Big Bone Disease

A multidisciplinary approach of Kashin-Beck disease in Tibet Autonomous Region (P.R. China)

François Malaisse and Françoise Mathieu

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Chapter 5

Studies and actions concerning several hypotheses

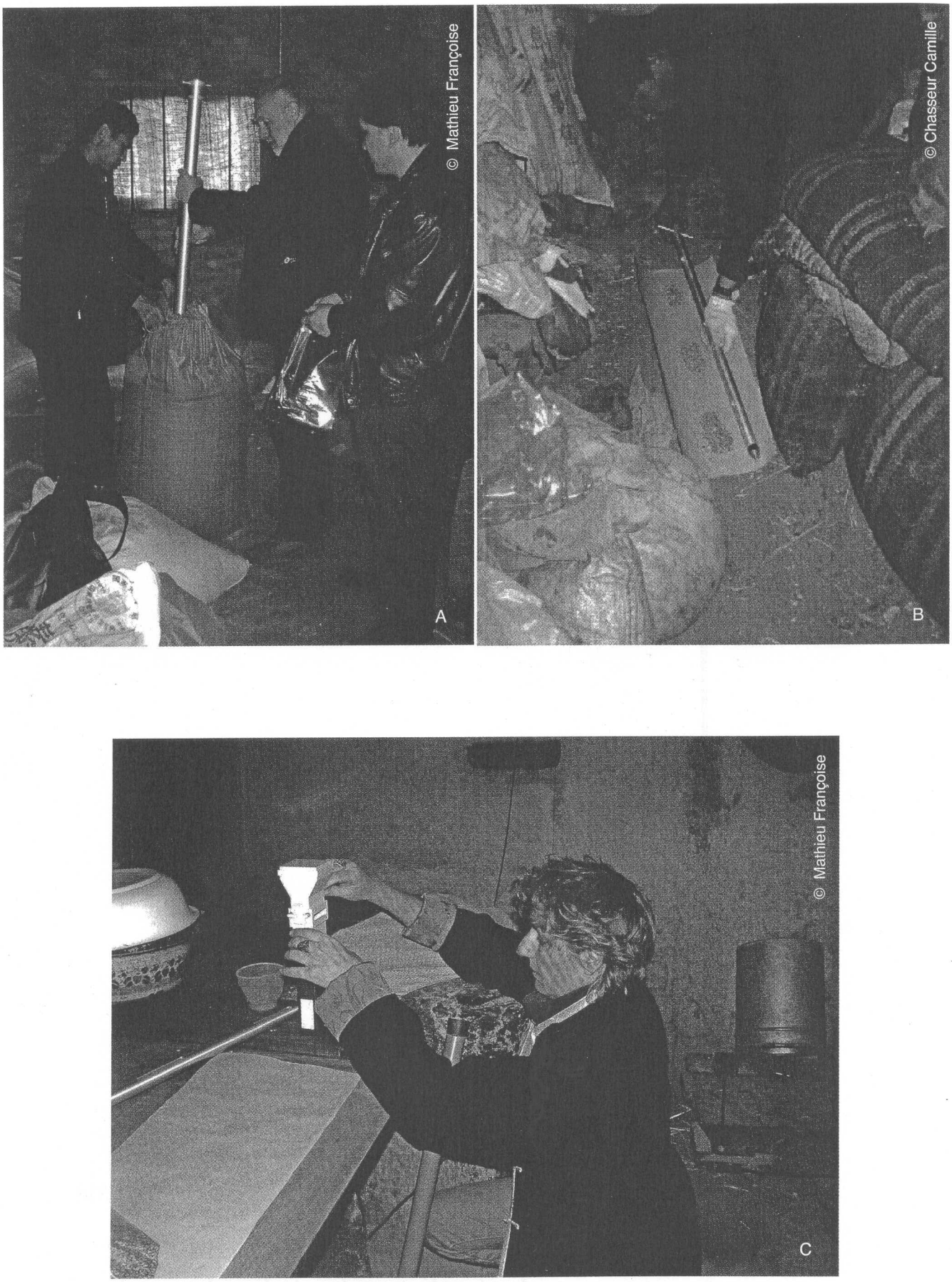

Plate 5.1. Surveys and samplings in the villages. A. Cereal grain are sampled in sacks or containers in the family store-room with a grain trier – B. This trier is conceived for sampling grain at different levels in bags or containers. It is important because fungal contamination may be different according the depth – C.Humidity of grain is also measured with a Samap device.

5.3 The alternative food path or the very little diversified diet hypothesis

François Malaisse, Georges Lognay, Eric Haubruge, André De Kesel, Emile Delcarte, Bernard Wathelet, Patrick Van Damme, Françoise Begaux, Camille Chasseur, Pelma Drolkar, Philippe Goyens, Maurice Hinsenkamp, Béatrice Leteinturier, Françoise Mathieu, Lopsang Rinchen, Christiane Van Marsenille, Lakpa Wangdu, Rinzen Wangla

5.3.1. Background

For a long time, the welfare of Tibetan populations suffering from the Kashin-Beck disease has been the target of a team supported firstly by «Médecins sans Frontières» (MSF) – Belgium, later by the Kashin-Beck Disease Foundation (KBD F).

In 1998, F. Malaisse joined the KBD team. During a first survey in summer 1998 he recognized four major macro-ecosystems in South Central Tibet. These are the urban (Plate 5.10), the sub-urban (Plate 5.11), the rural and the nomad macro-ecosystems (Plate 5.12). Presence of KBD is restricted to the rural group. One major difference between the livelihood of inhabitants of this unit versus livelihood in the others groups consists in the diet. Moreover, as developed in previous chapters, within this unit, prevalence of KBD differs from one valley to another. Progressively the importance of diet has retained more attention by the KBD team. Therefore a research programme was set up in order to obtain a better knowledge of the local diet of peasants, and in particular the diversity and the importance of alternative foods.

Such approach has much to gain from environmental ethnological studies or «Ethnoecology». Indeed, increase of local population welfare through a better understanding of their ecological knowledge is one of the main concern of ethnoecology. Ethnoecology is a young science. Its first utilisation goes back to 1954, during a study carried out by Conklin and dealing with the Hanunoo, a Philippine people. Ethnoecology may be defined as the extension of two disciplines, ethnography and ecology. Other authors consider that it is the natural confluence of four precursor rivers:

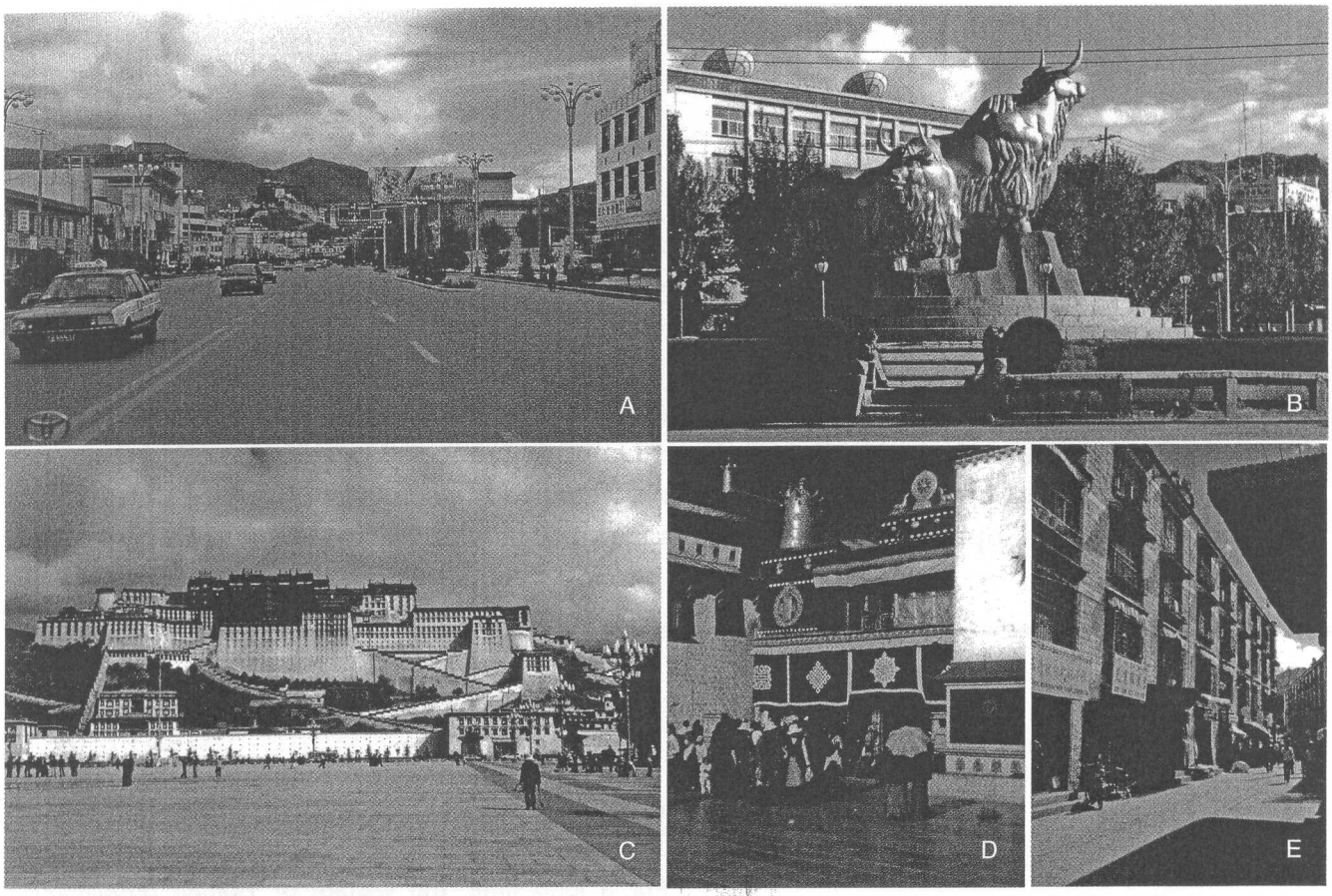

Plate 5.10. Lhasa city, an example of Tibetan urban macro-ecosystem. A. The Norpu Linka road – B. The 3 golden yaks monument on the round point of Central Beijing road – C. The Potala palace – D. Barkhor street – E. Tibetan street ambiance.

ethnology, agroecology, ethnography and environmental geography (Malaisse, 1997a). It brings together the description of the different nations, from their material and cultural manifestation (ethnology) to the science of the milieu (ecology) (Berlin, 1992; Toledo, 1992; Gragson et al., 1999; Nazarea, 1999; 2006; Malaisse, 2001; Martin, 2001). Ethnoecology is regarded as the study of the management by cultures (customs, beliefs, social forms and material traits of a radical, religious or social group) of natural and human-modified ecosystems. It is an ecological approach to understand and appreciate traditional knowledge of land and living organisms (notably plants and animals).

As developed in several papers, ethnoecology underlies the real support of «Lessons of the Past for a better Future», the theme of a symposium organized in Brussels by the Royal Academy of Overseas Sciences of Belgium in coordination with UNESCO in August 2001.

5.3.2. Alternative foods

Human foods belong to diverse sources, including mineral products and living products. The last is to be found within the 5 kingdoms, namely Protista, Monera, Fungi, Plants and Animals.

No alternative foods belonging to the two first kingdoms were quoted during the surveys conducted in South Central Tibet. Human foods belong to the three lasts kingdoms and are commented below.

Links between Man and Fungi probably appeared at the dawn of mankind (humanity), but detailed accounts on this matter are relatively recent. According to Hawksworth et al. (1995) the term «ethnomycology» was first used by Wasson and Wasson in 1957 in their «Mushrooms, Russia and History». Today it is an established and currently used term to designate the study of the local people's knowledge of Fungi and their uses. Ethnomycology is a multidisciplinary field of research with a worldwide growing interest among mycologists as well as ethnologues, linguists, pharmacologists, food chemists and others.

The local importance of mycophagy varies greatly from one nation to another. As far as the Tibetan plateau is concerned few ethnomycological accounts have yet to 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 and Durrieu (1996) report the consumption of 57 fungi (latin names). The

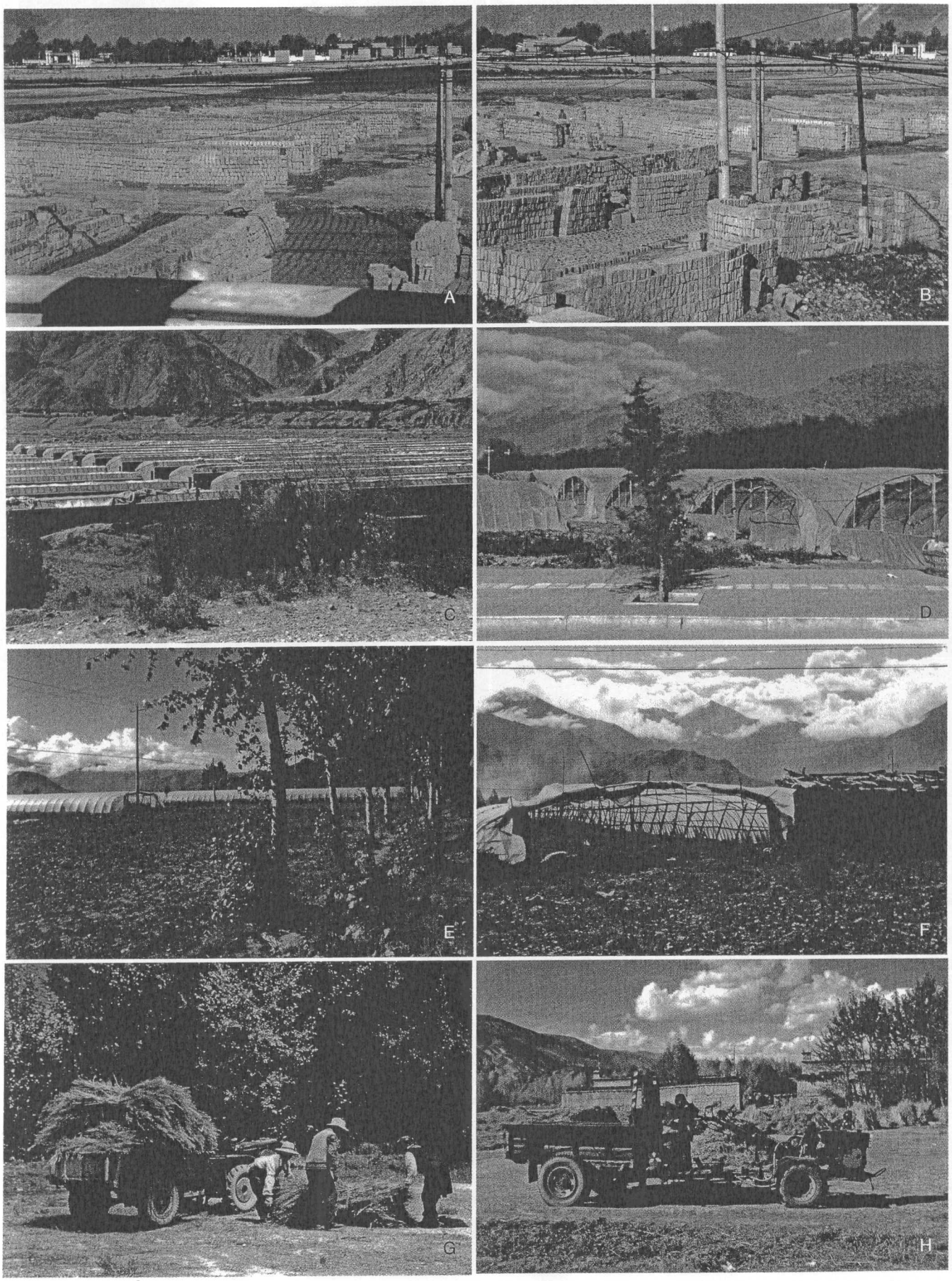

Plate 5.11. Around Lhasa city, the sub-urban macro-ecosystem. A. & B. Cement works – C. Market gardening – D. Tree nursery – E. & F. Canvas sheet covered greenhouses – G. & H. Tractors.

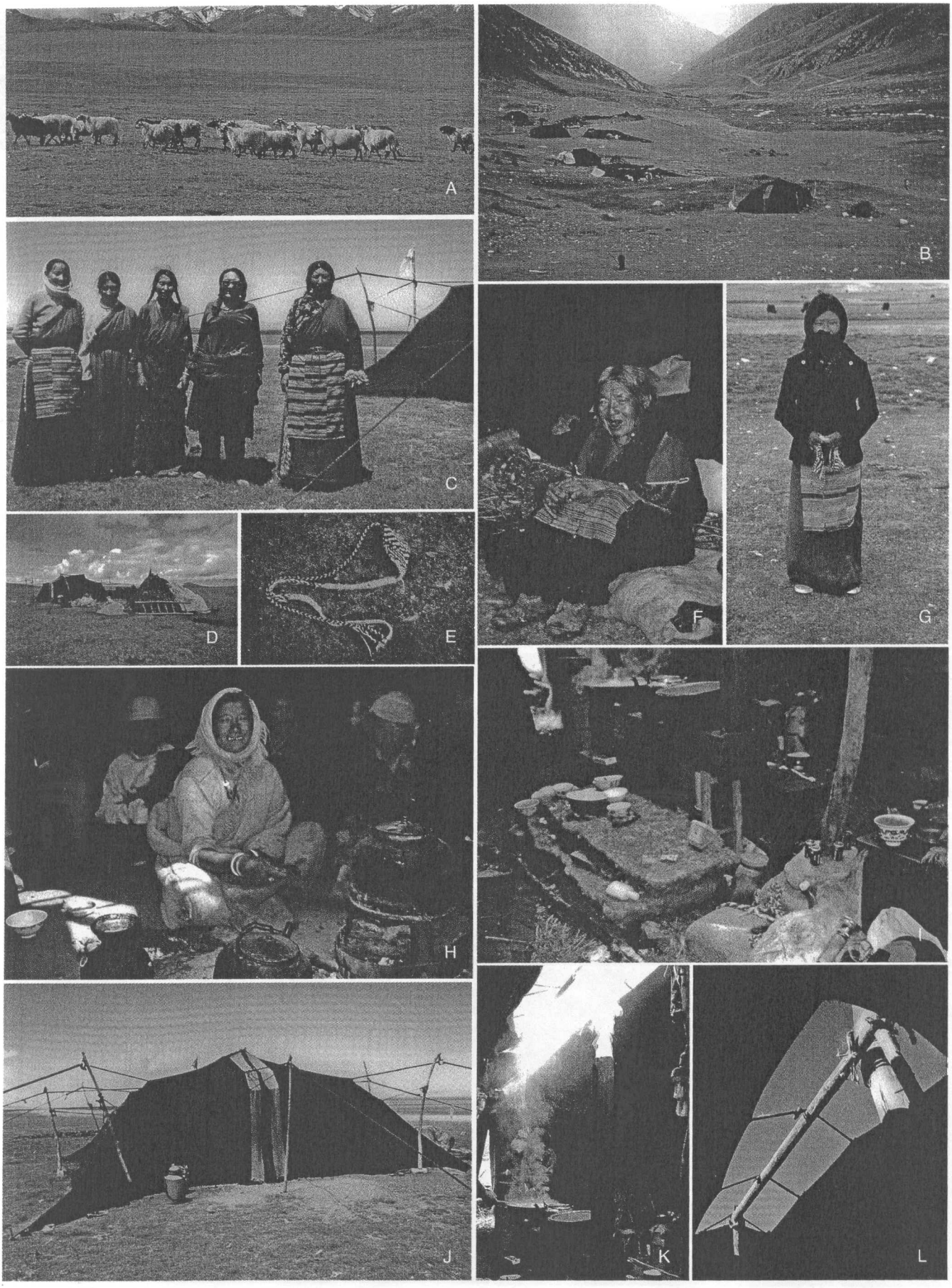

Plate 5.12. The pastoral zone or nomad macro-ecosystem. A. High plateau – B. Camping site during summertime – C. Nomads on Nam plateau – D. Camping site – E. Woollen catapult – F. Grandmother greeting – G. Young girl – H. Inner tent ambiance – I. Tent furniture (table) – J.Tibetan nomad tent – K. Inner tent ambiance – L. Top opening of a tent.

knowledge regarding fungi, as well as the consumption of mushrooms by Ü people, is hardly known and restricted. In spite of this, the Ü recognize about ten edible mushrooms and some other fungi for other uses. Usually mushrooms are collected for domestic consumption, mostly during field work or while tending the livestock (cows or others). Collecting for commercial purposes exists as mushrooms pickers head to the roads or the towns to sell their goods.

Ethnobotany has been defined as the study of people's classification, management and use of plants. This approach faces the challenging task of not only recording knowledge of the plant world, but also applying the results of their studies to biodiversity, conservation and community development. One of their goals is to ensure that local natural history becomes a living, written tradition in communities where it has been transmitted orally for many years (Martin, 1995). They are working against time, because local knowledge of the environment is fast disappearing in the face of worldwide destruction of natural areas and transformation of traditional cultures, which is, under others, the case in T.A.R. Good examples are the book of Martin (1995) that provides a fine methods manual, whilst Cunningham (2001) develops applied ethnobotany.

Several ethnobotanical surveys have been conducted regarding peoples inhabiting the Himalaya range and plateau. Most of them were located on the Southern slope of the range (Jest, 1972; Sacherer, 1979; Gaul et al., 1983; Toffin et al., 1985; Shrestha, 1988; Manandhar, 1989; 2002; Pohle, 1990; Johsi, 1991; Sundriyal et al., 2001). Less information concerns the Tibetan plateau, and mostly deals with medicinal plants (Tsarong, 1994; Dga' ba'i rdo rje, 1995; Kletter et al., 2001 as examples).

Alternative plant foods have received less attention. As far as South Central Tibet is concerned, preliminary results concerning Ü and Tsang peasant's knowledge should nevertheless be mentioned (Malaisse et al., 2002). This study leads to list 36 wild edible plants. Presently we have quoted the consumption by Ü of some 15 potherbs, 6 plants provide edible underground organs, 3 offer edible fleshy fruits, the flowers of 3 plants are sucked for their nectar, 4 plants are used as spices, 6 as aromatic herbs, one as a condiment.

Other aspects of ethnobotanical knowledge of Ü are tremendous; for instance they concern plants used in the phytotechny of the main crops or also for domestic uses. Underrated targets are notably incense and incense sticks or also plants used in dying as well as food colourings.

The term ethnozoology was used for the first time in 1914 by Henderson and Harrington studying the Indians tribes of the Great Plain, but interest turned to ethnozoology arises later (Chevallier et al., 1988). In 1966, ethnozoology was developed at the Museum National d'Histoire Naturelle of Paris by Pujol.

Ethnozoology is the study of the past and present interrelationships between human cultures and the animals in their environment. It includes classification and naming of zoological forms, cultural knowledge and use of wild and domestic animals.

Ethnoecological enquiries were carried out in 1998, 2000, 2001, 2002, 2004, 2005 and 2007 (Plate 5.13). They took place in 3 prefectures, 12 counties, 22 communities, 75 villages and 7 sites. All together, 116 families and some 215 peoples were involved (Plate 5.14). In fact, the number of people involved varies according to the targets. They were asked

– to enumerate the edible species they consume,
– to recognize taxa illustrated in an atlas,
– to rank the species eaten in decreasing order of preference,
– to comment on their habitat,
– to estimate the extent of time they ate those products last summer.

These enquiries allow to establish a citation index as well as to obtain an approached estimation of consumption.

Reference materials (collection B. Leteinturier and F. Malaisse for fungi, collection F. Malaisse for higher plants) are deposited in the diverse sections of the National Botanical Garden of Belgium (BR acronym according to Holmgren et al. 1990), notably Mycology Herbarium and Higher Plant Herbarium. Authorities of mushroom names are according to Brummit and Powell (1992), of higher plants according to the Flora of China (1994-2008).

5.3.3. Edible mushrooms

Local naming of ethnotaxa

In T.A.R., mushrooms are referred to as «*chamo*», but several ethnospecies are given a particular (unique, specific) name. This last name is frequently built from the syllable «*cha*», meaning mushroom, preceded by an attribute. It should be noted, on the other hand, that the word «*cha*», and no more the syllable, means «*meat*»; and consequently that the radical «*cha*», related to mushroom also brings to think about meat, as texture of certain mushroom is fleshy! No surprise therefore regarding the Tibetan proverb: «*cha mebo, chamo sa gui*», or «when there is no meat, mushrooms are eaten !».

As stated above, a precise nomenclature relative to diverse mushrooms exists. It is mainly based on the colour of the fruiting bodies or sporocarps. In this case, two radicals are put together, one of the colour and the second being «*cha*». It should be kept in mind that *karpo* means white, *serpo* yellow, the radical *ser* corresponding to gold, *marmo* means red, *djangpo*

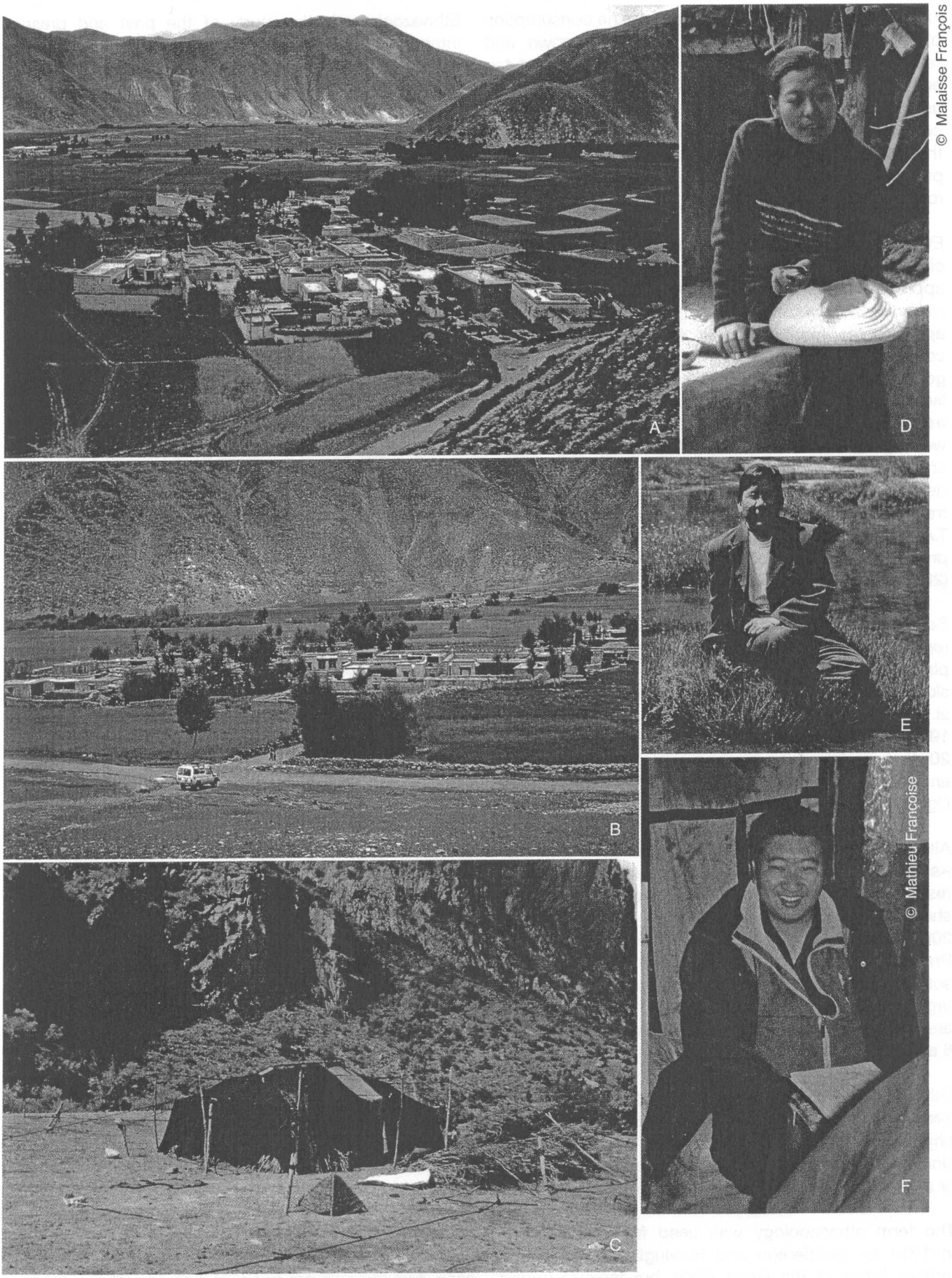

Plate 5.13. The ethnoecological survey. Ethnoecological inquiries took place in 75 villages and 7 sites. A. Lamotse village – B. Porokang village – C. Site in the vicinity of Tsingda – D. to F. Translations were carried out by 3 collaborators: D. Pelma Drolkar – E. Lopsang Rinchen – F. Lakpa Wangdu.

Plate 5.14. Some locutors of the environmental ethno-enquiries.

green, *wangpo* blue, *gyammu* brown, and *nakpo* means black, in such a way that some mushrooms are known as *karcha*, *sercha* and *marcha*.

A number of *Agaricus* with whitish colours are named «*karcha*». After heavy rains they are frequently encountered in fields and meadows. They are observed in abundance between 3,600 and 4,000 m a.s.l. and they are quite commonly eaten. *Agaricus* with a white cap are known as *pangcha*; another *Agaricus* (sect. Flavescentes), with a yellow cap, is known as *langchu*.

Sercha, or *Floccularia luteovirens*, is a yellow Tricholomatoid mushroom observed in July, especially in years with heavy rainfalls. It is mainly observed between 3,900 and 4,600 m in green short (dwarf shrub) vegetation of the *pangri* type. It appears as the most appreciated mushroom, and is frequently offered for sale in the town markets. It is eaten raw or preferably fried.

Chucha, also erroneously locally called «*mokro*», has several times been quoted during interviews. It refers to a representative of the Auriculariales, namely *Auricularia polytricha*, and it is sometimes sold on the markets. Its name, «water mushroom», refers to its occurrence in humid or very wet environments. When growing in polluted streams, *chucha* is not collected. It must not be confuse with *Auricularia auricula-judae*, the jew's ear, in fact *mokro* which is imported from other provinces of China and frequently offered for sale in town markets. The latter is mostly eaten by Chinese peasants, and only sometimes by Tibetans.

Some shaggy ink caps, among others *Coprinus comatus*, are also eaten from time to time, by few peasants. They are usually referred to as «*pungu kacha*», meaning «donkey mushroom». This naming is given according to the resemblance of the fruiting bodies with the erected penis of donkeys. They are available in June and July.

Marcha, a reddish mushroom outside, is more rare and collected in July. This Boletineae is only eaten after cooking.

In general trees and wood are linked with the name «*ching*», while «*djang*» refers to trees that were planted by man, like willows (*Salix* spp.) and poplars (*Populus* spp.). *Chingba* literally refers to «the tree goutre», because of the tumour this polypore (Polyporaceae) causes on its host. *Chingba* is on several *Salix* spp.; it is more and more eaten, offered for sale along roads and in town markets; one pound is sold for 4 yuans. *Djangsha* or «tree-mushroom», on the other hand, refers to *Lentinula edodes*.

It should be noted that a whitish to cream coloured pleurote is frequently sold in town markets. These *Pleurotus pulmonarius* are most often bought by Chinese people coming from other provinces and neglected by most Tibetans. In the same way it was observed that *Lentinula edodes*, the Japanese shii-take, becomes also frequent in town markets.

Finally we observed that the nomads from the surroundings of Shigatse identify *Calvatia* sp. as *porok-nata* or «crow-snuff» (*fide* Ritshen); although edible, this puffball is not eaten. Around Lhasa, in the rocky outcrops, *Calvatia cyathiformis* was found and named *pokoudi*, but not eaten.

The importance of collecting *yarzagonbu* or caterpillar fungus, should not be underestimated. This fungus, *Cordyceps sinensis*, extends in spring a thread-like to club-shaped fruiting body from a below ground caterpillar. *Cordyceps sinensis* is a parasitic fungus and it attacks and kills the hibernating larvae of *Aenetus* (*Hepialus*) *virescens* (Doubleday) an Hepialidae. The use of this fungus is primarily medicinal, it is known as a tonicum and appreciated for its energetic properties (Pegler et al. 1994). *Cordyceps sinensis* fruiting bodies are to be found in the Asian-alpine meadows, above 4,000 m altitude (Jingwei 1982). In T.A.R., the collecting occurs mainly in the vicinity of Chamdo and Nachku prefectures, in May and June; then (farmers) peasants seek through mountains in search of this manna, which provides an important financial injection. In the region of Amdo Golok, in eastern Tibet 9,105 kg of yarzagonbu were extracted from 1987 to 1992 (http://www.tew.org/wildlife/wildlife.biodiversity.html); this product is still of importance in Kumaon Himalayas (Garbyal et al., 2004). In South Central Tibet people are also looking for this mushroom. Even better, sometimes they eat half of the specimens they collect and sell the others.

Diversity and appreciation of fungi recognized

Table 5.2 lists the edible mushrooms recognized by Ü people and by Tsang farmers (Plate 5.15). If most of these peasants name, at first, two or three edible mushrooms, nearly a tenth are recognized. A few others are of interest for diverse reasons, mainly medicinal use. Each people interviewed reported to know 1 to 6 mushrooms, with a mean value of 2.68 taxa per person. Ethnospecies *sercha* and *karcha* emerge, with respectively 173 and 106 quotations (Table 5.2) and a citation index value of 321 and 106. Of lesser importance is *chucha*, with 95 quotations and a citation index of 87. Other mushrooms eaten are *djangcha* (41 quotations, citation index of 38), *pangsha* (42 quotation, citation index of 21), *langshu* (43 quotations, index of 21) and *tashopoungri* (12 quotations, citation index 4.5).

In suburban areas the consumption of *Pleurotus pulmonarius* progresses. Frequencies of citation, of preference and of consumption of *sercha* versus *karcha* increase with the higher altitude of the villages.

Importance of mushroom consumption

The 178 interviewees stated they use one to six different mushrooms for consumption, one man refuses all mushrooms. The average number of ethnospecies consumed per person is 2.68 ± 0.52.

Chemical composition of Tibetan edible mushrooms

• Oligoelements

Four species have been studied regarding their mineral content (Table 5.3.). They concern the three most eaten species as well as the major species commercialized in town markets.

Besides the interspecific variability, the measured concentrations of the potentially toxic elements like As, Cd, Pb and Hg are low for mushrooms which are renowned as bioaccumulators. Only *Floccularia luteovirens* shows high concentrations of Cd and Hg. Indeed the European norms for food products are 0.2 mg/kg fresh weight for both elements.

• Proteins

The same species have been studied regarding their protein content (Table 5.4) and amino-acid score (Table 5.5).

Lysine is a limiting amino-acid or nearly limiting all these mushrooms. Leucine is also limiting especially

Table 5.2. Mushrooms eaten in South Central Tibet.

Nr	Species	Translitteration of Tibetan name	Voucher L=Leteinturier M=Malaisse	Litteral translation	Number of citations (178 individuals)	Preference index	Rank
1	*Agaricus* (sect. *Agaricus*) *campestris* var. *squamulosus* (Rea) Pilát	karcha	M 15809, 15812	White mushroom	106 (58%)	143.5	2
2	*Agaricus campestris* L. s. l.	pangcha	M 15827	Steppe mushroom	42 (24%)	31.8	5
3	*Agaricus* sp. 1 (sect. *Flavescentes*)	langchu	L&M 540		43 (24%)	20.8	6
4	*Auricularia auricula-judae* (Fr.) Quél.	mogru	L&M 428, 538		(1, 2)		
5	*Auricularia polytricha* (Mont.) Sacc.	chucha, mogro	L&M 249	Water mushroom	95 (53%)	87	3
6	*Calvatia cyathiformis* (Bosc) Morg.	pokoudi			4	1.2	9
7	*Coprinus comatus* (O.F. Müll.) Gray	pungukacha, tashopungri	L&M 248, 544	Dunkey mushroom	12 (7%)	4.5	8
8	*Cordyceps sinensis* (Berk.) Sacc.	yarzagonbu	L&M 429	Winterworm, summer grass	5	(4)	
9	*Flammulina velutipes* (Curtis) Singer	zingzengu	L&M 543		(1)		
10	*Floccularia luteovirens* (Alb. & Schw.) Pouzar.	sercha	L&M 428, 431, 432, 462	Golden mushroom	173 (97%)	321.3	1
11	*Inocybe dulcamara* (Alb. & Schw.: Pers.) Kummer	djincha	L&M 426	Piss mushroom	(3)		
12	*Lentinula edodes* (Berk.) Pegl.		L&M 430, 463, 545, 546		16 (9%)	9.9	7
13	*Lentinus cyathiformis* (Schaeff.) Bres.	?	L&M 424	?	1		10
14	*Paxillus involutus* (Batsch.) Fr. s. l.	djangcha, marcha	L&M 547	Tree mushroom	41 (23%)	38.0	4
15	*Pholiota nameko* (T. Itô) S. Ito & S. Imai		L&M 552		(1)		
16	*Pleurotus ostreatus* (Jacq.) P.Kumm.		L&M 548		(1, 2)		
17	*Pleurotus cf. pulmonarius* (Fr.) Quel.	pingu	L&M 247		(1, 2)		
18	*Tyromyces* sp. 1	chinba	L&M 423	Tree goiter	1	0.3	10

(1) cultivated by Chinese peasants of other regions; (2) rarely eaten by Ü; (3) information to be confirmed; (4) mostly considered as medicine rather than food

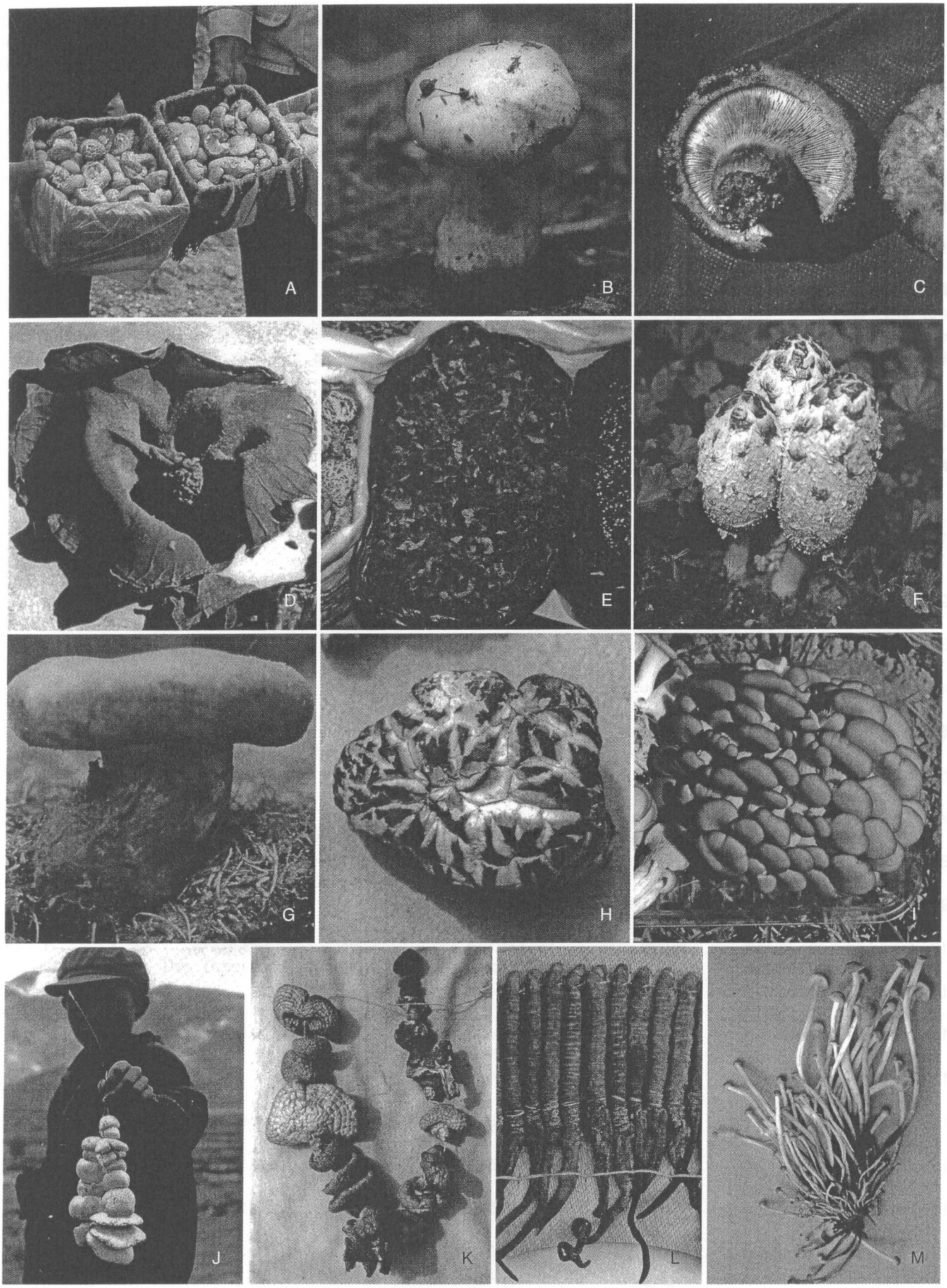

Plate 5.15. Some edible mushrooms . A. *Floccularia luteovirens* – B. *Agaricus campestris* – C. *Paxillus involutus* – D. *Auricularia polytricha* – E. *Auricularia auricula-judae* – F. *Coprinus comatus* – G. *Paxillus involutus* – H. *Lentinula edodes* – I. *Pleurotus pulmonarius* – J. *Agaricus campestris* var. *squamulosus* – K. *Floccularia luteovirens*, for winter consumption – L. *Aenetus virescens* caterpillar parasited by *Cordyceps sinensis* – M. *Flammulina velutipes*.

Table 5.3. Mineral content of four major Tibetan edible mushrooms (in % of 100 g D.M. or in mg/kg D.M. (Dry Matter)).

Mineral	*Agaricus campestris* var. *squamulosus*	*Auricularia polytricha*	*Floccularia luteovirens*	*Pleurotus pulmonarius*
P (%)	0.769	0.398	0.775	1.359
K (%)	3.112	1.612	4.630	6.460
Ca (%)	0.086	0.711	0.106	0.083
Mg (%)	0.141	0.452	0.150	0.223
Na (%)	0.052	0.172	0.040	0.160
S (%)	0.107	0.019	0.383	0.409
Cl (%)	0.032	< 0.001	0.014	1.670
Fe (mg/kg)	138	977	393	823
Mn (mg/kg)	8.3	164	31	31
Zn (mg/kg)	99	31	97	107
As (mg/kg)	0.80	1.45	0.35	0.86
Se (mg/kg)	1.26	0.27	0.72	0.92
Cu (mg/kg)	18	6.2	60	48
Cd (mg/kg)	< 0.01	0.03	2.96	< 0.01
Co (mg/kg)	< 0.01	3.73	2.12	0.34
Cr (mg/kg)	0.49	17	13	8.1
Ni (mg/kg)	0.83	8.7	3.9	3.9
Pb (mg/kg)	< 0.01	< 0.01	< 0.01	< 0.01
Hg (mg/kg)	0.05	0.04	1.18	0.63

in *Agaricus campestris* in which all the amino-acids are limiting. If we compare the relative proportions of essential amino-acids, they are best correlated to leguminous plants than to cereals. If we except *Agaricus campester*, the amino-acid score is near that of pea.

• Lipids

The lipid composition of ten species have been studied (Table 5.6).

The total lipid content of the investigated Tibetan edible mushrooms is quite low and ranged between 1.6 to 5.3% (DM). The fatty acid profile revealed constituents from C14 to C24 and highly unsaturated oils. Excepted in *Cordyceps sinensis* it was found that the major component was linoleic acid (C18:2), an essential fatty acid from the ω-6 family.

Discussion

The use of only one term for naming all the mushrooms in a local language is a common practise and mentioned in numerous ethnomycological studies. Adhikari and Durrieu (1996) point out that it is also the fact for nearly all the Nepalese languages (nine are listed). The same observation was made by Malaisse (1997b) concerning a number of languages from South Central Africa. It should be noted that the substantif «*shamu*», that is to say «hat» and by extension, «fungi with hat», is a general term used in Nepal (Sacherer, 1979); in Tamang «*syamo*» and in Nepali «*chyau*» are used in the same way (Bhandary, 1985).

The choice of the attribute for particular names originates from several aspects of the mushroom, such as macroscopical features (colour), ecological characters (mainly habitat), organographic analogies and so on.

Concerning *Cordyceps sinensis*, it should be noted that the vernacular name in Sherpa language (Nepal), is «*yer tsa gum bu*» (Adhikary et al., 1996), literally meaning «winter larvae, summer grass. The same is noted in Chinese «*dongchong xiacao*» (Jingwei, 1982), as well as in Tibetan; they all express the metamorphosis of the caterpillar in winter into a blackish filament, which resembles a little bit to a blade (Plate 5.15.L). The Nepalese name «*yer tsa gum bu*» strongly resembles the Tibetan name being «*yarzagonbu*».

In comparison to the ethnomycological literature from Nepal and the Himalayas, our records add a number of edible species which typically belong to high altitude open habitats. Adhikari and Durrieu (1996) mention 28 species, commonly found on the markets in Nepal. Most of these taxa, i.e. more than 50%, are exclusively ectomycorrhizal or symbiotic (including Termitomyces) suggesting that these come from forested areas at lower altitudes (below 3500 m). The saprophytic species they mention indicate that a number of species is cultivated, i.e. *Volvariella volvacea* and some *Pleurotus* spp. From the non-cultivated species mentioned in Adhikari et al. (1996), it seems only *Agaricus campestris*, *Coprinus comatus*, *Auricularia auricula-judae*, *Lentinula edodes* and *Cordyceps sinensis* are also found in Tibet. Given their large ecological amplitude, it is probably right to suggest that these taxa are common on markets from higher altitude villages and settlements. The list of edible species from Nepal, presented by Bhandary (1985), is more extensive and adds up to over a hundred edible species, including a high number of taxa like *Scleroderma* spp., *Mycena galericulata*, *Hygrocybe*,

Table 5.4. Composition in proteins of four major Tibetan edible mushrooms (in % of 100 g D.M.).

Protein	*Agaricus campester* var. *squamulosus*	*Auricularia polytricha*	*Floccularia luteovirens*	*Pleurotus pulmonarius*
N(%)	9.000	1.693	6.682	3.474
Proteins (%)	56.250	10.580	41.760	21.710
Asp	1.880	0.932	3.222	1.935
Thr	0.922	0.497	1.716	0.859
Ser	0.947	0.516	1.887	0.922
Glu	3.903	1.244	5.206	3.251
Pro	0.868	0.435	1.250	0.702
Gly	0.938	0.500	2.160	0.841
Ala	1.387	0.640	2.007	1.201
Cys-Cys	0.250	0.108	0.417	0.204
Val	1.111	0.527	1.577	0.957
Met	0.274	0.139	0.458	0.280
Ile	0.823	0.348	1.273	0.687
Leu	1.373	0.678	2.082	1.170
Tyr	0.455	0.221	1.039	0.536
Phe	0.732	0.374	1.260	0.692
Glu-NH2	5.432	0.773	3.711	2.236
His	0.611	0.223	0.743	0.355
Orn	0.204	0.019	0.630	0.143
Lys	0.978	0.493	1.915	0.949
Arg	0.997	0.510	2.038	1.029
Trp	0.39	0.19	0.42	0.28
Total	24.473	9.363	35.009	19.234

Table 5.5. Amino-acid score of Tibetan edible mushrooms (see Appendix II).

Amino-acid	mg/g prot.	*Agaricus campester* var. *squamulosus*	*Auricularia polytricha*	*Floccularia luteovirens*	*Pleurotus pulmonarius*
Thr	34	48	138	121	116
Val	35	56	142	108	126
Met + Cys-Cys	25	37	93	84	89
Ile	28	52	117	109	113
Leu	66	37	97	76	82
Tyr + Phe	63	33	89	87	90
His	19	57	111	94	86
Lys	58	30	80	79	58
Trp	11	63	159	91	119
	Score	30.00	80.34	75.53	75.43

Tremella sp. and others, which are not consumed in Europe. The common taxa in our and Bhandary's lists are again the same, almost cosmopolitan species. The most important species for Tibet which is missing in the accounts on Nepalese mushrooms seems to be *Floccularia luteovirens*. This taxon is badly known in Europe, ectomycorrhizal and associated in T.A.R. with shrub trees above 4000 m altitude. *F. luteovirens* is recognized by its stout tricholomatoid silhouette, a pale yellow to cream-coloured, 10 cm wide pileus, becoming paler with age, having at first yellowish and then paler slightly reflexed and fairly large squamules; the cap's margin is devoid of any striation and at least appendiculate when young. The lamellae are white with concolorous edge, adnexed and becoming yellow with age. The stipe is exceptionally cylindrical but most often strongly tapering to the base, full (rarely fistulose) and relatively short compared to the diameter of the pileus, measuring 2-3 cm long by 0.5-1.5 cm thick. It is annulate, whitish-yellowish and glabrous above the ring, yellowish and covered with reflexed squamules below the ring. Annulus is fixed half way the stipe, membranous, simple, whitish, becoming more yellowish and completely shrinked with age. The presence of *Inocybe dulcamara* among the edible taxa is unique and surprising, as this taxon belongs to a notoriously toxic genus *Inocybe* causing a Sudorian syndrome, i.e. due to muscarine (Bresinsky et al.,1985) and causing transpirations, excessive salivation, lacrymation, nausea, diarrhoea, eyesight problems, asthma. Hallucinations are not reported nor the interactions with alcohol. More studies are urgently needed to check whether poor people indeed consume this «pee mushroom» and if so, how they prepare it.

Table 5.6. Composition in lipids of Tibetan edible mushrooms (in % of total lipids).

Fatty acid		*Agaricus campestris* var. *squamulosus*	*Auricularia polytricha*	*Coprinus comatus* var. *ovatus*	*Coprinus comatus*	*Cordyceps sinensis*	*Flocularia luteovirens*	*Inocybe dulcamara*	*Lentinula edodes*	*Lentinus cyathiformis*	*Pleurotus pulmonarius*
Myristic acid	C14:0	0.16	0.54	0.65	0.32					0.35	7.37
Pentadecanoic acid	C15:0	0.22	1.09	0.38	0.22			0.12	0.93	2.62	0.40
Palmitic acid	C16:0	7.37	11.64	11.20	12.75	17.12	12.3	10.06	12.52	15.11	15.86
Palmitoleic acid	C16:1	1.7		0.97	0.61	1.59	1.03	0.48	0.76	0.97	1.35
Margaric acid	C17:0	0.29								0.50	
Stearic acid	C18:0	1.71	1.27	0.42	0.76	0.84	1.7	2.07	0.99	0.83	3.56
Oleic acid	C18:1 cis-9	2.69	13.79	5.50	6.37	52.77	13.2	35.63	3.39	8.31	26.14
	C18:1 isomer	1.07		1.40						1.84	2.52
Linoleic acid	C18:2	81.24	70.66	77.35	76.80	25.06	71.3	45.22	79.08	67.59	35.32
Linolenic acid	C18:3			0.93	1.26	1.93		0.71		0.22	3.03
Arachidic acid	C20:0	1.27									0.36
	C20:1										0.41
Behenic acid	C22	0.78									0.82
	C22:1									0.44	
Lignoceric acid	C24	0.45						0.34			tr
Others *		1.05	1.01	1.2	0.91	0.69	0.47	5.37	3.43	1.22	2.86
Total Lipids**		3.7	2.3	3.2	4.5	5.3	3.1	2.8	1.6	1.9	2.6

* Unidentified compounds; ** g lipids/100d Dry Matter (DM).

Conclusion

In conclusion, it appears:

– the popular knowledge of edible mushrooms in South Central Tibet is mainly limited to three ethnotaxa: *sercha*, *karsha* and *chucha*, sometimes also erroneously called *mokro*. Whilst the two first are eaten for themselves, *chucha* is always served with other food, mainly meat;
– more rare, even exceptional, is the consumption of 5 to 8 other taxa, of which five are certified by reference material;
– a reduced local consumption of fungi is noted for adults (1 to 5 time in summer), but is more frequent for children, mainly for those that tend cattle;
– a local distribution and consequently also a local consumption which is largely controlled by climatologic conditions (yearly temperatures and rainfall) as well as the ecosystems and land use (farming, grazing);
– *karsha* is frequent between 3,600 and 4,000 m altitude and mainly observed in fields and meadows; *sercha* is frequent between 3,900 and 4,600 m altitude and occurs in the bangri vegetation; finally *chucha*, which develops in aquatic conditions, presents a more wide altitudinal distribution, but is neglected when growing in polluted water bodies;
– there exists a clear gustative preference for *sercha*;
– *sercha* is frequently dried and conserved for winter consumption.

5.3.4. Edible potherbs

Previous studies

Some results on wild edible plants of South Central Tibet have already been published, namely a table of 36 plant taxa, their uses, as well as their Tibetan names (Malaisse et al., 2003). Those plants comprise 14 potherbs (39%), 9 spice plants (25%), 6 stem-legumes (17%), 4 edible underground plants (tubers, roots or corms) (11%) and 3 fleshy fruits (8%). Wild edible leafy plants or potherbs were in this way the most important group. Potherbs

are frequently one of the main item of alternative foods, even if in several regions, such as in tropical Africa, fruits take the top position (Malaisse, 1997b). Nevertheless diversity of potherbs vary greatly according to ethno-linguistic groups. High values have been quoted for several countries of Africa (Irvine, 1952; 1956) as well as South-East Asia (Christensen, 2002).

Diversity of potherbs

A fifteen or so potherbs were listed (Table 5.8, Plate 5.16). The relative importance of them was approached through a citation index score. Table 5.7 presents those values.

Sapo, the young nettle leaves (*Urtica* spp.), takes the top position. Anybody knows the plant – in fact several species are concerned – and this food is highly appreciated, collected and stored (Chap. 5.4). A soup, *suptuk*, is prepared from nettle young leaves.

The tender leaves and shoots of *koniu*, *Carum carvi*, came in second position. It should be noted that this herb is primarily known for the use of its fruits as spice (Németh, 1999) and medicine (Tsarong, 1994), but leaves are locally also used notably for importing aromatic flavours to sups and sauces (Bhattacharjee, 2000). We have quoted its presence during July and August at the Lhasa markets.

Cham-pah, *Malva verticillata*, is also a well known medicinal plant (Tsarong, 1994) and potherb, but less wanted.

The importance accorded by local populations to touchoung, an adder's tong fern, became obvious. Indeed, *tuchung* has three times been presented, during the interviews as a valuable legume entering a local soup. It took the fourth place as potherb. This fern produces one or two fronds, 5 to 15 cm long, at mid-July.

Some eight other items appear on table 5.7. Finally leafstalks and stems of rhubarbs, young shoots of asparagus are also eaten (Malaisse et al., 2003); but neither rhubarbs, neither asparagus are here considered as potherbs.

The lipid composition of ten plants is presented in table 5.9. As shown, except *Lancea tibetica* (7.0% oil), all the investigated plants have low lipid content ranging from 2.8 to 5.3% by weight. Their fatty acid methyl ester profiles determined by GC-FID of all of them show interesting levels of essential polyunsaturated fatty acids (from 29.7 to 70.7%). As in other common green vegetables α-linolenic acid (9,12,15-cis,cis,cis-octadecatrienoic acid) is the major constituent and plays a very relevant role on a nutritional point of view (precursor of biologically important eicosanoids with specific functionalities). The consumption of the different investigated potherbs contributes to the supply in ω-3 fatty acids for the Ü and Tsang peoples. Consumption of these potherbs should be encouraged.

Discussion

Young shoots and leaves of diverse nettles, including *Urtica dioica*, *Urtica triangularis* and *Urtica hyperborea*, are wanted in spring and consumed after boiling in water as spinach, the so-called *sapo*, or also air dried in view of further consumption as soup, called suptuk in South Central Tibet. The use of young leaves of the stinging nettle as green has been quoted for other populations within the Himalayan range, notably for the Tamang (Toffin et al., 1985), the Sherpas of the Rolwaling valley in Nepal (Sacherer, 1979), in Garhwal Himalaya (Gaul et al., 1983) as well as Sikkim Himalaya (Sundriyal et al., 2001). It is still observed elsewhere (see chap. 5.4). Leaves of several nettles may be boiled and eaten, or used young and uncooked as spinach. They are appreciated by local population in several countries, notably in Kenya for *Urtica massaica* Mildbr. (Friis, 1989; Maundu et al., 1999), in Simien mountains of Ethiopia for *Urtica*

Table 5.7. Relative importance of wild edible potherbs of South Central Tibet.

Species	Tibetan transcription	Number of recognition (37 interviews)	Number of citation (5 top plants)	Citation index
Urtica spp.	zapo	37	28	87
Carum carvi	koniu, toniu, sharotange	29	20	60
Malva verticillata	champa	28	8	27
Ophioglossum polyphyllum	tuchung	3	3	14
Taraxacum spp.	khumo, mo, yo, khurmong	23	5	13
cf *Angelica* sp.	cha	23	3	12
Codonopsis bulleyana	sukpa metok	14	4	12
Fagopyrum tataricum	tragö, koyowa, torcherawa, pagö	24	1	3
Chenopodium album	neu (lego, nubre)	12	0	0
Plantago depressa	tharam, (alathapo, popkera)	10	0	0
Sonchus brachyotus	gyakhur nagpo, gyegungwa, anggum, umguma	6	0	0
Lancea tibetica	didigonggu, payagpa	2	0	0

Table 5.8. Wild edible potherbs of South Central Tibet according to Ü and Tsang (after Malaisse et al. 2003, modified).

Family	Species	Voucher (L & M)*	Organ eaten	Use	Translitteration of Tibetan names (Wylie, 1959)	Transcription of Tibetan names (Tournadre, Dorje, 2003)	English names
Apiaceae	cf. *Angelica* sp.	342, 443	young upper part	green vegetable		cha	
Apiaceae	*Carum carvi* L.	278, 435	tender leaf and shoots	green vegetable	goh-nyöd	koniu, toniu	caraway
Asteraceae	*Cortia depressa* (D.Don) C.Norman		young leaf	green vegetable			
Asteraceae	*Sonchus brachyotus* DC.	535	young leaf	green vegetable	rgya-khur nag-po	gyakhur nagpo, anggum, umguma	
Asteraceae	*Taraxacum* sp. 1	277	young leaf	soup	khoor-m'ang	khumo, mo, yo	dandelion
Asteraceae	*Taraxacum tibeticum* Hand.-Mazz.	499	young leaf	soup	khoor-m'ang	ngo, mokhumo	Tibetan dandelion
Campanulaceae	*Codonopsis bulleyana* Forrest ex Diels	507	leaf and tender stem	green vegetable		sukpa metok	
Campanulaceae	*Codonopsis* aff. *mollis* Chipp		leaf and tender stem	green vegetable		sukpa metok	
Chenopodiaceae	*Chenopodium album* L.	452	limb of leaf	soup	sne'u	neu, lego, nubre	fat-hen
Malvaceae	*Malva verticillata* L.	357, 449	limb of leaf	soup	lcam-pa, cham-pah	champa	Chinese mallow, cluster mallow
Ophioglossaceae	*Ophioglossum polyphyllum* A.Braun apud Seub.	371	frond	soup		tuchung	adder's tong fern
Plantaginaceae	*Plantago depressa* Wild.	450	young leaf	soup	tha-ram	tharam, alathabo, popkera	plantain
Polygonaceae	*Fagopyrum tataricum* (L.) Gaertn.	355, 451	limb of leaf	soup	bra-rgod	tragö, koyowa, torcherawa, pagö	Tatarian buckweat
Scrophulariaceae	*Lancea tibetica* Hook.f. & Thoms	500	leaf	green vegetable	pa-yag-pa	didigonggu, payagpa	Tibetan lancea
Urticaceae	*Urtica dioica* L.	483	young leaf	vegetable, soup	za-po	sapo, suptuk	stinging nettle
Urticaceae	*Urtica hyperborea* Jacq. ex Wedd.	514	young leaf	vegetable, soup	za-po	sapo, suptuk	white nettle
Urticaceae	*Urtica triangularis* Hand.- Mazz.	504	young leaf	vegetable, soup	za-po	sapo, suptuk	nettle

* Reference collection (L=Leteinturier, M=Malaisse) deposited at Belgium National Botanical Garden [BR].

Table 5.9. Lipids composition of ten edible potherbs.

LIPIDS	***Urtica hyperborea***	***Urtica triangularis***	***Malva verticillata***	***Taraxacum* sp.**	***Ophioglossum polyphyllum***	***Angelica* sp.**	***Codonopsis bulleyana***	***Fagopyrum tataricum***	***Chenopodium album***	***Lancea tibetica***
Voucher	**L & M 514**	**L & M 504**	**L & M 449**	**L & M 277**	**L & M 371**	**L & M 443**	**L & M 507**	**L & M 451**	**L & M 452**	**L & M 500**
Total Lipids (%)	**3.2**	**4.0**	**5.0**	**4.5**	**2.8**	**2.8**	**3.3**	**4.4**	**5.3**	**7.0**
Fatty acid profile (Area%)										
Myristic (C14)	0,8	0,7	1,1	1,7	traces		0,5	traces		1,0
Myristoleic (C14:1)			0,7							
Pentadecanoic (C15)	0,1						0,4			0,5
Palmitic (C16)	11,4	11,3	15,3	19,3	15,8	18,7	13,3	12,0	16,8	15,5
Palmitoleic (C16:1)	4,8	5,7	5,9	5,2	1,9	5,1	4,1	6,2	6,1	5,8
Hexadecadienoic (C16:2)					0,8	1,5				
Margaric (C17)					0,2		0,3			
Stearic (C18)	1,5	1,4	3,0	1,8	3,5	1,4	1,3	1,2	1,0	3,4
Oleic + isomer* (C18:1)	2,4	0,9	4,0	1,8	9,3	2,3	2,3	3,4	3,4	4,7
Linoleic (C18:2)	11,7	11,0	6,6	14,8	15,2	31,3	23,2	13,6	13,4	14,5
6-octadecynoic (C18:1 tr)					17,1					
Linolenic (C18:3)	43,7	50,7	58,8	47,1	13,7	21,1	35,7	57,1	54,0	49,9
Arachidic (C20)	2,8	2,7			0,4	0,9	0,4			1,2
Eicosenoic (C20:1)					1,8					
Docosanoic (C22)	0,2	0,4		0,7	2,1	1,8	1,3			
Docosenoic (C22:1)	tr	2,5			3,5	0,8	1,9			
Lignoceric (C24)	2,7	1,9		0,6	2,6	2,3	2,1			
Saturated	19,5	18,5	19,3	24,1	24,6	25,1	19,3	13,2	17,8	21,6
Mono-unsaturated	7,2	6,6	10,6	7,0	16,5	7,4	6,4	9,6	9,5	10,4
Polyunsaturated	55,4	61,7	65,4	61,9	29,7	53,9	59,0	70,7	67,5	64,4
Acetylenic					17,1					

* cis-Vaccenic acid – tr = triple bound.

Plate 5.16. Some wild edible potherbs. A. *Sonchus brachyotus*: spring habit – B. Bag of *Taraxacum tibeticum*, for winter consumption – C. Plate of *Ophioglossum polyphyllum* – D. *Ophioglossum polyphyllum*: habit – E. *Malva verticillata*: habit – F. *Lancea tibetica*, habit – G. *Fagopyrum tataricum*: habit – H. *Plantago depressa*, autumn habit.

simensis Hochst. ex A.Rich., in Sierra Nevada for *Urtica dioica* L. subsp. *holosericea* (Nutt.) Thorne and *Urtica serra* Blume (Woodland, 1982). Consumption of a thick soup nettle-based is also quoted from Nepal (Sacherer, 1979). Nettle leaves lose their urticant property after a few minutes immersion in boiled water.

Malva verticillata, cluster mallow or Chinese mallow, is a well known plant by Ü (76% of recognition), but ranks only 8 citations (22%), thus moderately appreciated as potherb. It should be remind that its seeds are used in Tibetan medicine for renal disorders, the retention of fluids, frequent thirst and diarrhoea, whilst leaves and stems are given to women in the advance stages of pregnancy. Moreover the plant furnishes cream, yellow and green dyes. It is well known in Europe, where it is cultivated as a salad plant (Polunin et al., 1997).

Ophioglossum reticulatum is used as a substitute of spinach in villages and towns of Uttar Pradesh and Madhya Pradesh in India (Sharma, 2000), being still appreciated in Indonesia were it is eaten as salad or cooked as a vegetable. In Nepal, its fronds as well as those of *Ophioglossum nudicaule* L.f. are cooked as a vegetable (Manandhar, 2002). Within a pilot study undertaken in Namibia it has been reported that *Ophioglossum polyphyllum* may be used as famine food when few other plants are available but the species is not popular or well known (Larsen, 2001).

Young leaves of at least two dandelions (*Taraxacum* spp.), called *kouma*, are currently eaten in villages (Plate 5.16). The sale in town is of little importance and is seasonal. Eating of leaves of dandelion has been quoted from other countries, for instance Nepal (Manandhar, 2002), Garhwal Himalaya (Gaul et al., 1983), notably by Bhotias, Gujars, Gaddis aboriginal groups (Negi et al., 1993), and Sikkim Himalaya (Sundriyal et al., 2001), but also Europe (Couplan, 1998).

The use of young shoots and leaves of *Codonopsis thalictrifolia* as vegetable was moderately quoted (38%). The same use is reported for the young leaves of a plantain, *Plantago depressa* Wild. as well as for those of *Fagopyrum tataricum*, the Tartary buckwheat, whose grain provides a nutty-tasting flour which remind one of buckwheat, once widely cultivated in Europe (Mabey, 1997).

Fat-hen or common lambsquarters (*Chenopodium album*), is a common weed in T.A.R. At a regional scale, its consumption is quoted from India (Low, 1992), notably Garhwal Himalaya (Gaul et al., 1983), Sikkim Himalaya (Sundriyal et al., 2001), Western Rajasthan (http://www.hort.purdue.edu/newcrop/Famine Foods/), from Nepal (Manandhar, 2002), from China. Leaves are still eaten as a famine food, typically boiled with salt and chilli in several parts of India (Monghyr, Mirzapur, Dholpur, Alwar, Udaipur, Poona and Ahmednagar) (Manandhar, 2002). Moreover fat-hen is a well-known peasant potherb all over the world. Its mealy leaves have been harvested in Western Europa, Russia, Canada, America, Africa (Couplan, 1998).

Rarely quoted, *Sonchus brachyotus* (16%) and *Lancea tibetica* (5%) are of less importance.

Finally it should be noted that the Tibetan potherbs have more plants in common with pistic, a traditional special dish prepared from 56 wild herbaceous plants from western Friuli, in North-Eastern Italy (Paoletti et al., 1995), as with plants listed for Nepal (Manandhar, 2002).

5.3.5. Spices, aromatic herbs and condiments

Wild edible plant used as spice, aromatic herbs or condiments occupy an important place in the diet of populations inhabiting the Himalayan plateau. Information on there diversity may be found in several books and papers, notably Manandhar (2002).

Diversity

Some 23 ethnospecies have been quoted during the survey conducted in South Central Tibet (Table 5.10). Four of them are spices (Plate 5.17).

Konieu or caraway ranks the top position. It is known from anybody in South Central Tibet. The citation index ranks a very high value. It should be remained that besides the fruit wanted as spice, young leaves and also roots are edible (Norman, 2002). It is used to flavour meat. It has a pungent aroma that is warm and bittersweet, sharply spicy, with a note of dried orange peel and a slight but lingering hint of anise (Norman, 2002). The culinary essence of caraway is a very odorante cetone, the d-carvone and a terpene, the d-limonene. In South Central Tibet the plant occurs in open situations, on well-drained soils. Stems are cut in July. Konieu is offered to purchase on Lhasa markets from early July to early November. In rural Tibet bags of konieu exist in most of the houses.

Tcharsil, field pennycress or Mithridate mustard (*Thlaspi arvense*) presents an eurasiatic distribution. This hardy annual or bisannual herb occurs in cultures and rubble. Seeds are used to flavour dishes.

The cultivation of *Coriandrum sativum* has been noted in few villages.

Seven aromatic herbs have been quoted (Plates 5.18, 5.19).

As well as in Garhwal Himalaya (Gaul et al., 1983), several garlic plants are appreciated in South Central Tibet. At least six wild species dealing with the genus Allium are eaten. They are mainly distinguishable according to their

Table 5.10. Diversity of spices, aromatic herbs and condiments in T.A.R.

Family	Species	Voucher *	Organe	Use	English Name	Translitteration Tibetan names
Apiaceae	*Carum carvi* L.	L & M 278, 435	fruit	spice for meat, with needle	caraway	konieu
Apiaceae	*Coriandrum sativum***		fruit	spice for meal	coriander	
Apiaceae	*Cortia depressa* (D.Don) C. Norman		upper part	spice for meat, with needle		sharotange
Apiaceae	*Heracleum candidans* Wall. ex DC.	L & M 434	upper part	squach as aromatic herb		shakoktengual
Brassicaceae	*Thlaspi arvense* L.	M 16012	seed	spice	field pennycress, mitrhidate mustard	tcharsil
Lamiaceae	*Dracocephalum tanguticum* Maximowicz	L & M 534 M 16011	above ground part	powered as aromatic herb for meat and cheese		ngopyiang
Lamiaceae	*Dracocephalum nutans* L.	L & M 448, 498	inflorescence	spice for cheese		lugulangstal
Liliaceae	*Allium atrosanguineum* Schrenk	L & M 513	upper part	aromatic herb		lugra
Liliaceae	*Allium caesium* Schrenk		upper part	aromatic herb		simbo
Liliaceae	*Allium fasciculatum* Rendle	L & M 440	upper part	aromatic herb for meat		gogpa
Liliaceae	*Allium henryi* C.H.Wright		upper part	aromatic herb for meat		simbo
Liliaceae	*Allium macranthum* Baker	L & M 445	upper part	aromatic herb for meat		gyagok, simbo
Liliaceae	*Allium prattii* C.H.Wright	L & M 509	upper part	aromatic herb	Chinese red allium	dzinak
Liliaceae	*Allium wallichii* Kunth		upper part	aromatic herb		simbo
Liliaceae	*Allium* sp.	L & M 464	upper part	aromatic herb for meat		mouktok
Polygonaceae	*Rheum acuminatum* Hook. & Thomson	L & M 441	leaf petiole	condiment	rhubarb	numdi, chuju
Polygonaceae	*Rheum australe* D.Don	L & M 441	leaf petiole	condiment	rhubarb	numdi, chuju
Polygonaceae	*Rheum globulosum* Gage		leaf petiole	condiment	rhubarb	
Polygonaceae	*Rheum inopinatum* Prain		leaf petiole	condiment	rhubarb	
Polygonaceae	*Rheum lhasaense* Li & Hsiao		leaf petiole	condiment	rhubarb	numdi, chuju
Polygonaceae	*Rheum moorcroftianum* Royle		leaf petiole	condiment	rhubarb	chuju
Polygonaceae	*Rheum palmatum* L. **	L & M 460	leaf petiole	condiment	Chinese rhubarb	tchum
Polygonaceae	*Rheum pumilum* Maxim.		leaf petiole	condiment	rhubarb	
Polygonaceae	*Rheum rhomboideum* Losinskaja		leaf petiole	condiment	rhubarb	
Polygonaceae	*Rheum tanguticum* (Maxim.) Maxim.	L & M 508	leaf petiole	condiment	Chinese rhubarb	tchum
Polygonaceae	*Rheum webbianum* Royle		leaf petiole	condiment	rhubarb	

* Collection L & M = Leteinturier & Malaisse, M = Malaisse
** Locally cultivated

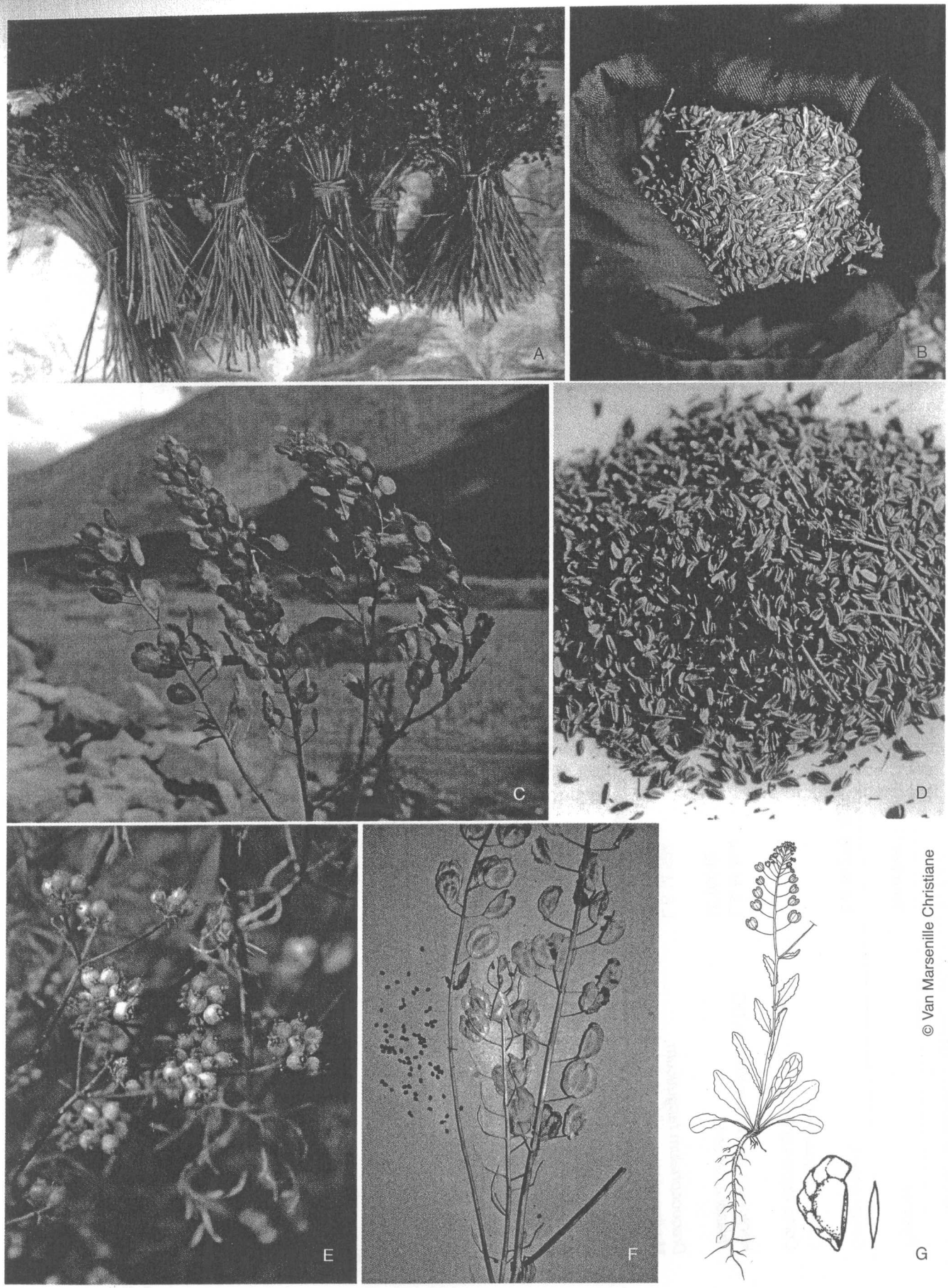

Plate 5.17. Some spices used in T.A.R. A. *Carum carvi*: fresh brunches – B. *Carum carvi*: fruits packed into bags during winter – C. *Thlaspi arvense*: habit – D. *Heracleum candidans*: fruits – E. *Coriandrum sativum*: fruiting plant – F. *Thlaspi arvense*: fruiting plant – G. *Thlaspi arvense*: habit, fruit and seed.

inflorescence colour (white, yellow, pink, purple, mauve, violet), but the leaves, broad or narrow, as well as the shape of the inflorescence are of interest. At the Lhasa markets, *Allium macranthum*, or *gyakok*, is available in July and August; in rural areas *Allium fasciculatum* (white globose inflorescence, *kokpa* or *kotste*), *Allium* sp. (elongated lilac inflorescence, muktok), *Allium atrosanguineum* Schrenk (yellow inflorescence) and *Allium pratii* (mauve inflorescence, broad leaves) are much appreciated.

Several species issued as condiment. These plants belong to the genus *Rheum* (Plate 5.20). *Rheum*, is a highly diversified genus with about 60 species. Rhubarbs are mainly confined to the mountainous and desert regions of the Tibetan plateau and adjacent areas. This genus represents a good example of the extensive diversification of the temperate genera in the Tibetan plateau, in which the forces to drive diversification remain unknown. To date, the infrageneric classification of *Rheum* has been mainly based on morphological characters but molecular studies are in course (Wang et al., 2005).

Consumption of leafstalk and stem of several rhubarbs appear frequently. This fact was already quoted by Bell (1928) who wrote «rhubarb grows wild and is of various kinds, some of great height». We have noted the use of *Rheum officinale*, *Rheum australe, Rheum palmatum* and *Rheum tanguticum*, but others authors have quoted *Rheum emodi* (Jest, 1972 in Sacherer, 1979) and *Rheum mootcroftianum* (Gaul et al., 1983).

Discussion

Several Tibetan species are from a long time used outside this area and their history, present range and cultivation will be commented on.

Caraway has a mountain Asiatic origin. It is to be found in Mediterranean kitchen and medicine since some 5,000 years.

Coriandre is already quoted in the Old Testament under the name of «gad». It was used to flavour bread by Hebrews. Leaves are sometimes used as potherb, even roots are edible (Viard, 2004). It occurs from Orient to Mediterranean countries. When drying the fruits loose their bug scent whilst their perfume increases, repealing orange zest.

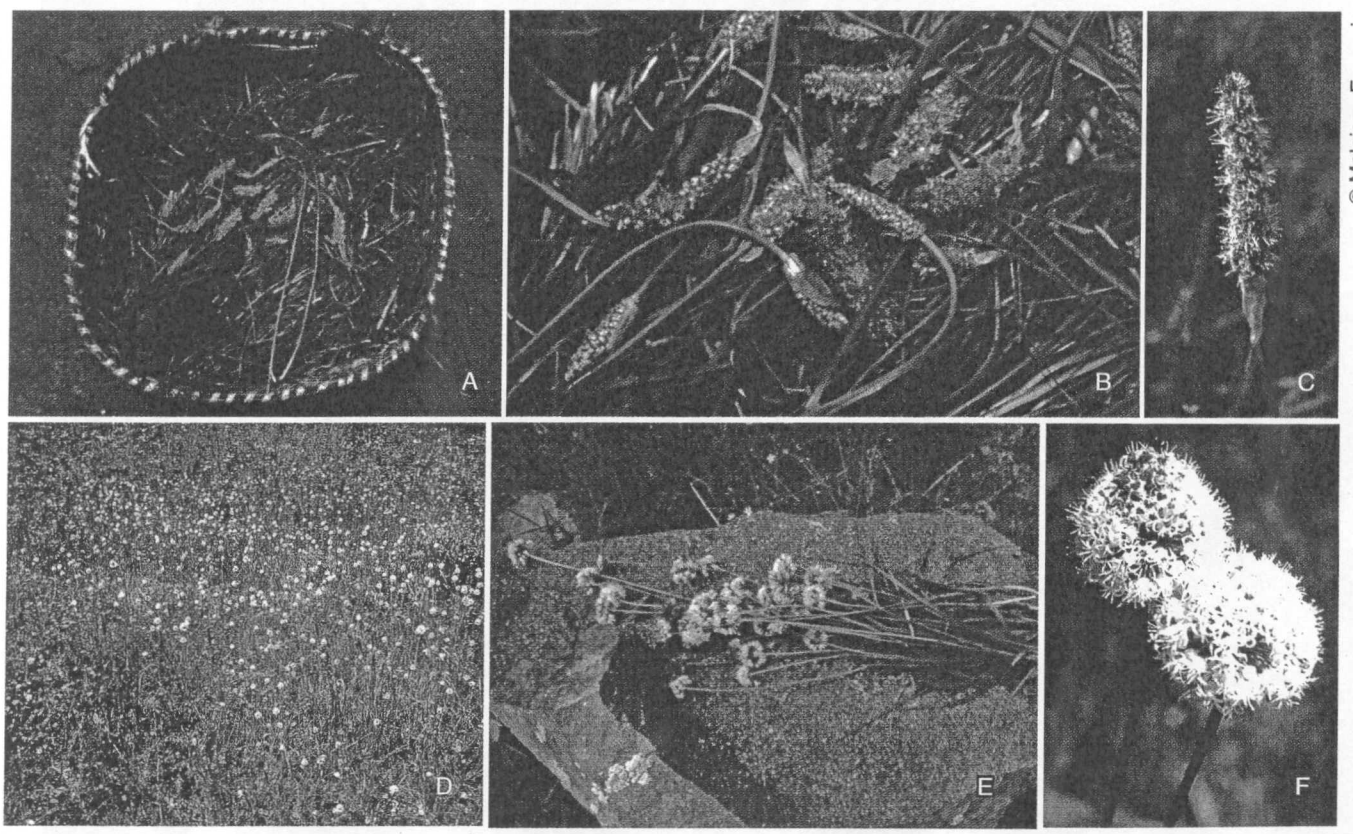

Plate 5.18. Two garlics of South Central Tibet. A. Basket of *Allium* sp. or *muktok* – B. Basket of *Allium* sp. or *muktok*: detail – C. Basket of *Allium* sp. or *muktok*: the elongate mauve inflorescence – D. *Allium fasciculatum* or *gogpa* in the wild – E. *Allium fasciculatum* or *gogpa*: habit – F. *Allium fasciculatum* or *gogpa*, the spherical white inflorescence.

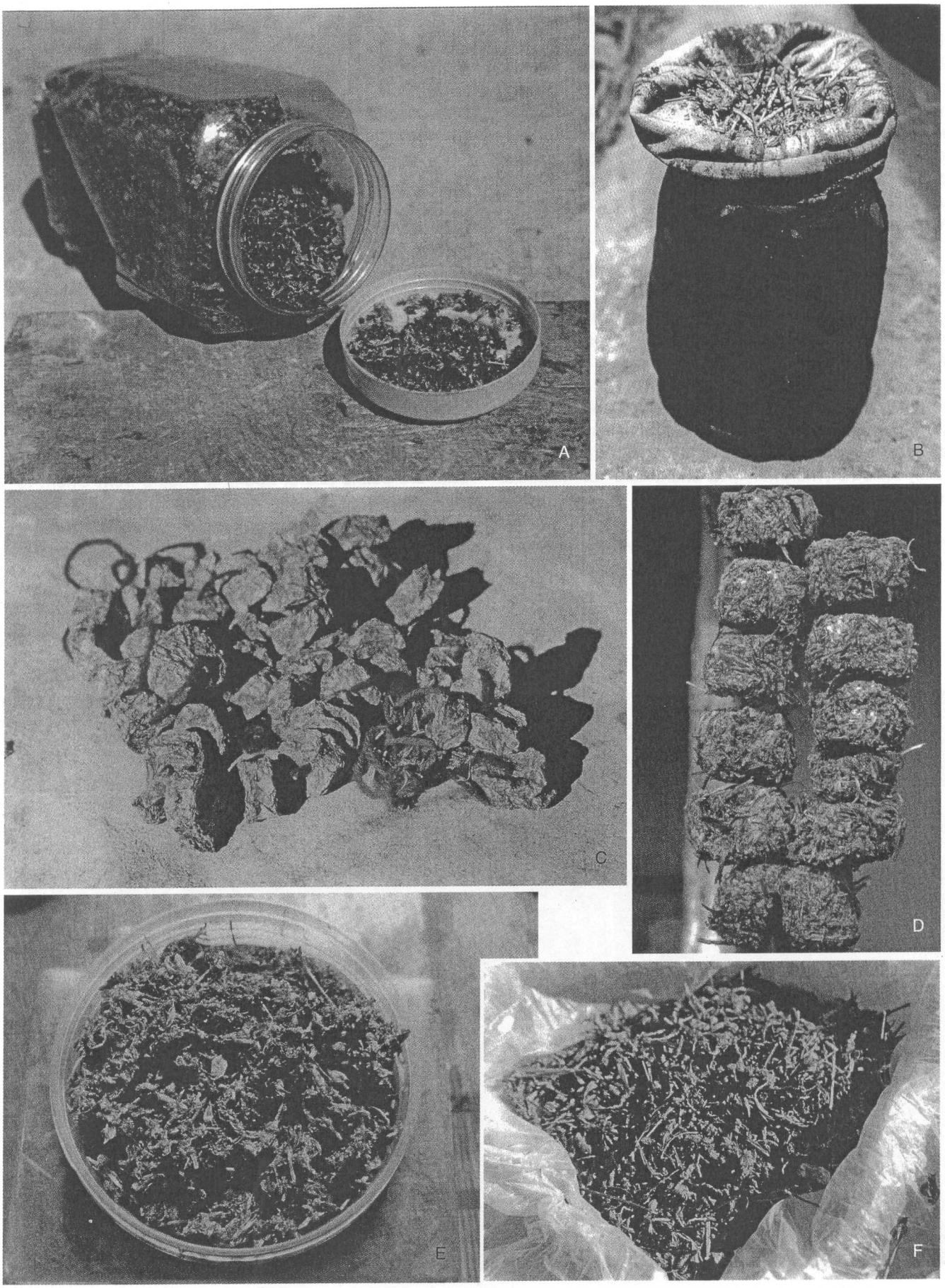

Plate 5.19. Diversity of aromatic herbs stored at home for winter consumption. A. *Allium henryi* or *simbo* – B. *Allium macranthum* – C. String of *Allium henryi* cubes – D. String of *Allium fasciculatum* cubes – E. *Allium caesium* – F. *Allium* sp.

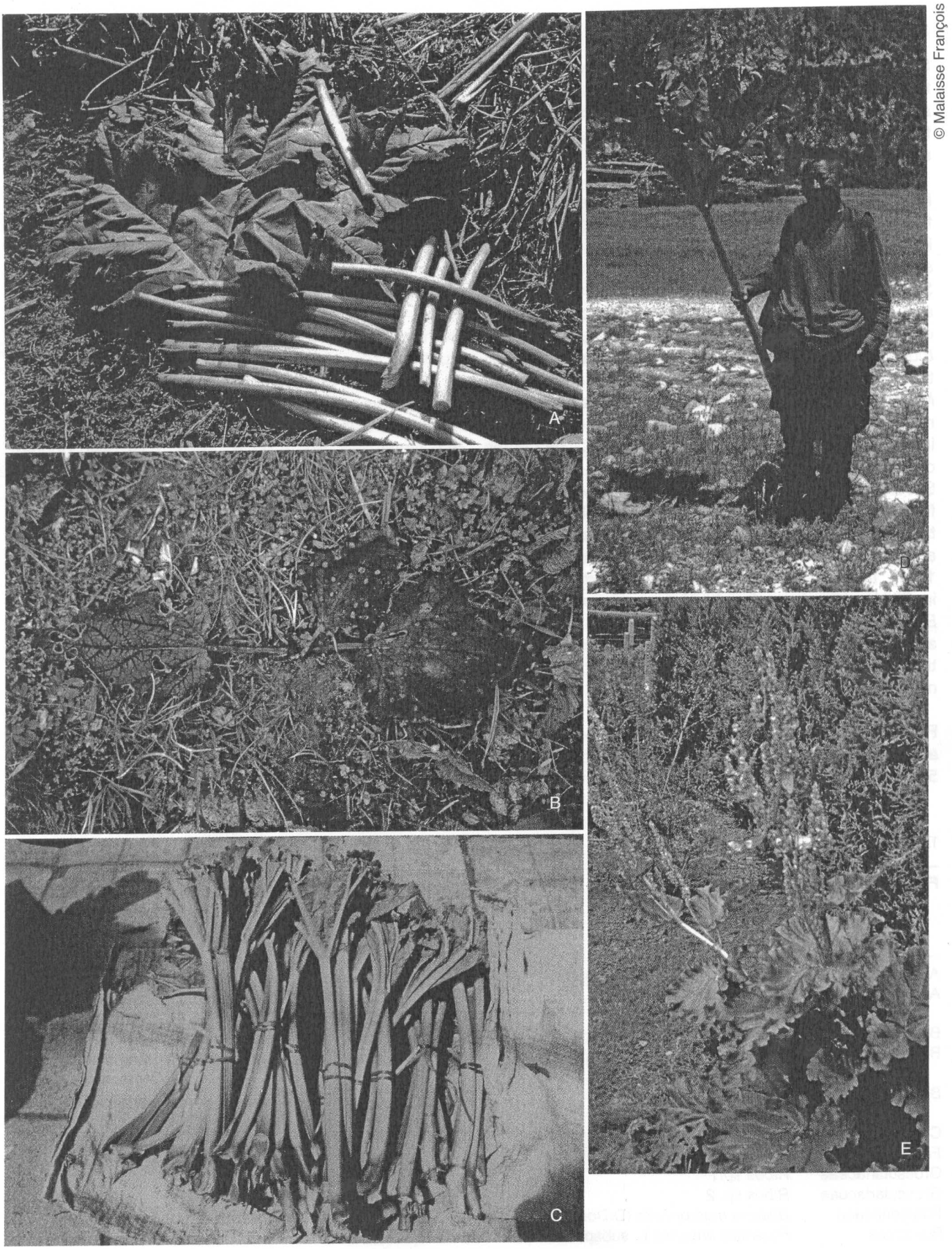

Plate 5.20. Some rhubarbs of South Central Tibet. A. *Rheum tanguticum* – B. *Rheum emodii* – C. *Rheum palmatum* – D. Collecting a leave of *Rheum tanguticum* – E. *Rheum* sp.

5.3.6. Other plant organs' foods

Some wild fruits, underground parts (rhizomes, roots, tubers, etc.), stems and flowers as well as receptacle are also eaten from time to time (Table 5.11). Two of them take a major importance, namely the tubers of a silverweed and the fruit of a rosebush.

Five wild fruits have been quoted (Plate 5.21). The fleshy mesocarp of the orange to red rosehips, locally known as *sindou* or *simbou*, of a dog rose called *sewa*, *Rosa omeiensis* Rolfe, are highly appreciated. *Sindou* are offered for sale in town markets in July and August (Malaisse et al., 2003). The scarlet berries of *Podophyllum hexandrum* called *momsussu*, *gyatse thumlo* or *abulu* are frequently collected and wanted; they are sometimes stored for winter consumption. *Momsussu* is also an important medicinal plant, the rhizome containing podophyllin, a possible drug used in treatment of cancer (Polunin et al., 1997). The berries of some *Ribes* spp. are also from time to time eaten. Several barberries occur in the area under study; ripe fruits of some are eaten. They have a slightly acide taste. The dark crimson fruits of *Berberis asiatica* Roxb. are eaten in Nepal (Toffin et al., 1985, Polunin et al. 1997), those of *Berberis asiatica* and *Berberis chitora* in Sikkim Himalaya (Sundriyal, pers. com.), those of *Berberis dictyophylla* from time to time in the studied area. Two other plants delivering edible fruits are kuyuk-thal-chak and *Asparagus curillus*; this information needs nevertheless confirmation.

Five underground organs have been quoted. *Potentilla anserina* subsp. anserina is the most important (Plate 5.22). It is a perennial herbaceous plant, whose dark brown tubers, toma, are a highly prized foodstuff, an observation already quoted by Grenard (1904). They are sometimes eaten raw, notably by nomad children, but come mostly into diverse recipes. They are associated in town to Losar, the Tibetan New-Year. The boiled tubers are mixed with cooked rice, butter and sugar in order to produce the toma daisel, of which consumption brings happiness. This dish is eaten by all the family members. Boiled tubers also go with *tchang*. Tubers are collected all year round and commercialisation in urban centres is important. The consumption, by Indians of the north-western coast of the USA, of «roots» of an other sub-species of silverweed, subsp. *pacifica* (Howell) Rousi, the nutritional value of which has been studied (Kuhnlein et al., 1982; Turner et al., 1892) should be quoted. Other underground organs eaten are the roots of *Microula* cf. *sikkimemsis* or pawalulu, the tubers of *Codonopsis convolvulacea* or *bala*, the roots of *Bistorta macrophylla* or mèmbou. Bala is eaten raw in September and November. Some other plants have been quoted during surveys but not yet collected such as the roots of *polomolo*, etc.

Some flowers are eaten or sucked, mainly by children, notably those of *Codonopsis thalictrifolia* or *soupka mèto*, and of *Caragana jubata*.

The receptacle of the inflorescence of *Jurinaea dolomiaea*, local names *purge numa*, *tora*, *warokyongma*, is eaten raw (Plate 5.22). It is well known and appreciated.

In conclusion the diversity of will edible plants is behind fifty plants and offers a panel of food able to increase the chemical components of the diet.

Table 5.11. Some wild edible species in T.A.R.

Family	Species	Voucher (L & M)*	Organ eaten	Use	Transcription of Tibetan names (Tournadre, Dorje, 2003)
Asparagaceae	*Asparagus curillus* Buch.-Ham.	402	stem, fruit	vegetable	nagkatampel
Asteraceae	*Jurinaea dolomiaea* Boiss.	342, 442	receptacle	raw, starch	purge numa, warokyongwa
Berberidaceae	*Berberis dictyophylla* Franch		fruit	eaten raw	
Berberidaceae	*Podophyllum hexandrum Royle*	410	fruit	eaten raw	momsussu, omsussu
Boraginaceae	*Microula* cf. *sikkimemsis* (C.B.Clarke) Hemsl.	366, 481	root	starch	pawalulu, atuputo
Campanulaceae	*Codonopsis convolvulacea* Kurz	M 15346	tuber	starch	bala, myewa
Fabaceae	*Caragana jubata* Poir		flower	eaten raw	
Grossulariaceae	*Ribes* sp.1		fruit		
Grossulariaceae	*Ribes* sp. 2		fruit		
Polygonaceae	*Bistorta macrophylla* (D.Don) Soják.	506	root	boiled, starch	mèmbou
Rosaceae	*Potentilla anserina* L. subsp. *anserina*	335	tuber	toma daisel preparation	troma, toma
Rosaceae	*Roa omeiensis* Rolfe	433	fruit pulp	eaten raw	
Scrophulariaceae	*Incarvillea* cf. *younghusbandii* Sprague	M 15784	root	starch	pupsta

* Collection L & M = Leteinturier & Malaisse; M = Malaisse.

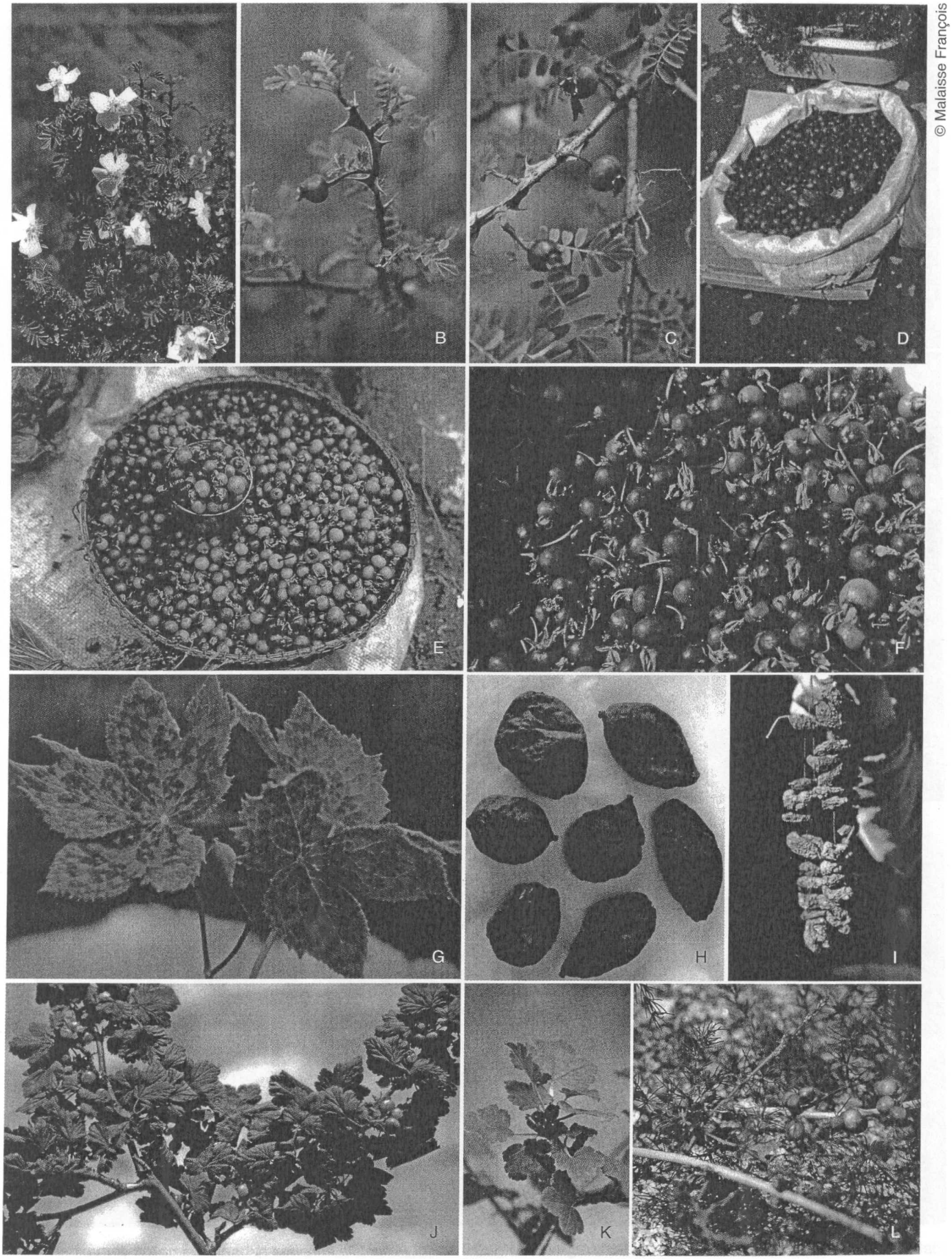

Plate 5.21. Some edible fruits. A. *Rosa omeiensis* or *sindou*: flowering twig – B. & C. *Rosa omeiensis* or *sindou*: fruiting twig – D. & E. Rosehips offered for sale in town – F. Idem, detail – G. *Podophyllum hexandrum* or *momsussu*: habit – H. *Podophyllum hexandrum* or *momsussu*: mature fruits – I. *Podophyllum hexandrum* or *momsussu*: dried fruits for winter consumption – J. *Ribes* sp. 1, fruiting twig – K. *Ribes* sp. 2, fruiting twig – L. *Asparagus curillus*: fruiting phenophase.

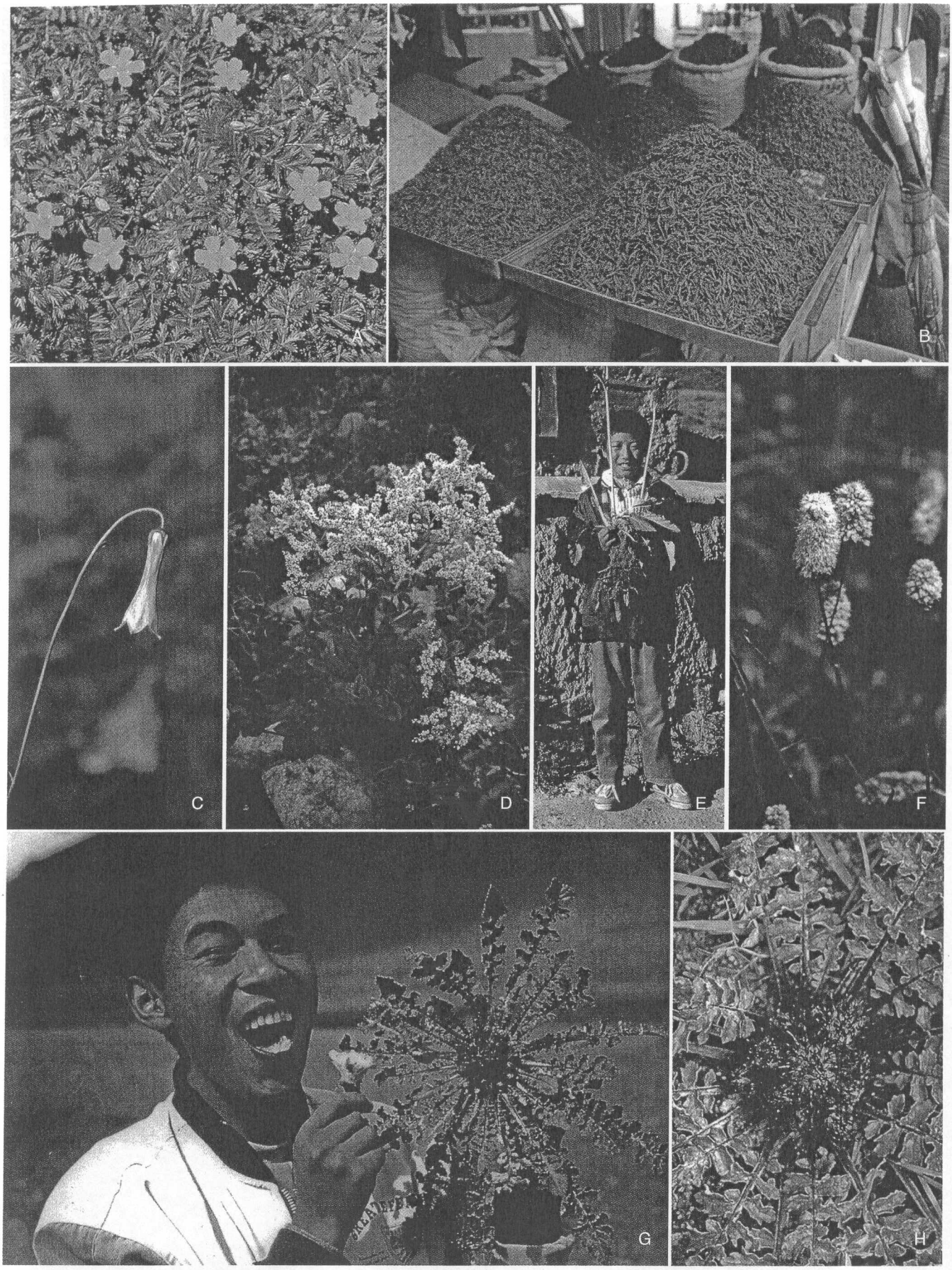

Plate 5.22. Some Tibetan plants with edible underground organs. A. *Potentilla anserina* subsp. *anserina* or *toma*: habit – B. Idem, tubers sale in town – C. *Codonopsis convolvulacea* – D. *Polygonum polystachyon* – E. *Bistorta macrophylla*: habit – F. *Bistorta macrophylla*: inflorescence – G. *Jurinaea dolomiaea*: edible receptacle – H. *Jurinaea dolomiaea*: flowering phenophase.