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LEAFFALL AND EXCRETION

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A dictionary of biology published as a Penguin book (ABERCROMBIE, HICKMAN and JOHNSON, 1951) defines excretion as: "Getting rid of products of metabolism (either by storing them in insoluble form, or by removing them from the body). In animals particularly applies to products of protein metabolism, organs mainly concerned being kidneys of vertebrates, Malphigian tubes of insects, and probably nephridia in many other invertebrates." The first part of this definition applies as well to plants as to animals; the second part is already an indication that excretion is often especially related to animals. Excretion of plants is generally treated in a stepmotherly way, so summarily in fact that textbooks of botany sometimes not even mention the word. Plants do not show distinct organs of excretion, and their protein metabolism is low compared with the carbohydrate metabolism. The excretion organs of animals which catch the attention, are those eliminating the waste products of the protein metabolism.

The waste products of the carbohydrate metabolism in plants, particularly carbondioxide and water, are always treated in the chapter on respiration. The elimination of oxygen is found in the chapter on photosynthesis, but it is not stressed that this is part of the excretion of plants.

To the writer's opinion FREY–WYSSLING (1945) gives a fine exposition of the excretion of plants, which he summarizes as elimination. He distinguishes between excretion, secretion and recretion, in which respectively excretes, secretes and recretes are eliminated according to the following scheme:

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resorption ─┬─→ assimilation ─┬─→ dissimilation ──→ excretion
            │                 └──────────────────→ secretion
            └────────────────────────────────────→ recretion
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Recretes are substances absorbed from the soil and eliminated without entering the system of assimilation. They are eliminated in different ways, e.g. guttation, rinsed out of the leaves by rainwater, or recreted in the plant body, for instance as calcium oxalate, calcium carbonate or silicic acid.

Secretes are the substances built up during assimilation, and do not enter the dissimilation. Cell walls, nectar and enzymes are examples of secretes.

Excretes are substances formed in the dissimilation process. Examples of these "waste products" are aethylene, tannins and alcaloids.

They leave the plant or are stored in living and dead parts of the plant, and quite often seem to be of some biological importance.

It is striking that Frey–Wyssling, who gives such a clear conception of the elimination process in plants, pays no attention to another possibility for plants to get rid of substances, viz. with parts which die and are separated from the plant, e.g. the leaves. VAN DER WOLK (1920) gave reflections on this subject without, however, mentioning exact figures.

The author had the opportunity to collect some data on this subject, and publication of these seems to be of some value. He realizes quite well that with the falling leaves substances leave the plant which can be considered as recretes, secretes and excretes, between which we cannot discriminate.

In the grounds of the Java Sugar Experiment Station at Pasuruan grows a sausage tree (*Kigelia aethiopica* Decne), a native from tropical Africa. The age of the tree is about 40 years; it is 8 m high and has a trunk free of branches of 3.5 m, with a circumference of 1.72 m at 1 m above the soil. At the end of the dry monsoon the tree drops, within a few days, all its leaves. About a week later the new leaves are completedly unfolded.

In 1952 the leaves were dropped between the 13th and 16th of November. The total mass of fallen leaves was collected and dried; the air-dry weight was 76.3 kg. Drying in vacuum at 95° C. gave a dry-weight of 66.5 kg. 1 kg (airdry) contained 1418 leaflets (mean figure from 5 counted kgs). A hundred leaflets had a total surface of 0.2877 sq. m (mean figure from 5 planimeter estimations). The total leaf surface of the crown is 311.3 sq. m.

Samples from this material were analyzed under supervision of Mr. P. J. Klokkers in the Chemical Laboratory of the Java Sugar Experiment Station. Also leaf samples collected on April 26th and July 23rd in 1952, respectively during the wet monsoon and in the beginning of the dry monsoon, were analyzed. Of this material nitrogen and ash were determined. Of the ash silicon dioxide, iron and aluminum oxide, calcium oxide, magnesium oxide, sulfate (SO_3), phosphate (P_2O_5) and potassium oxide contents were measured. Table I shows these materials all expressed in percentages of the dry weight of the leaves.

TABLE I

Chemical composition of Kigelia leaves, expressed in % of the dry weight.

Collected on:	April 26th	July 23rd	November 15th
N	1.42	1.08	0.72
Ash	20.6	23.4	26.7
SiO_2	16.0	18.0	20.8
$Fe_2O_3 + Al_2O_3$	0.06	0.05	0.16
CaO	2.51	2.90	3.58
MgO	0.25	0.26	0.21
SO_3	0.60	0.42	0.32
P_2O_5	0.41	0.30	0.19
K_2O	0.54	0.63	0.45

The author is well aware of the fact that these data are rough ones. It is not possible to give an indication in what way these compounds are present in the living tissues of the leaves. Nevertheless attention should be drawn to the fact that older leaves show a higher content of ash. Furthermore they are poorer in N, K_2O and P_2O_5 and richer in silicon and iron and aluminum oxide. In other words the older leaves are poorer in material which is more mobile in the physiological sense of the word or, according to the old traditional expression, in physiologically more important substances.

On the other hand the data give an idea of the total amount of material which a tree gets rid of when the leaves are shed. In 1952 this amounted for our *Kigelia*, calculated according to Table I, to no less than 0.5 kg N, 0.1 kg iron and aluminum oxide, 2.3 kg CaO, 0.1 kg MgO, 0.2 kg SO_3, 0.1 kg P_2O_5, 0.3 kg K_2O and 13.6 kg SiO_2.

The just mentioned phenomena, viz. that older leaves are poorer in physiologically more readily movable substances could be confirmed in three series of analyses, carried out in the same period. Samples were analyzed of just unfolded, full grown leaves and fallen leaves of *Mangifera indica* L. (mango tree), *Cassia fistula* L. (Indian laburnum) and sugar cane (Table II). In these cases too the quantity of ash of

TABLE II

Chemical composition of leaves of Mango, Cassia and Sugarcane of just unfolded (A), fullgrown (B) and fallen (C) leaves, expressed in % of the dry weight.

	Mango			Cassia		Sugarcane		
	A	B	C	B	C	A	B	C
N	2.41	1.14	0.60	3.07	1.63	0.78	0.61	0.45
Ash	6.0	10.0	12.3	6.2	6.9	6.7	8.3	14.1
SiO_2	0.40	5.5	7.4	0.07	0.23	1.74	5.00	11.9
$Fe_2O_3 + Al_2O_3$	0.04	0.03	0.05	0.04	0.09	0.03	0.02	0.02
CaO	1.15	2.71	3.33	1.22	3.05	0.18	0.19	0.22
Mgo	0.51	0.33	0.31	0.34	0.33	0.15	0.14	0.13
SO_3	0.60	0.43	0.46	0.24	0.33	0.15	0.22	0.22
P_2O_5	0.76	0.29	0.17	0.86	0.37	0.50	0.28	0.20
K_2O	1.91	0.34	0.15	2.33	0.86	2.12	1.37	0.99

older leaves was higher, and here too the contents in N, K_2O and P_2O_5 was lower. Differences in SO_3 and MgO were less striking, but the silicon content was again markedly higher in older and fallen leaves.

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