Regeneration- and cyclic processes in the Ocotea-Forests (*Ocotea usambarensis* Engl.) of Mount Kenya

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Synopsis

The montane to submontane regions of Mount Kenya, which is located on the Equator about 180 km north of Nairobi, are covered by 2000 km^2 of montane forests or forest-like vegetation. The regeneration and succession processes of these forests have been studied and classified phytosociologically.

The evergreen broadleaved forests of the submontane region between 1500–2500 m on the wet south-western slopes of Mount Kenya are dominated by the Camphortree, *Ocotea usambarensis* Engl. Nearly all specimens of this species are of an uniform age of about 400–600 years, which indicates a long succession cycle. The dioecious *Ocotea usambarensis* rarely produces seeds during mass flowering periods every 5–7 years, and these seeds are only viable for a few days even under most favourable conditions. After natural death of old trees the regeneration originates from suckers from old rhizomes in the shade of a fast growing secondary vegetation dominated by Euphorbiacee. After dying of the pioneer species, new *Ocotea* stands of an uniform age are formed.

Over-exploitation by heavy logging inhibits the regeneration of *Ocotea usambarensis*, and the natural vegetation is replaced by monotonous secondary Euphorbiacee forests, which regenerate in a succession cycle of their own.

Mount Kenya, Montane Forest, Bergwald, Regeneration, Ocotea usambarensis, Succession, Herbivory, Herbivorie

1. Introduction

The mountain forests of the submontane to subalpine zones of Mount Kenya comprise about 20 % of the remaining natural forests of Kenya. The very diverse evergreen submontane broadleaved forests on the extremely wet south-eastern and eastern slopes of the mountain are dominated by the large Lauracee *Ocotea usambarensis* Engl., the Camphortree. This species is widely distributed in the East African mountain forests between 1300 to 2600 m altitude (WHITE 1978, 1983; FRIIS 1992), and frequently logged for its valuable hardwood. Despite the enormous economic pressure and the resulting danger for the species, nearly no studies have been carried out on the regeneration of *Ocotea* and the succession processes of the respective forest communities. Only WILLAN (1965) described regeneration problems of the Camphor from Kilimanjaro and the Usambara Mountains in Tanzania. Willans observations indicated that the regeneration of *Ocotea* in natural or artificial gaps is inhibited by species of the fast growing Euphorbiacee genus *Macaranga*.

2. Materials and methods

For the phytosociological analysis of the Mt. Kenya forests (BUSSMANN 1994), from February to July 1992, February to July 1993 and November 1993 to June 1994, 610 individual relevés were established and sampled according to the method of BRAUN-BLANQUET (1964) and MUELLER-BOMBOIS & ELLENBERG (1974), slightly modified by HAMMEN at al. (1989). The relevés were placed subjectively, each of them representing a floristic homogenous area in homogenous forest stands. The localities of all relevés were chosen directly in the field, partly after use of aerial photographs. Every sampling plot was larger than the determined minimum area which was fixed as the area where on the double sample area (starting with 1 m^2) no relevant increase of the number of species could be observed. All relevés were sampled at least twice and in different seasons, for which reason the species inventory should be more or less complete in most cases.

During the extensive phytosociological fieldwork special attention was given to regeneration patterns and succession processes in the forests, these observations leading to the regeneration cycles presented here.

3. Syntaxonomy of the Ocotetea usambarensis BUSSMANN 1994

The Ocotetea usambarensis forests with their two storied tree layer are differentiated by *Ocotea usambarensis* Engl., often dominant in the upper canopy, *Xymalos monospora* (Harv.) Baill., *Lasianthus kilimandscharicus* K. Schum., *Pauridiantha holstii* (K. Schum.) Brem. and *Psychotria orophila* Petit. in the lower tree and the often dense shrub stratum, and

Asplenium sandersonii Hook., *Asplenium elliottii* C. H. Wright as well as *Panicum calvum* Stapf. among the herbal species. Character species of this class are *Strombosia scheffleri* Engl. and *Apodytes dimidiata* Arn. in the upper tree layer and *Tabernaemontana stapfiana* Britten, *Ochna insculpta* Sleumer, *Macaranga kilimandscharica* Pax and *Peddiea fischeri* Engl. in the lower canopy and the shrub layer. *Piper capense* L., *Cyphostemma kilimandscharicum* (Gilg.) Wild. & Drum., *Oplismenus hirtellus* (Kuhn) O. Kuntze, *Plectranthus luteus* (Guerke) Stanz., *Begonia meyeri-johannis* Engl. and the ferns *Dryopteris kilemensis* (Kuhn) O. Kuntze, *Blotiella stipitata* (Alston) Faden, *Elaphoglossum lastii, Trichomanes borbonica* Bosch., *Asplenium theciferum* (Kunth.) Mett. and *Oleandra distenta* Kuntze are character species of the herbal layer. The Ocotetea usambarensis forests are found mainly on the very wet southeastern and southern slopes of Mount Kenya on altitudes between 1550–2550 m, growing on humic Niti- and Acrisols and receiving an annual rainfall of 1500–2500 mm.

4. Phenology and germination of Ocotea usambarensis

In the Mount Kenya area, the main flowering of the dioecious *Ocotea usambarensis* occurs between early March and late April, at the beginning of the long rains. A second flowering can be observed after the start of the short rains in November. In most cases however, only few trees can be found flowering during these periods, whereas every 5 to 7 years mass-flowering can be found. Most of the produced fruits are attacked by gall-insects when still unripe or are eaten by birds. The few remaining seeds are only viable for a few days, even under the most favourable conditions like high humidity and radiation. Therefore, a regeneration of *Ocotea* by seedlings is very rare.

5. Regeneration and cyclic processes

During the fieldwork reported here, a great variety of the Camphor forests was examined. Nearly everywhere only very old *Ocotea* trees of approximately 300–600 years old (stem diameter 1.2–2.5 m) were found. Very few scattered young trees (less than 100 years old) were encountered on south-eastern Mount Kenya. Seedlings of *Ocotea* were found only in a few places, obviously due to the problems described for the seed development and germination of *Ocotea*. Notwithstanding the uniform age structure, numerous *Ocotea* saplings, originating from old roots were observed. Seedlings and young specimens of the other tree species of the Ocotetea usambarensis were found everywhere, indicating the exceptive character of *Ocotea* itself, while the other species follow normal regeneration patterns and therefore form a kind of mosaic structure.

The following succession cycle appeared to be typical for undisturbed Camphor forests (Fig. 1)

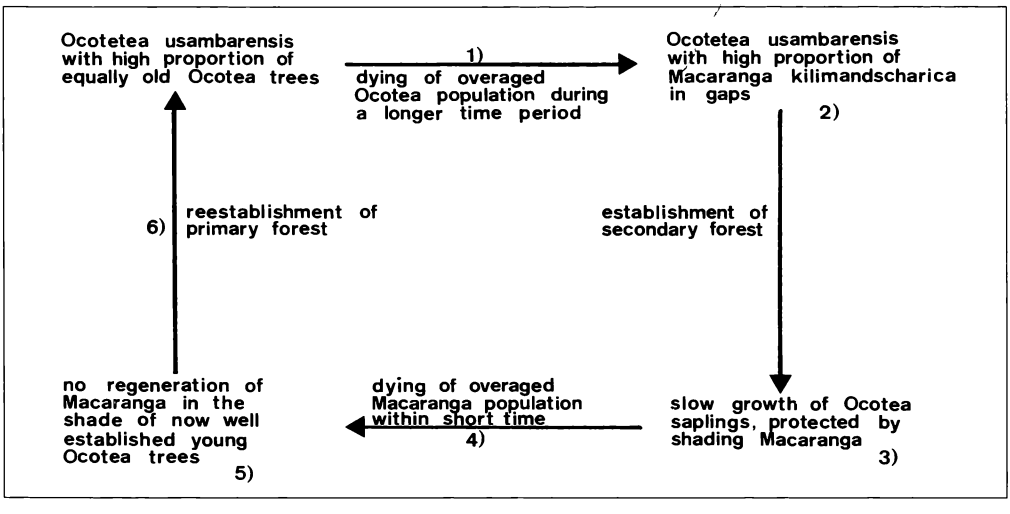

Fig. 1

Regeneration cycle of undisturbed *Ocotetea usambarensis* forests. For explanation see text.

Fig. 1

Regenerationszyklus ungestörter *Ocotetea usambarensis* Wälder; Erklärung siehe Text.

The equally old populations of *Ocotea usambarensis* trees in the Ocotetea usambarensis die over an extended period of time (1), thus creating a mosaic of gaps in which *Macaranga kilimandscharica* starts growing as secondary species (2). This leads to a Euphorbeacee forest similar to the Macarangion kilimandscharicae (BUSSMANN 1994) but only on small scale which does not change the structure of the forest to a significant extent. Regeneration of *Ocotea* from seedlings is negligible but numerous saplings from the roots of a fallen tree start growing not longer suppressed by the mother tree (3). *Macaranga kilimandscharica* seems to play an important role as shade tree because young *Ocotea* saplings apparently do not tolerate full sun. When the relatively short-living *Macaranga* trees break down, the meanwhile well established young *Ocotea* trees can close the gaps (4) and by shading prevent further germination or establishment of *Macaranga kilimandscharica* (5). Again *Ocotea* stands of a more or less uniform age result in which *Ocotea* trees generated from the roots frequently form large rings (6). Other species fill the centres of these rings which was observed frequently in the forests of Thunguru Hill.

Under conditions of heavy logging and overexploitation a different succession cycle was encountered in wide parts of the Ocotetea usambarensis forests, leading to a total change of the vegetation structure (Fig. 2).

The removal of *Ocotea usambarensis* in a large scale (1) leads to numerous big gaps in a very short time, especially as many additional trees are killed during felling, removal and transport of *Ocotea*. Even worse, the current logging practise often uses uprooting of the *Ocotea* trees and thus prevents the usual propagation by root saplings (2). The gaps are soon closed by *Macaranga kilimandscharica* and at higher altitudes by *Neoboutonia macrocalyx* (3), and. totally new vegetation types arise. Since *Ocotea* does not regenerate in these man-made »gaps« after breakdown of the pioneer trees, these secondary Euphorbiacee forests regenerate in a cycle of their own (4). The possibilities for a regeneration to primary forest are unknown, and the regeneration of the mentioned secondary forests into the original primary associations of the Ocotetalia usambarensis (5) would at least require a complete stop of logging around the »gaps«, thus enabling the removed species to intrograde from the margins. However, even then regeneration would require a very long time period. As an alternative, replanting of *Ocotea* and other primary forest species on a large scale appears possible and presumably would enable a faster regeneration.

6. Influence of large herbivores

The influence of high population densities of big game on the vegetation have been studien nearly exclusively in savanna ecosystems (BUECHNER & DAWKINS 1961; KORTLAND 1984). Only few data exist for mountain forest ecosystems (HOLLOWAY 1965; SCHMITT 1991; SCHMITT & BECK 1992).

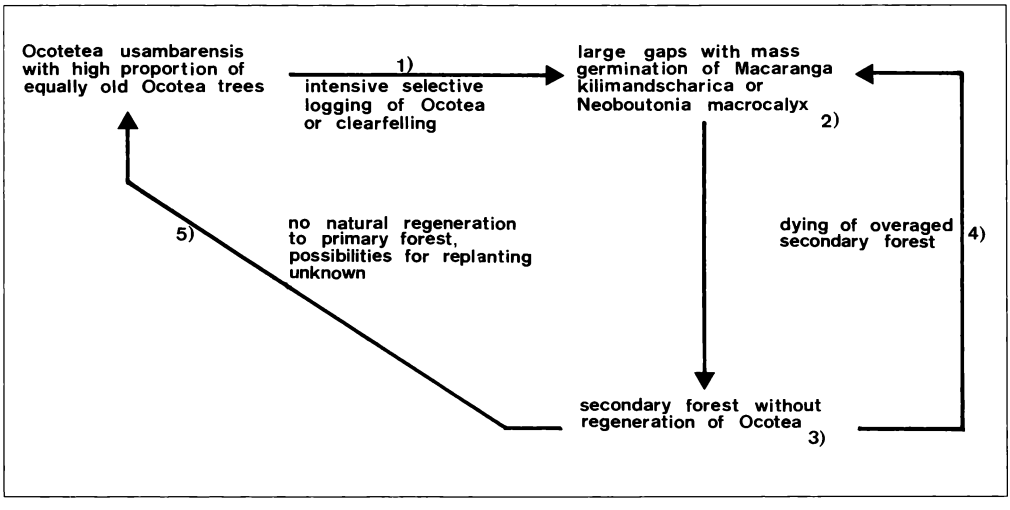

Fig. 2
Succession cycle of the *Ocotetea usambarensis* after heavy logging. For explanations see text.
Fig. 2
Sukzessionszyklus der *Ocotetea usambarensis* nach starkem Holzeinschlag. Erklärung siehe Text.

From the side of the forest administration, the high population density of big herbivores, mainly elephants, was claimed to be responsible for the failure of *Ocotea* regeneration. However, this argument could not be corroborated by the data of this study: In areas with an estimated equally high elephant population (as counted by dung), regions without heavy logging showed considerable regeneration, whereas in logging areas, especially when the *Ocotea* trees had been felled by uprooting, nearly no regeneration was observed. Therefore the main reasons for the failing regeneration of *Ocotea usambarensis* are over-exploitation and unsustainable logging practises.

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