

VII. A FIELD IMPRESSION OF THE LICHEN AND BRYOPHYTE ZONATION ON MOUNT KINABALU

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Vegetation descriptions of Mount Kinabalu (4101 m), the highest mountain in tropical Asia between the Himalayas and New Guinea, have resulted in different, conflicting zonations. Some stress more on floristic affinities, others more on physiognomy. A lowland zone reaching to about 1000 m is usually distinguished. The next 2000 m comprising the mountain forests are treated in many different ways. A summit zone (above 3800 m) is recognized rather often (cf. Stapf, 1895; Gibbs, 1914; Meijer, 1963; Van Steenis, 1964; Menzel, 1988). In our opinion the most convincing is the zonation proposed by Van Steenis, who stressed the floristic composition. This comprises three zones:

1. the foothill zone below 1000 m;
2. the montane zone from 1000 to 2500 m;
3. the subalpine zone above 2500 m.

Since this zonation was based on phanerogams it was tempting to investigate whether it is reflected in the bryophytes and lichens.

For a review of the bryological exploration of Mt. Kinabalu see Menzel (1988). Substantial lichonological exploration started with the collections made by Mason Hale (US) in 1964 which remain as the main source of knowledge of the lichen flora. Before that time only scattered specimens had been collected and afterwards several more lichen collectors have been on the mountain, but their results have not been published. No list of the lichens of Mt. Kinabalu has been made as yet. A provisional search yielded records for 54 taxa mainly taken from a few recent revisions. The actual lichen flora may include several hundred species.

Our observations were made during 7 days of fieldwork between 9 and 15 May 1989. On the Southwest-slope the surroundings of the Park Headquarters and the Summit Trail (1500–4100 m) were visited, and on the South slope the Poring Hot Springs (500–900 m). Most of our collections, ca. 400 lichens and an equal number of bryophytes still have to be identified. The present report is therefore provisional and based on field observations only. The lichens will be deposited in B and the Park Headquarters, the bryophytes in NY, F, FH, L, and NICH.

The sites visited are largely the same ones where earlier bryophyte and lichen collections had been made. Notably above 2000 m all collections seem to be from the same trail. Since this sometimes follows a ridge and sometimes goes along slopes or through valleys, the local conditions of fog and shelter may have given a biased impression of the bryophyte and lichen flora. The other sides of the mountain seem to be completely unknown licheno- logically and bryologically.

Generally speaking the zonation based on phanerogams seems to be reflected in the cryptogamic vegetation. However, additional subdivisions seem to be recognizable.

1. Foothills zone, below 1000 m — Here, in the dipterocarp rain forests, the lichen flora shows the characteristics of a tropical lowland flora: scarcity of foliose and fruticose lichens, abundance of Graphidaceae, Thelotre mataceae, and foliicolous lichens. *Sticta* appears near the upper end of this zone. Common bryophytes are Calymperaceae, Fissidens, Himantocladium, Homaliodendron, Hyophila, Thuidium, and Vesicularia among the musci, and Cyathodium, Dumortiera, and Pallavicinia among the hepaticae. Many are restricted to small populations on rocks along creeks or near waterfalls in the forest. Epiphyllous hepatics are not conspicuous. Sulphureous fumes seem to have impoverished the lichen flora near the hot springs.

2. Montane zone, 1000–2500 m — In the cryptogamic vegetation a subdivision is recognizable. However, the upper zone appears to be lichenologically impoverished and bryologically characterized by increased biomass rather than species composition. This supports Van Steenis' concept of a single montane zone.

2a. 1000–2000 m: 'Oak forest zone' — The lichen flora of the montane forests below ca. 2000 m is usually rather similar to the foothills in many aspects: crustose lichens are common both on bark and on leaves, and macrolichens are not conspicuous at ground level. However, differences in species composition are apparent, e.g. a higher frequency of Stictaceae, Megalospora, and Sphaerophorus. In the tree crowns *Menegazzia* and *Usnea* are common. The bryophyte flora is characterized by conspicuous *Garovaglia*, *Hypnodendron*, *Leucobryum*, *Rhodobryum*, *Trachyloma*, and members of the *Meteoriaceae*, *Mniaceae*, and *Hookeriaceae* (mainly epiphytic *Daltonia* and epilithic *Distichophyllum*). On wet rocks in shaded sites *Diphyscium* and *Fissidens* are found and near streams in forests epiphyllous hepatics may be plentiful.

2b. 2000–2500 m: 'Mossy forest zone' — At this elevation condensation reaches its maximum. The humidity is so high and constant that bryophytes abound everywhere inside the forests and lichens are largely restricted to the emergent treecrowns. Especially crustose lichens are much scarcer than in subzone 2a. Few lichens are able to survive between the thick moss cushions inside the forest, e.g. *Lobaria* species. In treecrowns species of *Cetraria*, *Parmotrema*, and *Usnea* aff. *longissima* occur, while *Anzia semiteres* is very common. Bryologically the subzone is mainly characterized by spectacular amounts of biomass. The dominant genera are the same as in subzone 2a. Interesting finds were *Marchantia* (seen around the Kamborongoh Telecommunication Station), *Spiridens* (Meijer, 1963), several species of *Rhizogonium* s.s., and *Sematophyllaceae*. *Sphagnum* blankets start to appear on the slopes.

3. Subalpine zone, above 2500 m — Most authors have divided this zone mainly based on its physiognomy. The distribution of cryptogams indicates a considerable differentiation:

3a. 2500–3200 m: 'Dense dwarf-forest zone' — Above ca. 2500 m the humidity decreases and more lichens appear on the trees, at first on exposed ridges, here *Menegazzia* shows up with perhaps 5 species; furthermore *Anzia*, *Bryoria*, *Cetraria*, *Parmotrema*, and *Usnea*. The inside of dense forests is still very mossy, but there is much *Megalospora*, *Sphaerophorus*, and *Stictaceae* in the undergrowth, with *Leptogium*, *Menegazzia*, and

Pannariaceae in the treecrowns. The bryophytes attain both a high abundance and a high species diversity. Notably the gullies off the main trail with frequent fog and the vicinity of the Paka Cave are very rewarding places with interesting species of *Dicranoloma* (especially *D. blumei*), *Ditrichum*, *Macromitrium*, *Mastopoma*, *Orthodontium*, *Plagiothecium*, *Sphagnum*, *Funariaceae*, and *Hookeriaceae* (mainly *Calypstrochaeta*). *Andreaea*, *Racomitrium*, and *Racomitrium* start to appear at about the elevation of the Paka Cave extending all the way to the summit and thus support the concept of Van Steenis' subalpine zone. *Bryum russulum* was collected here. Among the hepatics *Takakia* (collected by Meijer, 1963, near the Paka Cave) should be mentioned. Species of *Pallaviciniaceae*, *Bazzania*, *Mastigophora*, *Plagiochila*, *Riccardia*, and *Schistochila* are very abundant. Leafy hepatics often hang down from the branches much like *Meteoriaceae* at lower elevations.

3b. 3200–3800 m: 'Open dwarf-forest zone' — Between Laban Rata and Sayat Sayat the forest is more open with still more dwarfed trees. These are less festooned with bryophytes. Locally lichens become more conspicuous. This is probably due to both a drier climate and reduced shelter from the more stunted trees. The lichens essentially seem to be the same species as at 2500–3200 m, e.g. *Bryoria*, *Everniastrum*, *Heterodermia leucomela*, *Hypogymnia*, and *Gyalectaceae* in the shrubs, *Stereocaulon* on rocks, and *Baeomyces* on the soil. Among the mosses species of *Braunfelsia*, *Dicranoloma*, and *Schlottheimia* form conspicuous clumps or cushions on trees. *Campylopus* and *Polytrichaceae* abound on bare soil. *Polytrichadelphus* was collected for the first time on Mt. Kinabalu at this elevation. Hepatics are the dominant component of the bryophytes, both in terms of biomass and of species diversity.

3c. above 3800 m: 'Summit zone' — Here the landscape is dominated by bare rockflats, whereas epiphytic habitats are scarce. Bryologically this subzone is characterized by epilithic and epigeic mosses of the genera *Andreaea*, *Campylopus*, *Grimmia*, and *Racomitrium*, and a few species of *Bryaceae*. Where water stagnates in depressions on the rocky floor *Racomitrium* may form mats. Lichenologically two subsubzones are apparent. At 3800–4000 m the rockflats are nearly devoid of lichens. Above 4000 m on the summit plateau the rocks show vertical faces with lichens. This concerns in part species which usually prefer such habitats, such as *Acarospora* cf. *chlorophana*, but also other species which normally grow on more exposed rockfaces, such as *Rhizocarpon* cf. *geographicum*. Other genera represented include *Arctoparmelia* and *Umbilicaria*.

In the vegetation of *ultrabasic* rock no special lichens or mosses were found. The stunted open forests near Layang Layang show only the restrictions due to the limited choice in substrate. There is no indication that the lichen or bryophyte flora here more resembles those of higher elevations, or that it is especially rich. The grassy vegetation on ultrabasic soil near the Paka helipad has no terrestrial lichens contrary to what one would expect on such primary soil exposures. Nevertheless this site yielded an interesting moss: *Tetraplodon mnioides*, a dung moss.

The *soil banks* along the trail, a man-made habitat, have offered new opportunities for often very showy bryophytes and lichens. However, these tend to be wide-spread pioneer species not characteristic for Mt. Kinabalu. They, also, show an altitudinal zonation. Below 2000 m *Stereocaulon* (on rocky places), *Cladonia*, and several crustose lichen species

were observed. In the humid forest between ca. 2000 and 2500 m few lichens and many Polytrichaceae (*Dawsonia longifolia*, *Pogonatum*), *Breutelia*, and hepatics were present. From ca. 2600 to 3200 m several *Cladonia* species are abundant intermingled with *Stereocaulon*. Above 3200 m the banks do not differ much from the surroundings and show *Baeomyces* and *Stereocaulon staufferi*, which can be encountered on the natural rock exposures as well. It is remarkable that no *Cladina* has been found.

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