. The excretion of gonadotrophic agents is slightly increased after castration.

The concept of autonomy of the cancer cell in recent years has influenced thinking about cancer; according to this idea the malignant cell is dependent for its survival on few or no extraneous influences and proliferates even when solely dependent on catabolic effects of a starving host for its energy and growth. The present observations demonstrate that this concept is not general in application in the tumor field, since the prostatic cancer in man often is dependent on androgen for its survival.

In summary, it is possible by reducing the amount or the activity of circulating androgens to control, more or less but often extensively, far advanced prostatic cancer in large numbers of patients. In this special case, androgen control seriously disturbs the enzyme mosaic of the cancer cells at least with respect to the important energy producing protein-catalysts, the phosphatases. As a contribution to the problem of cancer treatment, it is well to emphasize that any interference with an important enzyme system of a cell, normal or malignant, will cause in that cell a decrease of size and function.

# COLORBLINDNESS AND THE DETECTION OF CAMOUFLAGE

By Dr. DEANE B. JUDD
NATIONAL BUREAU OF STANDARDS

ACCORDING to newspaper reports, colorblind observers have frequently been successful in spotting otherwise perfectly camouflaged positions. In order to show whether these reports can be believed, a brief analysis of the ways by which a normal observer can detect off-color camouflage must first be given.

## NORMAL VISION

A normal observer can make color discriminations of three kinds: light-dark, blue-yellow and red-green. If a camouflaged position appears neither lighter nor darker, neither bluer nor yellower and neither redder nor greener than the surrounding terrain, the observer with his naked eye can not detect it because of its color; it is therefore perfectly colored and matches its background perfectly.

## RED-GREEN BLINDNESS

The two most common forms of colorblindness are called deuteranopia and protanopia. Deuteranopes and protanopes are called colorblinds because they can not make red-green discriminations. To hide a position from such an observer as these it is sufficient to make it neither lighter nor darker, and neither bluer nor yellower than the background. It is not necessary to worry about whether the position is redder or greener than the surrounding terrain. These observers find it hard to pick out ripe strawberries from green or to pick out a rotten apple from a barrel of red apples, since the color differences involved are chiefly red-green differences. Since they can make yellow-blue discriminations quite as well as the normal observers, they are sometimes said to be only partially colorblind.

## RED-GREEN WEAKNESS

There are two other forms of abnormal vision which have to be considered. They are forms of vision intermediate between normal vision and deuteranopia and protanopia, respectively. The form intermediate between normal vision and deuteranopia is known as deuteranomalous vision, that tending toward protanopia as protanomalous vision. There are more

[33] W. W. Scott and C. Vermeulen, *Jour. Clin. Endocrinol.*, 2: 450, 1942. A. L. Dean, H. Q. Woodard and G. H. Twombly, *Jour. Urol.*, 49: 108, 1943.

anomalous observers of these types than there are partial colorblinds. About 2 per cent. of the male population would be classed as partially colorblind, and another 6 per cent. as anomalous, making altogether 8 per cent. abnormal. The protanomalous and deuteranomalous observers can make the three types of color discrimination possible for the normal observer, but their ability to make red-green discrimination is less than normal.

Other forms of colorblindness are relatively rare and associated with diseases of the eye; such eyes can not possibly compete with normal eyes for the detection of camouflage and can therefore be passed over. Likewise the fact that protanopes are distinguished from deuteranopes by being less sensitive to the long-wave (red) end of the spectrum than the normal observer has no separate special bearing on the detection of camouflage. But there is an important distinction between red-green blind and red-green weak observers, that is, between partially colorblind and anomalous observers which can conveniently be brought out by reference to an analysis of the ways by which a camouflaged position can be imperfectly colored.

### COLOR FOR CAMOUFLAGE

If a position is concealed by being covered with material having the same reflecting properties throughout the spectrum as the surroundings, then it can not be detected. Such concealment can be approximated, for example, by using the actual vegetation or dirt of the surrounding terrain, and these methods are recommended by the Engineers Field Manual wherever practicable. Cut branches, however, rapidly change color from wilting of the leaves, and dirt after a rainstorm because of difference in rate of drying out may be a giveaway, although the spectral character of the material is very similar to that of the surrounding terrain. These are examples of the most common way by which a camouflaged position becomes imperfectly colored; this way may be called the imperfect use of spectrally correct materials.

Because of the impermanence of natural materials for camouflage, paint containing more permanent colorants is widely used for camouflage. Various branches of the War and Navy Departments have issued color standards for such paints. In the formulation of such paints it is desirable to choose pigments having spectral characteristics similar to those of the elements of terrain which have to be matched, but whenever the pigments are different from those coloring the terrain, some differences in spectral reflectance have to be tolerated. Therefore, if a paint is prepared to match an element of terrain for a normal observer, there will be portions of the spectrum at which the reflectances nevertheless differ. By viewing the two through a selective filter transmitting such a portion of the spectrum, the normal observer, or any observer, would be able to see one lighter than the other, although viewed with the naked eye they would match perfectly. Color matches involving such invisible spectral differences are sometimes called pseudo matches, but a preferred terminology suggested by Ostwald is to refer to them as metamers or metameric pairs. Such pairs as exhibit marked spectral differences are called highly metameric, and are said to exhibit a high degree of metamerism. Whenever paint is used for camouflage some degree of metamerism must be tolerated; such camouflage, however accurately adjusted by the naked eye, is always open to detection by the use of selective filters, or by photographic means, the conspicuousness of the installation being proportional to the degree of the metamerism.

Thus, there are two ways in which camouflage paint may be wrong; the components may be combined in improper proportion, or they may themselves be spectrally inappropriate.

### REDUCTION SYSTEMS OF VISION

If a red-green-blind observer be shown a pair of samples which match to the normal observer, he will be unable to discriminate them. That is, normal metamers are also metamers for the red-green blind. On this account protanopia and deuteranopia are called reduction systems of vision. A red-green-blind observer fails to discriminate many pairs which are conspicuously different for the normal observer; and if the normal observer can not tell the color difference between two samples, neither can he. Therefore, if the camouflaged position be imperfectly colored solely because of choice of a spectrally imperfect material, there is no basis for expecting a red-green-blind observer to detect it.

The red-green weak observers, however, do not possess reduction systems. A metameric pair set up by a normal observer will usually be more or less off-match for a protanomalous or deuteranomalous observer. There is therefore a chance that an anomalous observer could with his naked eye detect a camouflaged position which would be undetectable by a normal or colorblind observer. But give the normal observer the correct spectral filter, and he could also detect the difference.

### EFFECT OF THE BACKGROUND

We have seen that a colorblind observer can not detect camouflage, which is at fault solely because of spectrally imperfect materials. Any advantage in substituting a colorblind for a normal observer must therefore rest in the detection of positions whose colors are imperfectly adjusted to that of the surrounding terrain. Let us inquire if there are likely kinds of blunders in applying camouflage which would be easier for the colorblind observer to detect than the normal.

A fairly common scene within which it is required to conceal a position is made up of patches of reddish-brown earth and yellowish-green foliage. The variegated pattern composed of these patches is well adapted to the concealment of a position from a normal observer. Even though it be somewhat too light or too bluish, the normal observer could fail to detect it because of the larger red-green differences in the scene. But consider the appearance of the scene to a red-green blind. The normal green of foliage to him appears dark-yellowish brown; the normal reddish brown of earth also appears dark-yellowish brown to him. He is not sensitive to the red-green differences which for the normal produce a variegated pattern; instead he may see a nearly uniform yellowish-brown field. Any element of terrain which is too light or too bluish could be quite conspicuous to such an observer. It is therefore possible to believe that a colorblind observer may detect camouflaged positions not detectable by the normal observer.

### Can Colorblindness Be Produced by Filters?

It is a natural question to raise whether this possible advantage of the colorblind can be duplicated by giving a suitable viewing filter to a normal observer. The filter required to suppress normal red-green discrimination is, of course, one which transmits only in the blue and yellow portions of the spectrum. If a filter could be found, for example, which transmits the double band 450 to 490 mμ and 560 to 585 mμ, it would render the red-green differences between grass and earth about one fifth as prominent and at the same time preserve about the same prominence of any yellow-blue differences. However, such a filter would transmit less than 10 per cent. of incident daylight, probably much less. It is a question whether any improvement in detection of lightness differences or yellow-blue differences would be obtained by a normal observer in this way even against a highly variegated red-green background. It should be noted that such a filter, although it would render a normal observer relatively blind to red-green differences, by no means makes him equivalent to either a protanope or a deuteranope. Such a filter would endow the subject of the experiment with a luminosity function having two separate maxima, one at about 470 mμ, the other at about 570 mμ, whereas the deuteranope has a nearly normal luminosity function whose maximum is at 555 mμ, and the protanope a similar function with the maximum shifted to about 540 mμ. It is possible to produce the phenomena of color blindness separately by means of filters, but they can not all be bestowed in this way upon a normal observer at the same time.

# OBITUARY

## WALTER BEAL ELLETT

WALTER BEAL ELLETT, head of the department of agricultural chemistry at the Virginia Polytechnic Institute and chemist for the Virginia Agricultural Experiment Station, died in Blacksburg, Va., on May 12, 1943. Dr. Ellett was born at Central Depot, now Radford, Va., on November 11, 1874. He was graduated from Virginia Tech in 1894 and immediately made an instructor in chemistry, earning his master's degree in 1896. He went to Germany in 1900 and graduated from the University of Goettingen in 1904 with the M.A. and Ph.D. degrees. While in Germany he studied under Tollens, Wallach, Nernst and Fleischmann. He was made head of the agricultural chemistry department in 1915, succeeding the late Professor Robert J. Davidson. He had been chemist of the Virginia Agricultural Experiment Station since 1906. Dr. Ellett was a member of the American Chemical Society and a fellow of the American Association for the Advancement of Science. His research at Virginia Tech has resulted in practical contributions to the fields of soil fertility, nitrification, fixation of phosphoric acid by the soil and fermentation. His many researches have been published in the various scientific journals and as bulletins of the Virginia Agricultural Experiment Station.

H. H. HILL

VIRGINIA POLYTECHNIC INSTITUTE

## RECENT DEATHS

DR. ARTHUR WILLIS GOODSPEED, professor emeritus of physics of the University of Pennsylvania, died on June 6 at the age of eighty-two years. Dr. Goodspeed was secretary of the American Philosophical Society from 1901 to 1935.

DR. ALBRO DAVID MORRILL, professor of biology at Hamilton College from 1896 until his retirement in 1928 with the title emeritus, died on June 8 in his eighty-ninth year.

DR. FRED W. HINDS, dean of the College of Dentistry of Baylor University, died on June 4 at the age of fifty-five years.

SIR ARTHUR NEWSHOLME, from 1908 to 1919 principal medical officer of the London Local Government Board, died on May 17 at the age of eighty-six years.