The Characteristics of Biodiversity in the Grand Canyon of the Yarlung Zangbo River in the Eastern Himalayas

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Physical Geography of the Grand Canyon

The Unique Heat-island Effect

The Qinghai-Tibetan Plateau, with an average elevation of 4,500m, is topographically the highest relief feature in China, and the highest and largest in the world. It averages 4,000m in elevation in the south-east, and by a gradual ascent rises to 5,000m in the north-west. The surface of the plateau's main body is chiefly made up of low mountains, undulating terrain, and broad basins. On the edges of the plateau, high mountain ranges constitute its geomorphologic skeleton.

The Qinghai-Tibetan Plateau, a landmass as large as 2.5 million sq.km and towering from the earth's surface up into the troposphere, has a strong impact on atmospheric circulation that originates from the heat exchange between continents and oceans. This effect includes mainly the mechanical force exerted by the landmass on the atmosphere, the frictional effect of the land at the boundary layer on air movement, and the heating up of the landmass in response to the absorption of solar radiation.

Based on research on the climate of the Qinghai-Tibetan Plateau, Chinese meteorologists have confirmed that in winter the effect of the plateau on atmospheric circulation is mainly due to mechanical forces; in addition it exerts its effect on atmospheric circulation by virtue of heating. In spring and summer, especially in June, the Qinghai-Tibetan Plateau is a huge heat source. An area of one square centimetre may emanate 880 J/cm^2 day equivalent of heat energy. The plateau, can transfer to the atmosphere 4.60×10^{18} J/day, averaged over a year. In June, the plateau puts out as much as 2.095×10^{19} J/day.

Under such circumstances, in spring and summer, the plateau land surface directly heats the lower atmosphere, significantly modifying the temperature and humidity. At below 500 mb, a strong low atmospheric pressure cell is formed. The heated, ascending air leads to an upper-level, strong and stable, high-atmospheric-pressure region in the troposphere above 430 mb, reaching the strongest effect at 150-200 mb. This has triggered the formation of the unique warm high-pressure phenomenon over the Qinghai-Tibetan Plateau.

The Qinghai-Tibetan high-atmospheric-pressure region occupies the upper level of the troposphere over a vast subtropical area of Asia and Africa. It influences not only the atmospheric circulation of the Northern Hemisphere, but also that of the Southern Hemisphere. Along with the pronounced seasonal changes in temperature, the air pressure also demonstrates a remarkable seasonal contrast. The more significant variations are related to the wind direction. In summer, the surrounding wind converges towards the plateau. In winter, it diverges from the

"the wind can go through the narrow passages composed of numerous valleys cut deep by running water on the south edge of the plateau"

plateau towards its periphery. Thus, a unique seasonal monsoon wind pattern of the plateau is established. The special heat-island effect of the plateau exerts a tremendous influence on its climate.

The Qinghai-Tibetan Plateau monsoon reinforces the monsoon phenomenon between southern and northern hemispheres, resulting in more vigorous exchanges of air, water, momentum, and energy. Most importantly, it induces and thickens the south-west monsoon in the lower troposphere. As confirmed by the simulation studies of Habn and Manabe (see Habn and Manabe 1925), without the plateau the centre of the continental low pressure would be located around 45° N and 125°E. Thus in July the mean south-west monsoon cannot go beyond 15° N in South Asia. With the plateau monsoon, the wind can go through the narrow passages composed of numerous valleys cut deep by running water on the south edge of the plateau, and move further northwards into the plateau core. Influenced by the varied landforms, the south-west monsoon regularly releases the water and heat that it brings while moving northwards into the plateau. Overall, it affects the distribution pattern of the ecosystems of the Qinghai-Tibetan Plateau region.

"this passage supplies the largest amount of moisture to the plateau"

The Moisture Passage and Climatic Diversity

The Yarlung Zangbo River flows eastwards through the Qinghai-Tibetan Plateau until it reaches Mailing County. There it turns north-eastwards, cuts in a zigzag through the east tip of the Himalayas, then a sharp curve brings the river southward into the Ganges Plain, and the Grand Canyon with a cutting depth of 5,000m on average and several hundred kilometres long was formed around Namjagbarwa Peak. It is like a giant gap from north to south, cutting the south-east part of the Plateau. The warm, wet air currents from the Indian Ocean can enter the inner part of the plateau along this gap, which is a decisive factor affecting the climate.

"the largest moisture transportation to the Qinghai-Tibetan Plateau"

The meteorological significance of the moisture passage on the Grand Canyon of the Yarlung Zangbo River is due to (1) the effects of the warm, humid air from the Indian Ocean flowing along the Bramaputra River upstream and then the lower reaches of the Yarlung Zangbo River, which reaches the inner part of the Qinghai-Tibetan Plateau and (2) the fact that this passage supplies the largest amount of moisture to the plateau out of all the moisture sources around the plateau.

Records show that the largest moisture transportation to the Qinghai-Tibetan Plateau, out of all those around the plateau, is the one along the Brahmaputra-Yarlung Zangbo River (500-1,000g $cm^{-1}s^{-1}$). This amount is close to the value of moisture transferring from the south side to the north side of the Changjlang River in summer. Other observatories around the plateau only recorded 100-400 $cm^{-1}s^{-1}$, 1-5 times less than that through the Yarlung Zangbo valleys.

"is the one along the Brahmaputra-Yarlung Zangbo River"

Obviously the lower reaches of the Yarlung Zangbo River are the most important moisture passage. The direction of the passage is along the Brahmaputra River to the north-east, then along the lower reaches of the

Yarlung Zangbo River to the north, finally turning north-west at the Great Bend Gorge climate with its large contrast in water and heat regimes. The plateau is marked for its varied climatic types. Although it falls in subtropical latitudes, its influence in augmenting the south-west monsoon and in impeding the cold air masses from the north have allowed the tropical monsoon climate in the Indian subcontinent to extend up to the south edge of the plateau to form a zonal climatic type. This type of climate may even extend to 29° 30' N along the Yarlung Zangbo River Valley.

The variations of the Grand Canyon climate not only reflect its diversified zonal climatic types, but also its numerous vertical changes due to a vast mountainous area on the edge of the plateau with tall snow-capped mountains on the broad and flat plateau surface. The mountains in different climatic zones have distinct vertical climatic zones. For example, the southern slopes of the eastern Himalayas on the south-east edge of the plateau have the most complete vertical climatic spectrum amongst mountains in humid areas of the world. It begins at the foot-slopes with humid tropical conditions and changes with elevation in a gradual gradient with reference to temperature and precipitation. With an increase in altitude the climate shifts to montane polar and high alpine polar.

Finally, it is necessary to point out that owing to the complexity of the plateau geomorphology, the climate is controlled by the unique air circulation pattern. Hence, the climate is highly changeable through time and rather unpredictable. If the south-west monsoon is relatively strong the moisture-heat assemblages along its water-vapour passages vary remarkably, and if an area is influenced by the monsoons, with an annual mean temperature ranging between 0.4 and 7°C, the position of the latitudinal zonal boundary will vary by about 100m up or down. Without doubt, such effects will have far-reaching consequences on ecosystem development and the rate of species differentiation.

As mentioned above, because of the moisture passage on the lower reaches of the Yarlung Zangbo River, places along the passage and those nearby have a very different distribution of heat and water from other places, and this difference has made a strong impact on the biological features there. This effect is closely related to the intensity of the moisture flow along the passage. The moisture flow decreases as it goes further north.

Biodiviersity of the Crand Canyon

A Rich Diversity of Ecosystems

Biodiversity refers to the diversity and variation of living things and the ecological complexity on which their existence depends. It includes genetic diversity, species' diversity, and ecosystem diversity (at three different levels of observation). Ecosystem diversity refers to the diversity of habitats for flora and fauna and ecological processes within ecosystems. As described in the above section, the diversified climates resulting from the plateau's unique geographical position, atmospheric circulation, and complex surface configuration have directly engendered a diversity of habitats for flora and fauna in this region. This diversity in the plateau's biotic successional history has brought equally complex ecosystem types and their constituent ecological processes.

The rain shadow effect of the eastern Himalayas and Mount Kangrigarbo in the middle part of the Grand Canyon of the Yarlung Zangbo River cause two important effects. Firstly, regional climatic differentiation is in a horizontal direction, the humid area is in the southern part and the semi-humid area is in the northern part. Secondly, towering mountains have water and heat conditions that change with elevation, thus vertical climatic differentiation occurs in the Grand

Canyon region: the annual mean temperature will rise or fall in accordance with elevation; rainfall increases with the rise in elevation from the foot to the peak of the mountain. Except for the foothills of the mountain range, generally the most abundant rainfall occurs at 2,400-3,200m above sea level in the southern part of the Namiagbarwa region, and in the northern part it occurs at 3,600-4,400m above sea level. Corresponding to the climatic changes, the vegetation of the mountain also presents obvious horizontal and vertical differentiation. The limits of the horizontal and vertical belts of the vegetation are closely related to important climatic factors such as the 1,000m line of annual rainfall, the limits of the snow mantle and frost in winter, cloud and fog limits in summer, and the permanent snow-belt.

"generally the most abundant rainfall occurs at 2,400-3,200m above sea level"

The vertical distribution of the mountain ecosystem

The Grand Canyon of the Yarlung Zangbo River is a mountainous area; each peak has its own particular vertical spectrum of the ecosystem, due to different geographic positions and elevations. We classified all vertical spectra into the following two types: (1) humid type, located in the southern part of the eastern Himalayas and Mount Kangrigarbo; and (2) semi-humid type, located in the northern part. It should be pointed out that a tongue-shaped humid area extends to the Baimagoxueng, Dongjug, Yiong, and Suotoug located in the northern part of the eastern Himalayan-Mount Kangrigarbo Range along the Yarlung Zangbo River Valley and is under the strong influence of the airflow from the Indian Ocean. In this area, there is a vertical spectrum of the humid type as in the southern part.

"the vegetation of the mountain also presents obvious horizontal and vertical differentiation"

(A) Standard vertical spectrum of the ecosystem for the humid mountains in the southern part

The standard vertical spectrum is composed of five vegetation belts.

"closely related to important climatic factors such as the 1,000m line of annual rainfall"

(1) Evergreen and semi-evergreen monsoon forest belt

The latitude of this area covered by evergreen and semi-evergreen monsoon forest is much higher than that of other rainforests in the world, so the rainforest in this area has been formed under special topographic conditions. Its ecological environment and the characteristics of the plant community are quite different from those of the equatorial and seasonal rainforests located between the Tropic of Capricorn and the Tropic of Cancer.

Evergreen monsoon forest ecosystem sub-belt

This sub-belt is situated to the north of 28° 30' N and the valley of the Yarlung Zangbo River and its tributaries below 900m above sea level. The climate is warm and moist, with a mean annual temperature of 22°-26°C and annual precipitation of over 3,000-5,000 mm. Eighty per cent of the annual rainfall occurs between May and October.

"there is a vertical spectrum of the humid type as in the southern part"

The vegetation is evergreen monsoon forest and the dominant species is the *Dipterocarpus turbinatus* family; it is an evergreen broad-leaf tree about

30- 40m tall. It forms part of the first tree layer in the forest, which has a discontinuous crown. The second tree layer of the community is generally composed of many semi-evergreen and deciduous broad-leaf trees such as *Canarium resiniferum*, *Shorea assamica*, *Terminalia myriocarpa*, *Mesua ferrea*, *Lagerstroemia minuticarpa*, *Mesua ferrea*, and *Toona ciliata*. The trees in this layer are shorter than the dominant ones. So the physiognomy of the rain forest is evergreen for the whole year.

Semi-evergreen monsoon forest ecosystem sub-belt

This sub-belt is situated to the south of 29°30' N on the slope of the valley of the Yarlung Zangbo River and its tributaries between 600 and 1,100m; it can rise above 1,400m in some places. The sub-belt reaches the limit of rainforest distribution. The mean annual temperature is 18-22°C and annual rainfall is 2,500-3,500 mm. There is severe drought in winter and spring, especially when the temperature rises rapidly in April and May.

Because of the above-mentioned climatic conditions, the evergreen monsoon forest ecosystem shows different characteristics from the semi-evergreen monsoon forest ecosystem. The first tree layer is mainly composed of semi-evergreen broad-leaf and deciduous broad-leaf trees which change their leaves at the end of the dry season. The dominant species are *Terminalia myriocarpa* and *Altingia excelsa* and other important plants of this layer include *Canarium resiniferum*, *Celtis tetrandra*, *Homalium zeyanicum*, *Lagerstroemia minuticarpa*, and *Toona ciliata*. However more than 80% of the tree species of the second tree layer are evergreen broad-leaf trees, including *Gynocardia odorata*, *Cinnamomum iners*, *Castanopsis indica*, and *Cleidion javanicum*. After the trees in the first layer have lost all their leaves during the dry season, the community shows a distinctive seasonal appearance of a mosaic, comprising the deep green tone of the crown of the second tree layer and brown tones of the bare branches of the first tree layer.

(2) Middle mountain evergreen and semi-evergreen broad-leaf forest ecosystem belt

This is a special belt in the middle and eastern Himalayan-Mount Kangrigarbo Range. The upper sub-belt of this belt is composed of semi-evergreen broad-leaf forest, which is endemic in the moist mountains. It differs greatly from the corresponding belt of the mountains in south China.

Middle mountain evergreen broad-leaf forest ecosystem sub-belt

This sub-belt is situated to the south of Gan dae (29°47'N), on the slope of the valley of the Yarlung Zangbo River and its tributaries — between 1,100 and 1,800m; in some places it can rise above 2,200m or drop down to 900m. The mean annual temperature is l5-18°C and annual rainfall is 2,000-2,700 mm. Sino-Himalayan elements are the main components of this forest, which is characterised by dominant species such as *Castanopsis cerataconth*a, *C. hystrix*, and *Quercus ladicosa* (oak tree). The forest is 25-40m tall, with an evergreen physiognomy the whole year round.

Middle mountain semi-evergreen broad-leaf forest ecosystem sub-belt

This sub-belt is situated in the valley of the Yarlung Zangbo River and its tributaries to the east of Baimagoxueng and to the south of Yiong between 1,500 and 2,400m, but it can rise above 2,600m in the northern part of the Mount Namjagbarwa Range. The mean annual temperature is 11-15°C. Because this sub-belt is just under the belt of the highest annual rainfall in these mountains, annual rainfall reaches 3,000 mm. The climax vegetation of the sub-belt is semi-evergreen broad-leaf forest composed of three communities: *Cyclobalanopsis lamellosa*, *C. xizangetsis*, and *Quercus tongmaiensis*. These forests exist only in the moist mountains of the "there are obviously different vegetation vertical spectra in the alpine scrub and meadow belt"

eastern Himalayas and its eastward range. During the end of the dry season, the trees of the first layer of this forest change their leaves and the physiognomy of the forest is exactly like the deciduous broad-leaf forest in autumn. The forest keeps its evergreen appearance in the other seasons.

(3) Sub-alpine evergreen coniferous forest ecosystem belt

The differences of the vertical vegetation spectra between the southern part and northern part of the Namjagbarwa Region are shown by the sub-alpine evergreen coniferous forest belt; in the southern part, the lower sub-belt is hemlock forest and in the northern part of the sub-belt is spruce forest.

Sub-alpine hemlock forest ecosystem sub-belt

"alpine evergreen scrub and herbaceous meadow"

This sub-belt is similar to the middle mountain semi-evergreen broad-leaf forest belt. The elevation is 2,400-2,800m, the mean annual temperature is 8-11°C, and annual rainfall is 3,000 mm. The climatic conditions of this sub-belt are suitable for the sub-alpine evergreen coniferous forest belt.

The climax plant community is hemlock forest, which is composed of the construction species *Tsuga dumosa*. This species is 40-70m tall and forms the first tree layer, which has a discontinuous crown. The second tree layer is mainly composed of deciduous broad-leaf trees. The surface of the soil in the forest is very moist and shady and branches and trunks are covered by thick mosses.

Sub-alpine fir forest ecosystem sub-belt

"alpine deciduous creeping willow scrub and *Kobresia* meadow"

This sub-belt occurs between elevations of 2,600 and 4,100m. The mean annual temperature is 2-8°C and annual rainfall is 2,000-3,000 mm. The climax plant community of fir forest is composed of the construction species *Abies delavayi* var. *mothoensis*, and *Abies delavayi* is the accompanying species of the first tree layer. The second tree layer of the forest is mainly composed of deciduous broad-leaf trees, but this layer is not well developed. Mosses grow luxuriantly in the forest.

(4) Alpine scrub and meadow ecosystem belt

There are obviously different vegetation vertical spectra in the alpine scrub and meadow belt between the southern part and northern part of the Haniagbarva Region. In the southern part, this belt is composed of the alpine evergreen scrub and herbaceous meadow sub-belt and the alpine deciduous creeping willow scrub and *Kobresia* meadow sub-belt. In the northern part, there is an alpine evergreen scrub and *Kobresia* meadow sub-belt,

Alpine evergreen scrub and herbaceous meadow ecosystem sub-belt

"evergreen broad-leaf scrub and herbaceous meadow"

This sub-belt appears between elevations of 3,800 and 4,300m, the mean annual temperature is –2-2°C, and the annual rainfall is 2,000-2,500 mm. The climax vegetation is composed of evergreen broad-leaf scrub and herbaceous meadow. The former generally grows on sunny slopes and the tops or ridges of mountains where snow melts in early spring. The azalea scrub, which needs a relatively long time to complete its growth cycle, can grow well. The scrub is mainly composed of the neriifloru *Rhododendron wardii*, *R. neriiflorum*, *R. laudandum*, *R. repens*, *R. lepidotum*, and *R. brachyanthum* subsp. *hypolepidotum*. The herbaceous meadow generally grows on shady slopes and in valleys where snow cover is heavy in the winter and melts completely in the late spring. The meadow is mainly composed of herbaceous communities, such as *Caltha sinogracilis f. rubriflora*, *Potentilla coriandrifolia var. dumosa*, *P. stenophylla*, and *Bergenia purpurascens*.

Alpine deciduous creeping willow scrub and *Kobresia* meadow ecosystem sub-belt

This sub-belt is situated between 4,200 and 4,500m in altitude, the annual mean temperature is 2-3°C, and annual rainfall is 2,000-2,500 mm. Snow cover is very heavy and it melts very slowly, so the plants here have the ability to survive under heavy snow cover for many years. The climax vegetation, which has a clear mosaic structure, is comprised of deciduous creeping willow scrub and *Kobresia* meadow. The willow communities include *Salix souliei*, *S. flabellaris*, *S. pilosomicrophylla*, *S. acuminatomicrophylla*, *S. annulifera* var. *maeriula*, *S. floccosa*, and *S. faxonianoides*. The height of the willows is less than 10m and their branches and twigs creep over the surface of stones and soil. There are some accompanying plants which are evergreen broad-leaf creeping shrubs. These include *Diapensia himalaica*, *Vaccinium modestum*, *Rhododendron pumilum*, and *Diplarche multiflora*. The *Kobresia* meadow is composed mainly of *Kobresia cercostachys* and *K. nepalensis*.

(5) The Alpine sub-niveal ecosystem belt

Alpine sub-niveal ecosystem sub-belt

This sub-belt is situated on slopes, between 4,400 and 4,800m. The climate is very severe, with an annual mean temperature of –3·5°C and annual precipitation of 1,000-1,500 mm. The majority of precipitation falls as snow and hail. The plants here grow under snow cover for more than nine months. The vegetation of this sub-belt is composed of pioneer plant groups, with the edification plants of these groups generally belonging to the lichen, moss, and composite families; they include mustard, pink, orpine, sedge, knotweed, and saxifrage. The vegetation is discontinuous.

(B) Standard vertical spectrum of the ecosystem for the semi-humid mountains in the northern part

The standard vertical spectrum is composed of four vegetation belts.

It should be pointed out that a tongue-shaped humid area extends to the Baimagoxueng, Dongjug, Yiong, and Suotoug located in the northern part of the eastern Himalayan-Mount Kangrigarbo Range along the Yarlung Zangbo River Valley and is under the strong influence of the airflow from the Indian Ocean. In this area, the vertical spectrum of the humid type is as for the southern part.

(1) The evergreen broad-leaf sclerophyllous forest ecosystem belt

This is the basic belt of the standard vegetation vertical spectra in the northern part. It contains only one sub-belt.

The evergreen broad-leaf sclerophyllous forest ecosystem sub-belt

This sub-belt is situated in the northern part of the eastern Himalayas and Namgrigarbo Range, except in the tongue-shaped humid area (mentioned previously) which extends to the "evergreen broad-leaf sclerophyllous forest"

Baimagoxueng, Dongjug, Yiong, and Suotoug located in the northern part. The elevation is 2,500-3,200m, the annual mean temperature is 8-10°C, and annual rainfall is 500-700 mm. The climax vegetation is evergreen broad-leaf sclerophyllous forest, which is one of the survivors of Palaeo-Mediterranean vegetation of the Tertiary period. The vegetation is composed of a *Quercus aquifolioides* community. It is about 20-30m tall and the dense crown of the community keeps a yellow-green appearance throughout the year.

(2) The sub-alpine evergreen coniferous forest ecosystem belt

This belt is composed of spruce and fir sub-belts.

"the dense crown of the community keeps a yellow-green appearance throughout the year"

The sub-alpine spruce forest ecosystem sub-belt

This sub-belt is similar to the evergreen broad-leaf sclerophyllous forest ecosystem sub-belt. It is situated at elevations between 3,200 and 3,600m. the annual mean temperature is 2-8°C, and annual rainfall is 700 mm. The rainfall is obviously low and the spruce forest adapts to a semi-humid climate. The climax vegetation of this sub-belt is *Picea likiangensis* var. *linzhiensis* community. The forest is 30-60m tall. Because of the dry climate, the moss layer is not developed, but a lot of *Usnea longissima* hang on the branches of the spruce and the community has a conspicuous grey-green appearance.

The sub-alpine fir forest ecosystem sub-belt

This sub-belt is situated at elevations between 3,600 and 4,200m, but in some areas it can rise above 4,400m. The annual average temperature is 0.5°C. It is located in the highest rainfall belt in the northern part; the rainfall is 1,000 mm and the climate is moister. The climax vegetation of this sub-belt is of the fir community as in the southern part, but the edification plants of the community are *Abies georgei* var. *smithii* (silver fir), which is adapted to the semi-humid climate. The forest is moist, so the moss layer grows well.

"this sub-belt is of the fir community"

(3) Alpine scrub and meadow ecosystem belt

This belt is composed of the evergreen *Azelia subina* scrub sub-belt and the *Kobresia* meadow sub-belt.

The alpine evergreen *Azelia subina* scrub ecosystem sub-belt

This sub-belt is situated at elevations between 4,000 and 4,400m. The climax vegetation of this sub-belt is complex: the evergreen azalea scrub is generally distributed on the northern slope and the evergreen coniferous juniper scrub on the southern slope. These two communities form a mosaic with *Kobresia* meadow. The evergreen azalea scrub is mainly composed of communities such as *Rhododendron phaeochrysum*, *R. principis* var. *agglutinatum*, *R. forrestii*, *R. microgynum*, and *R. nivale*; the evergreen coniferous juniper scrub is mainly composed of *Sabina pingii* var. *wilsonii* and *S. saltuaria*; the *Kobresia* meadow is mainly composed of *K. prainii*, *K. pygmaea*, and *K. nepalensis*. A wide variety of herbs also grow here.

"evergreen coniferous juniper scrub"

The alpine *Kobresia* meadow ecosystem sub-belt

This sub-belt occurs at elevations between 4,200 and 4,800m. The annual mean temperature is l-4°C and annual rainfall is 1,000 mm. Because the climate is cold and dry, it is very difficult for scrub to grow, apart from in microhabitats, and the vast majority of the area is covered by alpine *Kobresia* meadow. Alpine *Kobresia* meadow is the climax vegetation of this sub-belt and is mainly composed of *Kobresia pygmaea*, *K. cercostachys*, and *K. prainii* communities.

(4) The Alpine sub-niveal ecosystem belt

This only contains one sub-belt.

The alpine sub-niveal ecosystem sub-belt

This sub-belt occurs between elevations of 4,600 and 5,200m, the annual mean temperature is 3-6°C, and the rainfall is 1,000-1,500m. It is very cold and dry, and the vegetation of this sub-belt is similar to the corresponding sub-belt in the southern part.

A Centre of Species Differentiation and Variation

The moisture passage has the most profound influence on flora and fauna in the valleys on the lower reaches of the Yarlung Zangbo River. This has been described above. But for the majority, especially those plants and insects with a weak ability to move, the steep canyons form a powerful factor to separate them from the outside world. When the humid and warm air current passes through this area, it, together with the ground configuration, creates many unique micro-habitat pockets favourable for species' differentiation and variation.

The young Sino-Himalayan geo-element developed from the Indian-Malaysian geo-element and the eastern-Asiatic geo-element during the upheaval of the Himalayas. The valleys on the lower reaches of Yarlung Zangbo River are areas typical of this geo-element and of the species in the Himalayas. An initial survey disclosed 150 regional vascular-bundle plants growing in the moist area They include *Sphaerotylos medogensis* of the nettle family; *Parapteropyrum tibeticum* of the knotweed family; *Xizangia serrata* of the figwort family; and *Sinoleontopodium lingiatnum* of the chrysanthemum family.

They belong to the single species' genus. Many of the species are dominant species in their localities and have formed botanical colonies of their own, such as the communities of *Quercus lodicosa*, *Cyclobalanopsis xizanggensis*, *Quercus tungmaiensis*, and *Abies delavayi* var. *motuoensis*. They appear as the most attractive vegetation plants with distinct local characteristics along the passage area. All this shows that the valleys on the lower reaches of the Yarlung Zangbo River played an important, even decisive, role in forming the Sino-Himalayan geo-element.

Distinct species' differentiation in the passage is also seen in insects. There are quite a number of newly developed regional genera here such as *A. Serratus* and *Tenuifemurus** of Orthoptera and *Sigmacallis* and *Paraspitiella* of insects. Other kinds of species' differentiation are also apparent here. *Leptomia*, of the elytrum order, a special genus in the Himalayas, has 13 varieties along the passage. Eleven of the 15 species of *Tabanus* in Tibet are in the moisture conduit as special regional varieties.

Protection of New, Ancient, and Migrated Plant Species

Because of its favourable three-dimensional ecological environment and function as a corridor for the movement of living things, the moisture passage during the ice age in the Quaternary "the favourable ecological conditions in the moisture passage protected ancient local plants"

period served as a refuge to protect many ancient plant species. Some have flourished up to the present day. They include *Takakia lepidozioides*, a living fossil of Bryophyta; *Alsophila spinulosa* and *Sphaeropteris brunoniana* of Pteridophyta and *Dipteris wallichii*; *Podocarpus neriifolius*, *Gnetum pendulum*, *Cephalotaxus hainanensis*, *Amentotaxus argotaenia*, *Taxus yunnanensis*, *Tsuga dumosa* (gymnosperms); and *Tetracentron sinense* and *Euptelea pleiospermum* (angiosperms). Regarding lower plants, some ancient rusts have been preserved with their hosts, such as *Uredinopsis*, considered a living fossil, *Milesina* and *Hyalopsora*.

Rich in Species

The favourable ecological conditions in the moisture passage protected ancient local plants, exotic ones and cultivated many new species. Thus this area has the largest variety of flora and fauna in the Qinghai-Tibetan Plateau. According to a survey, there are 3,600 types of vascular-bundle plants that make up two-thirds of the total in Tibet. There are 400 types of macrofungi, accounting for 80% of Tibet's total, or about 60% of China's total. The passage also has 200 kinds of rusts which are about 25% of the country's total, and 2,000 kinds of insects, that is, 60% of Tibet's total. In addition, there is a greater variety of mammals, amphibious animals, reptiles, and birds.

"the passage also has 200 kinds of rusts"

The unique ecological environment in this region also has a profound influence on the growth of local plants and animals. This is shown by their extremely high biological reproductive rate. The dragon spruce and fir forests reach an accumulated volume of 2,300 cubic metres of timber per hectare. Their biological productivity is greater than 1,200t/ha. One giant dragon spruce, 73m tall and 2.5m diameter, has a volume of 50 cubic metres of timber. All these characteristics are rarely seen in forests in other areas.

The high productivity of plants in the passage provides sufficient food for insects and herbivorous animals. Their prosperity in turn stimulates birds and carnivorous animals to thrive. It is estimated that in the hilly lands in the passage there are over 1,000 *Budorcas taxicolor*, a precious animal under state special protection. The valleys on the lower reaches of the Yarlung Zangbo River, as a passage for air currents from the Indian Ocean to Tibet, are a treasure trove of species.

"high productivity of plants in the passage provides sufficient food for insects and herbivorous animals"

An Abnormal Biological Distribution

Benefiting from the warm, wet air current, large-scale humid tropical forests in southern Motuo on the lower reaches of the Yarlung Zangbo River stretch northward until latitude 29°30', forming the northernmost tropical mountain environment in the Northern Hemisphere. This makes it possible for many typical plants and animals to thrive at a much higher altitude and height of vertical distribution than they usually do. These plants and animals include *Porphyrellus graeilis*, *Pleurotus sajor-caju*, and *Goplana mirabilis* from lower plants; *Terminalia niyriocarpa*, *Altingla excelsa*, *Chukrasia tabtilaris*, *Homalium zeylanicum*, *Lagerstroemia minuticarpa*, and *Dysoxyltim gobara* from higher plants; *Python molurus* *biuittatus*, *Naja hannah*, and *Ophisatirus gracilis* from reptiles; *Pycnonotus jocosus*, *Dicrurus acneus*, *Arachnothera ma*, *Prcsbyils entellus*, and *Accros nipalensis* from birds; *Panthera tigris zintliak*, and *Viverricula indica* from mammals; and *Parrhinotermes khasii* and *Indopodisma kindoni* from insects.

The establishment of a canyon for flora and fauna on the northern and southern sides of the Gangrigabu Mountains and the Eastern Himalayas helps these species intermingle.

For instance, typical vegetation of the mountains' southern slopes, semi-evergreen broad-leaf forests and *Tsuga dumosa* forests, have migrated to Tongmai, Yigong, Pulong, and other places on the mountains' northern side. Plants and animals have also traversed along the passage to the mountains' northern side; these include lower plants such as *Quercus tungmaiensis*, *Tsuga dumosa*, *Cupressus torulosa*, and *Alnus nepalensis* of higher plants, *Pleurotus citrinopileatus* and *Battarrea phalloides*, animals such as *Macaca mulatta*, birds such as *Cissa flavirostris* and *Dicaeum ignipectus*, and insects such as *Melampsalta chaharensis*. Life forms from the northern side have also moved to the southern side. For instance, *Pinus dendata* and *Quercus aquifolioides* from the northern side are seen in Gandal and Lugu on the southern slopes.

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