Geobiocoenological differentiation as a tool for sustainable land-use of Socotra Island

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Abstract

Socotra Island (Republic of Yemen) is inhabited by descendents of a primeval south-Semitic language group for some 3000 years. The main way of living is traditional pasturage husbandry and in the lesser extent also fishery. Pasturage is practised in a similar extensive way as on continental Yemen. Increasing anthropogenic pressure on the natural resources is thus above all driven by livestock grazing and by excessive wood depletion used for construction and fuelwood. As a matter of fact, grazing practice influenced plant communities and notably contributed to the contemporary distribution and structure of tree populations around the island, including endemic *Commiphora* spp*., Boswellia* spp*., Dendrosicyos socotrana* and *Dracaena cinnabari*. Consequently, the most extensive vegetation type is low grazed forest dominated by some *Euphorbiaceae* representatives as *Croton* spp. or *Jatropha unicostata*, species unpalatable to the livestock. Preservation of the biological richness of Socotra Island will not be, therefore, possible without restrictions aimed at pasturage husbandry, at least in the key structural segments of the ecological network. Precise geobiocoenological differentiation is needed for recognizing the detailed state of natural conditions of the island.

Keywords: Socotra Island, vegetation tiers, geobiocoenological differentiation, pasturage, agroforestry

Introduction

In 1999-2001, within the programme of foreign development assistance of the Czech Republic a project was dealt with entitled "Creating an ecological network and agroforestry, educational and cultural doorway for sustainable development of Socotra Island (Republic of Yemen)". The objective of the project was to verify existing state of the island biotopes, delimit ecologically important landscape segments and work out a proposal of the ecological network aimed at: (1) conservation of endemic plants and animals, (2) preparation of a basis for sustainable agroforestry management by the local community.

The proposed methodical procedure of specifying structural elements of an ecological network on Socotra supposed (1) differentiation of the landscape potential condition, (2) differentiation of the present condition of geobiocoenoses (specification and mapping the biotopes), (3) categorization of present geobiocoenoses according to the intensity of anthropogenic effects and determination of the degree of ecological stability, (4) differentiation of the territory from the viewpoint of landscape management including the delimitation of ecologically important segments forming the framework of landscape stability. Differentiation of the natural (potential) condition of geobiocoenoses, i.e. of a condition which would occur in the present landscape after elimination of man impacts appears to be the objective of geobiocoenological typology (Buček & Lacina 2000) based on the application of the theory of geobiocoene type (Zlatník 1975). Results of geobiocoenological typology provide necessary data for the landscape protection, frameworks for differentiated landscape cultivation and bases for planning the landscape sustainable use.

After the conclusion of the first stage of the project in 2001 it appeared that a linkage of the creation of an ecological network with agroforestry measures and educational activities is

very useful under conditions of a pastoral landscape in an arid tropical region with islamic culture (Buček et al 2001).
The term "agroforestry" is defined as "a dynamic, ecologically based, natural resources management system that, through the integration of trees in farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels" (Leakey 1996). All forms of agroforestry can be characterized (1) by the growth of trees on the same land unit together with farm crops or animals in certain forms of special mixtures in a temporary time sequence and (2) by an important interaction between woody species and non-woody components of the system either of ecological or economic nature (Pancel 1993). According to FAO, the system of agroforestry can be classified into four categories: (A) agro-silvicultural systems (trees and farm crops), (B) silvo-pastoral systems (pastures and livestock, trees), (C) agro-silvo-pastoral systems (trees, farm crops and animals) and (D) home gardens (trees and shrubs with farm crops).
Within the project, it was necessary to obtain and evaluate elementary information on natural conditions of Socotra and their influencing by man, above all by livestock grazing which is the main source of subsistence of the local population. Within agroforestry activities, local population with horticultural experience was encouraged and supported to grow autochthonous woody species and to plant them in home gardens.
During the project implementation, an exclusion fence was also established in the Firmihin biocentre making possible to monitor the development of one of the most valuable island ecosystems, viz. the dragon´s blood tree forest with endemic *Dracaena cinnabari* not affected by pasture (Habrová 2002, 2003). Results of the project can contribute to find harmony between developmental plans and a need to ensure the existence of exceedingly valuable endemic species, populations and communities on Socotra Island (Pavliš & Buček 2002).

Material – natural and socioeconomic conditions
Socotra Island is the largest of islands belonging to Republic of Yemen. It is situated in the Indian Ocean between 12°19´ and 12°42´ N latitude and between 53°18´ and 54°32´ E longitude and from the viewpoint of geography it is the most NE part of Africa. The most western point of the island, Cape Ras Sha'ab is 235 km from the Africa coast (Cape Guardafui in Somalia). The island is probably formed by remainders of a former continental Afro-Arabian shelf. Its area is about 3600 km^2. The highest peak of Socotra is Mt. Jebel Skand in the central Haggeher mountain range with an altitude of 1540 m. The island together with smaller Abd-al-Kuri, Samha and Darsa isles forms the Socotra Archipelago.
From the viewpoint of natural science, the Socotra Archipelago is one of the most interesting places in the world which is also documented by a fact that the Socotra Archipelago was declared Biosphere Reserve, added to UNESCO´s World Network of Biosphere Reserves this year (www.unesco.org). The unique character of Socotra is the result of a long-term separation from the Africa continent characterized by high endemism of plant and animal species. For example, from 850 species of vascular plants recorded and described so far 273 species belong to Socotra endemic species (Miller & Bazara'a 1998).
Also the majority of woody species forming natural forest, woodland and shrub communities ranks among endemic species. The most important of them are arborescent dragon´s blood trees (*Dracaena cinnabari*), frankincense trees (*Boswellia ameero, B. elongata, B. dioscorides, B. popoviana, B. nana, B. socotrana*), myrrh trees (*Commiphora socotrana, C. ornifolia*, *C. parvifolia, C. planifrons*), arborescent spurges (*Euphorbia arbuscula, E. socotrana*), a rare endemic shrub *Dirachma socotrana* and the only known wild pomegranate species (*Punica protopunica*). Typical of Socotra are remarkable succulent woody species particularly the endemic cucumber tree (*Dendrosicyos socotrana*), the only woody species

from the family of *Cucurbitaceae*, desert rose (*Adenium obesum* ssp. *sokotranum*) and endemic *Dorstenia gigas* from the family of *Moraceae* rarely growing on shady rocks. Also fauna of Socotra is rich in species and little investigated yet.
A specific population of Socotra inhabitants originated on the island with its peculiar pastoral culture. They are called "bedu", live in tribes lead by sheikhs and have common land ownership so far. A close coexistence of the local population with nature is documented by the fact that “bedu” know to differentiate and name in their Socotran language virtually all species of local trees and shrubs.
According to various sources, there are 40 to 80 thousand inhabitants on the island occupying both coastal and the highest mountain parts of the island. It is evident that in the recent period, a rapid increase in the number of population occurs there which is typical of development countries. The main way of the livelihood of local inhabitants is extensively practised pasturage and to a lesser extent also fishing. Growing corn or other field crops have not been ever significantly used on the island. Growing date palms is an additional source of livelihood.

Methodology and procedures
Field notes and 55 phytosociological releves (1999-2001) served as a basis for specifying and processing the characteristics of geobiocoenological units. In the records, main features of ecotopes are characterized (altitude, aspect and slope inclination, general characteristics of the parent rock, topography and soil properties) and synusia of trees (general level of the upper canopy, layering /stratification/, degree of coverage of particular species). Further, those species of the undergrowth synusia are given which succeeded to be determined. In processing the characteristics, 58 records of the species composition of plant communities presented in the final report of the EPC/GEF/UNOPS project (Miller & Morris 2000) were also taken into consideration.
Vegetation tiers express connection of the sequence of vegetation differences with the sequence of differences in altitude and aspect climate. Vegetation zonation is particularly dependent on air and soil temperatures and on the amount and time distribution of atmospheric precipitation including horizontal precipitation. Including the segments of present geobiocoenoses with a changed biotic component into vegetation tiers requires assessing broader reginal relationships. Particular vegetation tiers can occur in a relatively broad range of altitudes peculiarities of topoclimate being often dominant for the biota. Therefore, to determine the vegetation tiers, it is necessary to use to the greatest extent bioindication either by means of the presence or absence of differentially significant species or by evaluating the vitality and life manifestations of tree "edificators" of geobiocoenoses. Species composition of the undergrowth synusia is a significant indication trait.
Considerable problems in the geobiocoenological typification of Socotra are caused by insufficient knowledge of basic properties of an ecotope. Knowledge of climatic conditions is very sporadic and data on the character of soils are quite missing. Therefore, a number of pilot climatic studies was carried out within the Socotra project, additional geological survey and basic pedological investigations (Buček et al 2001). Climatic examinations brought valuable results on differences in air and soil temperatures and air humidity and soil moisture in various parts of the island above all in relation to altitude and topography.
On the basis of field observations, the island vegetation was classified into vegetation tiers. To specify vegetation tiers and their boundaries, plant indicators were looked for and according to them the vegetation tiers were named. One of the objectives of the geobiocoenological typology was to provide a framework for plantings of autochthonous species in suitable conditions.

Under conditions of Socotra in the context of existing methods of land use, it was useful to focus particularly on improving the traditional agro-silvo-pastoral procedures of farming. As a basis of the positive modification of existing methods of farming was to implement testing the following agro-forestry suitable multifunctional tree species: *Ziziphus spina-christi*, *Punica protopunica*, *Tamarindus indica, Sterculia africana*, *Lannea transulta*, *Commiphora* spp., *Boswelllia* spp. Primarily, detailed phenological observations were carried out followed by assessing the outputs of tree breeding experiments in generative and vegetative propagation.
The aim of monitoring the development of established plantings of multifunctional species suitable for habitat corridors "wadi" or for establishing small-area biocentres was to accumulate experience and data for real plantings of useful woody species by a local community.

Results

Vegetation tiers

On Socotra, we differentiated five vegetation tiers reflecting differences in vegetation caused by differences in altitudinal and aspect climate particularly in temperatures and vertical and horizontal precipitation. Vegetation tiers are marked by numbers 1 to 5 from the most warm and most dry coastal plateaus up to relatively humid peaks of the Haggeher Mts. in the central part of the island. They are named either by orographic terms or according to the typical main tree species in the Socotra language (the term is in plural and means "many"). The use of names in the Socotra language is important because it also reflects the comprehension of plant communities by the local population.

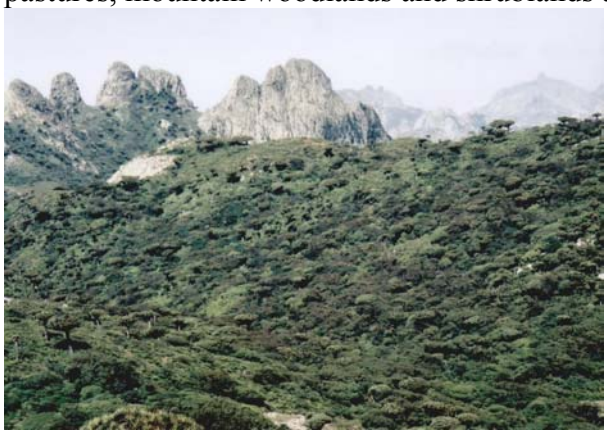
The first vegetation tier - planar, *meterhel,* includes areas of coastal plateaus and flat uplands with warm and dry arid climate at altitudes 0-100 (150) m. Mean annual temperatures range about 27°C, mean annual precipitation is lower than 200 mm. The area is without permanent watercourses; wadi streambeds are filled only in the period of rain. Deciduous shrublands and exclusively deciduous woodlands occur there. There is the highest density of settlements and very intensive impacts of pasture. Open low shrublands predominate often with areas of dwarf shrubs and degraded pastures in the vicinity of settlements.

The second vegetation tier - colline, *emhar*, occurs in rolling uplands and highlands with low precipitation and sub-arid climate at altitudes from (50) 100 to 500 (600) m. Mean annual temperatures amount to about 24°C, mean annual precipitation about 400 mm. There are predominantly periodically drying streambeds. Deciduous forests, woodlands and succulent shrublands usually with species of the family *Burseraceae* are typical of the vegetation. It refers to the region of high density of settlements where low shrubs predominate, dispersed dominant trees occur rather frequently and flat dwarf shrubs and succulent shrubs occur in patches.

The third vegetation tier - submontane, *ariob*, characterizes limestone plains and rolling uplands with cut valleys at altitudes from (400) 500 to 800 (900) m. There is relatively humid climate, permanent watercourses and effects of horizontal precipitation begin to show. Mean annual temperatures are about 22°C, mean annual precipitation ranges about 600 mm. Semi-deciduous forests and woodlands with optimum conditions for *Dracaena cinnabari* are typical of the vegetation. More humid climatic conditions indicate the regular occurrence of epilithic and epiphytic lichens. There is a low density of settlement, low shrubs predominate, often with infrequent dominant trees of *Dracaena cinnabari*, dwarf shrubs and even also grassland occur sporadically. Remnants of *Dracaena* forests and woodlands are rarely preserved.

The fourth vegetation tier - montane, *dagash*, includes rolling granite highlands and the highest parts of limestone plains with humid climate and relatively high precipitation, altitude ranges from 800 to 1200 (1300) m. Mean annual temperatures are about 20°C, mean annual precipitation including horizontal precipitation amounts to about 900-1000 mm. There is a strong effect of frequent low clouds and fog and regular occurrence of dew. It refers to the headwater of main watercourses. Torrents are characterized by permanent flow. At present, very low density of settlements occurs there. Evergreen forests and woodlands are characteristic of the vegetation; there is high cover of epilithic and epiphytic lichens. Closed and open high shrublands predominate, more rarely, particularly on steep debris slopes also remnants of natural forests and woodlands. Remainders of probably pre-Islamic huge stone huts have been sporadically preserved. Here and there, it refers to an archetype of the prehistoric pastoral landscape with areas of treated grasslands on plateaus and gentle slopes cultivated for a long time. Areas of the pastures are usually fenced by ancient rocky walls.

The fifth vegetation tier - alto-montane, *azabzabahan*, characterizes top parts (1200–1500 m) of the broken granite Haggeher highland affected by a peak phenomenon, with humid climate, markedly affected by horizontal precipitation. Mean annual temperatures are probably lower than 20°C, mean annual precipitation is higher than 1000 mm. The strong effect of wind, low clouds and frequent atmospheric precipitation replenished systematically through the formation of dew occur virtually throughout the year. It is the case of headwaters of permanent torrent streams. There are evergreen forests, woodlands and shrublands, the occurrence of epiphytic lichens and dwarf mountain shrubs on steep rocky cliffs is very abundant. At present, this region is without permanent settlement, there is a mosaic of treated pastures, mountain woodlands and shrublands and natural cushion-like vegetation on rocks.



On the basis of field research, within the development project a map of vegetation zonation was created by means of remote sensing through the combination of data layers of a satellite image (Habrová & Král 2002) - see Figure 1.
Delimitation of vegetation tiers was important for the framework of planting autochthonous species as edificators of natural geobiocoenoses.

Pastoral agroforestry
Livestock grazing on Socotra is the most important factor affecting the condition of geobiocoenose vegetation components already for millennia. Impacts of pasture on vegetation markedly increase during last decades so that a number of plant species and communities, which cannot regenerate under conditions of intensive pasture, are threatened.
Due to the effect of selective browsing, proportion of some woody species unpalatable or even poisonous for livestock increases. In lower vegetation tiers, particularly the following succulent species belong to them: *Adenium obesum* ssp. *sokotranum*, *Jatropha unicostata* and *Cissus subaphylla* forming sporadically dominants species of grazing shrubs. In higher

vegetation tiers, poisonous *Gnidia socotrana*, *Buxanthus pedicellatus* and *Cissus hamaderohensis* spread in shrublands (see Tab. 1).
In often long periods of drought, leaves, shoots and fruits of some woody species are used for livestock feeding. The most frequently used species are: *Acacia pennivenia, Boswellia* spp.*, Commiphora* spp.*, Tamarindus indica, Ziziphus spina-christi* etc. (see Tabs. 2 and 3). In the period of lack of pasture for livestock the feeding using leaves and shoots is of fundamental importance for the survival of livestock and traces of branch lopping can be found on trees throughout the island. Therefore, in modifying the existing pasturage to pastoral agroforestry on Socotra, it is necessary to take into consideration the use of trees and shrubs for livestock feeding.
In the course of the project implementation, threes suitable localities were found as well as suitable human resources to realize the production of planting stock of multifunctional autochthonous woody species. For the purpose of plant acclimation at higher altitudes, a suitable locality was found for seedling of *Dracaena cinnabari* and other multifunctional species.
In the course of recent three years, about 6000 plants of multifunctional autochthonous species were produced in forest tree nurseries (*Boswellia ameero, Dracaena cinnabari, Commiphora ornifolia, Sterculia africana, Tamarindus indica, Ziziphus spina-christi*) using both generative and vegetative methods of regeneration (see Tab. 4). Part of the species was distributed among the local community for growing in home gardens. The number of involved communities reached 40 in June 2003.

Discussion – social and cultural conditions
An increasing anthropogenic pressure on natural resources of Socotra is most markedly represented by cattle grazing and excessive consumption of fuelwood and building timber. At present, all vegetation formations of the island are disturbed in dependence on the density of settlements. Although the traditional form of Socotra husbandry took seriously into consideration limits of availability of sources for fodder and fuelwod there are at present evident symptoms of biocoenose degradation. It is the result of abandoning the traditional ways of life of "alternate" pasture cycles caused by negative effects of the "modern" world on traditional values.
Geobiocoenoses with natural development have been preserved only exceptionally on inaccessible places or on localities quite unsuitable for cattle grazing. Pasture shows also serious impacts on erosion. Owing to the cattle grazing, there is a critical condition of populations of the majority of woody species which were dominant in natural forest biocoenoses including rare and memorable endemic species such as *Boswelia* spp., *Commiphora* spp., *Dendrosicyos socotrana*, *Dracaena cinnabari*, *Sterculia africana ssp. socotrana, Euphorbia socotrana, Lannea transulta, Maerua angolensis* ssp. *socotrana*. Due to pasture, present populations of main arborescent woody species show markedly unbalanced age structure. Virtually throughout the island, systematic impacts of pasture result in the absence of natural regeneration, populations in preserved forest and woodland biotopes are overmature because natural regeneration has been quite destroyed due to excessive goat and sheep grazing and in mountains also due to cattle grazing. Thus, the most extensive vegetation formation of the island is a low grazing forest the dominant species of which are some species of the family *Euphorbiaceae*, above all *Croton socotranus* and *Jatropha unicostata* which are not consumed by cattle. Selective effects of pasture are also documented by the distribution of a poisonous *Adenium obesum* ssp. *sokotranum* while the endemic succulent species *Dorstenia gigas* from the family *Moraceae* occurs only rarely on inaccessible rocky cliffs. On the northern coast, all localities of mangrove stands have also disappeared and conditions for their

spontaneous regeneration do not occur. They grow old approaching the stage of disintegration.
Despite of this, Socotra under conditions of an arid tropical zone is exceptional due to the fact that forest and woodland biotopes have been preserved at all and have not been yet converted to degraded extensive pastures of semi-desert character. It is possible to speculate only that in the past, regeneration of grazed woody species on Socotra occurred in periodically repeated periods of decrease in the number of inhabitants connected with a decrease in cattle stocks. Preservation of forest, woodland and shrub biotopes was also supported by the fact that only dry wood was traditionally used as fuelwood and that tribal chiefs decided on felling trees suitable for the construction of dwellings.
The real use of protection and care of valuable biotopes appears to be a great problem under present conditions of Socotra. In 1996, the first proposal was presented concerning the protection of natural wealth of Socotra (Miller & Bazara'a 1998), later a more detailed proposal was prepared of the differentiated use of landscape including a proposal of the system of protected regions as a basis for the land-use plan, viz. Soqotra Archipelago Master Plan (Miller et al 2000). The predominant part (more than 70%) of the island is proposed for protection as a national park. The strictest regime is proposed in nature reserves (nature sanctuaries) occupying an area of 95 km^2, i.e. 2.5% of the island territory. In the proposed reserves, natural conditions of the ecosystem development without any economic activities should be protected.
In respecting the land-use plan, it is perhaps possible to prevent from negative effects of new developmental activities (industrial development, building, intensive agriculture). However, the greatest problem of Socotra consists in cattle grazing. With the exception of proposed nature reserves, "controlled cattle grazing" is proposed in all categories of protected regions. Reality of pasture prohibition or controlled pasture is of course very problematic under present conditions. Up to now, a cattle grazing is the main and often the only source of livelihood on Socotra. The growing number of inhabitants results in increasing cattle stocks and thus using all available sources of food for extensive cattle breeding.
Care of future forest biocentres is connected with agroforestry activities supported on Sumatra within the development project. In a number of localities forming the framework of ecological stability, it would be possible to preserve continuously and permanently tree populations as decisive edificators of natural geobiocoenoses. A long-term objective is to teach local population to regenerate woody species as part of procedures of pastoral agroforestry. The most suitable beginning of the sustainable use of local woody species is a support of establishing home gardens using those species which provide immediate benefits for local population (fruit, wood, fodder for livestock).

Conclusion

Socotra Island is a typical example of long-term impacts of cattle grazing. The problem of pasture restriction is very delicate because livestock (above all goats and sheep) represents the basic food source of natives for some 3000 years within the existing "agro-pastoral" husbandry. Any pressure aimed at forcible putting the cattle aside the source of fodder in the open is not realizable under present conditions. Possibilities consist in the gradual modification of traditional husbandry to a silvo-pastoral model or in the increasing development of tourism and related job opportunities. Only through ensuring alternative and convincing sources of livelihood it will be possible to change the direct socio-cultural and economic dependence of local inhabitants on their herds. Therefore, it is necessary primarily to prepare such a proposal which is transparently useful for natives and respects local pastoral traditions modifying them susceptibly though intensively.

References

BUCEK, A., LACINA, J. (2000): Geobiocoenological typology of landscape. Geobiocoenological publications, vol. 5, MUAF Brno. pp. 1-11. (in Czech)

BUCEK, A., PAVLIS, J., ADOLT, R., HABROVA, H., JELINEK, P. (2001): Final Report of the Project: Creating an ecological network and agroforestry, educational and cultural doorway for sustainable development of Socotra Island (Republic of Yemen). Ms, Praha. 233 pp.

HABROVA, H. (2002): Influence of Grazing on the Vegetation of the Biocentre Firmihin. In: Madera, P. (ed.): Ecological networks. Geobiocoenological publications, vol. 6, MUAF Brno, MZe, Praha, pp. 230-232. ISBN 80-7157-580-1 (in Czech)

HABROVA, H. (2003): The Impact of Grazing on the Landscape of Socotra Island. In: Rustic landscape. Memorial volume from the conference. pp. 27-31. ISBN 80-239-0763-8. (in Czech)

HABROVÁ, H., KRÁL, K. (2002): The application of Central-European geobiocoenological approach for delimitation of altitudinal vegetation zones in arid tropical conditions of the Socotra Island using data of remote sensing (RS). In.: Abstracts of the IXth Congress of the Czech Botanical Society „Floras, Distribution Atlases and Vegetation Surveys in Central Europe, 19.-23.8.2002: 62. ISBN 80-86632-02-4.

JENIK, J., LONGMAN, K.A. (1974): Tropical forest and its environment. Longman Group, London. ISBN 0-582-44045-9. 196 pp.

LEAKEY, R. (1996): Definition of agroforestry revisited. Agroforestry Today 8(1): 5-7

MILLER, A., BAZARA'A (1998): The conservation status of the flora of the Soqotran Archipelago. In: Dumont, H. J. /ed./: Proceedings of the first international symposium on Soqotra Island: present and future, Aden 1996. UNDP New York. pp. 15- 34

MILLER,A., MORRIS, M. /EDPP./ (2000): Conservation and Sustainable Use of the Biodiversity of Soqotra Archipelago. Royal Botanic Garden Edinburgh. 349 pp., Appendix 24 pp.

MILLER ET AL. (2000): Socotra Archipelago Master Plan. WS Atkins International.

PANCEL, L. (1993): Tropical Forestry Handbook I, II- Springer-Verlag Berlin-Heidelberg.

PAVLIS, J., BUCEK, A. (2002): Socotra Island – Conflict of developmental plans and conservation effort. In: Madera, P. (ed.): Ecological networks. Geobiocoenological publications, vol.6, MUAF Brno, MoA, Praha, pp. 248-254. ISBN 80-7157-580-1

PAVLIS, J., HABROVA, H., KRAL, K. (2002): Creating an ecological network and agroforestry, educational and cultural doorway for sustainable development of Socotra Island (Republic of Yemen). Partial report for the year 2002. Ms. Brno. 43 pp. (in Czech)

ZLATNIK, A. (1975): Landscape Ecology and geobiocoenology. VSZ Brno, 172 pp. (in Czech)

Tab. 1 - Trees and shrubs progressing on grazed lands

scientific name	socotri name	vegetation tier
Adenium obesum ssp. sokotranum	Esfed	1-2(3)
Buxanthus pedicellatus	Mitahan	(2)3-4(5)
Cissus hamaderohensis	Atrhe	2(3)-4
Cissus subaphylla	Atrhe	1-2(3)
Euryops arabicus	Betahen	3-5
Gnidia socotrana	Gaither	(2)3-4
Jatropha unicostata	Sebra	1-3

Tab. 2 - Plants used for livestock feeding in the drought times

scientific name	socotri name	vegetation tier
Acacia pennivenia	Tomhor	2-3
Acridocarpus socotranus	Kredlo	2-3(4)

Allophyllus rubifolius	Zerkin	(3) 4-5
Boswellia elongata	Ameiro	2-3
Boswellia ameero	Ameiro	2-3
Boswellia dioscorides	Samaano	2-3
Boswellia socotrana	Telie	2-4
Cephalocroton socotranus	Ten	(3)4-5
Commiphora ornifolia	Ekše	1-2 (3)
Commiphora socotrana	Lakham	(1)2-3
Cordia obovata	Abete	2-3
Lannea transulta	Kchenhor	2
Sterculia africana	Bojhen	2
Tamarindus indica	Sobhor	2-4
Ziziphus spina-christi	Thlót	1-2 (3)

Tab. 3 - Trees and shrubs recessing by grazing

scientific name	socotri name	vegetation tier
Boswellia ameero	Ameiro	2-3
Boswellia dioscorides	Samaano	3
Boswellia elongata	Ameiro	2-3
Boswellia popoviana	Loyfha	2-3
Boswellia socotrana	Telie	2-4
Commiphora ornifolia	Ekše	(1)2-3
Commiphora socotrana	Lakham	(1)2-3
Dracaena cinnabari	Arieb	2-5
Lannea transulta	Kchenhor	2-3
Maerua angolensis	Ešheb	1-2
Punica protopunica	Rehina	3-4
Sterculia africana	Bojhen	2-3

Tab. 4 - production of endemic species

species	vegetation tier	production	in gardens
Boswellia ameero	2-3	470	8
Commiphora ornifolia	1-2 (3)	1587	53
Dracaena cinnabari	2-5	750	9
Sterculia africana	2	429	6
Tamarindus indica	2-4	922	16
Ziziphus spina-christi	1-2 (3)	1110	17
Commiphora socotrana	(1)2-3	52	
Boswellia popoviana	2-3	0	1