of the motion of M. In the other half of this group, the light and atom will be moving in opposite directions, and, as the light must occupy a finite time in its passage through the field of influence of M, the effect of M on the light will be greater in those molecules in which the two directions coincide than can be compensated for by the equal number of molecules facing in the opposite direction in which the light and the atom approach each other and pass, but do not move together. Thus, for the molecules in which M is in motion *toward* d, there will be a resultant uncompensated effect upon the light.

The same holds true in a similar way for the molecules in which M is in motion *away* from d, but the effect which is caused by an atomic motion represented by s' turns and time t' will be different in amount from that caused by the first group. Thus a net rotation will be observed upon the emergent light.[1]

Conclusion.

The hypothesis here presented was worked out by the author in 1912. At that time no mention could be found that such an hypothesis had ever been suggested to account for the phenomena of optical activity, or, in fact, since, has one been found in the literature devoted to optical activity. The recent experimental results of Pickard and Kenyon, forming as they do, such a complete series of comparable data, have been used in the preceding paper to the exclusion of other and less conclusive results upon which previous deductions had rested. These offer for the first time an indication of the validity of the hypothesis that the phenomena of optical activity depend primarily upon an asymmetry of the attractive *Forces* exerted upon an asymmetric atom by its four adjacent atoms or groups.

CAMBRIDGE, MASS.

[CONTRIBUTION FROM THE KENTUCKY AGRICULTURAL EXPERIMENT STATION.]

THE OCCURRENCE AND SIGNIFICANCE OF MANGANESE IN THE SEED COAT OF VARIOUS SEEDS.

BY J. S. MCHARGUE.

Received October 8, 1914.

It has been observed by investigators that the different organs of some plants show considerable variation in the amount of manganese they contain. According to the researches of Jadin and Astruc,[2] the

[1] The possibility of the existence of optically active individual *symmetrical* molecules is suggested by the above, according to which a symmetrical and an unsymmetrical molecule may differ only in that the former produces an effect on the light which is compensated for by other molecules while the latter produces an uncompensated effect.

[2] Jadin and Astruc, *Compt. rend.*, 156, 2023 (1913).

aerial portions of plants contain more manganese than the subterranean. Pichard[1] also states that the seeds of plants are quite rich in this element.

While making some investigations on the occurrence of barium in plants,[2] in the spring of 1913, the writer observed that the ash of hazelnut shells emitted a distinct odor of chlorine upon the addition of hydrochloric acid, thus indicating the presence of manganese in the ash. This observation suggested an investigation on the amount of manganese in plants in general, and, in particular, as to the occurrence of this ele-

TABLE I.

Name of material.	Per cent. of Mn in the material dried at 100°.
Brown hulls of apple seed	Trace
Seed coats	0.0165
Kernels of apple seed after removing the skin	Trace
Brown hard shell of peach seed	0.0005
Brown skin off kernels	0.0110
Kernels of peach seed after removing skin	0.0019
Chestnut hulls	0.0106
Chestnut kernels after removing skin	0.0042
Horsechestnut, brown hulls, including inner coats	0.0022
Kernel of horsechestnut	Trace
Walnut, outside or soft hull	0.0015
Walnut, hard shells	0.0006
Walnut, skin off kernels	0.0100
Walnut, kernels, after removing skin	0.0033
Acorns	
Burr oak, outside shells	0.0088
Burr oak, brown skin covering kernels	0.0110
Burr oak, kernels, after skin was removed	0.0015
Cottonseed hulls	0.0026
Cottonseed meats	0.0018
Brazil nuts, hulls	0.0018
Brazil nuts, brown skin	0.0145
Brazil nuts, meats without the skin	0.0011
Almond, outer shell	Trace
Brown skin covering kernels	0.0044
Kernels, without skin	0.0009
Cocoanut, hard hull	Trace
Cocoanut, brown skin covering meat	0.0048
Cocoanut, meat, without the skin	0.0022
Cocoanut, milk	0.0002
Butter beans, skins off cotyledons	0.0037
Butter beans, cotyledons, without skin	0.0018
Wheat bran	0.0194
Wheat flour	0.0055
Corn bran	0.0011
Corn meal	0.0001
Onion	Trace

[1] P. Pichard, *Ibid.*, **126**, 1882 (1898).

[2] THIS JOURNAL, **35**, 826 (1913).

ment in the different parts of various nuts and seeds. Qualitative tests showed that manganese could be readily detected in the different parts of seeds, and closer examinations revealed the fact that certain coats surrounding the kernel contain very notable amounts of this element. Therefore, a number of analyses have been made for the purpose of showing the amount of manganese present in the different parts of the seeds of various plants. The results are given in Table I and indicate the percentage of the element manganese in the dry material.

The results in the table show considerable variations in the amount of manganese contained in the different parts of seeds of the same plants. It is to be observed that the seed coat immediately surrounding the kernel or cotyledons of seeds contains a considerably larger proportion of manganese than either the kernel or the outer epidermal coats. This concentration is especially noteworthy in the apple, peach, black walnut, acorn, Brazil nut, chestnut, almond and wheat bran. Wherever it was possible to dissect this thin membrane, usually brown in color, from the cotyledons to which it is attached, in sufficient amount for analysis, it invariably showed a higher concentration of manganese than any of the other parts of the seeds tested.

The chief interest in this connection lies in a plausible explanation of the function of the manganese at this particular point. The occurrence of manganese in this connection appears to be indicative of important biological relations, rather than a mere accumulation of either waste material or plant food.

In 1895, De Ray-Pailhade[1] observed the presence of laccase, an oxidase, in the seeds of a rather large number of different plants. In 1897, Bertrand[2] pointed out that laccase, an oxidase, obtained from the juice of alfalfa (*Medicago sativa*) contained considerable quantities of manganese, and has subsequently shown that small amounts of the salts of this element stimulated the oxygen-carrying power of the oxidizing enzymes and, therefore, concludes that this element has important biological functions in plant metabolism.

Since manganese has been shown to occur in unequal proportions in the different parts of plants and seeds of those plants, experiments were planned with the hope that some parallelism could be established with respect to the manganese content and the presence of oxidases in the different parts of the plants under investigation. In these experiments parts of raw plants were prepared and tested for the presence of oxidases by grinding a 1 g. portion with 10 cc. of distilled water, filtering through a dry filter into a clean test tube, without washing, and adding 2 cc. of a guaiacum solution. The color that developed was noted as "strong,"

[1] J. De Ray-Pailhade, *Compt. rend.*, **121**, 1162 (1895).

[2] G. Bertrand, *Ibid.*, **124**, 1355 (1897).

"moderate," "trace," and "none." The remaining portions of the same plant were then dried, ashed, and the manganese determined. The results obtained in a number of plants are given in Table II.

TABLE II.

Material.	Per cent. of Mn in the substance dried at 100°.	Guaiacum test for oxidases.
Irish potato peelings	0.0400	Strong test
Cubes cut from the center of the potato	0.0009	Trace
Brown hulls of apple seeds	Trace	Moderate
Seed coat	0.0165	Strong
Kernels	Trace	Trace
Sweet potato peelings	0.0075	Strong
Cubes cut out of the center of same potato	0.0020	Trace
Turnip tops	0.0900	Strong
Peelings off roots	0.0024	Moderate
Root meats	0.0009	Trace
Carrot tops	0.0062	Strong
Peelings off roots	not est.	Strong
Meat of roots near center	not est.	Trace
Onions, bulbs	Trace	None

While the results on the presence of oxidases in the above experiments are only qualitative, they are of sufficient importance to indicate a close relationship existing between the amount of manganese present and the depth of color produced by the guaiacum reaction for oxidases. In every case where manganese was found in appreciable amounts, a corresponding positive result was obtained for the presence of oxidases, and the absence of manganese was accompanied by negative reactions for oxidases. In these experiments it is shown that neither manganese nor oxidases are evenly distributed in the tubers and roots of potatoes, turnips or carrots, each being largely confined to the outer epidermal layers, thus indicating a close relationship between manganese, oxidases and free oxygen in the soil. In the case of the apple seeds very interesting results were obtained, inasmuch as they throw considerable light on the accumulation of manganese in the seed coats of different seeds and nuts. The seeds from a ripe apple were separated into three parts, the outer brown hull, the seed coat and the kernels, and each tested for the presence of oxidases. The outer brown hull showed a moderate blue coloration with guaiacum, the seed coat showed a strong blue coloration, and the kernels showed only a trace. A determination of manganese in each of these parts showed a larger proportion of this element in the seed coats than in the brown hulls, and only a trace in the kernels. Similar results with respect to manganese were obtained on the seed coats of the acorn, almond, black walnut, chestnut, Brazil nut, wheat bran, etc., all of which were not obtainable in the green or mature stages of growth at the time the investigation was being carried on. However, all of the last named plants are morphologically akin to the apple with respect to their seed coats.

A search through the literature upon the function and chemistry of the seed coats of various plants shows that no work has been done on this subject, and that botanists have thus far been unable to attribute any important function to this membrane in its relation to the embryo. From the above data, in connection with the researches of Bertrand and others, it is evident that a close relation exists between manganese and oxidases in plants. May we not also assume that the accumulation of manganese in the seed coat sustains a very important relation to the oxidizing enzymes in this part of the seeds? It is very probable that these enzymes have much to do with the selection, compounding and storing away of the reserve material in the kernels of seeds.

It has also been shown that fatty seeds absorb large quantities of oxygen during germination. De Ray-Pailhade[1] has shown that there was an increase in the presence of oxidases as the germination progressed. He further noted that, in the presence of laccase and free oxygen, philothion is converted into carbon dioxide, and thereby contributes to the respiration of the embryo plant.

It is therefore probable that the manganese in the seed coat also assists in stimulating the enzymes which split up the fats, sugars, starches, etc., and render them more readily available for the young seedling during the early stages of its growth.

If such be the function of manganese in plants, we must conclude that it bears a very important relation to the vital processes in seed formation and germination.

LEXINGTON, KY.

THE BITTER PRINCIPLE OF COMMON RAGWEED.

BY BURT E. NELSON AND GEORGE W. CRAWFORD.

Received October 2, 1914.

As part of a pharmacological study of ragweed, *Ambrosia artemisifolia*, Linn., Order *Compositae*, with a view to learning something of its supposed therapeutic value in the treatment of certain types of hay fever, it became desirable to isolate the bitter principle.

This was accomplished by extracting ten kilos of the partially air-dried drug with alcohol, distilling off the latter at a gentle heat, mixing the soft aqueous residue with more water and some aluminium hydroxide cream for separating the "resinoids," and, after removing the latter by filtration, clearing and defecating the aqueous filtrate by a slight excess of lead acetate. The remaining liquid was repeatedly extracted by ether

[1] J. De Ray-Pailhade, *Compt. rend.*, **121**, 1162 (1895).