Vegetation of the southern part of the Isalo Sandstone Massif (Central Madagascar, Africa) – differentiation and threats

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Introduction

The Isalo National Park is the fourth largest and one of the earliest protected areas in Madagascar. It was created in 1962, and covers an area of about 82 000 ha. The whole park (especially its southern section) is intensively managed by the local community and frequented by tourists. This may create many conflicts between the objectives of nature protection and human activities such as tourism, cattle grazing and gathering of useful plants. Although scientists frequently visit the area (comp. Andrew and Hawkins 1999; Nicoll and Langrand 1989), the fauna and flora of Isalo are still insufficiently described. There are no ecological papers related exclusively to the Isalo Massif (Andrew and Hawkins 1999), and thus all information should be useful for future study. That is why I have decided to present a short characteristic of the vegetation of this area, which summarises my observations carried out in January 2002.

Names of forest formations follow Du Puy and Moat (1998), plant names follow Schatz (2001) and Samyn (2001). Documentation is stored as a part of the Herbarium of Museum of Natural History in Wrocław (WRSL) media collection.

Physiography of the study area

The Isalo National Park is situated between 22°10'–22°40'S and 45°11'–45°23'E in the southwestern corner of the Province of Fianarantsoa. It is a rocky massif characterised by a unique sandstone landscape, dissected by a labyrinth of deep (up to 200 m) canyons and a jumble of ruiniform contours. Large differences in relief are a result of variation in rock quality, and also of intensive colian and water erosion. The elevation varies between 510 and 1268 m.

Isalo is probably a part of the earliest sedimentary layers of the Permo-Triassic Karroo Series, which was formed on the bottom of the Permian sea which covered part of Gondwana (Battistini 1972), but some parts of the massif originated in the Jurassic period (Sourdat 1970).

The climate is hot and rather dry. Temperatures range from monthly means of 17 °C in June to 25 °C in February (Andrew and Hawkins 1999). The rainfall is about 850–1200 mm per year, but falls almost entirely in the hot season (90 per cent from November–March). The dry season may extend to several months (Donque 1972). Some rivers and streams are permanent; there are also many seasonal watercourses.

Phytogeographically, the Isalo Massif is included in the Centre Area (Koechlin 1972), which covers the central plateau regions above an average height of 800 m a.s.l. The latest revision of primary vegetation places Isalo within "the evergreen sclerophylous forest zone" (Du Puy and Moat 1998).

Main types of vegetation

There are six main formations (Figure 1) occurring in the Isalo area: sclerophylous woodland dominated by *Uapaca bojeri*, evergreen humid forest (in deep shadowed canyons), *Pandanus* gallery thickets, xerophytic rocky vegetation, secondary shrub communities and pseudo-steppes which originated from intensive burning in the past. The differentiation of plant communities depends on two major factors – local habitat conditions and the degree of anthropopressure.

Evergreen sclerophylous (*Uapaca*) woodland (tapia forest)

The *tapia* forest is a lax formation with many gaps, where shrubs and herbaceous vegetation occur. The main components of this formation are small trees of *Uapaca bojeri* (*Euphorbiaceae*), which usually make up monotonous and monospecific stands. In some patches *Asteropeia* cf. *rhopaloides* (*Asteropeiaceae*) or *Sarcolaena isaloensis* (*Sarcolaenaceae*) also grow as subdominants.

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Other tree species (*Cussonia bojerii*, *Stereospermum euphorioides*, *Acridocarpus* sp., *Erythrospermum* sp., *Grevia* sp.) are very rare. All of these trees are resistant or tolerant to fire. The herb layer is composed of grasses and herbs; in some places it is lax. Some of the *Catharanthus* and *Fabaceae* species grow here. In general, the *Uapaca* woodland is very poor in species, both trees and other plants, but due to its rarity and uniqueness it deserves to be intensively protected.

The Isalo National Park protects one of the main remnants of this interesting forest of dry subtropical Madagascar zone (Du Puy and Moat 1996). The *tapia* forest also occupies other areas in the Central Highland, but only as small isolated patches (Du Puy and Moat 1998).

Evergreen humid forest

There are three different evergreen humid forest formations in the southern part of Isalo, occurring near the streams, in the deep ravines and shadowy moist places.

The deep canyons are covered by a formation of humid gallery forest. Its main feature is the presence of palm species (*Ravenea* cf. *glauca* and *Dypsis* spec.), *Breonadia salicina* (*Rubiaceae*), *Weinmannia* sp. (*Cunnoniaceae*), *Voacanga* cf. *thouarsii (Apocynaceae)* and *Dracaena* sp. (*Agavaceae*). Patches of this forest are very similar to the eastern Madagascar evergreen rain forests, and they may have natural origin. Their occurrence depends on the local microclimate and the high soil humidity, which prevents fires.

Some of the humid forest stands, however, are distinctly of secondary origin. Many introduced or spontaneously naturalised tree species (e.g., *Melia azedarach*, *Mangifera indica* or *Eugenia* spec.) occur in such patches. Most of these stands are very young. It suggests that this kind of vegetation was established after the National Park had been created (comp. also Andrew and Hawkins 1999).

The third humid formation is the gallery *Pandanus* thicket, dominated by *P. pulcher*, and an admixture of some common shrub species. It covers the shallow valleys of small streams, which cross the plateau surface. This formation is probably also of secondary origin, and grows in places where the forest is degraded and frequently burned (Andrew and Hawkins 1999).

Pseudo-steppes (*Aristida-Heteropogon* communities group)

The wide area of Isalo is covered by pseudo-steppes dominated by *Aristida* sp., *Trachypogon* sp. or the *Heteropogon* grass species. This is a type of anthropogenic formation that has been created by grass fires, which prevent tree regrowth. These fires were set for the benefit of grazing cattle, but due to the increasing number of foreign visitors, this management has been limited.

Although these pseudo-steppes are mainly built up by grasses, the biodiversity of these ecosystems is high. Many rare and endemic plant species occur here, too. The most common are *Menabea venenata* (*Asclepiadaceae*), *Catharanthus trichophyllus* (*Apocynaceae*), *Poivrea grandidieri* (*Combretaceae*), *Ischnolepis tuberosa* (*Asclepiadaceae*), *Secamone tenuifolia* (*Asclepiadceae*), *Commelina madagascarica* (*Commelinaceae*), *Tachiadenus* cf. *longiflorus* (*Apocynaceae*), *Tephrosia* cf. *isaloensis.* (*Leguminosae*), *Hibiscus isalensis* (*Malvaceae*), *Polygala isaloensis* (*Polygalaceae*), *Sinorchis* sp. (*Orchidaceae*) and others. Preservation of this formation requires occasional grass fires or grazing of local influence.

Rocky communities (*Pachypodium-Aloe* community group)

In rocky areas, particularly on steep slopes or ridges, the vegetation is extremely xerophytic. Numerous interesting and endemic species grow in these habitats, e.g. *Xerophyta* sp. (*Veloziaceae*), *Pachypodium rosulatum* var. *gracilius* (*Apocynaceae*), *Aloe isaloensis* (*Liliaceae*), small climbing shrubs of *Ficus* and many succulent species of *Kalanchoe, Cynanchum* and *Euphorbia*. No threats to the rocky communities have been recognised.

Secondary shrub (*Vangueria madagascariensis-Aphloia theaeformis* community)

The outer slopes of the Isalo Massif, which are in contact with fields and pastures, are covered by dense secondary shrub formations. *Mimosa latispinosa* (*Mimosaceae*), *Vangueria madagascariensis* (*Rubiaceae*), *Maesa lanceolata* (*Myrsinaceae*), *Aphloia theaeformis* (*Flacourtiaceae*), *Crotalaria* sp. (*Fabaceae*), *Tamarindus indica* (*Caesalpiniaceae*) are the most common components of this kind of vegetation. Many lianas and climbing shrubs such as *Adenia olaboensis (Passifloraceae), Poupartia* sp. *(Anacardiaceae)* and *Cryptostegia madagascariensis* (*Asclepiadaceae*) occur here, too. The species composition of this community is very similar to other secondary formations of disturbed areas of Central Madagascar.

Threats and human pressure

For a period of about 1000 years the Isalo area was under extensive human pressure due to grazing, burning, and forest clearing. Before human arrival, native grasslands had probably been restricted to small patches (Lowry et al. 1997). Today, after a millennium of human pressure, they are widespread not only in the Isalo Massif, but also in most of Central Madagascar. However, the rapidly increasing number of visitors, especially ecotourists has caused a reduction in traditional methods of pasture and agriculture.

At this moment there are some human activities pursued which may potentially be dangerous to the unique vegetation

of the Isalo Massif.

Tourism

The influence of tourism is difficult to assess. In the dry period there are about 50 guides working every day in Ranohira – the main visiting site. Each guide may lead no more than 10 people per day. This means that the number of visitors to the southern section of the National Park cannot exceed 500. In comparison with the sandstone areas in Europe (e.g., Góry Stołowe Mountains, Adršpašsko-teplické skály Cliffs or Bohemian Switzerland), the number of visitors is very low. In Isalo there are only three tourist paths, and the tourists are accompanied by a guide at all times. This suggests that, at this moment, tourism does not pose a serious threat to nature protection in this region.

Gathering useful plants or their parts

Many of the plant species growing in Isalo are very useful for the local community. The fruit of the common native trees – *Uapaca bojeri, Dracaena, Ficus* – are gathered, processed to preserve, or eaten fresh. *Pandanus* leaves are used for making mats and thatching. Numerous native or even endemic plants mentioned in this paper (e.g., *Catharanthus, Psiadia, Helichrysum, Commelina, Kalanchoe, Aloe, Tachiadenus, Maesa*) have wide use in traditional medicine and local culture (Samyn 2001). All of these plants are still collected as an important source of food and drugs for the local community.

Clearing of woods and regular grass fires

At present, woodland and grass fires are potential, but very serious, threats, especially to the *Uapaca* forest. Occasional burning or grazing of the pseudo-steppes, which occupy the Isalo plateau, should not be dangerous, because they are necessary to keep the current biodiversity.

Synanthropisation

Many introduced and naturalised plant species (mainly trees and shrubs) occur in the Isalo Massif and in its neighbourhood. The most common and dangerous to the native flora are *Psidium guajava, Acacia* sp., *Lantana camara, Aphloia theaeformis, Melia azedarach, Cassia occidentalis, Ageratum conyzoides, Euphorbia hirta* and *Mimosa pudica*. Synanthropisation has caused very serious damage in many tropical countries (Świerkosz 2000), and currently this process should be acknowledged as the most important threat to the native flora and vegetation of the Isalo Massif.

Conclusions

The main features of the vegetation of the southern part of the Isalo Massif (Central Madagascar) have been described in a preliminary way. There are 6 main formations occurring here: the sclerophylous woodland with domination of *Uapaca bojeri*, evergreen humid forest (in deep shadowed canyons), *Pandanus* gallery thickets, xerophytic rocky vegetation, secondary shrub communities and pseudo-steppes originating from intensive burning in the past. The differentiation of plant communities depends on two major factors – local habitat conditions and the degree of anthropopressure. The most important threat to the native flora and fauna of Isalo is the occurrence of invasive tropical plants, mainly trees and shrubs, which cause many changes to the structure and species composition of this region's unique plant communities (compare the invasions on Central European sandstone landscapes, Hadincová et al., this

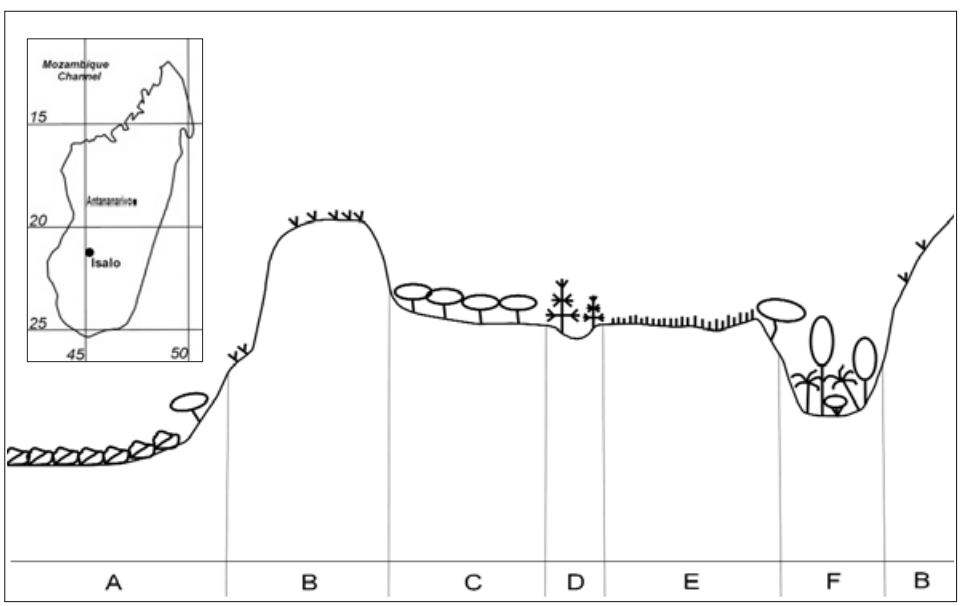

Figure 1. Schematic representation of the distribution of vegetation types in southern part of Isalo National Park
Key: a. Secondary shrub (*Vangueria madagascariensis-Aphloia thaeformis* community); b. Rocky communities (*Pachypodium-Aloë* community group); c. Sclerophylous (*Uapaca*) woodland; d. Gallery *Pandanus* thicket; e. Pseudo-steppes (*Aristidia-Heteropogon* communities group); f. Evergreen humid forest