stance is harmless when ingested by animals before it can be used in food or feed. Since such information is not yet available for diphenylamine, it is not safe to make any practical application of the results of this study.

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EDEMA IN VITAMIN E DEFICIENT CHICKS[1]

INCREASING the concentration of soluble salts in the diet has been stated by Dam and Glavind[2] to be an effective means of increasing the severity of the edema which develops in chicks fed a diet low in vitamin E. Experimental results confirming this statement have been obtained in this laboratory and were reported at the Ninth Informal Poultry Nutrition Conference held in Boston on March 31, 1942. For example, in one experiment 100 per cent. mortality resulted in a group of 9 three-week-old chicks given daily doses of NaCl solution (20 gms/100 ml) during a six-day period. Eight of the 9 chicks showed some form of edema. One of 8 control chicks given no NaCl died during the same period but showed no evidence of edema. The group given NaCl solution received 0.017 ml/gm body weight on the first day of treatment and the dose was gradually increased, reaching 0.021 ml/gm body weight on the sixth day. All chicks were fed a vitamin E-low diet consisting of dextrinized corn starch 59, dried skimmilk 20, casein 13, butyl fermentation residue 3, oyster shell flour 1, calcium phosphate 2, sodium chloride 1 and cod liver oil 1. To each kg were added 120 mg $MnSO_4 \cdot 4H_2O$, 2 mg thiamine, 2 mg 2 methyl 1–4 naphthoquinone and 1 gm choline hydrochloride.

Administration of NaCl solution was first tried because chicks fed diets similar to that given above did not develop edema as readily as did chicks fed the diet previously described,[3] which contained 54 per cent. of dried skimmilk. It appears that disturbance of the osmotic equilibrium is necessary in addition to vitamin E deficiency to cause generalized edema.

Supplementation of the diet outlined above with 20 per cent. of a practical chick mash protected chicks against edema even when NaCl solution was administered. Lower levels of the practical mash were not effective. These results were interpreted as an indication of the vitamin E content of this mash, but some doubt is cast on this interpretation by the report of Dam and Glavind that inositol and lipocaic also protect against edema.

Experiments in this laboratory on the specificity of the protective effect of vitamin E were directed toward compounds having similar antioxidant properties. Toluhydroquinone, p-xyloquinone and trimethyl hydroquinone were inactive when fed at four times the effective level of alpha tocopherol. They are also ineffective when fed to rats.[4] Beta tocopherol[5] was about half as potent as alpha tocopherol, and this also conforms to the results of rat experiments.[6]

Pappenheimer, *et al.*,[7] in their extensive studies on encephalomalacia in chicks showed that the primary changes in this manifestation of vitamin E deficiency were edema and hemorrhage resulting from alteration of the capillary walls in the brain. It now appears that such alteration occurs in other parts of the vitamin E deficient organism but is not usually sufficient to permit exudation unless the normal osmotic relationships are disturbed. The question may well be raised as to the possible relationship of capillary changes to the various manifestations of vitamin E deficiency in other species.

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ISOMORPHISM AND ISOTYPISM AMONG SILICATES AND PHOSPHATES

RECENT advances in the study of isomorphism and isotypism may be illustrated through examples taken from compounds related to two mineral groups, the garnets and the apatites. Investigations by numerous chemists and mineralogists have revealed new isomorphic and isotypic relationships among silicates and phosphates, such as the isotypism of $AlPO_4$ and SiO_2 reported by Huttenlocher. However, a complete discussion is beyond the scope of these brief comments and complete references to the diverse sources of the data are purposely omitted.

Isomorphism, in the sense of the mineralogist, is characteristic of those compounds which exhibit stereochemical miscibility (so-called mixed crystals). Limited isomorphism obtains when the stereochemical miscibility is limited, whereas complete isomorphism exists when numerous intermediate members have been proven.

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[1] Scientific paper No. A36a, Contribution No. 1857 of the Maryland Agricultural Experiment Station (Department of Poultry Husbandry).

[2] H. Dam and J. Glavind, SCIENCE, 96: 235, 1942.

[3] H. R. Bird and T. G. Culton, *Proc. Soc. Exp. Biol. and Med.*, 44: 543, 1940.

[4] C. Golumbic and H. A. Mattill, *Jour. Biol. Chem.*, 134: 535, 1940.

[5] Alpha and beta tocopherol and trimethyl-hydroquinone were furnished by Merck & Co., Inc., Rahway, N. J., through the courtesy of Dr. D. F. Green.

[6] P. Karrer and H. Fritzsche, *Helv. Chim. Acta*, 22: 260, 1939.

[7] A. M. Pappenheimer, M. Goettsch and E. Jungherr, *Conn. Agr. Exp. Sta. Bul.*, 229, 1939.

Isotypism overlaps to some extent the chemist's concept of isomorphism; it denotes compounds of equivalent structural types. Nevertheless, it is apparent that ionic substitution of the isomorphic sort is not a part of the connotation of isotypism. Actually the distinction between isomorphism and isotypism is somewhat arbitrary because it depends upon our knowledge of the mutual relationships of the compounds. Although miscibility among several isolated compounds may be unknown at present, the existence of one or more intermediate members, and hence limited or complete isomorphism, may be demonstrated at a later date.

Elementary texts on mineralogy may show the composition of garnets as $R''_3R'''_2(SiO_4)_3$, suggesting within this group the isomorphism which is well known. However, a more complex type formula is necessary to cover the phosphates, arsenates and hydrates which are now recognized as isotypes. These are:

$Ca_3Al_2(OH)_{12}$
$Ca_3Fe_2(OH)_{12}$
$Ca_3Al_2(SiO_4)_2(OH)_4$ (Pabst)
$Na_3Al_2(PO_4)_3$ (Thilo)
$(Ca_2Na)Mg_2(PO_4)_3$ (idem.)
$[Na(Ca,Fe)Al]Mn_2[(PO_4)_{2.5}(OH)_2]$ (McConnell)
$(Ca_2Na)Mg_2(AsO_4)_3$ (Bubeck & Machatschki)
$(Ca_2Na)Mn_2(AsO_4)_3$ (idem.)

These garnetoids have the type formula $X_3Y_2(ZO_4)_{3-m}(OH)_{4m}$, all are cubic and, with one probable exception, all have the space group of the common garnets (anhydrous silicates).

Isomorphism has not been demonstrated among these compounds except for the first three (Flint, McMurdie and Wells) and the last pair. However, P_2O_5 has very recently been found to the extent of about four per cent. (Mason and Berggren) as a constituent of a silicate garnet, demonstrating at least limited isomorphism of spessartite and a phosphate garnetoid. Replacements of R″ of the simple textbook formula are not necessarily bivalent elements, nor are the replacements of R‴ necessarily trivalents, although these valence conditions are almost universally fulfilled among the common garnets.

Turning to the apatites, the examples become even more complex but, again, a general formula may be devised: $X_{10}(F,OH,Cl)_2(ZO_4)_6$, where X is usually Ca or Pb, and Z is P, As or V. These compounds have been known for many years and will not be discussed. Several isotypes have been described recently and some of these are of considerable interest. They are:

$(Ce_{5.5}Ca_{3.5}Na)(OH,F)_2[(SiO_4)_{4.5}(PO_4)_{1.5}]$
(Hägele & Machatschki)
$(Na_6Ca_4)F_2(SO_4)_6$ (Klement & Dihn)
$Ca_{10}(OH,Cl,F)_2[(SiO_4)_3(SO_4)_3]$ (McConnell)

The last of these seems to form a complete isomorphous series with the corresponding phosphate compound, $Ca_{10}(F,OH,Cl)_2(PO_4)_6$.

Another very interesting feature of the isomorphism of apatite is the limited substitution of C for P, together with the suggested substitution of C for Ca. The isotypic carbon compounds, however, have not been discovered and probably do not exist. A more or less complete list of the substitutions, then, is:

$X \bumpeq$ Ca, Mn, Sr, Na, K, Ce, and, in lesser amounts, Y, La, Th, Ta, Fe, Al, Mg, and C (?).
$Z \bumpeq$ P, As, V, S, Si, Cr, and C.

Some of these are strange bedfellows indeed.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A DEVICE FOR CALIBRATING SMALL AIR PUMPS

To measure the concentration of moisture in the air at two or more levels, in connection with the development of a method for determining the rate of evaporation from land surfaces,[1] a chemical absorption hygrometer satisfactory for field use was devised.[2] An essential element of the hygrometer is a reciprocating pump of approximately 5 cc capacity per stroke, which for satisfactory operation must be accurately calibrated. Since the device that was developed for making the calibration may have other laboratory uses, it is described in the following note.

The essential operation of the device is replacing an unknown volume of air with an equal volume of water, the transfer taking place at atmospheric pressure and measuring this volume of water.

In Fig. 1, a diagram of the device (a) represents a liter flask in which water replaces a volume of air to be measured. The flask has a drain valve (b) in the bottom and a graduated glass stem (c) in the top. In the upper end of the stem is a three-position valve (d) through which flask (a) is opened or closed to the atmosphere or connected to the intake of an air pump. The stem is enlarged below valve (d) to enclose a spout (e) which is a water passage from reservoir (f) to flask (a). A glass tube (g), opened

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[1] C. W. Thornthwaite and Benjamin Holzman, *U. S. D. A. Tech. Bull.* No. 808, May, 1942.

[2] C. W. Thornthwaite, *Trans. Amer. Geophys. Union*, pp. 429–432, 1941.