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Ü Ethnomycology and Ethnobotany (South Central Tibet). Diversity, with emphasis on two underrated targets: plants used for dyeing and incense.

Ethnomycologie et ethnobotanique des Ü (Tibet centro-méridional). Diversité, y compris deux thèmes méconnus: plantes tinctoriales et encens.

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Résumé: Ethnomycologie et ethnobotanique des Ü (Tibet centro-méridional).- Diversité, y compris deux thèmes méconnus: plantes tinctoriales et encens.

Dans le cadre d'un programme consacré à la prévention et la recherche sur la maladie des Gros Os et mis en œuvre par la Kashin-Beck Disease Fund en Région Autonome du Tibet (R.P. Chine), une étude écologique a été développée dans la partie centro-méridionale au cours de 8 séjours de 2 à 3 semaines (1998-2007). Elle a permis de dégager, puis de renforcer l'intérêt d'une approche agro-environnementale dans la compréhension et la prévention de cette maladie. Parallèlement, la connaissance ethnomycologique et ethnobotanique des Ü-Tsang de ce territoire a été recensée. Au-delà de la connaissance bien documentée des plantes médicinales et de l'ethnopharmacologie, connaissance qui sera très brièvement rappelée, l'étude a abordé des thèmes méconnus, tels que la reconnaissance des unités de végétation, la diversité des nourritures alternatives (champignons, herbes potagères, épices, plantes aromatiques, condiments, organes souterrains, fleurs et fruits charnus consommés), l'utilisation des plantes en phytotechnie et pour le bien-être domestique. Une attention particulière a été consacrée aux plantes tinctoriales et à celles utilisées pour l'encens.

Enfin, les menaces pesant sur cette biodiversité sont dégagées et des suggestions pour une meilleure gestion sont énoncées.

Mots-clés: Kashin-Beck, *Ophiocordyceps sinensis*, *Onosma hookeri*, noyer de l'Himalaya, *Rhododendron anthopogon*, bâtons d'encens, savoir traditionnel indigène.

Abstract: In the frame of a programme directed by Kashin-Beck Disease Fund to the Big Bone Disease in Tibet Autonomous Region (P.R. China), an ecological study has been developed in the South-Central part during 8 surveys of 2 to 3 weeks (1998-2007). This has permit to establish, and later to reinforce the interest for an agro-environmental approach regarding the understanding and prevention of this disease. At the same time, the ethnomycological and ethnobotanical knowledge of Ü-Tsang populations of this area has been listed. Beyond the well documented knowledge of medicinal plants and of ethnopharmacology, knowledge that would be very shortly reminded, our study has broached underrated targets, such as the distinction between the diverse vegetation units, the diversity of wild edible products (mushrooms, potherbs, spices, aromatic herbs, condiments, edible undergrounds organs, flowers and fruits), the use of plants in phytotechny and domestic household. A particular attention has been devoted to plants used in relation to dyeing as well as plants used as incense. Finally, the threats hanging over this biodiversity are brought out and suggestions for a better management are proposed.

Key words: Kashin-Beck disease, *Ophiocordyceps sinensis*, *Onosma hookeri*, Himalayan walnut, *Rhododendron anthopogon*, incense sticks, indigenous traditional knowledge.

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INTRODUCTION

The present study concerns South Central Tibet. Both published data and new observations are put together. Regarding our field research, the area involved stretches three Prefectures (Shigatse, Lhasa and Lhoka) out. The network consists of 83 villages distributed in ten counties and their respective surroundings (MALAISSE et al., 2001). The people enrolled speak Tibetan (alternative name Central Tibetan). The Tibetan population in the area is estimated for 1,200,000 inhabitants. This ethno-linguistic group includes several dialects, of which Ü and Tsang subgroups are here concerned. Written Tibetan is reported to be based on a Southern dialect, Ü-Chan. It is the common script used by all of them. In Central and Northern Tibet, there are also around 500,000 [*Drokba*], nomad herders; they are not taken into account in the present study.

Ethnomycology

Ethnomycology studies the relationships between fungi and traditional societies, with macromycetes (macroscopic Basidiomycota and Ascomycota) comprising the group of greatest interest (ARORA & SHEPARD, 2008; WASSON & WASSON, 1957). Historical perspective from ethnomycology to fungal biotechnology has recently been commented (CHARAYA & MEHROTRA, 1999).

Although Tibetan ethnomycology has been insufficiently studied, some earlier information on this subject has nevertheless to be quoted. Two books illustrated with colour plates stand out, namely “Economic Macrofungi of Tibet” (MAO et al., 1993) and “Color Atlas of wild commercial Mushrooms in Yunnan” (WANG et al., 2004). Fine notes are also available (WINKLER, 2007, 2010a).

As far as the Tibetan plateau is concerned few ethnomycological accounts have yet been published. SACHERER (1979) studied the Sherpa’s mycological knowledge in the Rolwaling valley and reports the local names of 15 edible species. BHANDARY (1985) presents a synthesis for Nepal, listing 107 edible mushrooms (Latin, English and Nepali names), whilst for the same country, ADHIKARI & DURRIEU (1996) report the consumption of 57 fungi (latin names) and GIRI et al. (2005) of 23 species for Khumbu region. Some aspects concerning the Ü are below approached. Comments on the naming of fungi by Ü indicate a morphology based taxonomy (MALAISSE, 2008 b), as it is frequently the case for several ethno-linguistic groups (MALAISSE, 2010 for Bemba people; CARDOSO DOMINGOS et al. 2010 for Brazilian folk). It is mainly based on the colour of the fruiting bodies (gold, white, red [*sercha, karcha, marcha*]) as well as on its general form (erect penis of donkey [*pungu kacha*], tumour of tree [*chingba*]), less frequently to its ecology (wet sites [*chucha*], or seasonality -return of cuckoo- [*khukhu shamo*]). Collecting of morels in Eastern Tibet has also been described, at least six species of *Morchella* are involved (WINKLER, 2007, 2010).

Secondly, diversity of fungi species consumed by Ü has been listed, as well as mineral content and amino-acid score (4 major mushrooms) and lipid composition (10 species) have been published (MALAISSE et al. 2004, 2008 b). These papers also give valuable comparisons with the ethnomycological literature from Nepal and the Himalaya plateau (ADHIKARI & DURRIEU, 1996; BHANDARY, 1985; CHRISTENSEN et al., 2008). Comparison with edible mushrooms of surrounding areas indicates few common items. For instance, only 3 taxa of our study are quoted in a list of some 92 mushrooms eaten in Bhutan (TSHERING, 2013).

The importance of collecting [*yarzagonbu*] or caterpillar fungus has been the subject of many comments (notably MALAISSE et al., 2008 b). First, knowledge about this ethnospecies has involved, the fungus being considered successively as *Sphaeria sinensis* Berk., *Cordyceps sinensis* (Berk.) Sacc., more recently as *Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora (SUNG et al., 2007, Plate 1, Figure 1); in the same way the host has been regarded as the hibernating larvae of *Aenetus (Hepialus) virescens* (Doubleday), later as being hosted by some 57 species of root-borers (underground) hepialids, of which 37 belong to the genus *Thitarodes* (WANG & YAO, 2011). Recently several papers emphasize the urgent need of a more ethic management of this resource (Plate 1, Figure 2) and of a strong and watchful attention to its ecosystem in particular, and to

the alpine Tibetan meadows in general (SHARMA, 2004; WINKLER, 2009). These authors suggest ways to reach this goal.

Ethnobotany

Ethnobotany has been defined as the discipline concerned with the interactions between people and plants (JONES, 1941). Plants provide people with food, medicine, fuel, household materials, etc. Moreover as they are essential elements of ecosystems – they are at the base of food-webs – they take an important place in ethnoecology (TOLEDO, 1992; MALAISSE, 1997). They have also a great importance in agriculture, forestry, rearing, land-use development, etc. and consequently lie at the base of applied ethnobotany (HAMILTON et al. 2003). From the way that people recognize, name and classify plants to an approach where results benefit the poorest elements of Ü local people, the road has been long!

Aspects of ethnobotany in Tibet have been rarely quoted. Moreover data and accounts are dispersed within a very large diversity of literature; in such order that it is very difficult to sum up such knowledge. As far as the studied area is concerned a new source of irregular dispersion arises. Indeed citation of Tibetan plant material takes various forms. Local names are sometimes quoted. These provide already some source of variability, according the ethno-linguistic group to which the locutor belongs as well as the nature of the transcription of the local name that may vary according to the linguistic and language knowledge of the investigator (Tibetan, Chinese, English, etc.) involved. Less frequently Latin names may be provided. This, normally, would involve (1) a reference voucher, (2) collector name and number, (3) place where the material is hosted, (4) authority which has carried out the scientific determination. Very rarely this strong support exists. We have tried hard to fulfil these requirements. Authorities of higher plant names in the present paper are according to the Flora of China; reference materials (collection F. Malaisse) are deposited in the National Botanical Garden of Belgium (BR acronym according to THIERS, 2013).

Some earlier information on South-Central Tibetan ethnobotany has nevertheless to be quoted. We have selected one book and one paper as examples. A recent tremendous book is *Khawa Karpo*. Tibetan traditional knowledge and biodiversity conservation are well documented in this book of SALICK et al. (2012) published by the Missouri Botanical Garden Press. In the same way, with comments on present climate changes as well as plant ecology, we suggest to look at SALICK et al. (2009). Also of interest are other studies of ethnobotany dealing with the neighbouring areas (GAUR & TIWARI, 1987; JAIN & SAKLANI, 1991; NEGI et al., 1993; GAUR, 1999; PANDE et al., 1999; BADONI & BADONI, 2001).

RESULTS

Agro-environmental approach

A first step towards a better agro-environmental knowledge consists in an ecosystemic diversity approach based upon a recognition, and further identification of the main vegetation types as well as the agricultural systems. The plant society or phytocenosis furnishes the reference regarding the ecosystemic units' denomination. Differentiation's criteria rely upon the evolutional series concept, density of the plant cover layers, habitat characteristics as well as, last but not least, species composition.

An approach of vegetation diversity has taken place both through surveys and from interviews of the farmers. These two sets of data have been cross-matched.

The surveys have conducted to list the main vegetation units. The units recognized were allocated into two main groups, namely terrestrial and half-aquatic or aquatic. The formers allow distinguishing closed versus open vegetation units. For the later, lakeside regarding lotic conditions are to be kept apart. This information has been treated in more details elsewhere (MALAISSE, 2001; MALAISSE et al., 2003, 2008 a).

Interviews of peasants allow setting up a list of several local names. Short field trips permit to visualize their reality and further to identify the ecosystems to which they belong. In this way, the different habitats related to streaming water are recognised by local people under the name of

[*doutchou*]. On the other hand, the range of nuances concerning the diverse fields renders the importance devoted by villagers to this item. We were able to quote twenty different terms. For further information on the main vegetation units recognized by Ü people as well as their local names refer to MALAISSE et al. (2003, 2008 a), for the land-ecosystem to CHASSEUR et al. (2008).

Medicinal plants, phytotherapy and ethnopharmacology

Phytotherapy is a basic knowledge for Tibetan people. Information on medicinal plants has prolifically been published. Let us quote as examples TSARONG (1994), DGA' BA'I RDO RJE (1995), KLETTER & KRIECHBAUM (2001) and TENZIN DAKPA (2007). Some of those books enumerate some 547 taxa, most of them supported by paintings, drawings or photographs. From a taxonomic point of view some Lichens, Pteridophyta, Coniferopsida, Magnoliopsida and Liliopsida are involved. A detailed study of this flora as well as a fine comparison with the diversity of medicinal plants of surrounding areas such as Nepal (MANANDHAR, 2002) and India (GAUR & TIWARI, 1987; RANA et al. 2013) are beyond the scope of this paper. Nevertheless it should be kept in mind that a great importance is devoted to medicinal plants by Tibetan people.

Diversity of wild edible plants

Some results on wild edible plants of South Central Tibet have already been published, namely a table of 36 plant taxa (MALAISSE et al., 2003), as well as more detailed comments including chemical composition (MALAISSE et al., 2008). Wild edible plants comprise at least 17 potherbs, 5 spices, 7 aromatic herbs, 11 condiments, 5 underground organs, 5 fruits, 2 flowers and 1 receptacle. A total diversity including more than fifty taxa that offers a panel of food items able to increase the chemical components of the local people's diet**.** Table I presents an updated list, quotes the organ(s) eaten and their use(s); Tibetan names are also given. A special attention has to be directed to *Urtica* spp. (CHEN et al., 2003, 2004; MALAISSE et al., 2008 c), whilst staple foods have already been studied in a pilot study (DERMIENCE et al., 2013). Comparison with other areas of the Himalaya indicates great differences (NEGI & GAUR, 1994; MANANDHAR, 2002).

Phytotechny

The phytotechny by the Ü is mainly focus on barley. This phytotechny resorts to a wide range of agricultural instruments: from ploughing implements – such as the swing plough and the yoke – to hoe and sickle, to rake and flail, to bonds and ropes. This assortment of tools indicates a subtle recourse to the diverse materials available in the environment. Willows, poplars, junipers, barberries are the main genera providing woody furniture for the diverse agricultural instruments. Fibres of hemp, several barks are used for twisting ropes. Figure 3 (Plate 1) illustrates some of those instruments.

Domestic uses

Once more, vegetal materials supply a lot of products for domestic household. The list is long: furniture, churns and pestles, bowls, spoons, ladders, broomsticks, branches of celling, etc. Figure 3 (Plate 1) illustrates some of these products.

Plants used in relation to dyeing

The ancient use of several plants used in relation to dyeing has been noticed. Indigenous knowledge on natural dyes and weaving techniques has developed simultaneously, and was transferred from one generation to the other one (VAN DAMME, 2010). A lot of books deals with "natural dyes". Just to quote two examples, have a look at CARDON (2003) and BURGESS (2011).

Natural dyes concern some foods, leather and mainly wool. Those techniques are well documented by Ü, as well as for neighbouring areas of the Himalaya (ROY et al., 2002; SINGH HARIS, 2006). Nevertheless, it should be noted that, during the last years, resorting to dyes imported

from India or other provinces of China tends to become into general use, at least as far as wool is concerned. The ancient uses of five plants were indicated. They will be shortly commented on.

Table I. Wild edible plants according to Ü knowledge

Family	Species	Organe	Use	Tibetan name
Amaryllidaceae	*Allium atrosanguineum* Schrenk.	upper part	aromatic herb	Lugra
Amaryllidaceae	*Allium caesium* Schrenk.	upper part	aromatic herb	Simbo
Amaryllidaceae	*Allium fasciculatum* Rendle	upper part	aromatic herb for meat	Gogpa
Amaryllidaceae	*Allium henryi* C.H.Wright	upper part	aromatic herb for meat	Simbo
Amaryllidaceae	*Allium macranthum* Baker	upper part	aromatic herb for meat	Gyakok, simbo
Amaryllidaceae	*Allium prattii* C.H.Wright	upper part	aromatic herb	Dzinak
Amaryllidaceae	*Allium wallichii* Kunth	upper part	aromatic herb	Simbo
Amaryllidaceae	*Allium* sp.	upper part	aromatic herb for meat	Mouktok
Apiaceae	cf. *Angelica* sp.	young upper part	green vegetable	Cha
Apiaceae	*Carum carvi* L.	tender leaf and shoots	green vegetable	Konieu, sharotange
Apiaceae	*Carum carvi* L.	fruit	spice for meat	Konieu
Apiaceae	*Coriandrum sativum* *	fruit	spice for meat	
Apiaceae	*Heracleum candidans* Wall. ex DC.	upper part	squach as aromatic herb	Shakoktengual
Asparagaceae	*Asparagus curillus* Buch.-Ham.	stem, fruit	vegetable	Nagkatampel
Asteraceae	*Cortia depressa* (D.Don) C.Norman	young leaf	green vegetable	
Asteraceae	*Jurinaea dolomiaea* Boiss.	receptacle	raw, starch	Purge numa
Asteraceae	*Sonchus brachyotus* DC.	young leaf	green vegetable	Gyakhur nagpo
Asteraceae	*Taraxacum* sp. 1	young leaf	soup	Khumo, mo, yo
Asteraceae	*Taraxacum tibeticum* Hand.-Mazz.	young leaf	soup	Ngo, mokhumo
Berberidaceae	*Berberis dictyophylla* Franch	fruit	eaten raw	
Berberidaceae	*Berberis hemsleyana* Ahrendt	fruit, flower	eaten raw	
Berberidaceae	*Podophyllum hexandrum* Royle	fruit	eaten raw	Omsussu
Boraginaceae	*Microula* cf. *sikkimensis* (C.B.Clarke) Hemsl.	root	starch	Pawalulu, atuputo
Brassicaceae	*Thlaspi arvense* L.	seed	spice	Tcharsil
Campanulaceae	*Codonopsis bulleyana* Forrest ex Diels	leaf and tender stem	green vegetable	Sukpa metok
Campanulaceae	*Codonopsis convolvulacea* Kurz	tuber	starch	Bala, myewa

Campanulaceae	*Codonopsis* aff. *mollis* Chipp	leaf and tender stem	green vegetable	Sukpa metok
Chenopodiaceae	*Chenopodium album* L.	limb of leaf	soup	Neu, lego, nubre
Fabaceae	*Caragana jubata* Poir.	flower	eaten raw	
Grossulariaceae	*Ribes* sp. 1	fruit	eaten raw	
Grossulariaceae	*Ribes* sp. 2	fruit	eaten raw	
Lamiaceae	*Dracocephalum nutans* L.	inflorescence	spice for cheese	Lugulangstal
Lamiaceae	*Dracocephalum tanguticum* Maximowicz	above ground part	powered as aromatic herb	Ngopyiang
Malvaceae	*Malva verticillata* L.	limb of leaf	soup	Champa, lcam-pa
Ophioglossaceae	*Ophioglossum polyphyllum* A.Braun apud Seub.	frond	soup	Tuchung
Plantaginaceae	*Plantago depressa* Wild.	young leaf	soup	Tharam, alathabo
Polygonaceae	*Bistorta macrophylla* (D.Don) Sojak	root	boiled, starch	Mèmbou
Polygonaceae	*Fagopyrum tataricum* (L.) Gaertn.	limb of leaf	soup	Tragö, Koyowa
Polygonaceae	*Rheum acuminatum* Hook. & Thomson	leaf petiole	condiment	Numdi, chuju
Polygonaceae	*Rheum australe* D.Don	leaf petiole	condiment	Numdi, chuju
Polygonaceae	*Rheum globulosum* Gage	leaf petiole	condiment	
Polygonaceae	*Rheum inopinatum* Prain	leaf petiole	condiment	
Polygonaceae	*Rheum lhasaense* Li & Hsiao	leaf petiole	condiment	Numdi, chuju
Polygonaceae	*Rheum moorcroftianum* Royle	leaf petiole	condiment	Chuju
Polygonaceae	*Rheum palmatum* L. *	leaf petiole	condiment	Tchum
Polygonaceae	*Rheum pumilum* Maxim.	leaf petiole	condiment	
Polygonaceae	*Rheum rhomboideum* Losinskaja	leaf petiole	condiment	
Polygonaceae	*Rheum tanguticum* (Maxim.) Maxim.	leaf petiole	condiment	Tchum
Polygonaceae	*Rheum webbianum* Royle	leaf petiole	condiment	
Rosaceae	*Potentilla anserina* L. subsp. *anserina*	tuber	toma daisel preparatin	Toma, toma
Rosaceae	*Rosa omeiensis* Rolfe	fruit pulp	eaten raw	Sindou
Scrophulariaceae	*Incarvillea* cf. *younghusbandii* Sprague	root	starch	Pupsta
Scrophulariaceae	*Lancea tibetica* Hook.f. & Thoms	leaf	green vegetable	Didigonggu, payagpa
Urticaeae	*Urtica dioica* L.	young leaf	vegetable, soup	Sapo, suptuk
Urticaeae	*Urtica hyperborea* Jacq. ex Wedd.	young leaf	vegetable, soup	Sapo, suptuk
Urticaeae	*Urtica triangularis* Hand.-Mazz.	young leaf	vegetable, soup	Sapo, suptuk

* Locally cultivated

The use of a Boraginaceae, called [*moutsik*] or [*murtsi*], *Onosma hookeri* C.B. Clarke, is frequently requested. Literally [*murtsi*] means "red paint" ([*murt*] = red, [*si*] = paint). The reddish purple juice extracted from rootstocks of this species (Plate 2, Figure 4.a) is locally used by monks for dyeing paper and butter offerings (YOSHIDA, 2002). This last particular food is called [*tsok*] or [*tswô*] (Plate 2, Figures 4.b and 4.c). This offering is prepared from [*tsampa*], dried cheese, butter and a kind of red sugar imported from India. This preparation is offer during prayers all around the year, but mainly to the prior at the time of decease. The root of [*murtsi*] is put to soak, later squashed, in order to furnish a red dye with which the [*tsok*] summit is smeared.

The Himalayan walnut, a large deciduous tree, is indigenous to Tibet. Its fruit, a large green drupe, is an important article of diet (POLUNIN & STAINTON, 1997). The walnut tree is called [*tartong*], the nut [*tarka*], the husk [*tarbak*]. Husks are easiest to separate from the nuts while still fresh. The beige colouring that it furnishes is reputable being persistent, indelible. It should be remind, that the use of walnut as plant used in dyeing is an ancestral procedure. Already known from the Persians, walnut dyes are of great historic importance. In the first century AD, Pliny records their use to keep hair from turning white; his recipe included the use of walnut shells (probably husks) boiled with oil, ashes, lead and earthworms (CANNON & CANNON, 1994). The husk's use is quoted in the Venetian « Plichto » of 1548; it has been used during centuries in tapestry, namely in order to obtain brown shades called « old man flesh tint » (DUVIGNEAUD, 1997). CARDON & DU CHATENET (1990) pinpoint that the various tawny and brown tones obtained from leaves decoction or husk maceration are the result of a veritable cocktail of pigments (juglone, etc.). A mordant bath does produce a further range of shades, particularly with chrome, copper and iron. The use of walnut shell, leaf and bark has also been quoted from Bhutan (VAN DAMME, 2010) (Plate 2, Figure 5.A).

Roots of a rhubarb, [*chuch*], leaves of a rumex or [*shumba*] and of nettles or [*sabo*] are also of frequent use delivering respectively, after about one hour of soaking, yellow, fine olive and green tones. [*Sizou*], an alum collected in Rimpung area, is used for the mordant bath.

The basal stem and the root of diverse *Berberis* spp., including *Berberis asiatica* Roxb., contain berberine, an alcaloid dyeing product, furnishing a yellow dye used for wool and leather (Plate 2, Figure 5.B). This use has already been reported by CARDON & DU CHATENET (1990), as well as by POLUNIN & STAINTON (1997). Several names are locally given for barberries, notably [*kerpa*] and [*marzema*].

Arnebia benthamii (Wallich ex G.Don) I.M.Johnston belongs to the Boraginaceae family. It is a very striking plant with a very stout rootstock, yielding a red pigment. The plant is used since immemorial for purposes as varied as medicinal, as dyeing clothes, to colouring the offerings to deities and pigmenting of cookeries and other foodstuffs. It is also used as hair tonic and the root powder is applied to the hair mixed with hair oil.

Last, but not least, the use of *Polygonum polystachyum* Wallich ex Meissn. has been quoted. The species belongs to the succession of plants delivering indigo. Its correct Latin name is not easy to decide; its taxonomic and systematic position being the subject of many comments (SANCHEZ et al., 2009; GALASSO et al., 2009). Between others, the following names have been used: *Persicaria wallichii* Greuter & Burdet, *Aconogonon polystachyum* (C.F.W. Meissn.) M. Kral, *Persicaria polystachya* (C.F.W. Meissn.) H. Gross, *Rubrivena polystachya* (Wall. ex Meisn.) M.Kral, *Reynoutria polystachya* (.F.W. Meisn.) Moldenke. This synanthropic species is native in the Himalayas, quoted from Afghanistan to South-West China. It is a perennial herb, hemicryptophyte, 60 to 120 cm high. The leaves are the source of a blue dye called "Indigo dye"; moreover the flowers are sometimes used for delivering a red dye.

The diversity, as well as the plants involved highly differs of the importance of natural products in neighbouring countries. For instance in Bhutan the most important local dyestuff is [*lac*], produced from *Laccifer lacca* (Kerr), an insect living off wild fig trees. In Bhutan, lac is presently in high demand, and has become a cash commodity (VAN DAMME, 2010). In Nepal, some 170 plants are quoted by SRESHTHA (1994), whilst in Anurachal Pradesh in India, indigenous knowledge on dye preparation as well as on natural dye-yielding plants are well-documented (MAHANTA & TIWARI, 2005). But of the 37 plants listed, only *Juglans regia* is common with our results. In a detailed study on traditional dye yielding plants of Uttarakhand of India, GAUR (2008) listed some 106 species, of which 7 occurs in the altitudinal levels that are concerned in the present study. They are quoted in Table II, as well as their respective families, their altitudinal range, the organs concerned, the colour

they deliver and their vernacular Tibetan names. Lastly, just to compare, 38 and 17 plants are quoted respectively for Iban and Kelabit of Sarawak, in Malaysia (CHRISTENSEN, 2002)

Table II
Dye yelding plants of Tibet

Name	Family	Vernacular name	Habit	Plant part(s)	Dye color	Altitude range (m)
Arnebia benthamii (Wall. ex G.Don) John	Boraginaceae		H	root	red	3000-4000
Berberis hemsleyana Ahrendt	Berberidaceae		Ch	fruit	yellow	3600-4400
Geranium wallichianum D.Don ex Sweet	Geraniaceae		H	root	red-brown	2500-3500
Juglans regia L.	Juglandaceae	tarbak	Mp	bark/fruit	camel	up to 3500
Malva verticillata L.	Malvaceae	champa	Th	leaf/inflor.	lilas, cream	up to 3800
Nardostachys grandiflora Royle	Valerianaceae		H	inflor.	red	3000-4200
Onosma hookeri C.B.Clarke	Boraginaceae		Ch	root	red	3000-4700
Rheum moorcroftianum Royle	Polygonaceae	chuchu	H	root	yellow	3200-4000
Rheum webbianum Royle	Polygonaceae		H	root	yellow	3000-4000
Rhododendron lepidotum Wall. ex G.Don	Ericaceae		Nph	leaf/flower	pink-red	3000-3600
Rumex aff. *nepalensis* Spreng.	Polygonaceae	shumba	Ch	root	yellow-green	

For Habit : Ch: chamephyte, H: hemicryptophyte, Mp: mesophanerophyte, Nph: nanophanerophyte
Th: therophyte. Regarding Plant part(s) = inflor : inflorescence

Incense and incense sticks

Incense

The high adherence of Tibetan population to Tantric Buddhism implies the daily use of diverse plants, rich in aromatic resins, giving off, through combustion, a strong fragrance**.** Because of their religious importance and sweet smell, several aromatic plants are lighted in most of houses in the morning, providing a suitable sensitiveness for a tantric Buddhist meditation (Plate 2, Figure 6). This aspect of ethnobotany will be briefly reviewed.
We have quoted the frequent use of twigs of diverse conifers belonging to the family of Cupressaceae (juniper or «shoupa» for Ü, "shup" for Dzongkha of Bhutan) and Ericaceae (rhododendron or [*pamu*]) to this end. The collection of *Rhododendron anthopogon* D.Don, the bearded rhododendron, is an age-old custom; this dwarf shrub yields an incense and plays a role in sacred traditions across the Himalayas. It is one of five common incense plants to honour the earthly divine, the element of earth and the general environment. It is not rare at all of observing men or donkeys, heavily loaded, even overloaded with twigs of those plants, descending the steep slopes of hills. These twigs are also dispatched to towns in bundles. The roots of *Nardostachys jatamansi* (D.Don) Candolle, spikenard or [*pangpeu*], literally "incense of pang vegetation", are also used and sold in town markets.
Moreover the producing of incense requires several steps. Grated wood of juniper furnishes the support, to which are added several products such as [*yomba*] bark, [*menu*] (Asteraceae) roots as well as [*pangpeu*] roots, [*tsatseku*] grasses growing in nomad area. Some products are imported from India, [*routa*] and [*kouna*] notably. Fine quality is obtained by addition of deer musk, etc. Finally, some places are reputed for the incense they deliver, notably [*gaden kamba*], an *Artemisia* sp. *Gaden kamba* is a very aromatic product of woolly consistency; the plant is harvested in the vicinity of Gaden Monastery. Several *Artemisia* spp., notably *Artemisia vulgaris* L. var. *xizangensis* Y.Ling & Y.P.Ling are also used. TSHERING (2003) has listed forest plants used as incense in Bhutan; 20 taxa are quoted, notably *Juniperus* spp., *Cupressus* spp., *Rhododendron* spp., *Daphne* spp.

Incense sticks

Incense sticks have to been distinguished from the ingredients (such as product and binder) entering in the composition of the coat. Knowledge regarding incense sticks has been approached

through local production at Dyago. This village is located at 3988 m above sea level in Nyemo county. Incense sticks have a supporting core of split cypress wood.
Two to five ingredients enter into the composition of the coat. The basic product is made up of shred of juniper logs. This shred is obtained by a to and fro movement generated by a water mill which grates the squared juniper log on a stone. Junipers from Kombo are of great reputation. The second ingredient is a power obtained from the greenish bark of [*yombo*]. We have been unable to collect this shrub in flowering or fruiting state. The third product, added parsimoniously, is a mixture of grated [*pangpeu*] and of [*pukarma*] twigs. Rarely [*tsaciku*], a grass, is added; "*tsaciku*" is notably obtained from the surroundings of Damshungdu and Namtso. The mixture of these diverse powders is kneaded with cold water. The paste obtained is pressed through a pierced thimble and spread on a mosquito net; then put to dry (Plate 2, Figure 7.a-f).
TSHERING (2003) has listed raw material used in Bhutan's incense industry; 7 taxa are quoted, namely leaves of *Rhododendron anthopogon, R. setosum* and *Artemisia vulgaris*, roots of *Angelica* sp., *Nardostachys jatamansi* - locally known as [*pangpoe, pang poi*]- and *Inula* sp., and bark of *Cinnamomum tamala.*

CONCLUSION

In conclusion, several local uses, mainly collecting of branches as incense (or [*pama*]) and clear cutting for firewood, but also caterpillar ([*yarza gombu*]) and medicinal plants harvestings maintain a heavy anthropic pressure on the environment and notably on the forests, whose rarefaction increases continually. On a general approach, heterogeneity in ethnoecological knowledge in the Himalayas has been underlined (GHIMIRE et al., 2005) and conservation strategies will vary according to areas of concern. It has been suggested of creating herbal gardens in high altitude villages to provide medicinal plants for upgrading degraded ecosystems (MANJKOLA & DHAR, 2002), an approach supporting fine examples of complexicity.

The importance of medicinal plants as trade items in the Himalayas rural economy has frequently be underlined. This is notably the case of *Ophiocordyceps sinensis* (BOESI, 2003; SHARMA, 2004; WINKLER, 2005, 2008 a, 2008 b, 2010 b, 2011) and *Arnebia benthamii* (MANJKOLA & DHAR, 2002). The root if this last plant, used since immemorial, yields a red pigment, which has several medicinal properties, but is also used as a pigmenting material in hair oils, cookeries and for dyeing silk as well as the offerings to deities.

The present paper underlines the urgent need of a more accurate dialogue between politicians, local farmers and ecologists for a fine management of South Central Tibetan environment.

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Plate 1

Figure 1 : *Ophiocordyceps sinensis* in the wild (D. Winkler)
Figure 2 : Commercialization of *Ophiocordyceps sinensis* (F. Malaisse)

Figure 3 : Several woods implements (F. Malaisse)

a. Scraper
b. Plough
c. Sikle
d. Wooden ring of halter
e. Rake
f. Yak yoke
g. Willow

Plate 2

Figure 4a : *Onosma hookeri* or murtsi is used for producing a red dye (F. Malaisse)
Figure 4b : Stok (Pascale Bailly)
Figure 4c : Stok with red dye (Françoise Mathieu)

Figure 5a : Wool coloured with *Berberis* (brown), *Urtica* (green) and *Malva* (light lilas)
Figure 5b : Brown dyed wool by the Himalayan walnut's husk or tarbak (*Juglan regia*)
(F. Malaisse)

Figures 6 : Wooden incense burner (Françoise Mathieu)
Traditional wooden box for burning incense , mainly used in the house, are decorated with the 8 auspicious symbols

Figures 7 : Fabrication of incense sticks (F. Malaisse)
7a : paste - **7b** : Thimble with past - **7c** :Paste manure spreading - **7d** : Idem, detail - **7e** : Incense sticks drying
7f : Insence sticks ready for use.