interchange of phosphorus atoms takes place between the different leaves. The data in the table show also three intermediate stages in the phosphorus uptake of the plant and an increase in the ratio of 'radioactive' to total phosphorus with time.

The fact that the easy exchangeability already found for lead, which is only incidentally present in plant tissues, has also been ascertained for phosphorus, one of the chief constituents of plants, indicates that we have to do with a general property of plant constitution. To investigate this point closer, it is intended to continue these experiments with other elements.

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Biological Distribution of Metals

PROF. H. TER MEULEN'S work on molybdenum in plants[1] suggests some fundamental problems which will be best solved by spectrum analysis. The quantities of molybdenum recorded, 0·01–0·07 mgm. per kgm., are very much smaller than those in which other metals occur in plant tissues, and it is from a study of several elements, perhaps, that fundamental explanations may be discovered.

Plants and animals use certain of the elements available in the soil or food, and each form of life makes its own selection and, presumably, does so for its own peculiar metabolic needs. There are other elements which are taken in without selection and circulate in the concentration natural to those sources and, in animals at least, are passed out with the waste; in these cases the quantity of the element found will vary according to the quantity and quality of the circulating fluid in the tissue.

Many facts regarding the selective secretion of metals have been described in a paper on "Application of the Spectroscope to Biology"[2]. The position in plant life is not so simple as in animals, but results obtained from wheat plants, seeds, etc., indicate that metals used by plants are finally stored up, partly or wholly, in the seeds, a proof, perhaps, of their need and employment in the plant's economy.

Not only are certain metals stored in the seeds but also there are definite distributions of metals in the several parts of the seeds. Three analyses of seeds may be cited:

(1) *Apple seeds.* Three parts, dried in a steam oven, were studied—(*a*) the brown outer case; (*b*) the thin translucent coat of the endosperm; and (*c*) the endosperm. The average percentage results obtained from seven samples of apples, home and foreign, were as follows:

Sample	K	Mg	Ca	Sr	Mn	Cu	Fe
a	0·43	0·13	0·97	0·0050	0·0020	0·002	0·006
b	0·71	0·117	0·20	0·0005	0·0134	0·004	0·009
c	1·30	0·197	0·11	—	0·0023	0·005	0·0093

The uniform concentration of manganese in (*b*) is a noteworthy feature. Pear seeds gave somewhat similar results.

(2) *Seeds of the india rubber tree:*

Sample	K	Rb	Mg	Ca	Sr	Mn	Cu	Fe	Ni
Outer part of shell	—	—	trace	0·04	—	trace	trace	trace	—
Inner part of shell	0·5	0·009	0·09	0·50	0·003	0·007	0·008	0·01	trace
Coat of endosperm	1·8	0·050	0·08	0·08	0·001	0·006	0·013	0·025	trace
Endosperm	1·3	0·030	0·20	0·04	trace	trace	0·006	0·05	0·001

Traces of silver were present in all except the outer shell. The presence of so much rubidium is remarkable and it is also a notable constituent of latex.

(3) *Brazil 'nuts'.* Barium has rarely been found in plants or animals, but Seaber reported its presence in Brazil 'nuts'[3]. He analysed the outside and inside parts of the kernels and found up to 0·29 per cent of barium. The flame spectrographic method, by direct analysis of 0·025 gm., will detect about 0·08 per cent of barium, but no indication of that metal was found in either the outer or inner parts of the shell, or the endosperm; but the thin dark brown coat of the endosperm contained 0·7 per cent. Using larger quantities of the endosperm the presence of barium was detected, and the outer layers were found to contain more than the centre. These 'nuts' were of the Manáos variety.

A further step would be to germinate seeds such as the above and follow the metals into the parts of the stem, leaves, etc.

Nickel and cobalt are elements worthy of study, since they occur in a number of plant and animal tissues. Nickel was found in one fifth of the spices and herbal drugs analysed, mostly in traces, but St. Ignatius beans contained 0·014 per cent along with 0·003 per cent of cobalt, 0·03 per cent of manganese and 0·05 per cent of lithium. Nickel is present in tea and is constantly entering the human body. Cobalt occurs less frequently; but it appears to be a necessary constituent in the food of sheep as, in minute doses, it relieves and gradually cures 'coast disease' in Australia[4]. A similar disease, now under investigation, occurs in parts of New Zealand, and this has been cured by giving the sheep suspensions of each of two soils on which the disease does not occur. It is interesting to note that these two soils contain cobalt and nickel, while the soil on which the disease was contracted gave no indication of either metal.

Ter Meulen states that in a dozen different trees studied the molybdenum returns with the fallen leaves to the soil but that horse-chestnuts contain molybdenum which, in all probability, they withdraw from the leaves as they mature. In a previous communication[5], he reported high proportions of molybdenum, 3–9 mgm. per kgm., in beans and peas; all these indicate its concentration in the seeds. Presumably, in all the cases named above, the metals function in the leaves and are required also for the germination, etc., of the seeds. It is possible that the failure of the attempts to grow Brazil 'nuts' in Malaya and New Mexico may have been due to the lack of barium in the soils.

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