is less soluble (25°) in absolute methyl alcohol and in ethyl alcohol.

The absorption band at approximately 570 mμ has been observed by others, but its significance was never before determined. Van Eekelen, Emmerie, Julius and Wolff,[4] and Willstaedt and Jenson,[5] have postulated that the 570 mμ "chromogen" is another vitamin A. Karrer and Morf[6] suggested that hepaxanthin may give this same chromogen. On the other hand, Brockmann and Tecklenburg[7] found that oxidation products of vitamin A (*in vitro*) yield an absorption band at 570 mμ.

Further work is in progress to determine the structure of the new "carotenoid." Whether it is an intermediate metabolite of vitamin A or of β carotene, remains to be determined.

SUMMARY

A new carotenoid-like substance has been isolated from rat liver. A method for its separation and some of its properties are given.

The authors wish to express their gratitude to Dr. H. F. Seibert, of the S.M.A. Corporation, for the samples of the β carotene used in these studies.

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MOCK-DOMINANCE AND HYBRID VIGOR

Two plant varieties, one of which has twice as many internodes of half the length as the other, will be equal in height. A hybrid between these varieties will exceed their height by 12½ per cent. if internode number and length are exactly intermediate in inheritance, *i.e.*, if dominance is lacking. Here, then, is an apparent dominance for plant height, or an example of hybrid vigor in its pristine sense, that is not the result of dominance in its genetic meaning. This effect may conveniently be called *mock-dominance*. It results from the fact that plant height is determined as the product of number and length of internodes and from the relations that obtain between the means of products and the product of means.

These relations are simply shown by considering the products $A'B'$ and $A''B''$. Their mean, of course, is:

$$\frac{A'B' + A''B''}{2} \qquad (1)$$

The product of the means of the two components, on the other hand, is:

$$\frac{A'B' + A''B'' + A'B'' + A''B'}{4} \qquad (2)$$

Now:

(1) $=$(2) when $A'=A''$, or $B'=B''$, or both (3)
(2) $<$(1) when $A'>A''$ *and* $B'>B''$, or *vice versa* (4)
(2) $>$(1) when $A'>A''$ *but* $B'<B''$, or *vice versa* (5)

The relations indicated by (3), (4) and (5) apply generally to all characters that are the products of component dimensions which, in turn, are intermediate and independent in inheritance. It is evident that (3) describes what frequently may be expected in crosses between similar varieties, and (4) what may be expected when varieties similar in proportions but differing in size are crossed. The mock-dominant effect described by (5) is the expectation for characters in crosses between varieties differing in type with respect to those characters. The importance of this effect will depend upon its magnitude and its generality of occurrence. Adequate data on these points are not available.

Examples of characters in which this effect may frequently be manifest come at once to mind. The yield of grain per plant in cereals is the product of the number of grains and their average weight. Many-seeded varieties often tend to have relatively small grains and *vice versa*. Plant height has been referred to. Individual leaf area is the product of length and width. Longer corn leaves often are narrower than shorter leaves, particularly for extremes in length and width. Crosses between contrasting types should have leaves with larger areas than the mean of the parents. If the parent having leaves with smaller areas has more leaves than the other parent, there would be a cumulative mock-dominant effect on total leaf area per plant. The weight of ear in corn is the product of length, diameter and density. Length of ear, in turn, is dependent on number and length of the cob internodes, and density is even more complex.

The characters mentioned are among those the measurements of which have been largely used in the quantitative determination of hybrid vigor. They also are characters generally conceded to be controlled in inheritance by numerous genes lacking dominance. The same principles will apply to rates which are the products of subsidiary rates. Thus, growth rate is the product of the rates of cell division and of cell enlargement. Again, intense chlorophyll and small leaf area from one parent combined with weak chlorophyll and large leaf area from the other would establish a basis for superior photosynthesis in the hybrid.

[4] M. Van Eekelen, A. Emmerie, H. W. Julius and K. L. Wolff, *Acta Brevia Nederlandica*, 1: 8, 1931.
[5] H. Willstaedt and H. B. Jenson, *Nature*, 143: 474, 1939.
[6] P. Karrer and R. Morf, *Helv. Chim. Acta.*, 16: 625, 1933.
[7] H. Brockmann and M. L. Tecklenburg, *Ztschr. f. Physiol. Chem.*, 221: 117, 1933.

There is an ever-increasing body of evidence pointing to the interaction of dominant favorable genes as a sufficient explanation for hybrid vigor, and there is no intention here to explain this phenomenon on the basis of mock-dominance. The conditions necessary for its occurrence would not exist universally enough. Again, estimates based on available measurements indicate that the effects would be too small to account for any substantial part of such increases as are obtained, for example, in crosses between inbred lines of corn. Finally, it is doubtful whether even linkage and interference could excuse the failure to recover strains equal to the hybrid more frequently than has been the case in the past.

On the other hand, mock-dominance seems entirely adequate to account for the small excesses, of the order of 2 to 5 per cent., above the parental means that are reported from time to time in connection with breeding results. Whether it is a correct explanation in any case could be determined rather easily and definitely. When it is, such case will be eliminated from need of further consideration in connection with hybrid vigor in its broader sense, thus simplifying that problem. Moreover, it will be just those hybrids that are vigorous because of mock-dominance that will offer the greatest possibilities for isolating vigorous, true-breeding strains.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE PHOTOELECTRIC RELAY

THE combination of a mirror galvanometer and a photoelectric relay is ideal for the control of many systems where the null condition is to be maintained. The relay circuit described by Soller, Goldwasser and Beebe[1] was tried in the Kansas Agricultural Experiment Station milling research laboratory for the control of an adiabatic calorimeter for the measurement of the heating of damp wheat. Their circuit relies upon insulation leakage for the grid leak of the amplifier tube. Wide variations in the humidity of the air plus large voltage fluctuations in the electric current available caused frequent failure of the relay. This difficulty was overcome by rectifying the control circuit so that a grid leak of from 2 to 10 megohms could be used. The diode of a type 75 tube served for the rectification, while the triode replaced the 6C6 amplifier of the original circuit, so that the use of an additional tube was avoided.

With the introduction of the 117L7GT tube in 1940, considerable simplification was possible, since this tube has sufficient voltage amplification that the preliminary amplifier tube is not ordinarily necessary, and it also contains a rectifier section, which can be used to supply D.C. grid bias. Fig. 1 shows the circuit and specifies parts which will be satisfactory for most applications. Sensitivity may be increased by using higher values for R_3: 20 megohms should not cause instability. Adjustable sensitivity may be obtained by substituting a 1 megohm volume control for R_2. If a vacuum phototube is used instead of the gas-filled type 918, R_1 may be omitted and R_3 may be increased even to several hundred megohms if necessary for the required sensitivity.

The 117L7GT tube is rated at 45 milliamperes, but when operating on A.C. as in this circuit, the output can not be expected to be more than 30 to 35 milliamperes. For this reason the relay S_1 should operate on 30 milliamperes or less at not over 90 volts. The G. M. Laboratories type DD60B(64–14)CW relay has given good results, as has the Struthers Dunn midget relay wound for 50 volts or for 90 volts D.C. Ordinarily the screen resistor, R_4, can be omitted altogether, but some tubes have been found which overheat and fail to control if this is done, so 1,000 ohms is recommended as a minimum. If a relay operating on less than 15 milliamperes is used, R_4 should be increased to reduce the plate current of the tube to about the value required by the relay: 10,000 ohms will usually be satisfactory for relays using from 10 to 15 milliamperes.

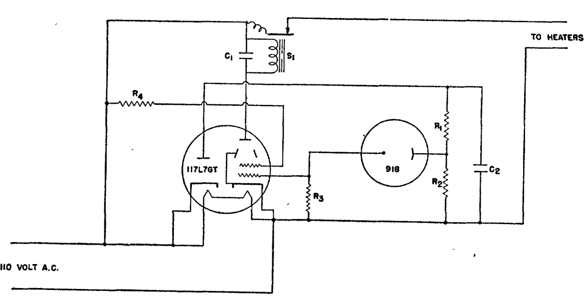

FIG. 1. C_1, electrolytic condenser, 4 or 8 mfd.; C_2, paper condenser, 0.1 mfd.; R_1, carbon resistor, 300,000 ohm; R_2, carbon resistor, 1 megohm; R_3, carbon resistor, 2 megohm; R_4, carbon resistor, 1000 ohm; S_1 relay. RCA type 918 gas-filled phototube. Type 117L7GT radio tube.

EARL B. WORKING

KANSAS STATE COLLEGE

[1] T. Soller, S. Goldwasser and R. A. Beebe, *Jour. Am. Chem. Soc.*, 58: 1703–1706, 1936.

Contribution No. 86, Department of Milling Industry, Kansas Agricultural Experiment Station.