Zeitschrift: Veröffentlichungen des Geobotanischen Institutes der Eidg. Tech. Hochschule, Stiftung Rübel, in Zürich

Herausgeber: Geobotanisches Institut, Stiftung Rübel (Zürich)

Band: 77 (1981)

Artikel: A comparative study of the flora and vegetation of Tibet (China) and the Carolinas (U.S.A.)

Autor: Li, Wenhua / Xie Ying, Zhao

DOI: https://doi.org/10.5169/seals-308669

A comparative study of the flora and vegetation of Tibet (China) and the Carolinas (U.S.A.)

by

LI Wenhua and ZHAO Xie Ying

Contents

1. Introduction

It has been stated by LIETH (1979) that the climate of the Carolinas belongs to the moist, warm temperate type which is found in the northern hemisphere

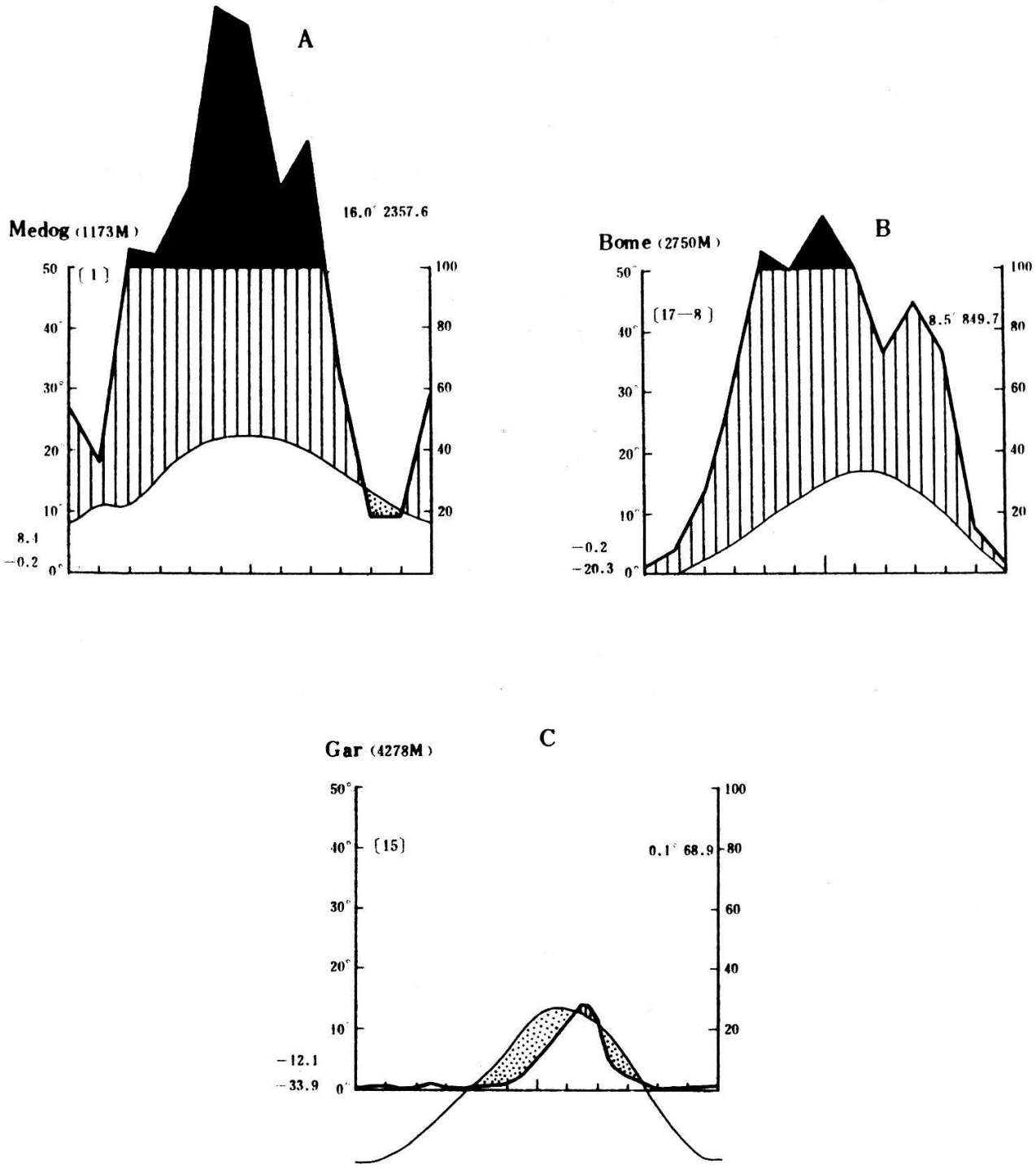

Fig. 1. The climate diagrams of different climatic types of Tibet.
A. Moist region. B. Humid region. C. Arid region.

going eastward in isolated spots in Portugal, Spain, France, Italy, the Balkan peninsula, South of the Caucasus, on the south slopes of the Himalaya range, in middle and northern China, Korea and Japan.

Following an invitation of Prof. Lieth, we are herewith presenting a comparison of the flora and vegetation in Tibet and the Carolinas. These two regions, far apart from one another, have more or less similar climatic conditions.

2. The physiogeographical conditions of Tibet compared with those of the Carolinas

Tibet (Xizang autonomous region) is situated in the southwestern part of China, extending from $78^{o}25'$ to $99^{o}05'$ E. and $26^{o}50'$ to $36^{o}30'$ N. with an area of 1.2 million km^2.

The drastic folding of the Tibetan plateau started in the pliocene and has continued until today. The lifting of the Tibetan plateau and the Himalaya systems originated from the collision of the Indian plate with Eurasia and has had a great influence upon the environment of vast regions.

Tibet is the highest plateau of the world with an average altitude of 4000 m a.s.l. The topography is by no means even. In general the relief is more or less smooth and rolling in northwestern Tibet and the altitude is higher than that in southeastern Tibet. The southeastern part is dissected considerably by deep valleys. There is a large number of mountain ranges, namely, the Himalaya in the south, Kunlun mountain in the north, Korakorum in the west and the Hengduan mountain in the east. Due to the fact that temperature decreases with increasing altitude from the low river valleys to the high mountains, one can see entire series of altitudinal belts from tropical, temperate to alpine-nival vegetation. This diversification can sometimes be observed distinctly within a relatively small area and it provides excellent conditions for ecological studies.

Precipitation in Tibet is influenced by the monsoon, coming chiefly from the Indian Ocean. The lofty Himalayan peaks block the moist air currents. As a result, the southern slopes of the Himalayas and the lower part of the Heng-

duan mountains have abundant rainfall. Precipitation steadily decreases from more than 2000 mm in Yalutsangpo Gorge to less than 50 mm in Alee in the western part of the plateau. This variation in precipitation results in diversity of vegetation types including humid forest, semihumid alpine scrub, semiarid steppe and arid alpine desert.

Figure 1 shows the climate diagrams of different climatic regions in Tibet. The Carolinas lie between 32°N. and 37°N. latitude. The southern boundary of the Carolinas is northward as compared to Tibet. The main outline of the physiography of the Carolinas developed over 200 million years ago. At present three physiographic regions are distinguished, the Blue Ridge mountains to the west, the gently rolling Piedmont in the center and the almost flat coastal plain in the east (ROBINSON 1979). Although the differences in elevation from near sea level on the coastal plain to more than 2000 m at the peaks of the mountains provide climatic analogues from subtropical climate to boreal, it cannot be compared to the topography diversity of Tibet.

In the Carolinas the temperature decreases from east to west. The annual range of the mean daily values is about 17°C throughout the state. In general, rainfall is over 1220 mm annually and there is no dry season, while in Tibet the annual rainfall varies very strongly in space and marked dry seasons are the rule. The differences and similarities of the hydrothermal conditions can help to explain differences in the survival and development of flora and vegetation in Tibet and the Carolinas.

3. A corresponding taxa of the flora in Tibet and the Carolinas

Before exploration by Chinese scientists little information was available on the flora and vegetation of Tibet. In the imagination of many persons resident in other places of the world, Tibet is a rugged highland, floristically depauperate with poorly developed vegetation types. Tibet, however, has especially in its southeastern part, a rather rich flora and it is not so impoverished as generally assumed and recorded in some literature.

According to the joint efforts of Chinese taxonomists, 208 families, 1258

genera and 5776 species of vascular plants (native or introduced) have been identified so far (Table 1). In order of richness of species, Tibet ranks fifth place by provinces in China (WU Cheng-Yi et al. 1980).

Table 1. Vascular flora of Tibet (China)*

Order	Families	Genera	Species
Pteridophytes	44	113	470
Gymnosperms	7	16	50
Angiosperms	157	1129	5246
Total	208	1258	5766

* Cited from the Editorial board of an enumeration of the vascular plants of Xizang (Tibet): An enumeration of the vascular plants of Xizang (Tibet) (1980).

Tibet is particularly rich in gymnosperms. There are 50 species belonging to 16 genera and 7 families. Among them *Pinus griffithii, P. densata, Picea spinulosa, P. Likiangensis, Abies spectabilis, A. Georgei, Larix potaninii, L. himalaica, Sabina* spp. are dominant in the subalpine and temperate belts. In the subtropical belt a number of rare conifers (e.g. *Amentotaxus, Cephalotaxus, Podocarpus, Taxus*) are mixed in the forests dominated by broadleaved species.

The southeastern part of Tibet is particularly rich in angiosperms. One can see representatives of almost all the different groups of the northern hemisphere plants. Tibetan flora is dominated by north temperate elements. In order of numbers of species the following families dominate: *Asteraceae, Poaceae, Ericaceae, Rosaceae, Fabaceae, Ranunculaceae, Scrophulariaceae, Orchidaceae, Primulaceae, Brassicaceae, Cyperaceae, Gentianaceae* and *Saxifragaceae.*

Apart from temperate families some tropical and subtropical elements are observed from *Lauraceae, Magnoliaceae, Fagaceae, Araliaceae, Dipterocarpaceae, Annonaceae, Myristicaceae, Flacourticaceae, Melatostomaceae, Combretaceae, Guttiferae* etc.

The flora of Tibet is characterized by the contradictory feature of scarcity

of endemic genera (four genera) yet high specific endemism (955 endemic species, ∿ 16.5%). The Tibetan flora is a new flora developed through migration of plants from surrounding regions (especially from Hengduan mountain) and differentiated during the process of the continuous lifting of the plateau and repeated glaciation during the pleistocene.

Comparing the flora of Tibet and the Carolinas, one finds that the Tibetan flora is much more complex both in number of species and in diversity of ecological conditions. This may be due to the following:

1. Tibet is situated at the intersection of three floristic subkingdoms: Holarctic, Indo-Malaysian and E. Asian.

2. The high diversity of the topographical and climatic conditions in Tibet provides numerous habitats for the survival and development of plants with different ecological characteristics.

3. The rising of the plateau and the interplay of glacial and interglacial periods during pleistocene have accelerated the migration and evolution of species.

4. The area of Tibet is four times as large as that of the Carolinas.

It is especially interesting to examine the similarities and relationships between the floras of these two widely separated regions with only slightly similar physiogeographical conditions.

According to a preliminary analysis, 135 families (∿ 62% of the Tibetan families), 395 genera and 154 species are found in both regions (Tables 2, 3). The close affinity between the flora of Asia and North America is very evident.

Several tropical and subtropical genera occur in both regions. As representatives among them we might mention *Cassia, Commelina, Melia* and *Litsea.*

Numerous genera of temperate mesic forests (25% of the Tibetan genera) occur in common. Included are such Arcto-tertiary elements as *Schisandra, Ulmus, Celtis, Pyrularia, Cornus, Astilbe, Acer, Panax* and *Tilia.*

Few native species in common (∿0.3% of the Tibetan species) are typical plants occurring under the canopy of forests or gaps in the forests. For example: *Lycopodium obscurum, Osmunda claytoniana, Pteridium aquilinum, Polygonum avi-*

Table 2. The common families, genera and species shared in Tibet and the Carolinas

Order	Families	Genera	Species
Pteridophytes	10	13	3
Gymnosperms	2	6	0
Angiosperms	123*	378**	151***
Total	135	397	154

* of which 116 native in both areas
** of which 271 native in both regions
*** of which 25 native in both regions

cularе, Caltha palustris, Aruncus dioicus, Oxalis acetosella, Circaea alpina etc. This may be connected to the process of the migration of whole communities and the environmental conditions which are more similar under canopies than in open habitats.

The rest of the common species are water or marsh plants.
It is indeed remarkable to see so many genera in common between Tibet and the Carolinas. It seems to us that, although Asia and North America are widely separated, the floras of both regions may be considered to have been derived from a common Tertiary flora which once covered much of eastern Asia and North America. As a consequence of the geographical and climatic changes which have occurred since the Oligocene, and especially during the Quaternary glaciations, the floras of the two regions have diverged, but they still retain remarkable similarities.

4. The vegetation of Tibet and the Carolinas

The natural vegetation of the Tibetan plateau is quite different from that of the Carolinas. According to COOPER (1979) eight major vegetation types can be distinguished in the mountain regions. Several additional vegetation types are recognized in the piedmont and the coastal plain regions of the Carolinas. While assignment of vegetation to community types is of necessity arbitrary,

Table 3. Corresponding taxa of the flora of Xizang (Tibet) and the Carolinas

Common families	Common genera	Common species
A. *PTERIDOPHYTA*		
1. *Lycopodiaceae*	*Lycopodium*	*L. obscurum*
2. *Selaginellaceae*	*Selaginella*	
3. *Osmundaceae*	*Osmunda*	*O. claytoniana*
4. *Hymenophyllaceae*	*Hymenophyllum, Trichomanes*	
5. *Pteridaceae*	*Pteridium, Pteris*	*Pteridium aquilinum*
6. *Athyriaceae*	*Cystopteris, Athyrium*	
7. *Aspleniaceae*		
8. *Woodsiaceae*	*Woodsia*	
9. *Dryopteridaceae*	*Polystichum, Dryopteris*	
10. *Polypodiaceae*	*Polypodium*	
B. *GYMNOSPERMAE*		
11. *Pinaceae*	*Abies, Tsuga, Picea, Pinus*	
12. *Cupressaceae*	*Juniperus*	
C. *ANGIOSPERMAE*		
13. *Saururaceae*		
14. *Salicaceae*	*Populus, Salix*	
15. *Myricaceae*	*Myrica*	
16. *Juglandaceae*	*Juglans*	
17. *Betulaceae*	*Corylus, Carpinus, Alnus, Betula*	
18. *Fagaceae*	*Castanea, Quercus*	
19. *Ulmaceae*	*Ulmus, Celtis*	
20. *Moraceae*	*Morus*	
21. *Urticaceae*	*Urtica, Laportea, Pilea, Boehmeria, Parietaria*	
22. *Santalaceae*	*Pyrularia*	
23. *Loranthaceae*		
24. *Aristolochiaceae*	*Asarum, Aristolochia*	
25. *Polygonaceae*	*Rumex, Polygonum*	*Polygonum hydropiper, P. lapathifolium*
26. *Chenopodiaceae*	*Atriplex, Chenopodium, Suaeda, Salsola*	
27. *Amaranthaceae*	*Amaranthus*	
28. *Nyctaginaceae*		
29. *Phytolaceae*	*Phytolacca*	
30. *Portulaceae*	*Portulaca*	
31. *Caryophyllaceae*	*Sagina, Cerastium, Arenaria, Stellaria, Dianthus, Silene*	
32. *Nymphaeaceae*	*Nymphaea*	
33. *Ceratophyllaceae*	*Ceratophyllum*	*C. demersum*

Table 3 (continued)

Common families	Common genera	Common species
34. *Ranunculaceae*	*Caltha, Cimicifuga, Actaeae, Aconitum, Delphinium, Aquilegia, Thalictrum, Anemone, Clematis, Ranunculus*	*Caltha palustris*
35. *Lardizabalaceae*		
36. *Berberidaceae*	*Caulophyllum, Berberis*	
37. *Menispermaceae*	*Cocculus*	
38. *Magnoliaceae*	*Magnolia, Schisandra*	
39. *Annonaceae*		
40. *Lauraceae*	*Litsea, Lindera*	
41. *Papaveraceae*	*Corydalis*	
42. *Cruciferae-Brassicaceae*	*Conringia, Lepidium, Draba, Cardamine, Arabis, Rorippa, Erysium, Sisymbrium, Descurainia*	*Rorippa islandica*
43. *Droseraceae*	*Drosera*	
44. *Crassulaceae*	*Sedum*	
45. *Hamamelidaceae*		
46. *Saxifragaceae*	*Tiarella, Chrysosplenium, Saxifraga, Astilbe, Parnassia, Hydrangea, Philadelphus, Itea, Ribes*	
47. *Rosaceae*	*Spiraea, Aruncus, Sorbus, Pyrus, Malus, Rubus, Geum, Fragaria, Potentilla, Rosa, Agrimonia, Sanguisorba, Prunus*	*Aruncus dioicus*
48. *Leguminosae-Fabaceae*	*Cassia, Thermopsis, Lupinus, Crotalaria, Rhynchosia, Erynthrina, Apios, Phaseolus, Vicia, Lathyrus, Indigofera, Astragalus, Desmodium, Lespedeza*	
49. *Oxalidaceae*	*Oxalis*	*O. acetosella*
50. *Geraniaceae*	*Geranium*	
51. *Linaceae*	*Linum*	
52. *Zygophyllaceae*		
53. *Rutaceae*	*Zanthoxylum*	
54. *Polygalaceae*		
55. *Euphorbiaceae*	*Phyllanthus, Euphorbia*	
56. *Callitrichaceae*		
57. *Buxaceae*		
58. *Anacardiaceae*	*Rhus*	

Table 3 (continued)

Common families	Common genera	Common species
59. *Aquifoliaceae*	*Ilex*	
60. *Celastraceae*	*Euonymus, Celastrus*	
61. *Staphyleaceae*		
62. *Aceraceae*	*Acer*	
63. *Sapindaceae*		
64. *Balsaminaceae*	*Impatiens*	
65. *Rhamnaceae*	*Sageretia, Rhamnus, Berchemia*	
66. *Vitaceae*	*Vitis, Ampelopsis, Parthenocissus*	
67. *Tiliaceae*	*Tilia*	
68. *Theaceae*		
69. *Hypericaceae*	*Hypericum*	
70. *Violaceae*	*Viola*	
71. *Passifloraceae*	*Passiflora*	
72. *Thymelaeaceae*		
73. *Elaeagnaceae*		
74. *Lythraceae*		
75. *Melastomataceae*		
76. *Onagraceae*	*Epilobium, Circaea*	*C. alpina*
77. *Haloragaceae*	*Myriophyllum*	
78. *Araliaceae*	*Aralia, Panax*	
79. *Umbelliferae - Apiaceae*	*Hydrocotyle, Centella, Sanicula, Chaerophyllum, Osmorhiza, Ligusticum, Angelica, Heracleum*	*Centella asiatica,*
80. *Cornaceae*	*Cornus*	
81. *Diapensiaceae*		
82. *Ericaceae*	*Rhododendron, Leucothoe, Pieris, Lyonia, Gaultheria, Vaccinium*	
83. *Primulaceae*	*Lysimachia*	
84. *Plumbaginaceae*	*Limonium*	
85. *Sapotaceae*		
86. *Ebenaceae*	*Diospyros*	
87. *Symplocaceae*	*Symplocos*	
88. *Styracaceae*	*Styrax*	
89. *Oleaceae*	*Fraxinus, Osmanthus*	
90. *Loganiaceae*		
91. *Gentianaceae*	*Gentiana, Swertia*	
92. *Apocynaceae*	*Trachelospermum*	
93. *Asclepiadaceae*		
94. *Convolvulaceae*	*Convolvulus, Impomoea, Cuscuta*	
95. *Boraginaceae*	*Cynoglossum*	
96. *Verbenaceae*	*Verbena, Callicarpa,*	
97. *Labiatae-Lamiaceae*	*Teucrium, Scutellaria, Lamium, Stachys, Salvia, Melissa*	

Table 3 (continued)

Common families	Common genera	Common species
98. *Solanaceae*	*Solanum*	
99. *Scrophulaciaceae*	*Lindernia, Limosella, Linaria, Veronica, Pedicularis*	*Veronica anagallis-aquatica*
100. *Bignoniaceae*	*Catalpa*	
101. *Orobanchaceae*	*Orobanche*	
102. *Lentibulariaceae*	*Pinguicula, Utricularia*	
103. *Acanthaceae*		
104. *Plantaginaceae*	*Plantago*	
105. *Rubiaceae*	*Galium*	
106. *Caprifoliaceae*	*Sambucus, Triosteum, Viburnum, Lonicera*	
107. *Valerianaceae*	*Valeriana*	
108. *Dipsacaceae*		
109. *Cucurbitaceae*	*Cucurbita*	
110. *Campanulaceae*	*Campanula, Lobelia*	
111. *Compositae-Asteraceae*	*Vernonia, Eupatorium, Aster, Erigeron, Gnaphalium, Xanthium, Helianthus, Spilanthes, Bidens, Artemisia, Cacalia, Senecio, Carduus, Lactuca,*	*Bidens cernua,*
112. *Typhaceae*	*Typha*	*T. latifolia*
113. *Sparganiaceae*	*Sparganium*	
114. *Potamogetonaceae*	*Potamogeton, Zannichellia*	*P. natans, P. pectinatus, P. perfoliatus, Z. palustris*
115. *Juncaginaceae*	*Triglochin*	
116. *Hydrocharitaceae*		
117. *Gramineae-Poaceae*	*Phragmites, Eragrostis, Sporobolus, Muhlenbergia, Aristida, Festuca, Poa, Briza, Bromus, Melica, Elymus, Hordeum, Trisetum, Deschampsia, Danthonia, Calamagrostis, Agrostis, Alopecurus, Milium, Stipa, Panicum, Sacciolepis, Echinochloa, Digitaria, Setaria, Erianthus, Andropogon, Heteropogon*	*Trisetum spicatum, Deschampsia caespitosa, Milium effusum*
118. *Cyperaceae*	*Scirpus, Eleocharis, Fimbristylis, Bulbostylis, Cladium, Cyperus, Scleria, Carex*	*Fimbristylis dichotoma*
119. *Araceae*	*Acorus, Arisaema*	*Acorus calamus*

Table 3 (continued)

Common families	Common genera	Common species
120. Lemnaceae	*Lemna, Wolffia*	
121. Eriocaulaceae		
122. Commelinaceae	*Commelina*	*C. diffusa*
123. Juncaceae	*Luzula, Juncus*	*J. bufonius, J. effusus*
124. Liliaceae	*Tofieldia, Lilium, Allium, Clintonia, Smilacina, Disporum, Streptopus, Polygonatum, Trillium, Aletris, Smilax*	
125. Dioscoreaceae	*Dioscorea*	
126. Iridaceae	*Iris*	
127. Marantaceae		
128. Orchidaceae	*Cypripedium, Spiranthes, Orchis, Habenaria, Pogonia, Listera, Goodyera, Malaxis, Liparis*	*Goodyera repens*

Main sources for comparison: RADFORD et al. (1978) and Editorial board of an enumeration of the vascular plants of Xizang (Tibet) (1980).

COOPER's classification is indicative of the low physiognomic diversity.

In Tibet the spatial pattern of distribution of natural vegetation is more complex with the integrated influence of physiogeographical and biological factors producing a great diversity of vegetation types. From southeast towards northwest the landscape gradually changes from humid forest through semihumid scrubs, semiarid steppes to alpine desert (LI WENHUA 1979). In the southeastern part of Tibet, especially in the southern slopes of the Himalayas and in the lower part of Hengduan mountains, vast forests have developed and the vertical belts of vegetation are clearly marked (Fig. 2).

In the lowest belt of the Himalayas (below 1000 m a.s.l.), where the mean annual temperature is more than 22°C (warm index more than 210), tropical evergreen and semievergreen forests have developed. The physiognomy of these forests is complicated and several strata can be distinguished. Dominant families include *Dipterocarpaceae, Myristicaceae, Annonaceae, Flacourticaceae* and *Hypericaceae*. Some of the above families show very peculiar crown shapes

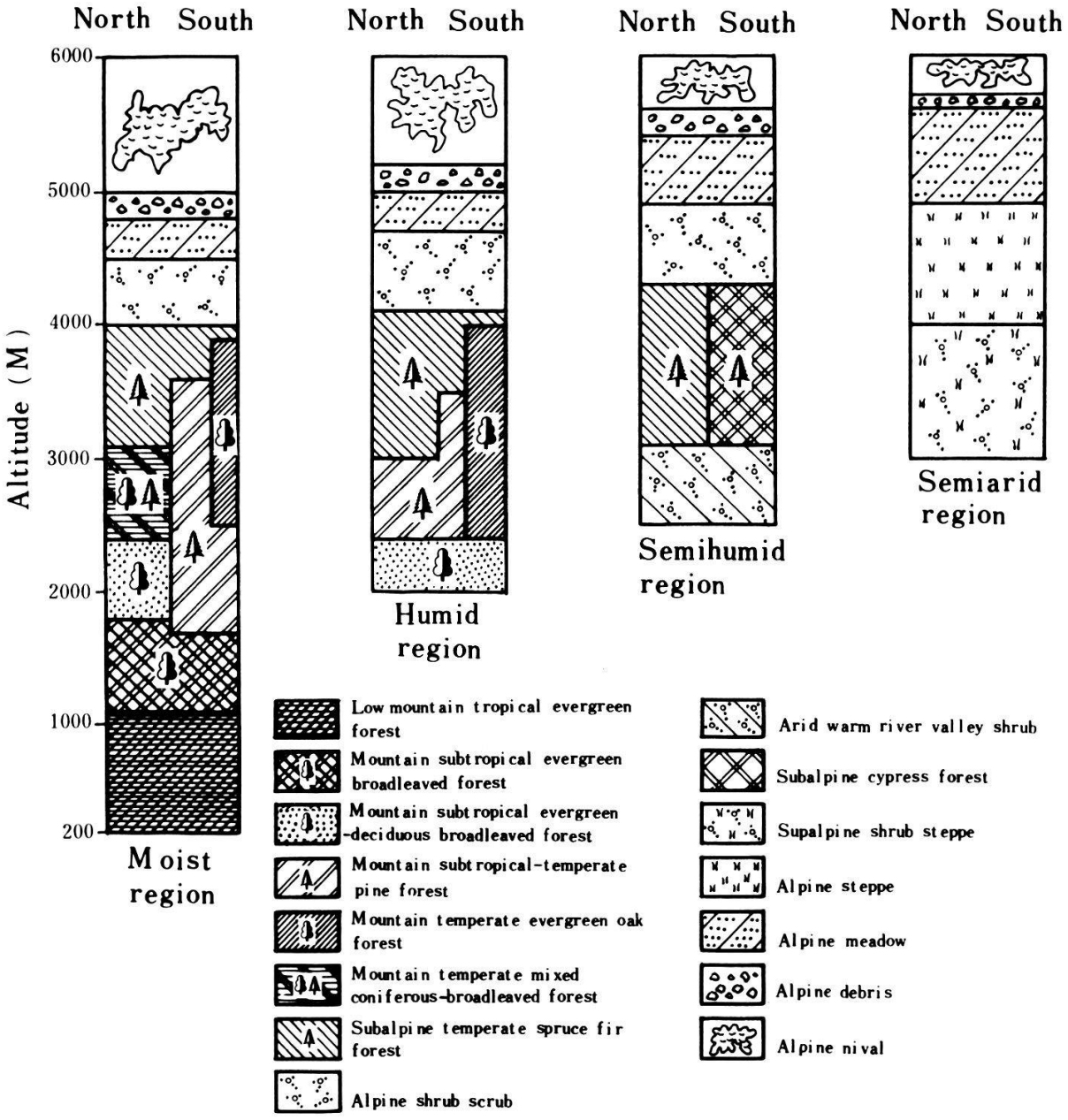

Fig. 2*. The patterns of vertical belts of forest vegetation in Xizang (Tibet).
*Modified from LI Wenhua and HANG Yiifeng (1977).

and conspicuous branching such as numerous, thin subhorizontally radiating branches. The epiphytes and parasites are especially well represented in these forests. The major families are *Orchidaceae, Loranthaceae, Balanophoraceae, Araceae* and *Euphorbiaceae*. To these must be added epiphytic ferns and mosses of different families. In seasonal dry forests epiphytic ferns, mosses and lichens play a much more restricted role. Some areas have been disturbed by lumbering and fire. In such areas *Ficus, Mallotus, Altingia excelsa* and different species of *Bambusa* form dense secondary stands. Along the rivers mixed broadleaved forests consisting of *Callicarpa, Ostodes paniculata, Macaranga denticulata* etc. are represented.

In the mountain subtropical belt (1000-1800 m a.s.l.) the mean annual temperature is about 15-20°C, annual sum of temperature ≥10° is 4200-6500°C, the warm index 110-170. The mean temperature of coldest month is more than 7°C. In this belt the subtropical evergreen forest is dominated mainly by *Fagaceae* and *Lauraceae*. Stands of Pine (*Pinus griffithii*) occur in sunny slopes. In the mixed evergreen deciduous forests (1800-2400 m a.s.l.), the climatic conditions are as follows: Mean annual temperature 11°C, annual sum of temperature ≥ 10°C is 3000°C, warm index 77, mean temperature of the coldest month is 3°C. The composition and the structure of the communities are simplier than in the subtropical forests. These forests are dominated by species of *Lauraceae, Fagaceae, Magnoliaceae* and *Araliaceae* with evergreen and deciduous elements. Deciduous species such like *Toona sinensis, Tetracentron sinense* are permanent associates of these forests. On the flood plains there are narrow belts of *Alnus nepalensis* and *Populus* forests. On the slopes where the forests have been disturbed by human activities, birch forests have developed.

At 2400-3100 m a.s.l. there is a mixed coniferous and broadleaved forest belt. The annual temperature is 8-11°C, ≥10°C sum temperature 1900-3000°C, coldest month temperature 8-11°C, warm index 48-77. *Tsuga dumosa* forest occurs on north facing slopes, while on the sunny slopes the pine forests and sclerophyllous *Quercus* forests (*Q. aquifolioides* and *Q. semicarpifolia*) have developed. From 3000 to 4000 m a.s.l. subalpine coniferous forest is widely distributed. The upper limit of this belt coincides with the upper limit of forests where the mean annual temperature is about 2°C, ≥10°C sum temperature about 500°C, warm index 13. The mean temperature of the coldest month is

-8°C. The mean temperature of the warmest month is about 10-12°C. The most typical forests consist of *Abies* and *Picea*. Timberline occurs around 4300 to 4500 m a.s.l. The mean annual temperature is about 0°C, ≥10°C sum of temperature near 0°C and the warm index about 6. The mean temperatures of the warmest month is 8°C. Here open stunted forests of *Betula utilis*, *Sabina* spp. and *Rhododendron* are developed.

Above the tree line up to 5000 m a.s.l. one finds alpine scrub and alpine meadow. Alpine scrub consists of a large number of *Rhododendron*, *Salix*, *Spiraea*, *Cotoneaster*, *Leptodermis*, *Berberis*, *Lonicera*, *Sibiraea*, *Potentilla fruticosa* etc. Alpine meadows occur mainly at 4000-4800 m a.s.l. and are characterized by different kinds of *Kobresia*, *Ranunculus*, *Potentilla* etc. Below the snowline and above the upper limit of the closed plant communities there are usually rock banks formed by the constant braking off of the rock from the summit and ridge. On these banks we found more than 100 kinds of plants. The climate is severe. The coverage of the vegetation is below 5% (LI BOSHING 1980). Above snow line no higher plants can survive, but several kinds of algae exist on the surface of the ice.

As one moves from the humid to subhumid and arid lands, the range of the altitudinal belts becomes shorter and the combination of the belts becomes simpler. Semi-arid alpine steppe of Tibet occurs in the northern part of Tibet at about 4500-5000 m a.s.l. The annual mean temperature is 3 to -5°C. The duration of the frost free period is only about 10-100 days. The annual rainfall varies from 200-350 mm. The dominant species are *Stipa subsessiliflora* var. *basiplumosa*, *S. purpurea*, *Artemisia wellbyi*, *A. stracheyi*, *Carex moorcroftii* etc.

Alpine desert lies in western and northwestern Tibet. This is the highest desert of Asia. It is characterized by the extreme type of climate. The mean annual temperature is lower than 0°C and only in July it has a positive temperature of 12°C. The rainfall varies from 50 to 100 mm. The flora is poor, consisting of central Asian and Mediterranean elements. The most important species are:*Ceratoides compacta*, *Ajania fruticulosa*, *Christolea crassifolia* etc. The coverage of vegetation seldom exceeds 5%.

In spite of great differences in the vegetation of Tibet and the Carolinas there are still several similarities between these two regions, particularly in the humid mountain region. Both regions have a *Picea abies* forest zone as the highest elevation forest vegetation. Under this zone there is a broadleaf zone consisting of oak and other species. The pine forests have developed mainly on dry sunny slopes with different species in Tibet and the Carolinas. It is interesting to note that the distribution of the same type of vegetation is situated at higher altitudes in Tibet than in the Carolinas. Sometimes this difference reaches 1000 m and more; e.g. the lower limit of spruce-fir forests is about 3000 m a.s.l. in Tibet, while in the Carolinas it is best developed at 2000 m a.s.l.

Summary

1. Tibet and the Carolinas are situated at nearly the same latitude. The physiographical conditions of these two regions are different in many aspects. There are slight similarities in topography and climate.
2. The flora and vegetation of Tibet is richer and more diverse when compared to the Carolinas. This is mainly due to special topographical and hydrothermal conditions as well as to the different geological history of these two regions, as well as the much greater land area of Tibet.
3. The Tibetan flora contains 5766 known native and introduced species in 1258 genera from 208 families. Of these 28 species (∿0.4%), 290 genera (∿ 23%) and 128 families (∿62%) are also native in Tibet and the Carolinas.
4. It is interesting to emphasize the great number of common families and genera of these two widely separated regions. This shows the common history of flora and vegetation in Asia and North America. On the species level the similarity is very low with ∿ 0.4% of the Tibetan species common to both floras against ∿ 16.5% endemic Tibetan species.

Zusammenfassung

1. Tibet und Nord- und Südkarolina liegen ungefähr auf gleicher geographischer Breite. Die physiographischen Verhältnisse sind dagegen in mancher Hinsicht verschieden. In der Topographie und im Klima sind Aehnlichkeiten vorhanden.
2. Die Flora und Vegetation von Tibet sind reichhaltiger und verschiedenartiger als jene in den Carolinas. Das ist vor allem auf die topographischen und auf die hydrothermalen Bedingungen und auf die verschiedene geologische Geschichte der beiden Gegenden, sowie auf die viel grössere Landfläche von Tibet zurückzuführen.

3. Die Flora von Tibet enthält 5766 bekannte einheimische und eingeschleppte Arten, die 1258 Gattungen und 208 Familien angehören. Von diesen sind 28 Arten (∿ 0.4%), 290 Gattungen (∿ 23%) und 128 Familien (∿ 62%) sowohl in Tibet als in den Carolinas einheimisch.

4. Es ist interessant auf die grosse Zahl gemeinsamer Familien und Gattungen dieser beiden so weit auseinanderliegenden Gegenden hinzuweisen. Diese zeigt die gemeinsame Floren- und Vegetationsgeschichte von Asien und Nordamerika. Auf der Stufe der Art ist die Aehnlichkeit recht gering. Die gemeinsamen Arten betragen ∿ 0.4% der tibetischen Arten gegenüber ∿ 16.5% endemischer Arten in Tibet.

References

COOPER A.W., 1979: The natural vegetation of North Carolina. Veröff.Geobot. Inst.ETH, Stiftung Rübel, *68*, 70-78.

Editorial board of an enumeration of the vascular plants of Xizang (Tibet), 1980: An enumeration of the vascular plants of Xizang (Tibet). Commission of Science and Technology of Xizang Autonomy Region, Beijing. 1-463.

Editorial board of the vegetation of China, 1980: Vegetation of China. Science Press of China, Beijing. 82-114.

LI Boshing, 1980: A primary study of the subnival vegetation of Xizang. Proceeding of Symposium on Qinghai-Xizang (Tibet) plateau. (Abstracts). Organizing Committee Symposium on Qinghai-Xizang (Tibet) Plateau Academia Sinica. 284 pp.

LI Wenhua, 1979: The vegetation in Tibet of China and its economic significance. In: Arid land plant resources, Texas, U.S.A. 650-654.

- and HANG Yiifeng, 1977: Forest of Tibet. Natural resources. Tome 2. Science Press of China. 10-28.

LIETH H., 1979: Introduction to the report volumes of the 16th IPE. Veröff. Geobot.Inst. ETH, Stiftung Rübel, *68*, 25-50.

RADFORD A.E., AHLES H.E. and BELL C.R., 1978: Manual of the vascular flora of the Carolinas. The Univ. of North Carolina Press, Chapel Hill. 1183 pp.

ROBINSON P.J., 1979: The climate of North Carolina. Veröff.Geobot.Inst.ETH, Stiftung Rübel, *68*, 51-60.

WU Chengyi et al., 1980: Dissertation upon the origin, development and regionalization of Xizang (Tibet). Flora through the floristic analysis. Abstract paper for the International Symposium on Qinghai-Xizang (Tibet) Plateau.

Address of the authors: LI Wenhua
ZHAO Xieying
Commission for Integrated Survey of
Natural Resources,
Academia Sinica,
P.O. Box 767
Beijing, People's Republic of China