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PHYTO-GEOGRAHICAL SURVEY OF NORTHWEST
SZECHWAN AND REGIONS OF CHANG-TU DISTRICT IN
COMMUNIST CHINA

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I. INTRODUCTION

I joined the Cultural Commission's Tibet Work Team on 7 June 1951 with the purpose of making a survey of the flora in Tibet. Due to difficulties of communications, I was only able to conduct my study along the northern part of Sikang. This undertaking covered almost 2,000 kilometers and took about six months [see Figure 1 appended at end]. About 500 kinds of specimens were collected, belonging to 81 families and almost 200 genera. Forest areas are vast and extensive and only the eastern part of Pa-su-hsien is a pure pastoral area. The rest are mixed agricultural-pastoral areas. Agriculture is confined to the lower alluvial terraces or a small part of the land in the alluval fan.
II. NATURAL CONDITIONS OF THE SURVEYED AREA

A. Geology and Topography

1. General Geological Description: A large proportion of rocks found in the area consists of arenaceous shales which formed themselves into red rock strata. Next are the limestone rocks. These rock formations are present in a few of the top ridges of the mountain ranges (from Chia-p'ia-na, Yen-ta-kou, and Chiang-ta to T'ung-pu; from Kang-t'oh to Teh-ke; and in the vicinity of T'uou-pa). Igneous rocks were seen in a few mountainous areas (such as Ts'io-erh-sh'an; from Chu-ching, Jan-to to E-na; Chahsi-ta-ts'ang; Yu-hsi-kou, and Peng-peng-la). The soil formed from the weathering of the arenaceous shales is mostly of a dull red color. Incompletely weathered conglomerate rocks were often seen falling down the rather steep cliffs. (This was especially noticeable at Yen-to.) It is difficult for plants to grow in this soil. Only a few species of the Labiatee and some small shrubs of the Staliceae families were found to grow together. These able to grow because of their deep main roots. Wherever arenaceous shale exists, vegetation is sparse and forests are especially lacking. Wherever the area is composed of limestone and granite, dense forestation grows and covers the area.

2. Topography and physical features: The mountain ranges and rivers generally run north and south. With the exception of the region along the eastern periphery of Pa-su, all the areas we traversed are mostly deep valley gorges. Peaks rise abruptly, and the lowest depth of some of the river valleys is about 3,000 meters. The water dividing the ridges of these mountains ranges from 4,000 to 5,000 meters.

The topography of these valley gorges can be divided into 3 types:

(1) Narrow valleys (V-shaped valleys) - The flowing river cuts through the steep, weathered and eroded banks on both sides for long distances. The slopes of the banks are 45° or greater with a cross-section shaped like a V. Most of these steep canyons were found in the four main rivers referred to above or in their main tributaries. On both sides of the very narrow bed, a few alluvial fans or alluvial terraces may be found. Sometimes there are no valley beds at all; or if there are, they appear only in traces. Sunshine on the valley is short, and their relative humidity is rather high. The main forest flora distributed over the area are Ficcia Balfouriana and Juniperus. Forestation
is dense and luxuriant along the banks of the gullies which are shadowy even when the sun shines. The vege-
tation of young forestation is crowded and profuse while old forest trees shoot up into the air. Broad-leaf fall
deciduous and acerose leafed forestation grow at the basis of the gullies. Some Betula japonica and Populus Davidiana
are scattered through the pine forests while only shrub-
bery diffuses through the J. pseudo-sabina Fischer et
Meyer juniper forest belts. The important forest areas
are as follows:
(a.) Ts'io-eh-sh'an -- There are many large gul-
lies in this area. Glaciers form U-shaped valleys at the
top of the mountains. There is a large glacial lake on
the eastern slope of the mountain surrounded by a forest
of aged Piceae. The climate in the gullies is damp and
humid, and the area is crowded with dense, luxuriant growth
of majestic Piceae and J. pseudo-sabina Fischer et Meyer
forests. Stretching from Ta-ma-tung over Ts'io-eh-sh'an
to Tung-t'ai-chan is a gulley over 100 kilometers long.
The forest and timber areas here are the most enormous in
this entire region.
(b.) Kuan-chai-tsu to K'o-lo-tung area -- There are
many narrow valleys in this area reaching lengths of 15
kilometers and covered with young and mature forests of
Piceae and the J. pseudo-sabina Fischer et Meyer variety
of junipers.
(c.) Yen-ta-kou (from K'o-lo-tung to Ta-ma-tung) --
The length of this very narrow and steep gully is over 10
kilometers running east and west. At the bottom and on
both sides of the gully grow dense and luxuriant foresta-
tion of broad-leaf trees. Piceae and J. pseudo-sabina
Fischer et Meyer grow on the slopes but not so luxuriantly.
(d.) Kang-t'oh to E -- This is a long narrow valley
about 10 kilometers running north and south. The gully is
narrow and steep. Both slopes of the gully are covered
from top to bottom with Piceae and J. pseudo-sabina Fischer
et Meyer. At the lowest level of the slope, birches and
poplars also grow. At the bottom of the gully small trees
of yellow poplars grow.
(e.) From E-na to Jun-to in Chiang-ta -- This
stretch of mountain valley is almost over 50 and some odd
kilometers long. Its width varies much but is wider than
the valleys described above. Small alluvial fans and
terraces were frequently seen along the river bed. When
we reached the uniform acerose-leaf forest region, it was
found to have been destroyed by human efforts, and some of
these trees remained only along the upper levels of the
mountain. Piceae forests grow luxuriantly along the route
from Je-ya to Teh-pi-ch'ia.
(f.) La-ma-la -- On the left bank of Lan-ts'ang River south of Ch'ang-tu, the mountain is about 5 kilometers long with varying width at different points. Piceae forest grows on the shady slopes while junipers and J. pseudo-sabina Fischer et Meyer grow on the sunny slopes. No birches or poplars were seen.

(g.) From Chung-yu to Cha-hai-ta-ts'ang -- This area is along the left bank of Lan-ts'ang River. It is not very deep with varying widths. The Piceae forest covering it is extensive. Birches and poplars are mixed in the Piceae forest on the lower slopes of the valley. However, shrubbery forest covers the southwest slope, and consists mostly of Berbericeas, Rosacea, Cotoneaster multiflora Bunge, etc.

(h.) From Ts'un-to to Fang-ta -- This is an area of many narrow valleys. Some large alluvial terraces exist in the river bed. Piceae and J. pseudo-sabina Fischer et Meyer forests grow in valleys with no river beds. This is both a forest and pastoral area.

(i.) Yu-hsi-kou -- This is a valley running east and west in the neighborhood of Lan-ts'ang River and lying between the Lan-ts'ang and Nu-chiang [Salween] rivers. Extensive Piceae and J. pseudo-sabina forests cover this area with birch forests growing among them on the shady slopes. On the north and south branch gully both Piceae and J. pseudo-sabina forest grow.

(2) Wide Valley Areas -- The base of the gullies is wider with a smaller difference in the incline and of flow of the river. Larger expanses of alluvial terraces are present in the river bed. At altitudes under 3,500 meters, small tracts of cultivated lands were found on the river bed. Mountain slopes are frequently under 45°. The vegetation on the valley slopes consists mainly of shrubbery forests and tall grass steppes. The height of the grasses growing on this tall grass plain ranges generally from 15 centimeters to 1 meter. Forests when evident are scattered on the mountain showing signs of withered growth. The main rock formations are stratified red sandstones. Limestone and granite are rather meager. Because of the width of valleys, there is more sunshine with greater moisture evaporation. Therefore these valleys are more arid than the V-shaped valleys. These valleys are:

(a.) Kan-tzu and vicinity -- On both banks of the wide Ya-lung-chiang there are thick layers of yellow alluvial soil suitable for cultivation. The area upstream
to Jung-pa-ch'a consists of chestnut colored calcareous soil, a large part of which is for cultivation. Forests have been destroyed, and only on both the east and west entrances of the pine forest, small areas of natural Piceae with withered J. pseudo-sabina, and new forests are evident.

(b.) From Ta-ma-tung to Teh-ke — This is a valley gully of a little over 10 kilometers long. The river bed is not large and sparse shrubbery forests cover the mountain slopes with tall grasses growing among the shrubs. There is a little farm land on both sides of the river, which serves both as a farming and grazing area.

(c.) Ch'ang-tu and vicinity — Ch'ang-tu is situated at the confluence of Ch'ang-ho and Tu-ho. The river bed is not wide and the lower part not deep. There are small areas of alluvial fans and terraces. Growing vegetation exhibited conditions of drought and without water for the irrigation of the farm lands, the yields are very low. The mountain slopes are mostly covered with grass and sporadic growths of shrubbery. There were no forests to be seen.

(d.) Yen-to and vicinity — The width and narrowness of the river valley is about average size with many bare mountains. The soil is mainly formed from weathering of arenaceous shale rocks. There are several flat and wide grassy banks in the river bed which can be utilized for cultivation. There is much good forage vegetation growing on the higher and steeper slopes (such as Themeda Foskali, Spodiopogon sibiricus, and Fennisetum flaccidum Grisebach). Sand and conglomerates derived from the weathered arenaceous rocks were not firmly settled on the mountain slopes. Only the few shrub families of Labiatae, Staticeae and Verbenae officinalis grow on the soil and effectively hold the water therein.

(e.) Hsiang-tui and vicinity — The topography of this area is similar to Yen-to. There are several flat and wide grassy banks. Because of the use of irrigation, most of these have become farm lands. The natural flora found here is also similar to those found at Yen-to.

(f.) From Tso-kung to Ts'un-to — This valley gully runs along the banks of the Yu-ch'iu-ho which is a tributary of the Salween River. Its length is over 20 kilometers. The river bed is wide at some places and narrow at others. The mountain slopes are sparsely covered with shrub forests and grassy land. A small part of the alluvial fans and alluvial terraces are utilized for cultivation.
(g.) From Chia-chiah to Ch'ang-tu -- This is a meandering gully about 40 kilometers long. The nature of the river bed is similar to that of the area from Ts'eo-kung to Ts'un-to. Because its physical features are lower, the drought is especially serious. The mountain slopes are a mixture of tall grass lands and shrubbery forests with scattered small areas of forestation at the top of the mountains. This area is chiefly pastoral.

(3) Area of rolling mounds (hilly plateaus) -- The physical features of these areas are rather high with very few rivers. The hilly ground along the river banks rise and drop, preserving their original high plateau feature. The inclination of the mountain slopes is under 15°. The climate is temperate; air pressure, low; radiation, strong, and rainfall, light. These conditions create drought. The flat grassy plains on both sides of the river are mainly covered with the variety of Blysmus compressus Panz grass. The grounds with shallow water are damper and on these grow mostly the variety of Cobrisia capillifolia grass. This area is used mostly for animal grazing. The extent of land in this area covered with vegetation is about 40–50%.

The specie of Cobrisia bifida Tang et Wang grass dominates the mound slopes if the sloping is under 15°. A small number of dwarf plants such as Leondopodium japonica, Gentiana scabra, Polygonum sphaerostachyum Kung, Polygonum viviparum L., and Secale mongolica Turczaninow are scattered among the dominant grass. Small patches of Cobrisia pygmea C. B. Clarke were also found scattered in the area. As the ground rises higher and the slope inclination becomes steeper, vegetation grows with less plant mixtures, and Cobrisia bifida Tang et Wang and Cobrisia Royleana Boeck dominates the area. In the summer these become good pasture lands for sheep and oxen.

(a.) From Yu-lung to Hai-tsu-sh'an -- The river bed is flat and wide. It is an extensive damp grassland with slight mountain slopes. The sunny slopes are entirely grasslands. In the shady slopes there are a few liceae and some shrub forests. Shrubs grown in this area are chiefly Prunus fructicosa L., S. iraeae alpina Pallas, Rhododendron fastigiatum Franchet, Salix Brachystachys, Benth., etc. Besides the Cobresia varieties of grass, the following variety of plants was also found: Potentilla bifurca, Plantago major L, Leondopodium japonica, Potentilla anserina L, Taraxacum officinale Wigg, Veronica agrestis L, Astragalus sinicus L, and a small variety of Ranunculaceae and some Gramineaceae. Vegetation coverage reaches 80–90% and there is a good grazing ground.
(b.) From Je-ch'uo-ch'iah via Pai-li to A-ch'i-lung -- This meandering waterway has a wide river bed. With the exception of a few small shrub forests on the shady sides of both banks, Cobresia grasses cover almost the entire river bed and the sunny mountains. This area is especially important as grazing pastures in summer and fall. The dominant grasses grown on the river bed flat-lands are the Blysmus compressus Panz and the Cobresia bifida Tang et Wang. Some Potentilla anserina L. were found among these. In the drier regions Fontilla bifurca was found. On the higher slopes are grown Cobresia bifida Tang et Wang and Cobresia pygmae which are mixed with the genus Polygonum and Secale mongolica Turczaninow. Vegetation coverage is about 50-70%, making it a good summer grazing pasture.

(c.) From La-tsai to A-tsu -- The physical feature of this region is rather high with an elevation close to 3,800 meters. The river bed is wide but with little water running through it. The slopes on each side of the river are not steep and there is very little shrubbery. A few Rhododendrons and Caragana bicolor Komarov were seen among the sparse shrubberries. Several regions are formed into flat grass banks. The dominant vegetation is the Cobresia, with a few species of Gramineae scattered among the grasses. Cobresia pygmae grows at higher levels with lime mixture of other plants. A very few Caryophyllacaeae and Primulaceae are scattered among them.

(d) From Pang-ta to L'ang-la -- This region of grassland represents the eastern edge of the la-su area. Its elevation is almost 4,000 meters. The river bed is very wide. The mountain tops on each side of the river are flat with very little shrubbery. Most of the land consists of Cobresia pygmae and Cobresia bifida grasslands. Stipa conferta Poiret and Aster trinervius Roxb are distributed in the flat wild grassy banks. Vegetation coverage is about 80% overall.

B. Soil and Climate

1. General Climate: The climate of this area is both arid and cold due to its high elevation and separation from the distant oceans by very high mountains. (Broad leaf evergreens are practically non-existent. Only one specie of yellow poplar was seen at Ta-ma-tung and on the banks of Chin-sha-chiang.) Summer is the rainfall season, and April-May of each year is drought season.
According to estimation, the annual rainfall for the agricultural areas is between 300 and 500 millimeters, and seasonally the greatest amount of precipitation occurs in the summer, next in amount is autumn, and both spring and winter receive the least amount of rain. The average annual temperature is above $5^\circ$ C, but it can reach as high as $16-17^\circ$ C. The lowest winter temperature is $-20^\circ$ C. In the shallow regions of the valleys, evening frost is still found in April-May. Morning frost is seen in August-September. Also, hailstorms occur between the months of July and September. As a result, Hordeum vulgare L. var. nudum Hk. f. of the Gramineae family is the main staple crop grown, due to its resistance to cold and its short growing period. This is grown in areas at the elevation of 3,000-3,800 meters. At higher altitudes, even Hordeum vulgare L. can not grow. The area of grasslands is greater than the cultivated area.

2. Types of soil and their distribution: The soil in this area can be classified into three types:

(1) Chestnut pedocals -- This soil is mainly distributed along the lowlands of the river valleys at the elevation of 3,000-3,700 meters. Generally this soil is found around the elevation of 3,500 meters. The alluvial fans and terraces of the river beds are mostly composed of this type of soil. The characteristics of this type of soil are its good drainage, richness in calcium, alkalinity, and top soil thickness of 20-30 centimeters. The color of this soil is light brown or gray-brown. Soil that developed from the red rock strata is purplish brown in color. The sub-soil is greyish white. The quality of the soil ranges from silt to coarse sand or gravel.

(2) Brown forest soil -- The distribution of this soil is at a higher elevation level than the chestnut pedocals, generally between 3,500 and 4,000 meters. This soil is found wherever there are forests. Because of weaker sunlight and greater precipitation, there is a richness in compost decay in the soil which is mostly acid or neutral. The top soil is dull brown color with a light loamy texture that can hold large quantities of water. The top soil is between 15 and 20 centimeters in thickness. The subsoil is over 30 centimeters in thickness and yellowish brown in color. Its great fertility is the reason for the area being the forestation region for Picea, Betula and Lupulus. The soil on the sunny slopes is light brown and its texture is similar to that of the brown soil. The top soil is thin with average fertility and less rich in compost. The subsoil is light yellowish brown and clay-like, and its thickness is about 40 centimeters. It is
distributed on the slopes the inclination of which is around 15-30°. The main vegetation on this region of the soil consists of J. pseudo-sabina Fischer et Leyser and shrub forests. Due to sparse growth, plants are easily washed away.

(3) Soil of the tall grass steppes -- This soil is found in the mounds, high grounds, and flat grass banks at the elevation level of 3,500-4,200 meters. Very little of this soil is found in the valley slopes or damp grounds below the elevation of 3,500 meters. Dead plants are difficult to decompose due to cold climate, and therefore the soil lacks compost materials. The soil contains tangled masses of partially decomposed roots which impart a foamy texture to the soil. Local inhabitants frequently use these partially decomposed materials for wall constructions and house repairs. The slightly claylike topsoil is 10-30 centimeters thick. The thickness of the subsoil is variable, greyish white, and contains much sand and gravel. The soil varies from slight acidity (poor drainage, low river bed, damp grounds) to slight alkalinity (mountain regions with fairly large slopes), and this is the main steppe area for the growth and distribution of Cibesiceae grasses and short grasses. It is an important summer pasture land.

III. RELATIONSHIP BETWEEN ENVIRONMENTAL CONDITIONS AND PLANT DISTRIBUTION

A. Distribution of Plants

1. Discussion on survey of perpendicular order of plant distribution in this area: In the perpendicular order of plant distribution in this area, different plants sometimes show very little difference among them, but their height has great variations. This is due to the complex topographical nature of this area. Beginning from the bottom up, plants are found to be distributed in the following order: tall trees, shrub trees, and finally the grasses. The more clearly defined environmental-induced perpendicular type changes are found in the area labeled belt followed by the area labeled strata. This discussion follows this order /see Figure 2 appended at end/.

(1) The forest steppe belt -- Altitude changes covered by this belt are very pronounced. Of the areas I have traversed, only Ch'a-hsi-ta-t's'ang (elevation 2,950 meters) on the banks of Len-ts'ang River was under an elevation of 3,000 meters. We were over 3,000 meters at all
other times. At this low altitude the distribution of Ficeae, for instance, had not reached the lower boundary of the forest belt. The upper boundary of this belt was generally limited to the elevation of 4,200 meters. However, many regions, due to their topographical features (flat), and climatic conditions (arid), are not suitable for forests at such a high altitude (most forest elevations average around 4,000 meters). Because the areas surveyed are narrow valleys at the northern end close to the steppes of Tsing-hai (the vast steppes of Yu-shu and Nan-ch'ien), the climate is cold and arid. Therefore on the slightly inclined mountain slopes many shrub forests (on shady slopes) and vast grasslands (on sunny and semi-sunny slopes) dot this belt. (For this reason this area is labeled the forest steppe belt which is both a forest and grazing area.) Going up from the bottom this belt can be divided into two strata:

(a.) Mixed stratum of summer green broad-leaves and acerose-leaves -- The elevation of this stratum is between 2,950 and 3,800 meters. The chief acerose-leaf tree found in this stratum is Picea Balfouriana, Rehder et Wilson which grows on shady slopes (small numbers of Picea Purpurea, masters are among them). The next important species is J. pseudo-sabina, Fischer et Meyer that grows on the sunny slopes. Other species like Larix Mastersiana, Rehder et Wilson that is found at Che-to-sh'an, and Abies Delavayi, Franchet are very sparse in this stratum. Betulaceae are often found growing in Piceae forests. These sometimes grow heterogenously at some places, and homogeneously as individual forests at other places. Betulaceae prefer sunlight and dampness, and most of them grew up over destroyed Piceae forests. If these two different types of trees are grown together, each will grow according to its natural abilities, but the Betulaceae will be overpowered and caused to die by the Piceae. The species Populus Davidiana, Dode is often found in this area, and since it prefers an abundance of moisture, it is limited to the valley swamps. The distribution of this species is at a lower altitude than the Betulaceae (3,000–3,400 meters). The brown soil in the Piceae forests is very rich and fertile, and very little sunlight falls upon it. At the forest edges the following shrubs are often found: Shrubs growing below the forests are Potentilla, Spiraea, Sibiracca, Lonicera, etc.

Shrubs along the gorges and edges of forests are Salix, Rhamnus, Ribes, Prunus, Lonicera, Acanthopanax, Malus, Cornus, Evonymus, Syringa, Hippohae, etc.
J. pseudo-sabina, Fischer et Meyer is found scattered on the sunny slopes. The shrubs that are often found below the forests are the Berberidaceae, Caragana bicolor, Cornus, Cotoneaster multiflorus, Bunge, etc. Besides these, there are many drought-resistant varieties of grasses that thrive in sunlight, forming large areas of grasslands on warm sunny or semi-sunny slopes.

(b.) Stratum of acrosc-leaved forest -- This stratum is spread over the elevation between 3,800 and 4,000 meters, and sometimes goes as high as 4,200 meters due to topographical features and conditions. The chief forest tree is Picea Balfouriana, Rehder et Wilson that grows on the shady slopes. Some species of J. pseudo-sabina were found opposite Cha-hsi-tsae-lang on the Lantseung River. Aside from the Potentilla, Spiraea, and Lonicera types of shrubs found below the forest, evergreen and deciduous Rhododendrons, like Rhododendron Trzewickii, Laximowicz and Rhododendron Turdumii, Rehder et Wilson, were also found. Some species of J. pseudo-sabina, Fischer et Meyer forests were found along the sunny or semi-sunny slopes, and in a few instances (such as at La-ni-la) some Juniperus trees were found. A heterogenous growth of Picea and Juniperus was found along the slopes of narrow valleys that run north and south. On wide valleys timber forests are replaced by shrub forests, which in extreme cases replace steppes to become an important forestry and grazing region, with the latter as the important occupation.

(2) Alpine shrub and steppe belt -- This belt exists between the forest belt and the snow line at an elevation of 4,000-5,000 meters. forests are completely absent in this region of Alpine shrub steppe. The only species of acrosc-leaved tree found was the shrub-like Juniperus squamata, Lambert. Beginning from the bottom this belt can be divided into two strata:

(a.) The Alpine shrub stratum -- This stratum is situated at an elevation of 4,000-4,500 meters. With the exception of a few mountain peaks the inclination of the slopes is generally not great. Short tree forests are evenly scattered on the steeper sunny slopes where the species of J. squamata, Lambert is sometimes found. The form of the J. squamata is like a bun, and among this species a small number of short shrubs such as Berberidaceae and Caragana jubata, Toiret are found. On the steeper and shady slopes there are large tracts of shrub forest which grow downward from the mountain peak to a definite boundary. Sunshine and evaporation increase because of the little changes in slope inclination, and these regions
change into grassy steppes. At a distance the lines separ-
ing the shrub forests from the grassy steppes can be
seen very clearly. The important shruberies of these
forests are Rhododendron fastigiatum, Franchet; Spiraea
trilobata, L.; Prunus fruticosa, L.; and the Salica-
ceae, etc.

Besides being spread out below shrub forests and
on shady and less inclined slopes, mountain steppes are
also found on the sunny and partly sunny slopes of flat
and low mountain mounds, and they are almost completely
covered by the two species of Cobresia Royleana, Boeck and
Cobresia Fifida, Tang et Lang grasses. The surface areas
of these steppes are much greater than the surface areas
covered by shrub forestation. These grasslands are im-
portant summer pasture grounds. All the grasses are of the
short variety no taller than 15 centimeters, covering
70-80% of the ground. Between Pang-ta and Lang-la only
one grass species, Stipa conferta Turczaninow, was found
to reach the height of about 1 meter. This species was
distributed over a large area of the rising sub-steppe
at the elevation of around 4,000 meters. This type of
grass deserves study as to its probable use.

(b) Alpine in steppe stratum -- This stratum is
found at the elevation of 4,500-4,800 meters. This is a
short grass region with complete absence of shrub foliage.
Snow and ice begin to cover this stratum around August and
September of each year and thaw in May-June of the follow-
ing year. This is the reason for the growth of special
types of flora in this region. The most prominent grasses
are the varieties of Cobresia and Blyssus. Scattered among
these grasses are several species of Gentiana, Polygonum
viviparum and ioniogonum sphaerostachyum, two species of
Suassurea sp., and several species of Caryophyllaceae, and
species of Arenaria L., Androsace Tatete Maximowicz and
other Caespitose plants of the Androsaceae family. Most
of these plants can utilize the food stored in the deep
long roots from the previous season and grow to maturity
quickly forming seeds to insure their propagation. This
cycle of growth, food storage, and maturity repeat them-
selves. All these Alpine plants are highly resistant to
cold blooming and forming seeds even after frost and snow.
Caespitose plants are especially adapted to resist wind
and cold.

(3) The cold placodium belt -- This belt is at the
elevation between 4,800 and 5,000 meters. Only several
months of the year are snow and ice free (June-August).
Neither grasses nor trees grow in this belt. After thaw-
ing of ice and snow, a small amount of mottled orange-yellow,
orange-red, and green placodium is found attached to the bare rocks.

(4) The snow-line — The snow-line exists around the elevation of 5,500 meters.

2. Different plant types seen along regions of survey route: The flora of this area can be divided into the following four types according to the law of horizontal regions (see fig. 1):

(1) Region of arid shrub steppe — The elevation of this region is between 3,000 and 3,500 meters, including the alluvial fans and terraces in the river valley. Agriculture is flourishing. The population is comparatively dense. The forests have been completely cut and destroyed while the pasturelands are over-grazed. The natural flora remaining are all drought and alkaline resistant strains. In the shrub forest remnants only the following species of Caragana, Rosaceae, Sophora, Phellodendron, Rhamnus and Cotoneaster remain. Among the large group of herbaceous plants, the Cobresia, Stipa, Pennisetum, Secale, Oxytropis, and Astragalus continue to grow. The soil is chestnut pedocal. The farmers grow poplars along the gullies and at the edge of the villages. They use wood farm tools and obtain lumber from these trees. The important areas in this region are Kan-tzu, Teh-ke, Ch'ang-tu, Yen-to, Hsiang-tui, etc.

(2) Semi-arid forest steppe region — This is a region of narrow river and valleys and steep mountain slopes situated at an elevation of 3,000–3,800 meters. It is important as a forest region. Shrubby and grasses are interspersed throughout the region, which makes it a mixed forest and grazing area. The forests have the following kinds of trees: Picea Balfourina Behder et Wilson, Picea Purpurea Masters, J. pseudo-sabina Fischer et Meyer, Juniperus chinensis L., Juniperus pseudosabina, Betula japonica var Szechuanica, and Populus Davidiana. These trees frequently are formed into large areas of virgin forests. The shrub trees found are: Rhododendrons, Spiraea, Spiraea alpina Pallas, Prunus fructicosa L., Salix, Cotoneaster multiflora, Berberis, Jambosa caryophyllus, Rosaceae, Caragana bicolor Konarov, Rhamnus, Rubus parvifolius L., Ribes alpestre, Araliaceae, Prunus tangutica, Prunus ansu, Malus kansuensis, etc. Graminaceae and Blysmus plants are the most abundant in the steppe, covering about 70% of the area.

(3) Alpine shrub steppe region — This region includes a small part of the alpine shrub and acerose leaf strata in the perpendicular order of plant distribution
mentioned previously, and it exists at an elevation of 3,800-4,500 meters. Incorporated in this region are the vast grassy steppes of northwest Szechwan and those south of Ch'ang-tu which are very important summer pasture lands. The shrub forests on the shady slopes are of secondary importance. The important steppe grasses are: Blysmus compressa, Cobresia bifida, and Cobresia pygmaea. The important shrubs are Rhododendron, Prunus fructicosa, Populus Davidiana, etc.

(4) Alpine steppe region -- This region exists at an elevation of 4,400-4,800 meters that includes the upper stratum of the high mountain shrubs, and the entire stratum of Alpine grassy steppe. Shrubs are very scarce in this region, and it is covered mostly by Cobresia Royleana, Cobresia pygmaea, etc. Scattered among these dominant grasses are a few small grasses like Gentiana, small leaf Polygonum, a few species of Saussurea and Arenaria, etc. Sheep and cattle are driven here for summer grazing.

3. Agricultural area boundary: Hordeum vulgare, L., var nudun Hk. f. is the main staple crop of this entire area. The line from Kan-tzu to Ch'ang-tu is generally between the elevation of 3,000-3,800 meters, and the lower limit of this boundary drops to 2,500 meters which is eastward from Kan-tzu. Southward along the Lan-ts'ang River to A-tsu (elevation 3,900 meters), Shih-pan-kou (elevation 3,800 meters), and Fang-ta (elevation 3,900 meters), the upper limit can reach 3,900 meters. Although there is frequent frost and snow in these three places, most of the Hordeum vulgare harvest is early harvest. In animal husbandry, the yak cannot adapt itself south of Chu-chia due to hot weather, and the P'ien-yu is substituted. (The P'ien-yu is a crossbreed between the yak and yellow ox. It can stand heat.) Therefore latitude 30.5° north is the dividing line between north and south. Crops like Brassica campestris, L., Fagopyrum esculentum, boenich, spring millet, Pisum sativum, Lens culinaris, medicus, etc. are limited to south of this line. In the lower valley grounds of spring millet can be grown. With the exception of Brassica campestris and Fagopyrum esculentum, the other three, spring millet, Pisum sativum, and Lens culinaris, are grown occasionally at valley bottoms below the elevation of 3,500 meters.

4. Types of area flora and their environmental adaptation: Plants in this area have developed special morphological and physiological changes and characteristics for adaptation to this complex natural environment.

(1) Analysis of plant families, genuses, and species. Over 1,400 specimens were collected in this area
totaling 81 families. Among these the families that had more genera and species are: Compositae, Gramineaceae, Labiatae, Rosaceae, and Leguminosae. The important large genera in this collection are: Laphra, Caragana, Lonicera, Cotoneaster, Rhamnus, Astragalus, Oxytropis, etc. This group contains the more arid resistant types of plants. From this, one can understand the semi-arid climate of this area. Many of the genera like the Pedicularis, Cobresia, Saxifraga, Saussurea, Gentiana, Neconopsis, Androsace, Arenaria, etc. are cold resistant strains. To total number of families and genera in this collection is not great, but the variety of species in one genus is much wider than plants found on level land. The following list of families and genera proves the point:

<table>
<thead>
<tr>
<th>Genus</th>
<th>Number of Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedicularis</td>
<td>23</td>
</tr>
<tr>
<td>Polygonum</td>
<td>10</td>
</tr>
<tr>
<td>Saussurea</td>
<td>8</td>
</tr>
<tr>
<td>Lonicera</td>
<td>8</td>
</tr>
<tr>
<td>Cotoneaster</td>
<td>7</td>
</tr>
<tr>
<td>Oxytropis</td>
<td>6</td>
</tr>
<tr>
<td>Androsace</td>
<td>6</td>
</tr>
<tr>
<td>Caragana</td>
<td>8</td>
</tr>
<tr>
<td>Astragalus</td>
<td>8</td>
</tr>
<tr>
<td>Gentiana</td>
<td>6</td>
</tr>
<tr>
<td>Ribes</td>
<td>4</td>
</tr>
<tr>
<td>Saxifraga</td>
<td>4</td>
</tr>
<tr>
<td>Laphra</td>
<td>5</td>
</tr>
<tr>
<td>Cobresia</td>
<td>5</td>
</tr>
</tbody>
</table>

(2) Abundance of high mountain type plants: Plants in this high mountain area are mostly highly capable of preserving their mountain type characteristics, and the following several types are the most prominent:

(a) Prostrate plants -- It is exceedingly cold and windy in the high mountains, and the growth period for plants is short. Many shrubs found at the elevation over 4,000 meters exhibited short and prostrate forms. Because of the yearly short period of growth, the plant's main root or branches extend very little upward, and the branch stems creep outward as if they are crawling along. The most common species seen was the Juniperus squamata that profusely covered the mountain slopes. The crown of its foliage is flat like a round bun. It is about several meters tall with the small side branches creeping and spreading outwards. The diameter of the tree crown frequently reaches 4-5 meters. This tree has many morphological types which can be selected for garden landscapes. On the mountain

- 15 -
slopes at Hai-tsu, a species of creeping poplar was found. Its height was about 5-8 centimeters and clung to the surfaces of rocks. Its leaves were shiny and oily green in color, and at a glance it resembled the yellow poplar. On the mountain peaks at Chia-pi-na we also saw another species of creeping poplar whose height was under 1 meter with a crown diameter about 2-3 meters. The two species of Cotoneaster horizontalis and Cotoneaster adpressa were frequently seen. Morphologically they are very short plants clinging and creeping between cracks of rocks, and turn into a solid red in the fall which is quite beautiful. On the mountain slopes between Chu-chiah and L'ang-sh'an there was a species of creeping Ephedra which exhibited short and dense branches grouping into the shape of a bun. The branches of this plant are very hard.

(b.) Caespitose-Decumbent plants -- At all the high mountain passes between the elevation of 3,800 and 4,200 meters that we passed through, we found several species of perennial herbaceous caespitose-decumbent plants growing on flat slopes and slightly inclined mountain sides. The most prominent ones are the Thylacospermum Caespitosum Schiskin of the Caryophyllaceae family, Arenaria kansuensis, Stellaria decumbens, and the caespitose-decumbent members of the Primulaceae family. All these plants are either caespitose or decumbent with long main roots growing deep in the ground. The side branches growing on the surface of the ground are very short and dense, stretching out irregularly. This type of plant can withstand cold, maintain the warm ground temperature and reduce evaporation at the same time. These are typical types of high mountain plants.

(c.) Bulb and Tuber plants -- The high mountains are covered with snow almost throughout the year with very cold climate. Because of the short growing period, the plants mostly draw upon the food substances stored in the previous year in their main roots, bulbs, or tubers for growth and seed formation requirements during the growing season. By the process of photosynthesis more food is manufactured and stored for future use. These are typical short life plants. There are both annuals and perennials in this group of plants. The prominent ones are the following: (i) plants with large and long main roots -- Rheum palmatum, Gentiana macrophylla, Oxytropis, etc., (ii) Bulbs -- Fritillaria Roylea, Hooker, etc., (iii) Tubers and corms -- Potentilla anserina, L., and Polygonums.

(d.) Plants with small hairy leaves -- There are many plants of this type: Meconopsis, Caragana, Thermopsis, Saussurea, Astralagus, and Oxytropis.
(e.) Snow blooming plants -- On most of the high mountain passes and steppes, we saw many plants whose flowers frequently bloom in the snow. Some examples are the species of Saussurea, several species of Gentiana and Fleurospermum.

(f.) The family of Cobresiaceae grasses in the steppes -- Because of the high altitude and extreme cold in this region, the dominant grasses of the Cyperaceae are the Cobresia, and Blysmus species. The quality of the Blysmus compressus Fanz is the best, and it is found in the shallow waters of the lowest region of the river bed, covering over 80% of such regions. The yield of this grass is rather high, and over a long period of time, it has spread over a wide area, providing good pasture lands for the winter. Cobresia Pygmaea C. B. Clarke is distributed over especially higher grounds. The quality of the grass is good and it covers about 70% of the ground. Although its yield is low, such lands are valuable for summer grazing (the most important grass feed for the Tsing-hai and Tibet yaks). The grass Cobresia bifida Tang et Wang is distributed in the regions between the above two grasses. It is important for spring and fall grazing. The remaining two grasses, Cobresia capillifolia C. B. Clarke and Cobresia Royleana Boek, are limited in growth, and their quality is poor. The following chart presents this group of grasses clearly.

<table>
<thead>
<tr>
<th>Chinese Name</th>
<th>Scientific Name</th>
<th>Type</th>
<th>Growth</th>
<th>Elevation</th>
<th>Regions of Perpendicular Abundant and Environmental Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>nshi-sung</td>
<td>Cobresia</td>
<td></td>
<td>Cold-arid</td>
<td>4,000-</td>
<td>Alpine shrub stratum of the alpine shrub steppe and alpine steppes stratum Alpine grasslands</td>
</tr>
<tr>
<td>grass</td>
<td>Pygmaea</td>
<td>type</td>
<td>4,800</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table above presents the distribution and growth conditions of the Cobresia grasses. The table includes information on the Chinese names, scientific names, types, growth conditions, and elevations. The regions of perpendicular abundance and environmental conditions are also included.
<table>
<thead>
<tr>
<th>Name</th>
<th>Scientific Name</th>
<th>Type</th>
<th>Growth</th>
<th>Elevation (in meters)</th>
<th>Regions of Perpendicular Abundant Order of Distribution and Environmental Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kao-sung</td>
<td>C. Royleana</td>
<td>Cold-damp</td>
<td>Around 4,000</td>
<td>Alpine shrub stratum (alpine grasslands)</td>
<td></td>
</tr>
<tr>
<td>grass</td>
<td>Boeck</td>
<td>type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ying-sung</td>
<td>C. capillifolia</td>
<td>Cold</td>
<td>3,900</td>
<td>Aerose leaf stratum of the forest steppe belt (peat soil)</td>
<td></td>
</tr>
<tr>
<td>grass</td>
<td>C. B. Clarke</td>
<td>Temperate</td>
<td>4,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P'o-sung</td>
<td>C. bifida</td>
<td>Warm-arid</td>
<td>3,500</td>
<td>Forest steppe belt (well drained arid slopes and calcareous earth)</td>
<td></td>
</tr>
<tr>
<td>grass</td>
<td>Tang et Wang</td>
<td>type</td>
<td>4,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shui-so</td>
<td>Blysmus</td>
<td>Warm-damp</td>
<td>3,000</td>
<td>Forest steppe belt (flat lands, peat and calcareous soil at places of shallow underground water table)</td>
<td></td>
</tr>
<tr>
<td>grass</td>
<td>Panz</td>
<td>type</td>
<td>4,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
full maturity with seed formation is accomplished by most species in July-August. Most of these species produce beautiful and adorable flowers. (These plants in the future can be grown for enjoyment.) The chart in section IV gives a complete description of this family.

<table>
<thead>
<tr>
<th>ID</th>
<th>Scientific Name</th>
<th>Place</th>
<th>Flower Color</th>
<th>Date of Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pedicularis alaschanica Maxim ssp. tibetica Maxim</td>
<td>Chieh-to-sh’an (4190)</td>
<td>Yellow</td>
<td>July 2-8, 1951</td>
</tr>
<tr>
<td>2</td>
<td>P. cheilianthifolia Schrenk</td>
<td>Teh-ke, Hai-tsu-sh’an (4967, 5012a)</td>
<td>Purplish</td>
<td>July 24</td>
</tr>
<tr>
<td>3</td>
<td>P. confertiflora Traian</td>
<td>Chiang-ta to Chio-ya (5315)</td>
<td>Purplish</td>
<td>August 18</td>
</tr>
<tr>
<td>4</td>
<td>P. crenolopha Maxim</td>
<td>Vicinity of Kan-tzu (4342)</td>
<td>Bright</td>
<td>July 11</td>
</tr>
<tr>
<td>5</td>
<td>P. cyathophyloides Limpr</td>
<td>Vicinity of Teh-ke (5249)</td>
<td>Purplish</td>
<td>August 5</td>
</tr>
<tr>
<td>6</td>
<td>P. Elwesii Hk. f.</td>
<td>Je-ya (5462)</td>
<td>Purplish</td>
<td>August 22</td>
</tr>
<tr>
<td>7</td>
<td>P. Granieri Bonsh</td>
<td>E(5220)</td>
<td>Yellow</td>
<td>August 11 (?)</td>
</tr>
<tr>
<td>8</td>
<td>P. ingens Maxim</td>
<td>Teh-ke, Hai-tsu-sh’an (4989a)</td>
<td>Purplish</td>
<td>August 23</td>
</tr>
<tr>
<td>9</td>
<td>P. integrifolia Hk. f. var. integerrima Tsoong.</td>
<td>From Je-ya to Teh-puchia (5470)</td>
<td>Purplish</td>
<td>July 28</td>
</tr>
<tr>
<td>10</td>
<td>P. kansuensis Maxim</td>
<td>Kang-ting (4170) E (5250a), Pai-li (5355)</td>
<td>Purplish</td>
<td>July 11</td>
</tr>
<tr>
<td>11</td>
<td>P. lachnoglossa Hk. f.</td>
<td>Kan-tzu (4345), From Chiang-ta to Chueh-yung (5317)</td>
<td>Purplish</td>
<td>July 12-13, Aug. 18</td>
</tr>
<tr>
<td>ID</td>
<td>Scientific Name</td>
<td>Place</td>
<td>Flower Color</td>
<td>Date of Collection</td>
</tr>
<tr>
<td>----</td>
<td>-------------------------</td>
<td>----------------</td>
<td>--------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>12</td>
<td><em>P. longiflora</em> Rudolph</td>
<td>Teh-ke, Hai-tsu-sh'an (5013, 5024)</td>
<td>Yellow</td>
<td>July 24</td>
</tr>
<tr>
<td>13</td>
<td><em>P. melampyriflora</em> Franchet</td>
<td>Teh-ke (5109)</td>
<td>Purplish red</td>
<td>August 5</td>
</tr>
<tr>
<td>14</td>
<td><em>P. oederi Vahl</em></td>
<td>Teh-ke, Hai-tsu-sh'an</td>
<td>Light yellow</td>
<td>July 24</td>
</tr>
<tr>
<td>15</td>
<td><em>P. oederi var. heteroglossa</em> Frain</td>
<td>Chieh-to-sh'an (4219)</td>
<td>Yellow</td>
<td>July 3</td>
</tr>
<tr>
<td>16</td>
<td><em>P. przewalskii</em> Maxim. ssp. microphyton Li</td>
<td>Chieh-to-sh'an (4224)</td>
<td>Yellow</td>
<td>July 3 with purplish tint</td>
</tr>
<tr>
<td>17</td>
<td><em>P. rhinanthoides</em> Schrenk var. labellata Frain</td>
<td>Chieh-to-sh'an (4235)</td>
<td>Purplish red</td>
<td>July 22</td>
</tr>
<tr>
<td>18</td>
<td><em>I. rupestris</em> Franchet</td>
<td>To-pa to, Je-ya (5430, 5454)</td>
<td>Purplish red</td>
<td>August 22</td>
</tr>
<tr>
<td>19</td>
<td><em>P. siphonantha</em> Don</td>
<td></td>
<td>Purplish red</td>
<td>August 22</td>
</tr>
<tr>
<td>21</td>
<td><em>P. szetschanica</em> Maxim. ssp. Typica var. normalis Tsoong.</td>
<td>Teh-ke sung-lin-kou (4364)</td>
<td>Purplish red</td>
<td>July 15</td>
</tr>
<tr>
<td>22</td>
<td><em>P. tatiensis</em> Franchet</td>
<td>E-na (5269, 5275)</td>
<td>Purplish red</td>
<td>August 12</td>
</tr>
<tr>
<td>23</td>
<td><em>P. tongolensis</em> Franchet (?)</td>
<td>Teh-ke (5144, 5150a)</td>
<td>Purplish red</td>
<td>August 5</td>
</tr>
<tr>
<td>24</td>
<td><em>P. trichoglossa</em> Hk. f.</td>
<td>E-la (5275a)</td>
<td>Purplish red</td>
<td>July 24</td>
</tr>
<tr>
<td>25</td>
<td><em>P. verticillata</em> L.</td>
<td>Teh-ke, Hai-tsu-sh'an (5012b)</td>
<td>Purplish red</td>
<td>July 24</td>
</tr>
</tbody>
</table>
1. Agricultural Plants

Because of the high physical features of this area, only the species Hordeum vulgare L., var. nudum Hk. f. (lo-m'ai) is grown, and it grows only at the bottom lands of the river bed. This species of Hordeum vulgare needs only four and one-half to five months to grow. If the early part of the year is good, the Hordeum vulgare can be harvested and another crop of Triticum aestivum L., or Brassica campestris L., var. Rapa Hk. f. et Anders can be planted. Sometimes spring millet (growing period is half a month longer than Hordeum vulgare) is grown in a few regions. In the low river valley grounds Pisa sativum and Lens culinaris are also grown but the cultivated areas are more limited. In the cultivated Hordeum vulgare fields, there is a species of wild Avena sativus L. Because this wild species ripens half a month earlier than the Hordeum vulgare, its seeds will fall to the ground before the Hordeum vulgare can be harvested, so that next year this wild species of Avena sativus will grow again. Prior to the regular harvest, the farmers pull up the wild Avena sativus entirely and use them for animal feed. In the agricultural area the introduction and growing of cold resistant and early ripening crops can be successful. Such crops that can be introduced are: potato, Setaria italica Beauvois, Panicum miliaceum L., Panicum miliaceum var. effusum Alefeld, Avena sativus L., Avena nuda L., Secale cereale L., Cicer arietinum L., Linum usitatissimum L., Canna sativa L., Nicotiana rustica L., etc.

2. Staple Plants

The staple food of the people of Tibet is Hordeum vulgare which is ground into flour and made into to be eaten with beef, mutton and milk products. At present over 20 kinds of vegetables have been introduced at Kan-tzu, Ch'ang-tu and Lhasa. According to our investigations, wild local plants that can be used for food are Fritillaria Roylei Hook, Potentilla anserina L. (called "chu-e-ma" by the Tibetans), Capsella Bursa-pastoris Medicus, Rheum palinatum L., Rheum Alexandre Batal, Arctium lappa L., Malva sylvestris L., Portalaccio celeracea L., Artemisia pectinata Pallas, and Setaria italica Beauvois.

3. Timber Trees and Fuel Plants

The main forest timbers in this area are Ficea Balfouriana Rehdor et Wilson and Juniperus Pseudo-sabina Fischer et Meyer. Their timber reserve is most extensive,
These timbers can be used for construction, for making tools and utensils, and as raw materials for paper making. The tannin content of the Picea bark reaches 16.13% (according to 1953 analytic report of the Central Ministry of Forestry and Agriculture.) Besides these two species, Betula japonica Siebold var. Szechuanica Schneider and Populus davidiana Dode are also important timbers. In Tibet, Prunus fruticosa L. is called "p'ien-ma", and in the construction of Lama monasteries in Szechwan and Tibet, the branches of this tree are often bundled together and dyed black and used as cushions under the leaves. They are strong and beautiful. In areas of dense population where there are few forests, shrubs are used for fuel. In nearby houses, one finds cut prickly shrubs such as Sophora vicifolia Hance, Hippophae rhamnoides L., Caragana bicolor Komarov, and Rhamnus. Shrubbery trees are found some distances from villages, and they consist of Cotoneaster multiflora Bunge, Rhododendron fastigiatum Franchet, Spiraea trilobata L., Juniperus squamata Lambert, Prunus fruticosa L., Sibiraea laevigata Maximowicz var. angusta Rehder, and Lonicera. From this it can be seen that fuel is a very serious problem. If trees could grow in villages, this would help solve the problem of fuel shortage.

4. Feed Plants and Poisonous Grasses

In the area surveyed, including the regions of la-su and Cheng-k'o, the homes of the 39 tribes are strictly pastoral. All the other regions are both agricultural and grazing country. Sheep and yaks are the chief animals, raised, and in the summer and fall they are driven to high mountain pastures (elevation between 3,500 and 4,000 meters with the Cobresia and Blysmus as the main grazing grasses forming the main cyperaceae grassy steppe). In spring and winter the herds are driven to the lower part of the valleys (under 3,000 meters altitude). South of Ch'ang-tu along the arenaceous shale slopes of the lower valleys of the Lan-ts'ang River, four species of superior feed grasses, Spodiopogon, Themeda, Bromus, and Pennisetum, grow into a vast grassy land which can be used for grazing, or they can be cut and stored for animal feed. In some places, the grass Urtica cannabina L. is cut for winter feed. Along the highway from Kan-tzu to Ch'ang-tu only the species of Pennisetum, Stipa, and tall grasses were found. Their distribution is scattered, which makes it difficult to harvest. During the winter when heavy snow covers the mountains, the herds are forced to be driven to shrub forests for grazing. Therefore, the cultivation of grazing grass is a serious problem. Poisonous grasses

...
in this area are many and varied, especially along both sides of the highway. Because the area is over grazed, more poisonous grasses grow. One of the most important poisonous grasses is Stipa conferta Poiret that grows at an elevation of 3,000–4,000 meters. It grows ruggedly in arid and alkaline calcareous soil and when fully mature, it reaches the height of one meter or more. After the animal has eaten it, the first symptom is a stomach-ache, followed by acute constipation and urinary obstruction leading to death of the animal. The next poisonous grass is the species Astragalus secundus De Candolle of the Leguminosae family which animals mistakenly eat. This grass is distributed throughout the farming regions that are below the elevation of 3,500 meters. After hungry animals have eaten a large quantity of this grass, they first show dementia behavior jumping and kicking and running in all directions. After continued eating of this grass they become more demented with their heads hanging low, and refuse to eat. Finally acute constipation and urinary obstruction set in. The animals become dehydrated and finally die. The conditions exhibited are like loco poisoning. Other poisonous grasses such as tu-nac-yung (phoneticized Tibetan) (aconitum), helica, and Delphinium grow profusely along the highway roadsides. Studies should be made on their control and eradication.

5. Pharmacological Plants

Besides animal derived pharmacological products such as musk, deer's antlers, and antelope horns, there are many varieties of pharmacological plants in this surveyed area. The important ones are listed below.

(1) Ch'ung-ts'ao (also known as Tung-ch'ung-hsiat-ts'ao-Cordyceps sinensis Sacc.) -- This variety of plant commonly grows in damp regions in forests and shrub forests. They are dug up in April–May of each year. According to the 1950 estimate of the Office of Economics of the Si-kang People's Autonomous Government, the annual production of Ch'ung-Ts'ao in northwest Szechwan was over 20,000 catties. They are most abundant in Lang-ting, Li-hua, and Yu-shu regions. They are important tonics.

(2) Rheum palmatum Linnaeus -- Distribution of this plant is found in the wide sunny and semi-sunny valley slopes at an elevation of 3,000–4,000 meters. Sometimes they are found in large single homogenous groups. When the "tea" from boiling roots of this plant is fed to horses, it can cure their constipation and urinary obstruction. It is estimated that the annual production of this
plant in northwest Szechwan is over 500,000 catties. These are dug up and sliced in the spring of each year. The root bark is rich in tannin. During the year 1950-51 the Kan-ting Native Products Company purchased 180,000 catties of this plant.

(3) Fritillaria Hoylei Hooker. This plant is distributed among shrub forests at an elevation of 3,000-4,000 meters. According to the 1950 estimate of the Office of Economics of the Si-kang Area People's Autonomous Government the annual production of this plant in this surveyed area was between 40,000-50,000 catties. But according to the estimates made by the Kan-ting Native Products Company ending June 1959, over 58,000 catties have already been purchased. Kang-ting, Ch'iu-lung, Tao-fu, Teh-ke, Li-hua, and Ch'ang-tu sien's produce large quantities of this plant.

(4) Gentiana macrophylla Pallas. A large quantity of this plant is produced on the slopes of wide river beds at an elevation between 3,000 and 3,500 meters. Its growth is especially abundant along road sides of highways because animals do not eat it. In late fall or early spring of each year, the roots are dug up for medicinal use.

(5) Ephedra. Five species of Ephedra were collected in this surveyed area. Of these varieties, the species of Ephedra Gerardiana Wallich is widely distributed and produced. It has tall stems and long branches. The farmers around Kan-tzu cut and collect these for fuel. There are large distributions of these plants along the banks of Ya-lung-chia and Chin-sha-chiang. There is another species that resembles E. intermedia Schrenk et Meyer (?) that grows in large groups along the banks of Lan-ts'ang River. The entire plant is white and is about half a meter tall. Along the banks of Lan-ts'ang River a small number of E. sinica Stapf was also seen among the shrub forests. There is another species, E. Fedtschenkoe O. Pauls that was sometimes seen along river sand banks. This is a very small plant that is not taller than 5 centimeters. Besides these species there is another species of Ephedra that has profuse, dense and hard branches forming the shape of a bun. This was found at Chu-chia on the banks of Lan-ts'ang River at approximately 4,000 meters elevation. The production of this species is quite abundant.

Production of the following plants -- Paeonia Delavayi Franchet, Hyoscyamus agrestis litaibel, Anemarrhena asphodeloides, Xanthoxylum simulans lince, the Saussureas and Flutycoda grandiflora, is also great but they will not be dealt with here in detail.
Other special use plants — Horticultural plants in this area that can be improved are the two species of the family, Riveae alpistre Dene and Rubus parvifolius Rolfe, and the several species of Prunus ansu Komarov, P. tangutica Koehne, and the persimmon. These are all cold resistant fruit trees, and attempts should be made to encourage their cultivation.

### V. COMPARATIVE CHART ON CHINESE AND SCIENTIFIC PLANT NAMING

<table>
<thead>
<tr>
<th>(1) Gymnosperms</th>
<th>Abies Delavayi Franchet</th>
<th>Larix Mastersiana Rehder et Wilson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinaceae</td>
<td></td>
<td>Picea Sartoriana Rehder et Wilson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P. Purpurea Masters</td>
</tr>
<tr>
<td>Cupressaceae</td>
<td>Juniperus chinensis Linnaeus</td>
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</tr>
<tr>
<td></td>
<td>J. pseudo-sabina Fischer et Meyer</td>
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<tr>
<td></td>
<td>J. squamata Lambert</td>
<td></td>
</tr>
<tr>
<td>Gnetaceae</td>
<td>Ephedra Fedtschenkoeae O. Pauls</td>
<td></td>
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<tr>
<td></td>
<td>E. Girardiana Wallich</td>
<td></td>
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<tr>
<td></td>
<td>E. intermedia Schrenk et Meyer (?)</td>
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<tr>
<td></td>
<td>E. sinica Stapf</td>
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<table>
<thead>
<tr>
<th>(2) Angiosperms</th>
<th>Abies Davidiana Dode</th>
<th>Populus cathayana Rehder</th>
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<tbody>
<tr>
<td>Salicaceae</td>
<td>Salix Souliei Seemen</td>
<td>S. Matsudana Koidz</td>
</tr>
<tr>
<td>Betulaceae</td>
<td>Betula japonica Siebold, var. Szechuanica Schneider</td>
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<tr>
<td>Ulmaceae</td>
<td>Ulmus pumila Linnaeus</td>
<td></td>
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<tr>
<td>Moraceae</td>
<td>Cannabis sativa Linnaeus</td>
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</tr>
<tr>
<td>Urticaceae</td>
<td>Urtica cannabina Linnaeus</td>
<td></td>
</tr>
<tr>
<td>Polygonaceae</td>
<td>Pagopyrum esculentum Moench</td>
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<tr>
<td></td>
<td>Polygonum sibiricum Laxmann</td>
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<td></td>
<td>P. tenuifolium Kung</td>
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<td></td>
<td>P. sphaerostachyum Kung</td>
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<td></td>
<td>P. viviparum Linnaeus</td>
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<tr>
<td></td>
<td>Rheum Alexandre Batal</td>
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<tr>
<td></td>
<td>R. palmatum Linnaeus</td>
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</tbody>
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- 25 -
<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
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<tbody>
<tr>
<td><strong>Fumariaceae</strong></td>
<td>Fumaria officinalis Linnaeus</td>
</tr>
<tr>
<td><strong>Caryophyllaceae</strong></td>
<td>Arenaria kausensis Maximowicz</td>
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<tr>
<td></td>
<td><em>Stellaria decumbens</em> Edgeworth</td>
</tr>
<tr>
<td></td>
<td>Thylacospermum caespitosum Schischkin</td>
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<tr>
<td><strong>Ranunculaceae</strong></td>
<td><em>Paeonia helvayi</em> Franchet</td>
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<tr>
<td></td>
<td><em>Aconitum sp.</em></td>
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<tr>
<td><strong>Oleaceae</strong></td>
<td><em>Meconopsis Horridula</em> Hk. f. et Thoms</td>
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<tr>
<td><strong>Papaveraceae</strong></td>
<td><em>M. integrifolia</em> Franchet</td>
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<tr>
<td><strong>Cruciferae</strong></td>
<td><em>Brassica campestris</em> Linnaeus var. <em>Rapa</em> Hk. f. et Anders</td>
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<tr>
<td><strong>Saxifragaceae</strong></td>
<td><em>Capsella Bursa-pastoris</em> Medicus</td>
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<tr>
<td></td>
<td><em>Ribes alpestris</em> Dene var. giganteum* Janczewski</td>
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<td></td>
<td><em>Cotoneaster adpressa</em> Bois</td>
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<tr>
<td><strong>Rosaceae</strong></td>
<td><em>C. horizontalis</em> Decaisne</td>
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<tr>
<td></td>
<td><em>C. multiflora</em> Bunge</td>
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<td></td>
<td><em>Malus kausensis</em> Schneider</td>
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<td></td>
<td><em>Prunus Ansu Komarov</em></td>
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<td></td>
<td><em>P. tangutica</em> Kohne</td>
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<td></td>
<td><em>P. Serrulata</em> Lindl.</td>
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<td></td>
<td><em>P. Tomentosa</em> Thunb.</td>
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<tr>
<td></td>
<td><em>Potentilla anserina</em> Linnaeus</td>
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<tr>
<td></td>
<td><em>P. bifurca</em> Linnaeus</td>
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<tr>
<td></td>
<td><em>P. fructicosa</em> Linnaeus</td>
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<tr>
<td></td>
<td><em>Rosa Omeiensis</em> Rolfe</td>
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<tr>
<td></td>
<td><em>Rubus Parvifolius</em> Linnaeus</td>
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<td></td>
<td><em>Sibiricae laevigata</em> Maximowicz var. <em>angusta</em> Rehder</td>
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<tr>
<td></td>
<td><em>S. alpina</em> Pallas</td>
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<tr>
<td></td>
<td><em>S. trilobata</em> Linnaeus</td>
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<tr>
<td></td>
<td><em>Astragalus secundus</em> De Candolle</td>
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<tr>
<td></td>
<td><em>Bauhinia Bonatiana</em> Pampanini</td>
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<tr>
<td></td>
<td><em>B. Faberi</em> Oliv.</td>
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<tr>
<td></td>
<td><em>Caragana bicolor</em> Komarov</td>
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<td></td>
<td><em>C. brevifolia</em> Komarov</td>
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<tr>
<td></td>
<td><em>C. spinosa</em> De Candolle</td>
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<tr>
<td></td>
<td><em>C. jubata</em> Poiret</td>
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<tr>
<td></td>
<td><em>Cicer arietinum</em> Linnaeus</td>
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<tr>
<td></td>
<td><em>Lens culinaris</em> Medicus</td>
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<tr>
<td></td>
<td><em>Lespedeza dahurica</em> Schindler</td>
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<tr>
<td></td>
<td><em>Salweania hardii</em> Baker</td>
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<tr>
<td></td>
<td><em>Vicia amoena</em> Fischer var. oblongifolia* Regel</td>
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<tr>
<td></td>
<td><em>V. unijuga</em> Al. Braun</td>
</tr>
<tr>
<td></td>
<td><em>Sophora viciifolia</em> Hance</td>
</tr>
</tbody>
</table>

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- 26 -
Linaceae
Linum perenne Linnaeus var. Sibiricum Planchon
L. usitatissimum Linnaeus
Xanthoxyllum simulans Hance
Malva sylvestris Linnaeus
Myricaria bracteata Royle
Stellera chamaejasme Linnaeus
Wikstroemia canescens Rehd.
Hippophae rhamnoides Linnaeus
Rhododendron fastigiatum

Rutaceae

Malvaceae

Tamaricaceae

Thymelaeaceae

Elaeagnaceae

Ericaceae

Primulaceae
R. Irzewsckii Laximowicz

Gentianaceae
R. Purdomii Rehder et Wilson

Solanaceae
Androsace Tapete Laximowicz

Bignoniaceae
Gentiana macrophylla Pallis

Caprifoliaceae
Pyoscyamus agrestis Kitaibel

Compositae
Nicotiana rustica Linnaeus

Lonicera glauca Hk. f. et Thoms

2. Monocotyledons

Gramineae
L. hispida Pallis

Cyperaceae
L. microphylla Wildenow

Avena fatua Linnaeus
A. nuda Linnaeus

P. miliaceum Linnaeus var.

Panicum miliaceum Linnaeus

Cobresia capillifolia C. B. Clarke

C. bifida Tang et Wang

Pennisetum flaccidum Grisebach

Secale cereale Linnaeus

Blechnum compressus Lanz

Setaria italicca Beauvios

Cobresia pygmaea C. B. Clarke

Stipa conferta Poir et

C. Royleana Boeck

S. mongolica Turczaninow

Scirpus littoralis Schrad.

Bordeum vulgare Linnaeus var.

Fritillaria Roylei Hooker

nudun Hk. f.

Saussurea sp.
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3. Hooker, J. D., 1879-1897. The Flora of British India, I-VII.
6. Hedlin, Sven, 1922. Southern Tibet II, A List of Flowering Plants from Inner Asia, pp. 27-98.
Figure 1. Map Showing Northeastern Sachalin Phyto Survey Route and Parallel Order of Plant Distribution.

I. Arid Shrubs Steppe Region (3,000-5,000 meters)
1. Woody Plants
2. Herbaceous Plants
II. Semi-Arid Forest Steppe Region (3,000-3,000 meters)
1. Trees
2. Herbaceous Plants
III. High Mountain Shrub Steppe Region (3,000-4,500 meters)
1. Woody Plants
2. Herbaceous Plants
IV. High Mountain Steppe Region (1,400-1,800 meters)
1. Herbaceous Plants
Figure 2. Chart Showing the Perpendicular Order of Plant Distribution in Northwest Szechwan and Chief Forest Species.

1. Snow line
2. Exposed bare rocks
3. Frozen plantium belt
4. High-mountain steppe strata
5. High-mountain shrub and steppe belt
6. High-mountain shrub strata
7. Sunny slopes
8. The main grasses in the steppes are Coptis compacta, C. D. Clarke, Coptis capillifolia, C. D. Clarke, Coptis Poyleana, Bock, etc.
9. Small amount
10. Deciduous-leaf forest strata
11. The chief grasses in the steppes are Elymus compressus, Dars, Coptis bifida, Tang et Hau, etc.
12. Forest steppe belt
13. Acerose-leaf trees
14. Mixed broad-leaf and Acerose-leaf trees strata
15. Broad-leaf trees
16. (Land containing Hordeum vulgare L. var nudum Hk f. used for the cultivation of Salicaceae, Populus, and Ulmaceae saplings)
   (The chief grasses in the steppes are Blysmus compressus, Panz, Stipa sp. and Cobresia Bifida, Tang et Wang)