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REVIEW ARTICLE

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Ethno-agricultural approach to the rural environment in the prevention of Kashin-Beck disease

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Abstract Kashin-Beck disease occurs in several villages of Tibet; however, its local importance varies greatly. The ecoclimatological as well as the phytogeographical framework of the studied area are presented. An ecological approach based upon the ethno-ecosystem concept was carried out in the vicinity of each village. This study identifies 18 vegetation units on a structural basis; they were named for the dominant plants of each unit. Half of them belonged to the aquatic milieu. The different factors controlling their distribution were also identified. Particular attention will be paid to the links between man and the environment, particularly regarding alternative food intakes and water supply access.

Résumé La maladie de Kashin-Beck est signalée dans divers villages du Tibet; toutefois son importance locale varie grandement. Les cadres écoclimatologique et phytogéographique de la zone d'étude sont présentés. Une approche écologique, basée sur le concept de l'ethno-écosystème a été effectuée dans les environs immédiats de chaque village. Cette étude conduit à reconnaître 18 unités de végétation d'un point de vue structural; elles sont dénommées sur base de leurs plantes dominantes respectives. La moitié d'entre elles relèvent du milieu aquatique. De plus, les divers facteurs contrôlant leur distribution sont identifiés. Une attention particulière sera portée en ce qui concerne les liens existant entre homme et environnement, en particulier en ce qui concerne les nourritures alternatives et l'accès à l'eau.

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Introduction

Kashin-Beck disease (KBD) is an endemic osteochondropathy primarily affecting children. More than thirty million people live in areas where the disease is endemic. Approximately two million people are affected in China alone. The unknown etiology of the disease represents a continuing challenge to medical and agro-environmental sciences [15]. Currently, it is possible to identify a few predisposing factors, such as a mountain environment, selenium deficiency, poor nutrition, a high concentration of organic matter in drinking water, and contamination of barley grain by fungi-producing mycotoxins. Several agricultural and traditional practices appear to affect the incidence of KBD. In order to understand the many health problems presented by this condition, social, cultural, economic, and political, as well as ecological and agricultural factors should be considered [4, 14, 20, 23]. The aim of this review is to introduce ethno-agricultural awareness into strategies designed to prevent Kashin-Beck disease.

Environment

Geographical factors

Between the Himalayas to the south and the Kunlun Shan to the north, from 78°23′ to 99°05′ E and from 26°50′ to 36°53′ N, on about 2.4 million km^2, an area of about five times the size of France, stretches a highland area called the Tibet Autonomous Province. Tibet borders with Sichaun, Yunnan, Qinhai and Xinjiang; India, Nepal, Sikkim, Bhutan, and Burma lie to the south and it is bordered by Kashmir to the west. Northern Tibet is very dry and forms a massive plateau about 4500 m high containing several ridges. Southern Tibet collects the last monsoon rains. A longitudinal rift valley stretches from west to east between Himalaya and Transhimalaya, where the High Brahmaputra or Tsangpo (literally "the river" in Tibetan) flows. In the valleys, sheltered from winds, the summers are mild enough for barley to grow. The evolution from the wild barley of Tibet, very similar to that of primitive cultivations, to the presently cultivated forms has been documented [30] and is of primary importance to the incidence of KBD.

Climatic features

Two main factors control the climatic characteristics of Tibet: the topographic configuration and the atmospheric circulation. A south-east north-west orientated cross-section indicates a clear line with regard to mean annual rainfall, which varies between more than 2000 mm during the tropical monsoon and less than 50 mm. During winter, western winds are dominant; in summer, the southern and south-eastern part of the plateau are subjected to warm, wet monsoon winds. The climate is very dry during winter. Schweinfurth [26, 29] and Chang [2] have described the dry valleys of the Tibetan Himalaya. The Tsangpo valley appears as a subzone at the margin of two continental plates. There, annual precipitation is usually between 300 and 500 mm. The mean annual temperatures are between 4°C and 8 C. The mean temperatures during the warmest month vary between 10°C and 16 C. Sunshine is abundant and the growing season is longer than in the higher colder meadows. Around Lhasa, rains are frequent from late June to early September.

Geological features

The Tibetan plateau, often called the “roof of the world”, is a collage of continental fragments that were added successively to the Eurasian plate during the Paleozoic and Mesozoic ages. Paleomagnetic data indicate that these fragments were at southern latitudes during the Paleozoic age. The sutures between these microplates are marked by scattered ophiolitic material trapped between the crystal blocks during accretion. From north to south, the main Tibetan crystal blocks are the Kunlun, Songban-Ganzi, Qiangtang, and Lhasa terrains. The plateau is underlain by a continental crust which is 65 km thick; it is usually about 30 km thick. Elevation of the plateau began in the early Miocene age and probably reached its present elevation about 8 million years ago [18].

Phytogeography

Our knowledge of the flora of Tibet comes from rare foreign expeditions [37], notably in the 1950s and from several expeditions of the Chinese Academy during the past decades [41]. The flora of Tibet comprises 164 families, 1145 genera, and some 5296 species of Spermatophyta, with about 955 endemics [39]. According to the areas where they are found, this flora may be classified under five major geoelements: the north temperate (7.4%), the Central Asiatic (7.0%), the Tibetan (5.8%), the Sino-Himalayan (54.0%), and the tropical (12.9%) [42]. Five floral regions have been identified, namely from southeast to northwest: the Indo-Malayan, belonging to the paleotropical empire; the Sino-Himalayan; a transition zone; the Tibetan; and the Central Asian floral region belonging to the Holarctic empire [42]. The diversity of the various vegetation belts contributes to the phytogeographical background of the area. It has been concluded that neither the traditional altitudinal zonation [31, 32], nor low mountain latitudinal zonation can be applied to Tibet. As a result of its special vegetation characteristics, the Tibetan plateau is identified as an independent region, for which a special high plateau zonation has been proposed [2, 3]. From southeast to northwest the following belts occur: tropical evergreen forest, tropical monsoon forest, mountain evergreen broadleaf forest (upper limit of 1800 m), mountain mixed forest, mountain coniferous forest, subalpine thickets, high-cold meadow, high-cold steppe, semi-desert, and high-cold desert. The Tsangpo Valley is generally identified as a xeric shrubland-steppe plateau zone [2, 27]. With increasing altitude other vegetation belts are seen whose flora and vegetation have been studied [1, 6, 9, 10, 11, 12, 13, 17, 22, 33, 38, 43]. The spatial heterogeneity of human activity provides another means of differentiation. According to land-use patterns, three ethno-ecological zones may be identified, namely: the urban zone, the agricultural zone, and the pastoral zone.

Methodology

The area studied stretches over three prefectures (Shigatze, Lhasa, and Lhoka), seven communities, and 28 villages. The concept of an ecosystem has been one of the most important developments in ecology during the 20th century and aspects of human welfare have also recently been considered [5]. From an ethno-ecological approach this has led to the definition of a new unit: the ethno-ecosystem, which may be defined as “all elements in an environment inhabited by man and through which he establishes intuitive and cognitive relations with each of those elements” [25]. The ethno-ecosystem adds a cultural dimension to the preoccupation of spatial and temporal ecosystems [21]. Incorporating this concept, mainly with regard to agriculture, into our understanding and management of environmental approaches will be increasingly investigated by developed societies [19].

In this way a first step towards a better agri-environmental understanding requires an ecosystem diversity approach based upon a recognition, and further identification of the main vegetation types as well as of the agricultural systems. The plant society or phytocenosis supplies the support for the units naming (=denomination) of the diverse ecosystems. The criteria for differentiation rely upon the concept of evolutional series, the density of the layers of covering plants, the characteristics of the habitat and the composition of the species.

A vegetation survey was therefore carried out in the area of activity of Médecins Sans Frontiers-Belgium in South-Central Tibet in July-August 1998. Our study was completed by making a plant reference collection of some 650 voucher specimens. This collection was registered at the Belgium National Botanical Garden (the acronym BR according to Holmgren et al. [16]). The aim of this paper is to develop a typology of the diverse vegetation units identified during our field survey.

Vegetation units

The diverse vegetation units identified were allocated into two main groups, namely terrestrial and half-aquatic or aquatic. The former allows a distinction to be made between closed and open vegetation units. For the latter, lakeside conditions will be considered separately. Diverse habitats relating to flowing water are identified by local people under the name of “doutchou”.

A. Terrestrial vegetation units

AA. Closed vegetation units

Woody units

Sabina przewalskii Kom. (FM 15,528) forests. These coniferous forests formerly extended over a wider area. Remnant forestry patches where noted in the Reting valley, namely in the vicinity of Tsangchung. Several local uses, mainly branch collecting for incense (or *pama*) and clear cutting for firewood, maintain a heavy anthropic pressure on those forests, whose rarefaction continues to increase.

Hippophaë neurocarpa (BL & FM 265) open forests. The occurrence of these open forests is restricted to narrow ecological conditions, mainly on alluvial sites supporting contrasting hydrological conditions due to the large amplitude of fluctuations of the ground water depending on the season. The presence of such woody patches was noted on islands and stream banks in several valleys, namely along the Nyemo River, in the vicinity of Nyemo, as well as in the Reting valley.

Willow-birch woodlands (Salix cf. sclerophylla Anders and Betula sp.). This unit is linked with poor acidic soils in the lower part of the subalpine belt. Birch woodlands are not at all rare. The presence of a *Ribes* sp. was observed. For the area under consideration, such woodlands were quoted between Tsingda and Tsangchung.

Shrubbery steppe. A regressive stage of several woody climax units is demonstrated by several shrubby vegetation units. A preliminary set of shrubs has been listed, including spindle-tree, currant-bush, jasmine and honeysuckle (in the surroundings of Djamey).

Myricaria germanica (L.) Desv. (FM 15,093) pioneer thickets. These thickets, 1.0–2.5 m in height, are linked to riversides, namely gravelly riverbeds. The pinkish-red inflorescence developed in June and July easily identify this typical vegetation unit.

Ruderal (nitrophilous) stream thickets. Such thickets have been observed in the vicinity of Neudong. *Clematis tangutica* (Maxim.) Korsh (FM 15,268), *Thalictrum foetidum* L. (FM 15,271), *T. atriplex* Finet & Gagnepain (FM 15,272), *Aconitum* sp., *Rosa omeiensis* Rolfe (FM 15,099), and *Cucubalus baccifer* L. (FM 15 276) are some of the main components.

Herbaceous units

Fields (agro-ecosystems). As far as the main crops are concerned, barley, colza, potatoes, peas, and wheat agro-ecosystems will be distinguished. They all are in need of further detailed studies.

Meadows. Reap fields versus pasturelands are a classic approach to differentiation. The first are very rare while the later are common. Grazed meadows are differentiated according to two main ecological factors: soil richness (rich, medium, and poor) and soil hydration (dry, fresh, moist, and very damp). For instance, *Caltha palustris* L. var. *himalensis* (D. Don) Mukerjee occurs in damp places on grazing grounds; *Potentilla anserina* L. (BL & FM 335), locally well known as “toma” or “droma”, on fresh soils. Short overgrazed lawns, located near streams, are dominated by sedges and are called “naka.”

Rocky slopes. In this mountainous environment, rocky slopes are frequent. They support grasslands and rocky steppes as well as bare, rocky deserts. As far as grasslands are concerned, their flora varies with altitude. For instance, *Viola biflora* L. characterizes the meadows of the subalpine belt.

AB. Open vegetation units

Sandy deserts. These occur in the Tsangpo valley, between Neudong and Djamey, around km 41. Their origin relies on large amounts of sand deposited along the Tsangpo during swellings, which were later reworked by wind into sand dunes. Sandy slopes on mountainsides are also observed; their local name is “chiri”, while when piedmont with scattered bushes they are recognized as “katang”.

Steppes. The steppe vegetation of Tibet has been approached by Schweinfurth [27] and reviewed by Wang [34, 35, 36], who identifies four types of communities, namely the tussock grass, the rhizome grass, the rhizome sedge, and the semi-undershrub steppe. The former is the most widely distributed at high altitudes and the most typical, the semi-undershrub steppe, occurs frequently in the area under consideration. In fact, several units occur according to lithology, altitude, exposition, etc. Steppes extend to 5200 m, even 5400 m, in elevation. We observed several different types.

Gneiss rocky steppes. Gneiss rocks exposed to the southeast carried an open vegetation. In the crevices, a rare sandy substratum accumulates which allows the development of dense carpets of *Selaginella pulvinata* (Hook. & Grev.) Maxim.(FM 15 003), *Corallodiscus kingianus* (Craib.) Burtt (FM 15 007). Less frequent are *Aleuritopteris argentea* (Gmel.) Fée (FM 15 004). Locally shrublets, such as *Ceratostigma griffithii* C.B. Clarke (FM 15 005), *Lonicera tibetica* Bur. & Franch. (FM 15 008) are scattered.

Other rocky shrubby steppes. Other plants observed are, among others, *Polygonatum cirrhifolium* (Wall.) Royle (FM 15 208), *Cotoneaster tenuipes* Rehd & Wils (FM 15 214), *Asparagus filicinus* Buch-Ham ex C. Don. (FM 15 209).

Altiherbosa on rocky screes. Clusters of *Arisaema flavum* (Forsskal) Schott (FM 15055) are the most typical features of rocky scree. The species is reported from Afghanistan to Tibet. In Nepal, as in Tibet, it is mostly observed on stony slopes in drier areas [24].

Alpine meadows. With high elevation meadows are more common. Their distribution and structure have been reviewed by Zhou [44].

B. Aquatic and half-aquatic vegetation units

These habitats are of primary interest as they provide water for humans. Water from streams and rivers is used primarily for washing.

Lakeside habitats. The chemical characteristics of the lakes of Tibet have been discussed by Fan Yun-qi [7]. On a general pattern the mineralization increases from southeast to northwest, fresh water lakes becoming gradually salt water lakes and then saline lakes. Lakeshore vegetation relies on this pattern; nevertheless these ecosystems were not approached during our survey.

Lotic habitats

- River banks.
- Pools.
- Hot springs.
- Marshes. The total area of marshes in Tibet is about 11,000 km² [40]. They have been classified into two major types (gley fens and peat moors) and eleven subtypes according to the geomorphology situation and the water supply regime. Their upper limit is about 5200 m above sea level. Marshes, dominated in July by pinkish carpets, are typical of the Nyemo valley.
- Peat bogs. Several units occur:
  - With hummocks, occurrence of *Pedicularis anas* Maxim. var. *tibetica* Bonati (FM 15 169)
  - Developed on slopes: *Primula sikkimensis* Hook. (FM 15 100)
- Aquatic meadows with *Hippuris vulgaris* (FM 15 162).
- Temporary water bodies.
- Permanent adduction channels (slow flow). Several social heliophytes were observed. Most frequent are diverse *Potamogeton* spp. and *Nymphoides* sp.. They were observed in the Kyi-tchou valley, up-stream from Lhasa.
- Small waterfalls. Not at all rare in the alpine belt, these small waterfalls hosted a particular and diverse flora.

Conclusions

The present paper lists a preliminary inventory of vegetation units identified in the area under consideration by MSF-B in South-Central Tibet. The most prominent characteristic is the large diversity of vegetation units observed. Moreover, several factors appear to control their distribution:

- Altitude, including temperature and vegetation belts
- The geomorphology of the valleys and the distinction between dry and wet subsystems, as well as the significance of local lithology
- The relative importance and nature of native agricultural systems
- The water cycle and systems, with its effects on the water supply
- The impact of human intervention on vegetation and landscape [28]

A more detailed approach to investigating the structure of agro-ecosystems and the functions as well as the diverse facets of ethno-ecology is now required.

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