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The rôle of the epiphytic vegetation in the water balance and humus production of the rain forests of the Uluguru Mountains, East Africa

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Abstract

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The biomass of the epiphytic vegetation, its rainfall interception capacity and the humus accumulation in the epiphytic synusia have been studied in two different types of rain forests in the Uluguru Mountains, Tanzania.

Résumé

Pócs, T. (1976). La végétation épiphytique des forêts ombrophiles des Monts Uluguru (Afrique orientale) – Son importance dans le bilan hydrique et la production d'humus. *Boissiera* 24: 499-503. En anglais.

Dans les Monts Uluguru (Tanzanie), la biomasse de la végétation épiphytique, sa capacité d'interception des précipitations, et l'accumulation d'humus dans les synusies épiphytiques ont été étudiées dans deux différents types de forêt tropicale humide.

Methods

Two average plots were selected at different altitudes in the rain-forests of the Uluguru Mts., Morogoro District, Tanzania (cf. also Pócs, 1974): a submontane rain-forest in the Mwere Valley, SE of Morogoro Town, at 1525 m above sea level, and a subalpine, mossy elfin forest on the top of Bondwa Peak, S of Morogoro Town, at 2120 m altitude. The estimated rainfall (Jackson, 1970; East African Meteorol. Department, 1971; Pócs, 1974) of the two stations are 2500 and 3000 mm/year respectively. There are no dry seasons. The submontane rain-forest is dominated by *Myrianthus holstii, Parinari excelsa* and *Allanblackia stuhlmannii,* with a two- to three-stratose canopy. The epiphytes are mostly nest-forming ferns, such as *Asplenium nidus, Asplenium dregeanum, Microsorium punctatum.* The tree trunks and branches are covered with a thin layer of bryophytes. The canopy of the subalpine elfin forest is one-layered, very dense and 4-6 m high. Epiphytes occur in the form of a thick cloak, covering all stems and branches and hanging down as long beards, composed mostly of bryophytes accompanied by many lichens, ferns and orchids. In the canopy a compact layer of epiphytes develops, too.

The first task was to estimate the biomass of the epiphytes in the submontane rain-forest and the second to measure their water interception capacity. The number of phorophytes was counted as well as the average number of epiphyte nests per hectare. Different types of epiphytes were collected from a given area. Their fresh weight was measured under average weather conditions before rain, then they were moistened to their maximum water absorption capacity. After that they were left during half an hour on a wire net until the surplus water trickled down, they were weighed and finally dried at 80°C temperature in an oven until their weight was stabilized, and they were weighed again. From the above-mentioned measurements the following data were possible to obtain: the fresh and dry weight of the epiphytes per hectare, and from the difference between their fresh weight and their weight when moist, the interception capacity (expressed in % of the dry weight) of the different parts of different epiphytes. These values were applied to a model rain-forest community of one hectare, multiplied with the average number of phorophytes and nests, the average trunk surface, etc. In this way a rough approximation was obtained.

In the subalpine, mossy elfin forest the work was much simpler, because all strata were easily available (cf. also Baynton, 1968). The intercepting surface of the phorophytes was measured and all epiphytes were collected within an average area of 1 m^2. This material was treated and measured in the same way as that described above. The bryophyte floor stratum was treated in the same way but kept separate.

At the same time, the litter and humus accumulation among the epiphytes was measured. The results are summarized in Tables 1 and 2.

Results and discussion

It appears from Table 1 that, in the submontane rain forest, the most effective rainfall interceptors are the canopy microepiphytes (cf. also Hopkins, 1960), the living and dead root systems of the epiphytic nests and the accumulated humus in the latter. The amount of humus in the epiphytic synusia was 130.1 kg/ha. The water intercepted by the epiphytes represents near 6000 l/ha, which surpasses the water amount absorbed by the leaves of the canopy. The water quantity intercepted by the epiphytes is equivalent to 0.6 mm rainfall per occasion, which, even by 200 rainy days a year, is negligible. Based on these figures, the total interception (epiphytes + phorophytes) can be estimated at more than 10 000 l/ha at one occasion, which corresponds to 1 mm rainfall. This means about 200 mm rainfall interception per year, or about 8% of the annual precipitation.

Table 2 shows that the epiphytic biomass in the mossy elfin forest is about ten times larger than in the submontane rain-forest. Mostly the epiphytic vegetation consists of bryophytes, which are highly effective as rainfall interceptors, being able to absorb, together with the intermixed humus, almost 50 000 l water per hectare at one occasion. This amount, calculated upon 200 rainy days a year, is equivalent to 1000 mm (200 x 5 mm) precipitation. The canopy leaves absorb about 6000 l and the ground-covering bryophytes, again, almost 3000 l water/hectare. Finally, if the herb layer is not taken into account, almost 60 000 l water is absorbed at one occasion, which means more than 1200 mm rainfall per year.

The amount of humus in the epiphytic synusia of the mossy forests is about 2500 kg/ha. In other rain-forest types studied by the present author in the Uluguru Mountains, this value varies between 120 and 250 kg/ha only. This considerable humus accumulation is related to the great amount of epiphytic biomass and must play an important rôle in the nutrient cycling of these forests, which usually live on very poor soils (cf. Witkamp, 1971). The high water interception value of the epiphytic vegetation in the mossy forests results partly from the thick moss cover and partly from the "epiphytic" humus, both these components being very active interceptors. Thus, the above-mentioned data show the great importance of the montane mossy forests of the inselbergs and watersheds in East Africa. They defi-

	Fresh weight g	*Dry weight g*	*Water uptake by moistening g*	*Interception capacity % related to the dry weight*	*Multiplying factor per hectare*	*Interception l/ha*
Leaves of the phorophytes/m2	1638.2	1000.0	454.7	45.4	10 000	4547.1
Microepiphytes on 1 m2 area of the canopy branching system	102.5	56.5	454.8	508.0	10 000	4548.1
Microepiphytes on 1 m2 tree trunk surface	199.7	78.2	339.3	434.0	1 000	339.3
Macroepiphytes on tree trunks/ m2 leaves	183.4	23.2	73.2	45.4	1 000	73.2
Stems + roots	76.7	55.0	340.9	192.7	1 000	340.9
Nest epiphytes leaves/nest	4756.8	824.6	374.3	45.4	41	15.3
living roots/nest	3849.7	1501.2	681.6	116.4	41	27.9
dead roots/nest	2608.1	885.0	2963.5	334.9	41	121.5
litter/nest	886.4	404.4	527.6	130.4	41	21.6
humus/nest	7502.2	3173.5	8620.7	271.6	41	353.5
Total		*Dry weight*				*Interception capacity*
Nest epiphytes with humus		277.9 kg/ha				539.8 l/ha
All microepiphytes		643.2 kg/ha				4887.3 l/ha
All macroepiphytes on trunks		78.2 kg/ha				414.1 l/ha
All epiphytes		993.3 kg/ha dry weight				5821.2 l/ha

Table 1. – Submontane rain forest at 1525 m altitude.

	Fresh weight g/m2	*Dry weight g/m2*	*Water uptake by mostening g/m2*	*Interception capacity % related to dry weight*	*Interception l/ha*
Podocarpus leaves in canopy	1359.4	748.8	505.54	67.5	5 055.4
Allanblackia leaves in canopy	275.3	59.5	102.41	173.3	1 024.1
Epiphytic orchids	330.5	83.4	120.95	145.0	1 209.5
Epiphytic ferns	18.6	6.3	6.92	109.8	69.2
Litter and humus among canopy epiphytes	440.9	245.3	473.42	193.0	4 734.2
Microepiphytes on branches	1341.9	614.5	2894.20	471.0	28 942.0
Microepiphytes on trunks	706.2	278.0	1098.10	395.0	10 981.0
Microepiphytes on roots	410.3	117.1	395.79	338.0	3 957.9
Bryophyte cover of the ground	213.3	72.3	284.11	393.0	2 841.1
Total of epiphytes		10 993 kg/ha dry weight			45 159.6
Total of humus and litter		2 450 kg/ha dry weight			4 737.2

Table. 2. — Subalpine, mossy elfin forest at 2120 m altitude.

nitely play an active and important rôle in the protection of slopes against erosion (cf. e.g. Ellison, 1944; Ekern, 1950; Temple & Rapp, 1971) controlling the damaging effects of torrential rainfalls and regulating the rhythm of watercourses. It can be concluded that, in the mossy forests, about one third of the total rainfall is absorbed by the dense epiphytic cover (mostly bryophytes) and that, in the submontane rain-forests, these epiphytes do not highly influence the amount of rain reaching the ground (cf. Trapnell & Griffiths, 1960).

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