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Abstract

The Nguru mountains in Morogoro Region are part of the Eastern Arc of Precambrian crystalline block mountains of Tanzania. These mountains enjoyed favourable climatic conditions since their uplift in the Cretaceous and on the rainy slopes forest vegetation could persist continuously. Up to the present, almost 40,000 ha catchment forest is protected in three major and several minor state reserves. The area stretches about 60 km in NNE-SSW direction and 30 km across. The massif is divided in four major groups of mountains: Messumbwa (Messumbi), Mafulumula, Manyangu and Kanga, divided from each other by deep, rocky valleys, which carry their water to the Wami river on the Mkata Plains. The annual rainfall varies between 1200-4000 mm on the rainy slopes and between 800-2000 mm on the lee side.

The following vegetation belts were observed: 1) Bamboo forests and thickets on Mafulumula summit area at 2000-2400 m altitude. 2) Altimontane elfin forests and ericaceous heaths at 2000-2300 m on the more rainy southeastern side. 3) Montane evergreen forests at 1400-2000 m, on the rainy side rainforest, above 1800 m mossy forest character with many epiphytes.

4) Submontane (intermediate) rainforests on the E slopes, mesic forests on the W slopes at 800(900)-1400(1500) m. 5) Lowland rainforests in the E facing valley, miombo woodland and dry semi-evergreen forest on the drier and more open slopes between 300 and 800 (on the W up to 1200 m).

Among edaphic communities, there exists rich rock vegetation on the granitic cliffs and evergreen riverine forests rich in rainforest elements along Mjonga, Diwale, Divue and Mkindo rivers. On the alluvial Mkata Plains *Acacia* - *Cassia* wooded grassland dominates on mbuga (black cotton soil, vertisil) alternating with permanently waterlogged *Papyrus* swamps and groundwater forests and with miombo woodland on the clayey and with *Combretum* woodland on the sandy projections.

The flora of the area is still quite unexplored, due to its difficult accessibility, especially the central plateau. Recent explorations resulted in many discoveries of undescribed new species or endemics previously known only from the Usambara, Uluguru or Ukaguru mountains. We know several strict endemics of the Nguru mountains mainly from the exploration by Schlieben from the 1930s. The Nguru mountains, together with the Ulugurus, Ukagurus and Usagaras, can be considered, as the "core area" of the crystalline arc mountains in eastern Tanzania.

Tamás Pócs, Research Institute for Botany, Hungarian Academy of Sciences, H-2163 Vácrátót, Hungary.

Ruwa-Aichi P.C. Temu, Dept. of Forest Biology, Sokoine University of Agriculture, P.O. Box 3010, Chuo Kikuu, Morogoro, Tanzania.

Thadei R.A. Minja, Morogoro Region Catchment Forest Project, P.O. Box 1020, Morogoro, Tanzania.

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SURVEY OF THE NATURAL VEGETATION AND FLORA OF THE NGURU MOUNTAINS

by Tamás Pócs, Ruwa-Aichi P. C. Temu & Thadei R. A. Minja

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INTRODUCTION

History of exploration

The Nguru mountains remained relatively unexplored until the present times, probably due to the difficult accessibility of its central part: no roads exist in the mountains above 500-800 m altitude except footpaths. The first botanical collectors in the area were Stuhlmann, Peter and Sacleaux; between the two World Wars Schlieben's activity is to be mentioned, who first visited the highest summits of the mountains (Mafulumula and Messumbwa) and collected many of their endemics, then Semsei and Kibuwa, the first Tanzanian collectors, before and after Independence. Drummond and Hemsley, later Brenan and Greenway, also visited the area. Between 1969 and 1989, Pócs paid 11 visits to the mountains, accompanying or accompanied by Mabberley, Schlieben (who revisited the mountains in 1971), the Csontos brothers, more recently R.P.C. Temu, V.R. Nsolomo, L. Mwasumbi, J.C. Lovett, D.W. Thomas, S. Bidgood, K. Vollesen, A. Persson, T.R.A. Minja and E. Knox. Apart from them, M. Thulin, Mhoru and R. Schippers made important collections in recent times, (cf. Gillett 1961; D. Polhill 1988).

The only botanical accounts (beside the descriptions of new species) published hitherto are the list of woody endemics of Uluguru and Nguru mountains by Polhill (1968) and an account on its tree vegetation (Lovett & Thomas 1988).

Geographical conditions

Nguru mountains are typical part of the Eastern Arc chain of Precambrian block mountains in coastal Tanzania (and S Kenya). Geologically they belong to the Usagaran layer of the Mozambique Belt, consisting of metasedimentary and meta-igneous rocks such as granulites, gneisses and anorthosites. The mountain range was uplifted and faulted parallel to the present Wami River, at the eastern edge of the South-Central African Plateau in the Cretaceous. Since that period forest vegetation could develop practically undisturbed under the protecting shield of Indian Oceanic climate, probably escaping from the repeated dry periods which devastated the inner parts of continental Africa so many times. During the dry periods the areas between the mountains were covered by dry grasslands and woodlands, therefore the forested hills were isolated from each other and the forest floras developed as if in islands, producing a number of endemics in many taxonomic groups (like in *Saintpaulia*, *Streptocarpus*, *Impatiens*, *Pavetta*, *Psychotria*), which have now indigenous species in each mountain group. The final result is a very ancient forest flora with elements reflecting old Gondwanalandic, Palaeotropical and West African links and with many endemics.

The present climate of Nguru mountains is still oceanic, humid tropical on the eastern and semihumid on the western side, with a double rainy season. As rainfall records are scattered, it is difficult to give a full picture of the rainfall distribution, but by extrapolations and vegetational observations we can conclude that on the eastern slopes the mean annual rainfall varies between 1200 and 4000 mm, on the western slopes between 800 and 2000 mm, being lowest at the foothills and highest between 1800 and 2100 m altitude. The wettest are the central valleys on the eastern side (Diwale, Divue), while the slopes of Massumbwe and Kanga are drier. In the wet, E facing Diwale Valley, at 520 m altitude, Mhonda Mission recorded 2003 mm rainfall as a 7-year average. The driest part of the mountains is the Ndole - Digobeke basin on the western side in the rainshadow of the central plateau and highest summits. Above 1000 m altitude on the east and above 1500 m on the west, rain can occur in any season, although its maximum distribution follows the short rainy season between October-December and the long rains in March-May. The mean annual temperature varies between 25°C (eastern foothills) and 15°C, with occasional frosts (Mafulumula summit) if we use the approximation proposed by Pócs (1976:163).

The topography of Nguru mountains is very variable. To the East, the mountain chain emerges quite abruptly, with steep slopes and sharp, rocky ridges from Mkata Plains, the alluvial valley of Wami River, practically along the Mwomero - Kanga road, which connects the Morogoro-Dodoma highway through Handeni to the Tanga-Arusha highway. The lowest points along this road are at 360 m at Kwadihombo and at Turiani. The western and northern slopes in general are less steep although Messumbwa has magnificent cliffs also on its west face. On the western and northern sides several small basins are formed of various altitude between 600 and 1000 metres, with a watershed between Lukigula and Chogowale streams which limit the mountains from the West, and turning eastwards form natural borders also on the North and South, finally carry their waters in the Wami.

The Nguru mountains form a chain consisting of four parts. To the South, Massumbwe (called also Messumbwa, Messumbi) with its 2110 m rocky peak forms a magnificent bastion well visible from over 100 km distance. It is connected to the central plateau of the mountains by a 1400 m high saddle. The central plateau is a more or less rectangular area with almost 100 km² surface above 1800 m altitude. It is very rich in rainfall and highly dissected by many streamlets, which arriving at its edge, give way to huge waterfalls, e.g. the 250 m high Chazi Falls. The summits on the plateau are not steep, e.g. the highest point of the mountains, Mafulumula Peak (2400m) hardly emerges from the surrounding area and is not well visible. On the other hand, the escarpments of the plateau are very rocky and steep, forming several hundred metres high cliffs in all directions. Probably these circumstances made the area so difficult to access for botanists. The central plateau is separated by Diwale River valley from the block of Manyangu or Masimba Hill, which is also plateau-like with a 1920 m summit and abrupt,

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rocky faces to the West and to the North. The Diwale Valley serves as an important connection between the eastern and western sides of the mountains, between Turiani and Maskati or Pemba villages. This footpath is the best approach to the central plateau as well. The SSW-NNE directed chain of the three above-mentioned blocks is then interrupted by the deep (420 m) Mjonga Valley, which separates the block of Kanga mountain. Kanga is not in the line of the previous chain; it stands isolated at 7 km distance east from the northernmost Manyanga block. Between the two, the range of 750 m high Matomondo hills is found. Kanga mountain consists of three high, very spectacular peaks of 2019, 1725 and 1740 m altitude. Their regular steep cones are well visible from very long distances, like from Morogoro, Chalinze or even from Korogwe at 120 km to the Northeast.

The most important human settlements are along the Mwomero-Kanga (-Handeni) road, where the wet tropical climate coincides with fertile alluvial soil conditions. Here crops of the humid tropics are widely grown as rice, coconut, sugarcane, cocoa, jackfruit, breadfruit, avocado, pineapple and the largest teak plantation in the country (Mtibwa). The largest settlement is Turiani, with the division headquarters. Mtibwa is important besides its teak plantations due to its sugar industry. Mtibwa Sugar Estate is again one of the largest in Tanzania. This virulent agricultural activity and industry is kept alive by the permanent waterflow from the mountains. Therefore the catchment area of Nguru mountains is vital for this densely populated part of Tanzania. Luckily, at the moment 37,384 ha catchment forest is under government control (Morogoro Region Catchment Forest Project) within 3 major forest reserves: Mkindo, Nguru South and Kanga. The other forest reserves either belong to local authorities or cover low hills or alluvial land. Nguru South Forest Reserve (including Manyanga F.R.) is by far the largest and most important, covering the highest rainfall area.

There are problems with encroachment (Chamshama, Nsolomo, Persson 1990), although these are not as serious as in many other catchment areas. But, as a high rainfall area, the risk of deforestation is higher than elsewhere and as its result, during the torrential rains in 1971 and in 1988-89, serious landslides occurred on the slopes above Turiani, which claimed several human lives and hectares of fertile land surface.

VEGETATION

The Ngurus belong to the few mountains of East Africa, where, at least in certain parts, all natural vegetation belts can be observed from the lowland rainforest to the altimontane *Arundinaria alpina* bamboo thicket. The vegetation zonation of Nguru mountains is comparable to that of the Ulugurus (Pöcs 1976), as a basically North-South oriented block mountain with an obvious asymmetry between the eastern and western slopes due to the overwhelming East-West direction of winds carrying the precipitation. On the slopes, the forest belt is much more intact than in the Ulugurus, at least on the rainy eastern slopes above Turiani. We try to characterize the vegetation zonation based on a transect made in this part (see Fig. 4) with reservation for the fact that the Kanga mountain on the Northeast and Massumbwe block on the southern end are much drier than this central part, hence the zonation is different. The vegetation belts (zonal vegetation types, climax belts) from up to down are as follows:

Bamboo forests and thickets

Arundinaria alpina forms a quite continuous belt on the summit and western slopes of the highest Mafulumula peak between 2000-2400 m altitude. Isolated stands occur also on the ridges near the southern edge of the plateau and on the isolated summits above Maskati. These bamboo stands occur above and behind the wettest slopes, but obviously occupy the coolest belt of the mountains. *Arundinaria* occur on the western slopes in mixed stands down to 1850 m altitude. The undergrowth of the monotonous, shady stands is quite poor in other phanerogams; *Streptocarpus bambuseti*, *Asplenium linckii*, among shrubs *Peddiea subcordata* and *Rauvolfia marni* can be mentioned.

Elfin forests and Ericaceous heaths

Elfin forests: altimontane stands of stunted, 3-6 m tall trees with very dense, microphyllous, evergreen canopy occur only on the summits of most oceanic parts of tropical West and East Africa - in Tanzania in the Uluguru, Uzungwe, Ukaguru and Nguru mountains, fragments in the West Usambara and Pare Mts. They can occur at the upper climatic forest limit or among special edaphic conditions, on highly leached peatlike soils on wind exposed, very rainy ridges and peaks (Van Steenis 1972; Pócs 1974, 1976). We know them from the Nguru mountains from the central plateau, at the headwaters of Chazi and Divue streams, dominated by *Syzygium cordatum*, *Podocarpus falcatus*, *Garcinia volkensii*, *Polyscias stuhlmannii* and *Rapanea melanophloeos*, at 1900-2400 m altitude. *Dissotis dichæanthæroides* is a constant endemic element in its shrub layer, where a new species of giant *Lobelia* was also discovered recently (*Lobelia nitabaeniana** Knox ined.). In the canopy, on thin branches *Tridactyle brevifolia**, a tiny orchid, seems to be common, while on larger branches *Stolzia viridis** is creeping. Among trunk epiphytes *Sphaerociconium splendidum* is the most common. The ground is covered by the cushions of *Synrhopodon stuhlmannii* and a *Sphagnum* sp., on shady cliffs among many Hymenophyllaceae *Pityrogramma aurantiaca** occur. Lovett and Thomas (1988) report from the summit of Kanga peak a similar community, among somewhat drier conditions, with the occurrence of a new *Afrosersalisia* sp., *Ilex mitis* and *Cussonia lukwangulensis**.

On shallow, rocky soil, elfin forests are usually replaced by 2-3 m tall, open Ericaceous heaths dominated by *Erica arborea* and *Phyllippia* spp., with *Stichenus inflexus*, *Blechnum punctulatum*, *Asplenium buettneri* (central plateau); *Notonia amaniensis*, *Polystachya tayloriana*, *P. adansoniae*, *Rangaeria muscicola* (Kanga SE ridge 1300 m) in the herb layer. On the S face of the rocky Kanga peak a very interesting heathlike community occurs at 1300-1400 m altitude. It is formed by 2-3 m tall *Xerophyta spekei* bush, with creeping *Neobenthamia gracilis* (orchid) and *Urogentias ulugurica** (see also Lovett and Thomas l.c.). In contrast to the usual habitat of *Xerophyta* (Velloziaceae) bush, this extraordinary heath is wet and on the seeping rocks large cushions of *Sphagnum* occur.

Evergreen montane forests (Afremontane forest, White 1983)

Various types occur in the Nguru mountains, according to the varying altitude and rainfall:

Mossy montane rainforest

It is the most luxuriant type of montane forests, developing on the upper slopes of the rainy, eastern side with rain above 3000 mm a year, at 1800-2000 m altitude, usually in contact with the elfin forests. The canopy is formed by the same species as in the following type, but differs by the large amount of epiphytes, mostly ferns and bryophytes, covering the trunks, branches and shrubs. They are close to those described from the Uluguru mountains (Pócs 1974, 1976), but differ in a number of endemic species, such as *Cincinnobotrys ranarum** (undescribed) besides the common *C. oreophila*, *Streptocarpus bambuseti*, an undescribed *Pavetta* and *Impatiens*, with the large masses of an endemic treefern: *Cyathea humilis* var. *pynophylla*. An undescribed orchid, *Mystacidium nguruense*, is common as a trunk epiphyte here.

Montane rainforests

Occupy large areas all over the mountains, on the eastern slopes between 1400-1800 m, on the western side between 1600 and 2000 m altitudes. Dominant species in the canopy: *Ocotea usambarensis*, *Podocarpus falcatus*, *Allanblackia uluguruensis*, *Syzygium guineense*, *Parinari excelsa*, *Xymalos monospora*, *Dombeya burgessiae*; on the SE slopes of Kanga peak according to Lovett and Thomas (l.c.): *Agauria salicifolia*, *Aphloia theiformis*, *Cassipourea congoensis*, *Cryptocarya liebertiana*, *Garcinia volkensii*, *Ilex mitis*, *Maesa lanceolata*, *Macaranga capensis* var. *kilimandscharica*, *Myrica salicifolia*, *Nuxia congesta*, *Polyscias stuhlmannii*, *Rapanea melanophloeos*, *Schefflera goetzenii*, *Rawsonia reticulata* and others. The shrub layer of these montane forests is rich in endemic (partly undescribed) *Pavetta*,

* indicates records new to Nguru mountains

Lasianthus and *Memecylon* species (e.g. *Memecylon amaniense*), 3 species of tree ferns (*Cyathea manniana*, *C. fadenii* and the endemic *C. humilis* var. *pyncnophylla*). Common epiphytes are *Vittaria guineensis* var. *orientalis*, *Impatiens keilii*, *Elaphoglossum aubertii* and other species, *Grammitis pygmaea*, *Sphaerocionium splendidum*, *Trichomanes parvulum*, *T. erosum*, *Hymenophyllum sibthorbioides*, *H. kuhnii* and other Hymenophyllaceae, *Asplenium dregeanum*, in the ground layer *Asplenium holstii*, *Brachystephanus africanus*, *Dorstenia hildebrandtii* var. *schlechteri*, the endemic *Impatiens mesumbaensis*, *Blotiella stipitata* and *Blechnum* species are typical.

Mesic montane evergreen forest (Undifferentiated afro-montane forest sensu White 1983)

These occur on the drier, mostly western slopes of the Nguru mountains, more commonly on the southern and northern parts, usually between 1500 and 2000 m. While the composition of their canopy layer is very close to the previous types, the scantiness of epiphytes, lack of tree ferns and the much less hygrophilous undergrowth well distinguishes it. In the shrub layer *Psychotria goetzei* and *P. cryptogrammata*, *Euphorbia schimperiana* var. *pubescens*, *Coffea mufindiensis*, *Turrea holstii* and *T. floribunda*, *Flacourtia indica*, *Pavetta mshigeniana* and *P. sparsipila*, in the herb layer interesting grasses as *Ehrharta erecta* var. *abyssinica*, *Festuca africana*, ferns like *Cytomium caryotideum* var. *micropterum*, *Christella parasitica*, *Polystichum fuscopaleaceum*, among balsams *Impatiens kentrodonta*, *I. nana*, *I. sodenii*, among Acanthaceae *Brachystephanus africanus*, *Crossandra tridentata* and *Barleria amaniensis*, among sedges *Carex echinochloë* and *C. chroosaccus* occur in larger amounts, East of Maskati at 1500-2000 m altitude.

Submontane rainforests (Transitional rainforests of Moreau, 1935 and White, 1983)

The highest, most complex forests of the mountains, containing the largest timber volume. They occupy mostly the eastern slopes in all parts, between 800-900 and 1400-1500 m altitudes. In their structure and species composition they are closely related to the similar forests of East Usambara mountains, near Amani (Moreau 1935), in the West Usambara (Hall 1981; Lovett 1985, 1989), Jluguru (Pócs 1976) and Uzungwe mountains (Lovett 1984). Their canopy is three-layered with 40-55 m tall emergents. Common canopy trees are in the Diwale valley system near Mhonda according to Lovett and Thomas (1988): *Afrosesalisia cerasifera*, *Albizia gummifera*, *Allanblackia stuhlmannii*, *Isodeiopsis stuhlmannii*, *Cephalosphaera usambarensis*, *Chrysophyllum gorongosanum*, *Cylicomorpha arivifera* (especially on places previously logged), *Drypetes reticulata*, *Ilex mitis*, *Isobrerlinia scheffleri*, *Leptaulus holstii*, *Leptonychia usambarensis*, *Macaranga capensis* var. *capensis*, *Mesogyne insignis*, *Pyrianthus holstii*, *Ochna holstii*, *Octoknema orientalis*, *Odyndea zimmermannii*, *Parinari excelsa*, *Andanus* cf. *engleri*, *Polyscias fulva*, *Strombosia scheffleri*, *Trichoscypha uluguruensis*, *Trilepsium adagascariensis* and *Uvariadendron usambarense*; only above 1000 m: *Beilschmiedia kweo*, *Garcinia ngaensis*, *Lasiodiscus usambarensis*, *Newtonia buchananii* and *Zenkerella egregia* (small tree).

In the shrub layer *Chassalia albiflora*, *Gravesia riparia**, *Lasianthus cereiflorus*, and *L. himanscharicus*, *Lobelia longispala*, *Pavetta mshigeniana** and other species, *Piper capense* and *P. nbellatum*, *Memecylon cogniauxii* and *M. schliebenii* are important.

In the herb layer we could observe in the Diwale valley system: *Leptaspis cochleata*, *morphophallus stuhlmannii*, *Renealmia engleri**, *Gymnosiphon usambaricus*; among Commelinaceae: *Alisota schweinfurthii* and *Starfieldiella imperforata*, among orchids: *Calanthe sylvatica*, *Didymoplexis africana** and *Malaxis prorepens*, on boulders *Bulbophyllum intertextum*; among Acanthaceae: *Menandriopsis afro-montanus* and *S. warneckei*; among ferns: *Asplenium mannii*, *A. macrophlebium*, *A. bilaterale*, *Antrophyum mannianum* (on shady cliffs, together with *Vandenboschia radicans*), *Marattia xinea* and *Pteris kiviensis*, on irrigated streamside rocks: *Elaphoglossum spatulatum* and *haerostephanos arbuscula*.

The most important epiphytes are: *Asplenium nidus*, *Grammitis kymbilensis*, *Lycopodium crydioides*, *L. holstii* and *L. verticillatum*, *Vittaria lenormandii* and *V. guineense* var. *orientalis*, *Procris nata* and *Viscum shirens* (Semiparasite).

Among climbers worth mentioning are: *Basella alba*, *Danais xanthorrhoea** and *Dioscoreophyllum kensii*.

These submontane rainforests were, together with the lowland rainforests in Diwale valley, the most favoured targets of sawmills (one operated for a long period in Manyangu Forest Reserve) and pitsawers at the present time. As a result, the once common *Entandrophragma excelsum* is almost extinct. In Manyangu forest near the former sawmill, replacing the exploited timber, *Maesopsis eminii* is planted and *Cephalosphaera usambarensis* regenerated with success.

We observed much drier types of submontane evergreen forests on the western slopes below Maskati and on the southeastern ridge of Kanga mountain, between 900 and 1300 m altitude, mostly on rocky habitat. We know the Kanga stands better. The canopy of these forests differs by a few more xerotolerant elements, such as *Cola greenwayi* and *C. stelenacantha*. On boulders large stands of *Phoenix reclinata* occur. In the shrub layer of Kanga stands a new species of *Encephalartos*, *Memecylon erythrodontum*, *Schizozygia coffaeoides*, *Psychotria tanganyicensis*, *P. lauracea*, *Asparagus racemosus*, *Maytenus undatus* occur. In the herb layer among ferns *Asplenium paucijugum*, *A. buettneri*, *A. holstii*, *A. pellucidum* ssp. *pseudohorridum*, *A. rutifolium*, *Arthropteris orientalis*, *Dryopteris inequalis*, *Elaphoglossum lastii*, *Pellea schweinfurthii*, *Pteris similis*; among phanerogams *Carex spicata-paniculata*, *Cynorkis uncata*, *Saintpaulia brevipilosa* and *Lefebvreia droopii* are worth mentioning. As epiphytes, *Angraecopsis tenerima*, *Belvisia spicata*, *Vittaria volkensii* and *Streptocarpus kirkii*, in deep shade *Hymenophyllum kuhnii* and *Trichomanes melanotrichum* were observed.

Lowland vegetation between 360 and 800 (1200) m

Several important vegetation types occur in this zone on the lower slopes of Nguru mountains, differing from each other in the amount of available rainfall and in the effect of fire.

Lowland rainforests

The best known stands occur in the Diwale valley and on its side valleys between 550 and 800-900 m altitude, especially at the southern foot of Manyangu. Probably there are more remnants in the lower parts of Divue and Mkindo valleys. Unfortunately, most areas once covered by these forests are now under cultivation and only small coppices indicate their former presence, consisting of typical lowland forest trees, as *Tetrapleura tetraptera*, *Parkia filicoidea*, *Erythrophloeum suaveolens* or *Milicia excelsa*. The canopy of lowland rainforest is tall, but in Nguru mountains not as variable as that of the submontane forests. Canopy trees behind the former Manyangu Sawmill are: *Anisophyllea obtusifolia**, *Erythrophloeum suaveolens*, *Cylicomorpha parviflora*, *Cephalosphaera usambarensis*, *Mesogyne insignis*, *Milicia excelsa*, *Parkia filicoidea*, *Rhodognaphalon schumannianum*, *Tetrapleura tetraptera* and *Uapaca paludosa* (in some parts dominant emergent, with stiltrooted base). Lower trees: *Memecylon erythranthum* (cauliflorous), *Dicranolepis usambarica*, *Mesogyne insignis* (more often than in canopy). In the ground layer: *Hypolytrum testui**, *Renanthera engleri**, *Marantochloa leucantha*, *Palisota schweinfurthii*, *Calvoa orientalis*, *Justicia matammensis*, *Geophila obvallata* ssp. *loides*, *Psychotria pocsii*, *P. usambarica* and *P. tanganyicensis* are typical. Among epiphytes *Asplenium nidus*, *Culcasia orientalis*, *Pyrrosia lanceolata* and *Antrophium immersum*, among orchids *Polystachya tessellata* and *Solenanthes aphylla* should be mentioned.

In the Mkange Valley of the ESE slope of Kanga mountain we observed similar lowland rainforest at 700-800 m altitude, among a bit less humid conditions, without *Uapaca*, and with dominant *Parkia filicoidea* and with *Terminalia sambesiaca* in the canopy, *Erythrococca polyandra*, *Cola greenwayi* and *C. stelenacantha* in the second tree layer. *Uncaria africana* ssp. *africana** is an interesting Rubiaceae climber, occurring together with the halfwoody *Thunbergia kirkii*.

Dry semi-evergreen forests (Zanzibar-Inhambane undifferentiated forest partly, sensu White, 1983)

Climatic climax on the drier slopes of the low belt in Nguru mountains, characterized by moderately tall canopy trees (about 25 m), partly deciduous species, especially the emergents. The presence of succulents (*Euphorbia candelabrum*, *E. quadrialata*, *Sansevieria* spp.) and treesized *Pandanus* cf. *engleri* is also typical. On the SE slopes of Kanga Mt. *Cola* species with different Rutaceae (*Teclea*,

Zanthoxylum) are the dominants in this type, intermixed with *Scorodophloeus fischeri*, *Sterculia appendiculata*, *Erythrophloeum suaveolens*, *Milicia excelsa*, *Antiaris toxicaria*, *Rhodognaphalon schumannianum*, *Tabernaemontana pachysiphon*, *Bequaertiodendron natalense*, *Erythrina saculeuxii*. In the shrub layer *Schlechterina mitostemmatoides*, the interesting heterophyllous Passifloraceae shrub is typical, in the herb layer *Nephrolepis biserrata*, *Phymatodes scolopendria*, *Hillieria latifolia*, *Pouzolzia parasitica* occur.

Miombo (*Brachystegia*) woodland

Miombo woodlands are common on the drier lower slopes of Nguru mountains and foothills, as fire climax, usually developing due to the effect of regular fires, from the dry semi-evergreen forests. Not necessarily all miombo are fire derived. Probably on shallow, rocky soil miombo occurred as primary vegetation and spread secondarily. The miombo are best developed on the two ends and on the western slopes of the mountains, where it can go as high as 1200 m altitude. The dominant trees are *Brachystegia microphylla*, *B. boehmii* and *B. spiciformis*, *Pterocarpus angolensis*, *Julbernardia globiflora*, *Pteleopsis myrtifolia*, *Stereospermum kunthianum*, *Diplorhynchus condylaecarpon*. In the shrub layer *Securinea virosa*, *Deinbollia borbónica*, *Anona senegalensis* and *Uvaria acuminata* are common (near Kanga and Kwedilomba villages). The herb layer is dominated by tall grasses (*Themeda triandra*, *Hyparrhenia rufa*) and by sedges (*Cyperus hemisphaericus* and others).

Edaphic communities

Rock vegetation

On the rock cliffs of Nguru mountains, depending on their altitude and humidity, very different communities develop. *Aloë schliebenii*, a very isolated endemic of the mountains (Lavranos 1969) generally occurs in rock habitat between 1000-2400 m, associated to very different plants. On dry, W exposed rocks above Maskati at 2000-2100 m altitude *Eragrostis olivacea* accompanies it, with *Crassula schimperi* ssp. *phyturus*, the monotypic endemic *Thulinia albolutea* (orchid), *Conyza newii*, *Pellea longipilosa*, *Pentas lanceolata* ssp. *quartiniana* and *Blaeria* cf. *breviflora*. On the wetter, open Kanga peak Lovett and Thomas (1988) observed *Streptocarpus hirsutissimus**, *Impatiens sodenii* and *Urogenias ulugurica**. On the half-shaded cliffs of Mafulumula (E side, 1850 m) we observed *Streptocarpus saxorum* associated with *Aloë schliebenii*, accompanied by *Selaginella caffrorum*, *Crassula schimperi* ssp. *phyturus*, *Elaphoglossum acrostichoides*, *Helichrysum schimperi* and *Impatiens sodenii*, among mosses *Rhacocarpus purpurascens* was dominant. Somewhat lower (1500 m) on the shady cliffs *Coleochloa microcephala** (sedge) was dominant, accompanied by *Urogenias ulugurica**, *Antrophium mannianum* and *Saintpaulia pusilla**. Both here and on the S cliffs of Masimba (1300 m) and of Kanga (same altitude) *Pentas longituba* was common. No doubt, if further exploration of the high and steep cliffs of the mountain can be realized (maybe with the help of professional climbers), many interesting new records, including new species, can be detected.

The dry, low altitude rock habitats, especially the summit of smaller rocks in the miombo belt, is inhabited by *Xerophyta* (Velloziaceae) vegetation, which is rich in xerophytic, often poikilohydric plants (like *Pellea* ssp. and *Actinopteris* spp. among the ferns) or in succulents (*Aeolanthus*, *Aloë*). It is interesting that at this altitude *Aloë morogoroënsis* occurs on rocks, instead of the endemic *A. schliebenii*. The richest dry rock vegetation developed on the southern tip of the mountains (above Kwedilomba and Msufini) and in the dry, western basins.

Riverine vegetation

The riverine forests inside the mountains approach in their composition the neighbouring rain forests e.g. along Diwale stream, at 560 m altitude, *Bridelia micrantha*, *Breonadia salicina*, *Erythrophloeum suaveolens* and *Harungana madagascariensis* are the main trees. *Hypolytrum testui* occur in the herb layer. At the E foot of Kanga (Lovett and Thomas, 1988) *Bequaertiodendron natalense*, *Erythrophloeum suaveolens*, *Ricinodendron heudelotii*, *Scorodophloeus fischeri* and *Ziziphus pubescens* are the

components of the canopy, and in the ground layer *Aframomum angustifolium* and *Olyra latifolia* are dominant in a groundwater forest. We observed at the same place *Ficus exasperata* and *Trema orientalis*, as small trees, *Monanthes trichocarpa*, as climber and *Grewia forbesii* in the shrub layer.

The riverine forests on the alluvial plain, in the E foreground of Nguru mountains, are quite different. Their emergent trees are deciduous, only the smaller trees and shrubs are evergreen. *Sterculia appendiculata*, *Grewia goetzeana*, *Sorindeia madagascariensis* and *Cordia myxa* were observed among the trees near Kwadihombo, with *Hibiscus calyphyllus*, *Sida acuta*, *Acahypha fruticosa*, *Solanum goetzei*, *Deinbollea borbonica* in the shrub layer, *Flagellaria guineensis* as climber and *Geophila obvallata* ssp. *ioides*, *Pseuderanthemum hildebrandtii*, *Momordica trifoliata* and *Ipomoea irviniae*, as herbs.

Within the riverine vegetation should be mentioned the specially adapted plant community of submerged rocks of cataracts and waterfalls. These conditions are best visible at the Turiani Falls of Diwale Stream, under the bridge, where *Hydrostachys angustisecta* (Hydrostachyaceae) associates with the much smaller, mosslike *Tristichia trifaria* (Podostemaceae) in a rheophytic community. At least temporarily emerged rocks of the streambeds are often colonized by the Asclepiadaceae subshrub *Kanahia laniflora*.

FLORA

According to the classification of White (1978, 1983) the higher, montane part of the Ngurus belong to the Afromontane region, the lower forest belts to the Zanzibar-Inhambane (coastal) region, while the surrounding lowlands belong to the Zambezi region concerning the flora. Of course, there are no sharp limits between these regions and the affinity of the concerned belts to the regions in question is relative. The Zanzibar-Inhambane endemics are more common in the lower forest belts (like *Schlecteria mitostemmatoides* or *Uncaria africana*), while afromontane endemics are more common in the higher belts (like *Cardamine africana* or *Syzygium guineense* ssp. *afromontanum*). If we treat here the Nguru mountains as a unit within the archipelago like the Afromontane region, it can be subdivided in a West African, Northeast African (Ethiopian), Central-East African and a Southeast African subregion. Within the Central-East African subregion the crystalline Eastern Arc mountains doubtless form a well-defined district, as its phytogeographic importance was underlined by many authors (Polhill 1968; Hilliard and Burt 1971; Pócs 1974, 1975, 1982; Axelrod and Raven 1978; Brenan 1978; White 1978; Lovett 1988). Pócs (1989) proposed a finer and more detailed subdivision of the Eastern Arc floristic district, based on the distribution of the endemic species in the different mountain groups. Accordingly, the Nguru mountains belong to the central, core area of the Eastern Arc mountain range, together with the Uluguru, Usagara, Ukaguru mountains and Berega Hills.

The topographic and climatic conditions, which favoured the isolation of endemics within the Eastern Arc mountains were discussed in the introduction. Each massif has its own endemics within this group, but there are common endemics shared both by the neighbouring (or more distant) mountains and mountain groups.

Our present knowledge on the flora of Nguru mountains is far from complete. Even so, we attempt to enumerate examples from the different endemics in the area.

Strict, narrow endemics restricted to Nguru mountains:

<i>Aloë schliebenii</i> Lavranos	1300-2100 m
<i>Aerangis</i> sp. nov.	1800-2200 m
<i>Cinnobrotis rananum</i> Pócs, ined.	1500-2300 m
<i>Craterispermum longipedunculatum</i> Verdc.	1200 m
<i>Crotalaria</i> sp. nov.	2040 m
<i>Dissotis dictyophylla</i>	1600-2200 m
<i>Encephalartos kanga</i> Pócs, ined	1200-1500 m
<i>Impatiens messumbaensis</i> G.M. Schulze	1400-1900 m
<i>I. nguruensis</i> Pócs, ined.	1900-2000 m

<i>Lobelia ritabaeniana</i> Knox, ined.	1900-2100 m
<i>Memecylon erythranthum</i> Gilg.	
<i>M. verruculosum</i> Brenan	300-2100 m
<i>Mystacidium nguruense</i> Cribb, ined.	
<i>Pavetta axillipara</i> Bremek.	
<i>P. coelophlebia</i> Bremek.	1900-2100 m
<i>P. manyanguensis</i> Bridson	1800 m
<i>P. sp. nov.</i>	1900-2000 m
<i>Phyllanthus rhizomatosus</i> A.R. Sm.	680 m
<i>Polystachya canaliculata</i> Summerh.	600 m
<i>P. rugosilabia</i> Summerh.	900 m
<i>Streptocarpus bambuseti</i> B.L. Burtt	1600-2100 m
<i>S. burtii</i> Pócs, ined.	1400-1900 m
<i>S. stomandrus</i> B.L. Burtt	
<i>Tetrorchidium uluguruense</i> Verdc.	550-600 m
(in spite of its name, it does not occur in Ulugurus)	
<i>Thulinia albohutea</i> Cribb	2000 m
<i>Zimmermannia nguruensis</i> A.R.-Sm.	680 m

Studying the above list, it is obvious that the majority of indigenous species are restricted to the high altitude, mossy montane forests or rocks at the same height, a belt which favoured species isolation during the changing climatic periods. There is one monotypic, generic endemic (*Thulinia*), many of the other endemics belong to polymorphic genera, which produce species restricted to the different members of Eastern Arc too (*Impatiens*, *Memecylon*, *Pavetta*, *Polystachya*, *Streptocarpus*). Some others seem to be more isolated, as the *Cinnabotrys*, *Encephalartos*, *Tetrorchidium* and *Zimmermannia*, which probably have a greater phylogeographic significance.

We consider subendemic species to be those which occur in the other mountains of the crystalline Eastern Arc, but their area does not exceed its limit. The combination of the mountains where they occur underlines the close relationship between Nguru, Uluguru, Ukaguru and Usagara mountains (although we do not know much about the two last mentioned):

Species shared by Nguru and Uluguru mountains

Allanblackia uluguruensis
Diaphananthe orientalis (Mansf.) Rasmussen
Gravesia hilophila (Gilg.) A. et R. Fernandes
G. riparia A. et R. Fernandes
Impatiens hamata Warb.
Lasianthus pedunculatus E.A. Bruce
Lefebvreia droopii C.C. Townsend
Lobelia morogoroensis Knox et Pócs, ined.
Milletia sericantha Harms
Neobenthamia gracilis Rolfe
Pavetta sparsipila Bremek.
Polystachya subdiphylla Summerh.
Stolzia viridis Cribb
Streptocarpus hirsutissimus E.A. Bruce
Thamnojusticia grandiflora Mildbr.
Tridactyle brevifolia Mansf.
Zenkerella egregia Léon
Zeuxine lunulata Cribb et Bowden

Species shared by Nguru and Usambara mountains

Pavetta holstii K. Schum.
Psychotria pocsii Borh., ined.
Uvariadendron usambarense R.E. Fries
Renanthera engleri K. Schum. (+ Kakamega Forest in Kenya)

Common species of the Nguru and Ukaguru mountains

Saintpaulia nitida B.L. Burtt
Streptocarpus schliebenii Mansfeld

Species endemic in the Nguru, Uluguru and Ukaguru mountains

Cussonia lukwangulensis Tennant
Impatiens kentrodonta Gilg.
Peddiea subcordata Domke
Saintpaulia pusilla Engl.
Urologium ulugurica Gilg. et C. Benedict

Common endemics of Usambara, Uluguru and Nguru mountains

Danaë xanthorrhoea (K. Schum.) Bremek.
Dicranolepis usambarica Gilg. (also Taita Hills)
Pentas longituba K. Schum.

Finally, those subendemic species which occur southwards from the Nguru mountains to the Uzungwe mountains, Usagara, Mufindi Escarpment or the Mahenge Plateau and reach their northernmost distribution limit in the Ngurus should be mentioned:

Amorphophallus stuhlmannii (Engl.) Engl. et Gehrm.
Coffea mufindiensis Bridson ssp. *mufindiensis*
Erythrococca polyandra (Pax et K. Hoffm.) Prain
Garcinia semseii Verdc.
Milletia semseii Gillett
Pavetta lynesii Bridson
Pavetta mshigeniana Bridson
Psychotria megalopus Verdc.
Trichalysia acidophylla Robbrecht

Of course, there are very many subendemic flora elements which are then widespread through the whole Eastern Arc range, down from the Taita Hills or Usambaras to the Uzungwe mountains, like *Gymnosiphon usambaricus* Engl. or *Anisophyllea obtusifolia* Engl.

It is striking that the Nguru mountains show the closest affinity to the Uluguru mountains at 80 km distance and not to the Ukaguru mountains which lie only at 40 km distance and are interconnected by the Mamboya Hills. The explanation is probably that, concerning climatic conditions and vegetation zones, the Ulugurus are much more similar to the Ngurus and hence have more common features in their floral composition. The level of exploration may also play some role (we do not know enough about the flora of the Ukagurus).

We hope that the above survey of the flora and vegetation of these very rich and still underexplored mountains will encourage and help further research.

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REFERENCES

- Axelrod, D.I., Raven, P.H. 1978. Late Cretaceous and Tertiary vegetation history of Africa. In: Werger, M.J.A.(ed.): Biogeography and Ecology of Southern Africa. Junk, den Haag.
- Brenan, J.P.M. 1978. Some aspects of the phytogeography of tropical Africa. - Ann. Missouri Bot. Garden 65:437-478.
- Chamshama, S.A.O., Nsolomo, V.N. & Persson, A. 1990. Human impact on the forest vegetation of Nguru mountains. (In this Proceedings).
- Gillett, J.B. 1961. The history of the botanical exploration of the area of "The Flora of Tropical East Africa" (Uganda, Kenya, Tanganyika and Zanzibar) Compt. Rend. IV^e Réunion, AETFAT - 1961:205-229.
- Hall, J.B. 1981. The University Forest, Mazumbai: A report based on data collected during the field practical training exercise for B. Sc. (For), Year 1, in 1981. Division of Forestry, University of Dar es Salaam, Morogoro. 13 pp.
- Hilliard, O.M., Burtt, B.L. 1971. *Streptocarpus*, an African Plant Study. Pietermaritzburg, Univ. Natal Press.
- Lavranos, J.J. 1969. A new *Aloe* from Tanzania. - Cactus and Succulent Journ. (U.S.) 42:150-151.
- Lovett, J. C. 1985. An overview of the moist forests of Tanzania. Final Report of the Tanzania Forest Habitat Evaluation Project, supported by the World Wildlife Fund. Tanzania Nat. Sci. Res. Council, Research Monographs. Mimeographed.
- 1985. Results of the first International Uzungwe Expedition 1984. Variable area large tree survey. Missouri Bot. Garden. 19 pp. Mimeographed.
- 1988. Endemism and affinities of the montane forest flora of Tanzania. In: Goldblatt, P. & Lowry, P.P. II (eds.), Modern Systematics in African Botany. Proceedings of the AETFAT 11th Plenary Meeting, St. Louis June 10-14, 1985. - Monogr. Syst. Bot. Missouri Bot. Gard. 25:591-598.
- 1989. Classification and status of the moist forests of Tanzania. Proceedings of the 1989 AETFAT Congress (1990).
- Lovett, J.C. & Thomas, D.W. 1988. Report on a visit to Kanga mountains, Tanzania, - East Afr. Nat. Hist. Soc. Bull. 18/2:19-22.
- Moreau, R.E. 1935. A synecological study of Usambara, Tanganyika Territory, with particular reference to birds. - J. Ecol. 23:1-43.

- Pócs, T. 1974. Bioclimatic studies in the Uluguru mountains (Tanzania, East Africa) I. - *Acta Bot. Acad. Sci. Hung.* 20:115-135.
- 1975. Affinities between the bryoflora of East Africa and Madagascar. - *Boissiera* 24:125-128.
 - 1976a. Bioclimatic studies in the Uluguru mountains (Tanzania, East Africa) II. Correlations between orography, climate and vegetation. - *Acta Bot. Acad. Sci. Hung.* 22:163-183.
 - 1976b. Vegetation mapping in the Uluguru mountains (Tanzania, East Africa). - *Boissiera* 24:477-498 + 1 map.
 - 1982. The forest flora and vegetation of the old crystalline mountains of Tanzania and their importance for soil and water conservation. Seminar/Workshop on Forest Conservation in Tanzania, Tanga 16-18 February, 1982. 5 pp. Mimeographed.
 - 1990. The gene pool values and their conservation in the natural forests. Seminar/Workshop on "Management of Natural Forests of Tanzania" Olmotonyi, Arusha, Tanzania, 5-10 December, 1988, (in press).
- Polhill, D. 1988. Flora of Tropical East Africa. Index of Collecting Localities. Royal Botanic Gardens, Kew.
- Polhill, R.M. 1968. Tanzania. In: Hedberg, I. & Hedberg, O. (eds.) Conservation of Vegetation in Africa South of the Sahara. - *Acta Phytogeogr. Suecica* 54:166-178.
- van Steenis, C.G.J. 1972. The mountain flora of Java. Introduction. E.J. Brill, Leiden, 1-80.
- White, F. 1978. The Afromontane Region. In: Werger, M.J.A. (ed.) Biogeography and Ecology of Southern Africa. 463-512. Junk, den Haag.

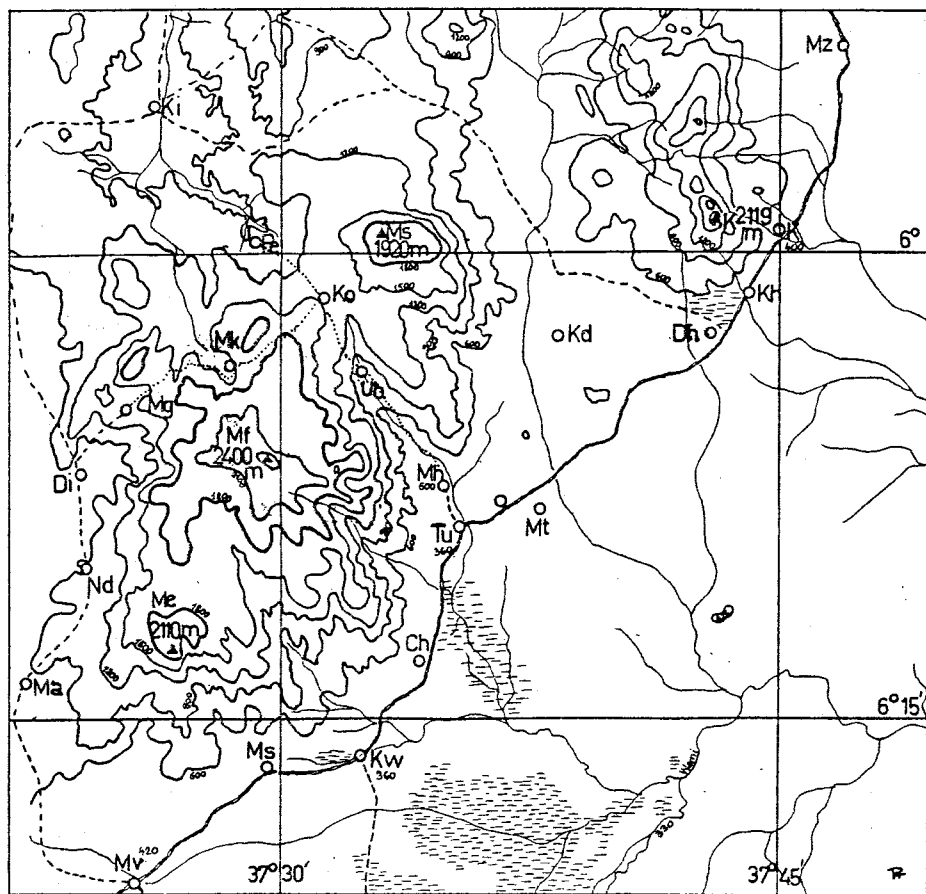


Fig. 1. Topography of the Nguru mountains.

Abbreviations: Ch = Chazi, Dh = Dihinda, Di = Digobeke, K = Kanga, Kd = Kwadole, Kh = Kwadihinda, Ko = Kombola, Ma = Matale, Me = Messumba, Mf = Mafulumula, Mg = Mogole, Mh = Mhonda, Mk = Maskati, Ms = Masimba, Mt = Mtibwa, Mv = Mvomero, Mz = Mziha, Nd = Ndole, Pe = Pemba, Tu = Turiani, Ub = Ubili

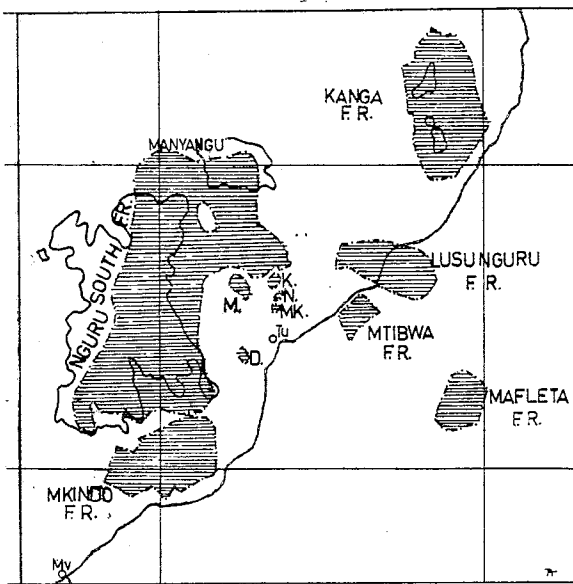


Fig. 2. The Forest Reserves in the Nguru mountains.

Abbreviations for Local Authority Reserves: D = Disalasala, K = Kwangola, M = Mabundi, Mk = Mkanghala, N = Ngalonga.

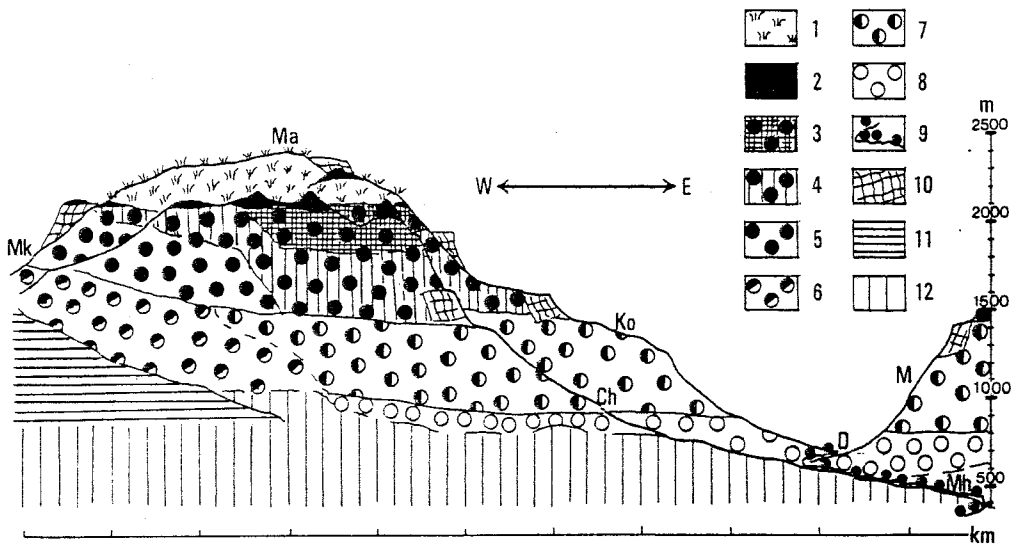


Fig. 3. Vegetation belts in the Nguru mountains. The transect is laid approximately in East - West direction through Masimba - Mafulumula.

1. *Arundinaria alpina* stands, 2. Altimontane elfin forests, 3. Mossy montane rainforests, 4. Montane rainforests, 5. Mesic montane evergreen forests, 6. Mesic or dry submontane forests, 7. Submontane rainforests, 8. Lowland rainforests, 9. Riverine (gallery) forests, 10. Rock vegetation, 11. Dry semievergreen forests and miombo woodland, 12. Cultivated area with forest fragments.

Abbreviations: D = Diwale River, Ch = Chazi River, Ko = Kombola village, M = Masimba Hill, Ma = Mafulumula summit, Mh = Mhonda Mission and village, Mk = Maskati Mission and village.

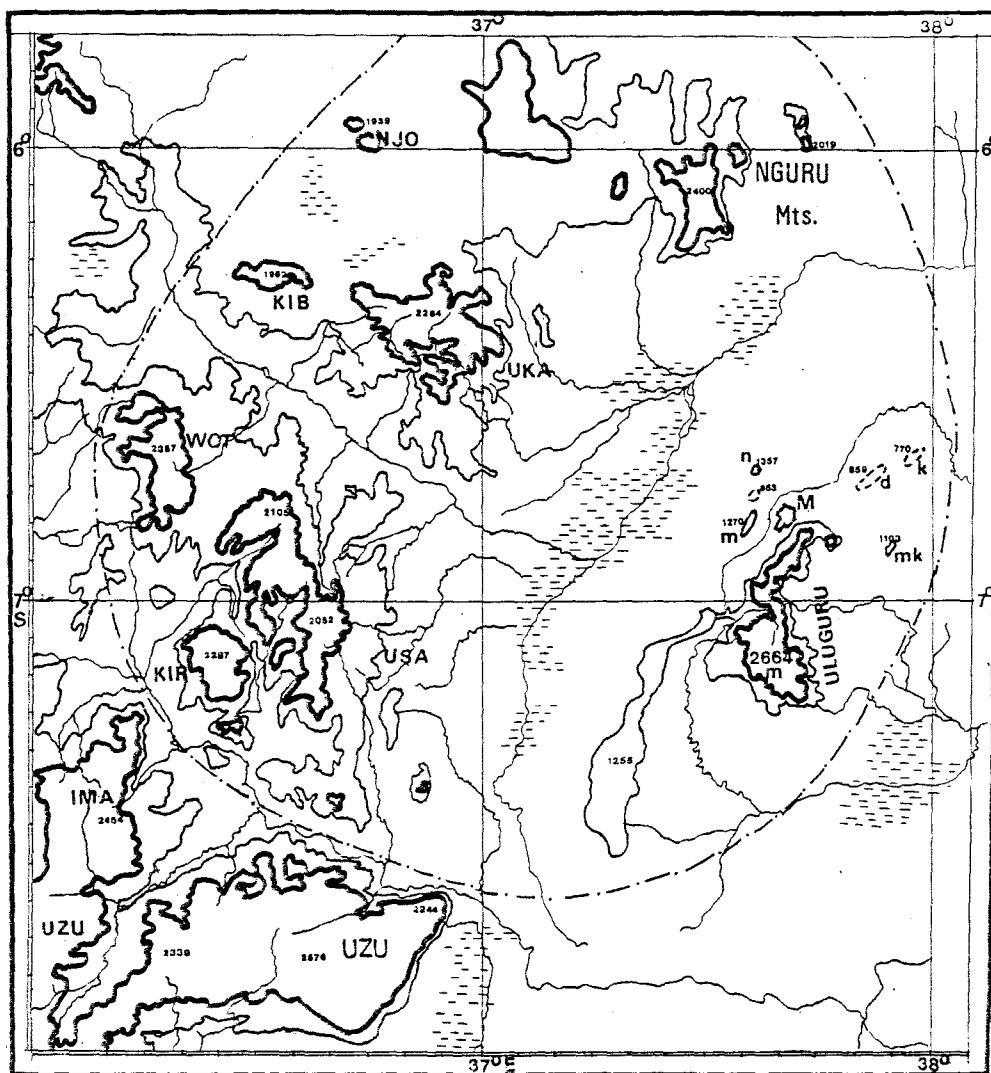


Fig. 4. The central, core area of the crystalline Eastern Arc block mountain range (surrounded by broken line). Contours at 1000 and 1500 m. Drawn by J. Bakalár.

Abbreviations: d = Dindili Hill, IMA = Image and Selegu Mts., KIB = Kiboriani Hills, KIR = Kirambo Hill with Mangalisa F.R., k = Kitulanghalo Hill, m = Mindu Hill, mk = Mkungwe Hill and F.R., M = Morogoro town, n = Nguru ya Ndege Hill, NJO = Njoge Hill, UKA = Ukaguru Mts., USA = Usagara Mts., UZU = Uzungwe Mts.