Geoecological Reconnaissance in the Alpine Belt of Southern Tibet

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ABSTRACT: Along with four vegetation profiles taken in 1984 in S Tibet climatically induced regressive plant successions were observed. Recently, frost heaving-adapted plant communities of the free gelifluction belt have been descending toward the alpine belt. The hypso-zonal cyperaceae turfs of the alpine belt have been exfoliated by the Himalaya fohn, and the alpine steppe communities have been advancing for an unknown period of time. The following hypothesis for this is given: The turfs must be interpreted as relics formed under wetter climatic conditions before the start of the Himalaya fohn and the related Indian summer monsoon. It is concluded that this *Kobresia pygmaea* age occurred just after the deglaciation of the Tibetan plateau and before the start of the Indian summer monsoon.

Introduction

Preliminary results of geoecological reconnaissance of the vegetation pattern of the alpine belt of S Tibet based on a description of four profiles along the expedition route are presented. The profiles are arranged chronologically in the direction of the rainscreen of the Main Himalayan Range to the south with a steplike increase in altitude starting at 3730 m near Lhasa and reaching 5450 m in the upper Sun Kosi catchment. The present attempt should give an impression of what the vegetation of the alpine belt of S Tibet is like. Emphasis was given to the vegetation cover as influenced by morphodynamic processes and the ongoing changes in the plant communities in the reaction to climatic changes. Thus, the subject of this paper should assess the relation between gelifluction, deflation, the impact of grazing, and the vegetation cover. The goal here is a representation of the vegetation pattern reflecting the effects of changing climate.

Plant Communities in the Hills North of Lhasa (29° 31' N, 91° 06' E)

Delimitation of the Alpine Belt

Situated in the Transhimalaya N of the Yarlung Zangbo the profiles extend down from the alpine belt to the valley floor at 3730 m. At least presently, the hills of Lhasa are treeless, and no forest remnants such as solitary trees or tree stubs were found. There is no evidence of the upper treeline or the approximate altitude of the subalpine belt. Nevertheless, the lower limit of the alpine belt is more clearcut than would be expected in mountains lacking any forests. Even from a good distance an obvious change in the percentage of the plant cover ca. 400 m above the valley bottom can easily be recognized: On the lower slopes the plant cover ranges up to at least 30% while the upper slopes are covered to more than 60%. Another easily visible feature which fits nearly this fringe at the lower limit of the alpine belt is the incision of desert gorges (see plate 3:1; Hövermann 1987) which mainly set in below 4300 m. These gorges cut deeply into the loamy soils down to the sandy granite debris and the granite bedrock itself. Above this altitudinal belt of light-brown loamy soils eroded by desert gorges, there is a change to dark alpine soils at ca. 4300 m.

The phytogeographical proof of the lower limit of the alpine belt has to be derived from forested parts of the Himalayas where species appering above the upper treeline are of significant alpine character. Cushion-forming species of dominant alpine distribution represent the most characteristic plant life form of this altitudinal belt. Their lower limit of dominant distribution corresponds with the upper limit of dominant distribution of species which are classified as being of non-alpine distribution. Both groups are interlinked in a transition zone of quite different extra-zonal biotopes.
Besides this hypso-zonal differentiation (Miehe 1986) the chasmophytic flora and the lichen cover is rather distinct: Below 4100–4200 m the granitic boulders are only sparsely covered with lichens, above this level boulders in every aspect are covered with lichens. There is possibly an increase in humidity with altitude along with clouds covering the upper slopes of this valley in the afternoon. Obviously, the growth of lichens which depend on dew, is faster than the exfoliation of the granite above 4100–4200 m. Chasmophytic phanerogams are confined to crevices between or in boulders. Phanerogams growing on top of those boulders in soil as in known from humid mountain ecosystems are absent. Between 4100 and 4200 there is a conspicuous change in the chasmophytic flora which underlines the abovementioned altitudinal differentiation: Below 4100–4200 m the rosettes of Corallodiscus cf. kingianus and Selaginella tamariscina, which both were shrivelled in August 1984, Rhodiola chrysanthemifolia subsp. sacra, and Pellea nitidula on the base of those boulders occur in all aspects. Above 3800 m, and exclusively in shady aspects Selaginella sanguunolenta, which has not yet shrivelled in August, occurs with the above-mentioned species.

The alpine chasmophytic plants growing above 4100 m are Rhodiola bupleuroideae, Androsace graminifolia, Saxifraga cf. punctulata, and Saxifraga sp. 1178. The rhizoid creeping Neocheioperis waltoni occurs on sunny slopes above 4200 m and is still present at 4620 m; on shady slopes this fern’s lower limit is the same as that of Selaginella sanguunolenta at 3800 m.

Plant Communities of the Lower Alpine Belt

The dominating plant communities have their limits in the same altitudinal belt as the chasmophytic flora: On N-facing slopes above 3800 m and on E-facing slopes above 4100 m some dwarf shrubs of the Himalayan inner valleys (Stainton 1972; Miehe 1982) occur with a 80–90% cover of phanerogams, i.e. Spiraea sp., Cotoneaster cf. tibeticus, Rosa sericea, Potentilla fruticosa var. ochreata, and at least two Berberis spp. They are accompanied by Stellera chamaejasme, Aconogonum tortuosum (which ascends from the valley floor), colonies of 30-cm-tall Iris sp., Allium fasciculatum, Astragalus melanostachys, Pedicularis oliveriana, Delphinium pseudograndiflorus, D. caeruleum, Erirrichium microcarpum, Aster crenatifolius, Rabdosia parviflora, Genitana farreri, G. kuroo, Swertia hispidalca, Campanula sylvetica, Heracleum thomsonii var. thomsonii, Lancea tibetica, Taraxacum sp., and Thalictrum reniforme.

More common on the shady slopes were Kobresia pratina, K. royleana, (preferably grazed) and Carex decantescens. These 10- to 20-cm-tall cyperaceae seem to dominate most parts of the shady aspects, whereas tall forbs such as Iris sp., Stellera chamaejasme, and Rabdosia parviflora more often occur on E-facing slopes. Grasses were nearly absent; on N-facing slopes Stipa consanguinea was rather frequent.

Artemisia spp. are common on these slopes and well confined to altitudinal belts. Artemisia prattii is the common species of the lower alpine belt in the alpine tall forb communities; less frequent are Artemisia vexans and A. desertorum var. jacquemontiana. The tiny silvery leaved Artemisia minor can sporadically be found above 4050 m on sunny slopes and becomes frequent at 4300 m on sunny windward slopes and open ridges.

Plant Communities of the Subalpine, Semidesert Belt

This altitudinal belt has its upper limits at 4100 m, except on W-facing slopes where the subalpine, semidesert plant communities meet the alpine cushion communities at 4200 m. These slopes are apparently the driest habitats, obviously caused by the prevailing westerly winds.

Dwarf shrub communities are the most common ones; Artemisia santolinifolia (which is the most aromatic of the above mentioned species), the thorny dwarf shrub of Sophora moorcroftiana, and the shrublike Ceratostigma minus are the characteristic species. Grasses are here more frequent than in the alpine belt (Pennisetum flaccidum, Orinus thoroldii, Andropogon monroi, and Tripogon trifidus). Rather frequent are the following species: Mitula spicata, Anaphalis xylorhiza and Leonotis kingianus. More common species of the lower alpine belt in the alpine tall forb communities; less frequent are Artemisia vexans and A. desertorum var. jacquemontiana. The tiny silvery leaved Artemisia minor can sporadically be found above 4050 m on sunny slopes and becomes frequent at 4300 m on sunny windward slopes and open ridges.

Approximately above 4300 m flat hemispherical cushions become the dominant life from in place of tall forbs. These flat hemispherical cushions grow in a dark alpine turf and are obviously the more common, the more wind exposed the habitats are. The turf is composed of Kobresia pygmaea which no longer forms a closed cyperaceae cover but gives way to cushions and lichens covering all the space not occupied by living phanerogams. The most common cushion is the flat, hemispherical, compact Androsace tapete. Other silvery leaved flat cushions are Anaphalis xylorhiza and Leonotis kingianus. Other common, flat, and compact hemispherical cushions are Arenaria kusunensis and Hypolititia sycalanthiformis. Further common species are Cyananthus incanus, Leibnitzzia ruficoma, Astragalus tribulifolius, A. confertus, Pedicularis integrifolia, Potentilla potaninii, Heracleum thomsonii var. thomsonii, Pleurospermum hookeri, Cortiella hookeri and Carex oxyleuca. The grasses of these cushion dominated slopes are the tiny Stipa purpurea and Tripogon trifidus. Exposed granitic debris of this alpine belt is covered by lichens if it has not been recently trampled by animals.