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印度喜馬拉亞山東南麓大吉嶺區之土壤與植物

侯學煜

（摘　要）

1945年10月中旬，作者留印三月另一週，會作三次野外調查，計包括印緬邊區、恆河平原及喜馬拉雅山東南麓等三區，茲先將大吉嶺區調查結果，草成此文。

調查區域

大吉嶺位於喜馬拉雅山東南麓，在我國西藏邊境，全區是山地，海拔自1000到9000呎不等，主爲酸性的片麻岩地層，在拔海6500呎地點，年平均氣溫爲56.3°F.，年雨量爲122吋。

土　壤

灰壤——灰棕壤組合：在拔海8500呎左右的山頂，灰壤見於草地上，而灰棕壤則發育在森林之下。

灰棕壤——灰化黃壤組合：在拔海7000—8000呎地帶，森林下仍是灰棕壤，而草地上則爲灰化黃壤。

灰化黃壤——粗骨土組合：在拔海1000—3000呎地帶，片麻岩生成灰化紅壤，酸性砂岩生成礫質土。

全區土壤特徵可歸納如下：

(1) 土壤pH值：全區因土壤母質爲酸性片麻岩，各類土壤剖面亦爲酸性反應；pH值約自4.0至5.5。A_1層之pH值恆較B層爲大，而土壤剖面內之A層及B層均較母岩之酸度爲高。

(2) 土壤有機質：從土壤有機質分析結果觀之，顯示植物種類對於土壤有機質之含量高低，有密切的關係，在拔海8500呎之地帶，發育於森林下的灰棕壤，表土含有機質33.92%，而同處草類和蕨類植物發育下的灰壤的表土，僅含有機質11.08%，但在相同的植物環境下，拔海高度或局部氣候，也是支配土壤有機質含量的重要因素，例如在拔海3000呎地帶，長有草類的灰化紅壤，僅有極薄之有機質層，該層有機質含量爲3.37%，而在拔海8500呎地帶，長有草類的灰壤，則有較厚層有機質，其含量爲11.08%。

(3) 可溶性鋁質：全區土壤含有高量可溶性鋁，大約自20至160 p.p.m.，其含量與pH值高低相關，土壤pH值愈酸，可溶性鋁含量就愈高。

(4) 可溶性鈣鎂及鉀質：全區土壤之可溶性鈣，鎂及鉀等之含量均較低，但就同一土壤剖面而言，富於有機質的A_0或A_1層的鈣鎂和鉀質，常較B層爲高，此點顯示此等成份是來自植物遺體，亦即指示土壤中有機質與肥力之關係。

(5) 全區土壤有效磷含量均甚低。

(6) 全區土壤硝酸態氮之含量均極低，並有下淋現象。

植　物

本文所論植物，僅以作者所採集而經各專家鑑定爲限，其中以蕨類植物爲主。

本區的土壤都是酸性反應，所見的植物是以嫌鈣性者爲主，這些嫌鈣性植物與拔海高度的關係很顯著，茲將常見的植物種類，敍述如下：

（一）主分佈於拔海 7000—8500 呎地帶的植物：

蕨類植物

Dennstaedtia scabra (Wall.) Moore
Dicranopteris linearis Under.
Hiciropteris glauca Under.
Hymenophyllum crispatum Wall.
Hymenophyllum exsertum Wall.
Lindsaya cultrata Sw.
Lycopodium clavatum L.
Plagiogyria pycniphylla (Kunze) Mett.
Pteridium aquilinum Wightianum Trym.
Pteris aspericaulis Wall.

種子植物

Castanopsis tribuloides A. DC.
Lindera pulcherrima Bth.
Osbeckia crinata Bth.
Rhododendron arboreum Sm.
Rhododendron grande Wight
Pieris formosana D. Don
Vaccinium refereseeda HK.
Vaccinium Serrasm Wight

（二）主分佈於 1000—3000 呎地帶的植物：

蕨類植物

Adiantum philippense L.
Blechnum orientale L.
Aglaomorpha coronans copel
Lycopodium cernuum L.
Nephrolepsis cordifolia Pressl
Tectaria spp.
Polypodium lucidum Roxb.

種子植物

Oxysoira paniculata DC.
Themedra arundinacea Ridl.

A Preliminary Study of the Soils and Vegetation of Darjeeling Area, Southeastern Himalaya, India

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INTRODUCTION

In the winter of 1945, while delayed in India waiting for the passage to the United States, the author investigated the soil geography of three different regions in that country. For two weeks from late November to early December, he undertook his investigation in Darjeeling Area, Southeastern Himalaya. There has been little published information available on the soils of this area. The present paper briefly describes some of the soils observed and of the vegetation, chiefly dealing with the Pteridophyta, which are grown on those soils.

The methods used in the examination of the soils are as those described by the different authors. The determinations of organic matter were made by the titration method described by Peech and others (6). The chemical analyses of the available elements were made largely according to the procedures described by Merkle (4). The pH values of the soils were determined by the use of the quinhydrone electrode as described by Piper (7).

The author wishes to thank Dr. S. K. Mukerjee, curator of the Lloyed Botanic Garden of Darjeeling, India for his valuable suggestions and assistance given throughout the field work, and his aid in identifying all the flowering plants and some Pteridophyta. Most Pteridophyta mentioned in this paper were identified by Mr. C. V. Morton, associate curator of the Division of Plants, Smithsonian Institution, D. C., U. S. A. To him the author is indebted. Finally, a word of thanks must be given to Dr. F. G. Merkle, professor of soil technology at the Pennsylvnia State College, Pa., U. S. A. for his guidance and suggestion regarding the soil analysis and the privilege of analyzing the soils in his soil testing laboratory.

AREA SURVEYED

The area surveyed is a part of southeastern Himalaya situated approximately 27° 3' N. latitude and 88° 18' E. longitude at a distance of about 386 miles by rail from Calcutta.

Topographically, the area is mountainous and hilly. The elevation ranges from 1,000 to 9,000 feet. To the east are the mountains of Bhutan rising above 17,000 feet in

Chumango or Dopendikand. To the west lie the mountains of Nepal-Sandakphu at a height of 12,000 feet. On the northern horizon at a distance of about 45 miles, the majestic snowy mountain of Kiuchinjunga at a height of 28,146 feet rises above other peaks.

Geologically, most of the area is covered by micaceous, coarse gneiss and schists (10).

There is a meteorological station at the elevation of about 6,500 feet. The maximum temperature is about 70°F in hot months and the minimum temperature is 35°F in cold months. The mean annual temperature is 56.3°F (Table 1), and the average rainfall is 122 inches a year. Snowfall is occasional in winter (Normand, 1937)(5).

No meteorological station is found at higher elevations, but some stations at lower elevations take records of rainfall only. The rainfall at the elevation of about 4,800 feet is the most heavy, being 161 inches a year. The climate at the bottom of the mountain as evidenced by the natural vegetation shows the tropical features. There the elevation is below 1,000 feet and the annual rainfall is 131 inches.

Table 1. Monthly and Annual Temperature of Darjeeling °F (1900—1942)

	Mean max.	Highest	Mean min.	Lowest	Mean
Jan.	47.4	59	35.4	34	41.4
Feb.	47.8	59	36.2	—	42.0
Mar.	55.0	64	42.4	40	48.7
Apr.	60.8	68	48.3	45	54.5
May	62.6	67	52.0	48	57.3
June	64.7	70	56.2	47	60.4
July	65.5	68	57.7	56	61.6
Aug.	65.2	75	57.3	56	61.2
Sept.	63.3	72	55.7	54	60.0
Oct.	61.4	74	50.0	41	55.7
Nov.	55.8	61	43.0	37	49.4
Dec.	50.3	61	36.7	35	43.5
Year					56.3

Tea is the most important cash crop in this area. Other crops grown are maize, Irish potatoes, and some rice.

In this mountainous area the maximum elevation of tea planatation is 7,000 feet above sea level. Above this elevation, this crop can not be grown normally and a very low yield would be obtained. The most favorable elevation for tea plantation in this area is around 5,000 feet at which elevation the yield of the tea is high, and the flavor excellent. In places below 3,000 feet though the yield is good, the flavor is poor.

Maize is a very important crop near Kurseong at an elevation of 4,800 feet. A very low yield is obtained at elevation above 7,000 feet. In Kurseong the maize is sown in February and harvested in August.

The Irish potato is also a common crop. It can be planted at places up to an elevation of 10,000 feet. Good quality and high yield are obtained at the high elevations. In Darjeeling at an elevation of 7,000 feet potatoes are planted in February and harvested in July.

Rice is not commonly raised in this mountainous region, being confined to areas below 3,000 feet. Its growth period is from February to October.

PODZOLIC SOIL-GRAY BROWN PODZOLIC SOIL ASSOCIATION

This soil association occurs in areas at an elevation of 8,500 and 9,000 feet. The podzolic soil is found locally on exposed areas on which grasses and ferns are native; while the gray brown podzolic soil is seen under forest cover.

A profile of podzolic soil is described as follows:

Location: Senchal, Ghoom, Darjeeling

Topography: Mountain top, 8578 feet in elevation

Parent rock: Micaceous gneiss

Vegetation: Grasses and ferns

Profile description:

A_1 0—7 cm. (Hl—1) Very loose and friable, granular, light gray brown clay loam with many grass roots.

A_2 7—35 cm. (Hl—2) Yellow brown, friable loamy clay with feebly cloddy structure and many grass roots.

B 35—50 cm. (Hl—3) Pale yellow brown, loose and friable loamy clay with fewer roots.

C 50 cm. downwards. (Hl—4) Brown micaceous gneiss.

The analytical data are shown in Table 2.

Table 2. Analytical data for Senchal podzolic soil

(Ions extractable 1/2 N CH_3COONa at pH 5.0 except determinations of pH and organic matter)

Soil Sample number	Depth in cm.	NO_3 p.p.m.	P p.p.m.	K p.p.m.	Ca p.p.m.	Mg p.p.m.	Al p.p.m.	pH	Organic matter %
Hl—1	0—7	trace	2.5	150.0	1,600.0	80.0	60.0	5.45	11.08
Hl—2	7—35	trace	2.5	90.0	800.0	80.0	120.0	5.22	3.23
Hl—3	35—50	40.0	2.5	60.0	200.0	20.0	160.0	4.63	8.16
Hl—4	50—rock	0.0	2.5	60.0	0.0	20.0	40.0	5.37	—

The above data give a clear picture of the nature of the process of podzolization (Robinson, 1932) (Byers and others, 1938). In the first place, there is a marked rise in the organic matter content in the B horizon. Secondly, the increase in active aluminum content with depth is shown. Thirdly, there is some evidence of nitrate movement in the rise in the B horizon. In addition to these data, it is evident that the accumulation of clay in the B horizon is found from the field observation.

On this soil the dominant species of grasses and ferns are:

Elsholtzia strobilifera Mth.(H5068)

Anaphalis contorta H. K. f. (H5074)

Pteris aspericaulis Wall. (H5078)

Lycopodium clavatum Linn. (H5057)

In addition, one species of Bamboo is frequently seen.

A profile of gray brown podzolic soil is given below:

Location: Senchal, Ghoom, Darjeelin

Topography: 8550 feet in elevation

Parent rock: Micaceous gneiss

Vegetation: Forest

Profile description:

A 0—2 cm. (Hl—5) Leaf litter.

A 2—7 cm. (Hl—6) Very friable, brown clay loam with rich humus.

B 7—18 cm. (Hl—7) Yellow brown, friable loam with many roots.

C 18 cm. downwards (Hl—8) Weathered gneiss.

The analytical data of the above profile are presented in Table 3.

The data indicate an accumulation of nitrate and active aluminum in the B horizon. The presence of a high content of organic matter, and of available phosphorus, potassium, calcium, and magnesium in the A horizon results from the leaves of the trees.

Table 3. Analytical data for Senchal gray brown podzolic soil

(Ions extractable in 1/2 N CH_3COONa at pH 5.0 except determinations of pH and organic matter)

Soil sample number	Depth in cm.	NO_3 p.p.m.	P p.p.m.	K p.p.m.	Ca p.p.m.	Mg p.p.m.	Al p.p.m.	pH	Organic matter %
Hl—5	0—2	trace	600.0	600.0	3,200.0	200.0	30.0	4.83	—
Hl—6	2—7	0.0	5.0	120.0	800.0	160.0	100.0	4.63	38.92
Hl—7	7—18	20.0	2.5	60.0	200.0	20.0	120.0	4.21	9.27
Hl—8	18—rock	0.0	2.5	30.0	200.0	20.0	60.0	5.04	—

The remarkable features of vegetation growing on this soil are comparatively dense population, more complex floristic composition and presence of three strata. The composition

of the three strata is given as follows:

Stratum 1. Trees are 10 meters or more in height. The following two species are dominant.

Rhododendron grande Wight (H5070)

Lindera pulcherrima Bth. (H5073)

Stratum 2. One species of Bamboo having a height of 1—2 meters is dominant (H5069)

Stratum 3. All plants of this stratum are undergrowth. They are all shadeloving plants.

Flowering plants:

Anisiaea pleropoda (H5072)

Carex bengalensis Rosb. (H5071)

Daphue cannabina Wall. (H5083)

Pteridophyta

Asplenium nigrifes (Bl.) Morse (H5077)

Athyrium macrocarpum var. Atkinsonii Clarke (H5085)

Diplazium sp. (H5079) (H5080)

Lithostegia foeniculacea (Hook.) Ching (H5075)

Plagiogyria pydnophylla Kedz. (H5081)

Beside the above mentioned plants, Trichomanes fiscidiforme L (?) (H5076) is found on the surface of gneiss under moist and shady conditions, and Arthromis Wallichiana Ching (H5084) and Oleandra Wallichii (Hook) Presl (H5091) are frequently seen climbing the trees of Stratum 1.

GRAY BROWN PODZOLIC SOIL-YELLOW PODZOLIC SOIL ASSOCIATION

This soil association is found at an elevation ranging from 4,000 to 7,000 feet.

The description of a gray brown podzolic soil which is distributed at places with forest is as follows:

Location: Darjeeling

Topography: 7,100 feet in elevation

Parent rock: Gneiss

Vegetation: Forest

Profile description:

A_1 0—2 cm.* (H1—9) Light brown, very friable, granular silt loam.

A_2 2—20 cm. (H1—10) Light gray brown, loose and friable silty clay loam with weakly developed cloddy structure.

B 20—35 cm. (H1—11) Gray brown, loose and friable, granular silty clay loam.

BC 35—85 cm. (Hi—12) yellowish brown sandy loam.

C 85 cm. downwards. (H1—13) Weathered gneiss, rich in mica.

*No A_0 was taken, but was incorporated with A_1.

The analytical data for above soil are shown in Table 4.

Table 4. Anaiytical data for Darjeeling gray brown podzolic soil

(Ions extractable in 1/2 N CH_3COONa at pH 5.0 except determinations of pH and organic matter)

Soil Sample number	Depth in cm.	NO_3 p.p.m.	P p.p.m.	K p.p m.	Ca p.p.m.	Mg p.p.m.	Al p.p.m.	pH	Organic matter %
H1—9	0—2	0.0	2.5	150.0	2,400.0	240.0	100.0	5.14	22.22
H1—10	2—20	trace	2.5	30.0	1,200.0	0.0	160.0	4.03	7.86
H1—11	20—35	trace	2.5	30.0	0.0	0.0	160.0	4.15	3.98
H1—12	35—85	0.0	2.5	30.0	0.0	0.0	100.0	4.18	0.89
H1—13	85—rock	0.0	2.5	90.0	0.0	0.0	20.0	6.05	—

The data give no indication of accumulation of organic matter, but show the translocation of active aluminum and, to a smaller degree, nitrate in the B horizon. Furthermore, the increase in pH with depth is slightly shown. The considerable amount of available potassium, calcium, magnesium, and organic matter in the A horizon is also due to the humification of leaves.

Growing on this soil, the following woody plants are found.

Castanopsis tribuloisis A. DC. (H5126)

Cryptomeria japonica D. Don (H5128)

Daphne Sureil Prain (H5122)

Mahonia acanthifolia Tak. (H5124)

Muchilus odoratissimus Nees (H5133)

Osbeckia crinata Bth. (H5102)

Pieris formosana D. Don (H5054)

Quercus laminellesa Sm. (H5225)

Rhododendron arboreum Sm. (H5132)

Sporarea corynebosa Rosb. (H5127)

Strobilanthes divericata T. And. (5134)

Vaccinium refresceda HK. f. (H5056)

Vaccinium serrasum Wight (H5121)

The following ferns are the undergrowth. Some of them are grown on the rock surface.

Angiopteris evecta (Forst) Hoffm. (H5103)

Asplenium acubatum var. rufobarbatum (H5117)

Asplenium ensiforme Wall. (H5062)

Asplenium latifolium Don (H5120)

Asplenium nigripes (Oze) Moore (H5108)

Asplenium onyphyllum Wall. (H5099)

Athyrium macrocarpum (Blume) Bedd. (H5059) (H5099) (H5114)

Athrium macrocarpum var. Atkinsonii Clark (H5661) (H5064)

Athrium nigripes (Blumo) Moore (H5116)
Cystopteris tenuiseeta (Blume) Mett. (H5111)
Dennstaedtia scabra (Wall.) Moore (H5109)
Dicranopteris linearis (Burrm) Under. (H5113)
Dryopteris aurita (Hook.) C. Chr. (H5200)
Dryopteris paleacea (Swartz) Hand-Mzt (H5092)
Gymnogramme acurita HK. (H5101)
Hiciopteris glauca Under. (H5508)
Hymenophyllum Cripatum Wall. (H5118)
Hymenophyllum exsertum Wall. (H5098)
Lindsaya cultrata Sw. (H5097)
Lithostegia fosniculacea (Hook.) Ching (H5075)
Nephrodium molle Sch. (H5104)
Oleandra Wallichii (Hook.) Presl. (H5091)
Perenca cyatheoids Don (H5093)
Plagiogyria bryanophyllan Kwaz. (H5058)
Plagiogyria pycniphylla (Kunze) Mett. (H5096)
Polypodium amoenum Wall, (H5090)
Polypodium Griffithiana HK. (H5089)
Polypodium juoladifolium (H5094)
Polypodium normal Don (H5112)
Poeypodium subdigesatum (H5065)
Polystichum aculeasum Sw. (H5067)
Polystichum yunnanense Christ (H5117)
Pteridium aquilinum var. Wightianum (G.) Trym (H5106)
Selaginella monosgerma (H5110)
Woodwardia radicans Sw. (H5095)

In addition to the above mentioned ferns, Carex bengalensis Roxb. (H5050) and Juncus sp. (H5051) are frequently seen.

In the exposed area, some epiphyta such as Vaccinium nummularia HK. f. (H5053) and Hemiophragna beterophylla Wall. (H5052) are grown on the surface of the soil.

The yellow podzolic soil is distributed widely in open areas which are not covered by forest. One profile of this soils is described as follows:

Location: Arya, 3 miles west of Darjeeling
Topography: 5500 feet in elevation
Parent rock Gneiss
Vegetation: Grasses, ferns and tea shrubs
Profile description:

A 0—15 cm. (Hl—24) Light gray brown, very friable, fine sandy loam, containing trace of humus.

B1 15—60 cm. (Hl—25) Yellow brown with grayish tint, loose and friable fine sandy

loam.

B_2 60—120 cm. (H1—26) Yellow brown fine sandy loam.

C 120 cm. downwards. (H1—27) Weathered gneiss.

Table 6 Analytical data for Arya yellew podzolic soil

(Ions extractable in 1/2 N CH_3COONa at pH 5.0 except determinations of pH and organic matter)

Soil sample number	Depth in cm.	NO_3 p.p.m.	P p.p.m.	K p.p.m.	Ca p.p.m.	Mg p.p.m.	Al p.p.m.	pH	Organic matter %
H1—24	0—15	0.0	2.5	120.0	200.0	80.0	80.0	4.50	3.89
H1—25	15—60	trace	2.5	60.0	0.0	0.0	80.0	4.50	1.32
H1—26	60—120	0.0	2.5	80.0	trace	0.0	120.0	4.38	1.47
H1—27	120—rock	0.0	2.5	60.0	trace	0.0	20.0	5.04	—

The above data show a slight movement of nitrate, active aluminum, and organic matter in the profile.

On this soil the following species of ferns are found.

Equisetum sp. (H5184)

Pteris biauria L. (H5191)

Sphenomeris chinensis (L.) Maxon (H5181)

On the surface of gneiss, Aglaomorpha cornaus (Wall.) Copel (H5194) is frequently seen. Several species of grasses were noted.

RED PODZOLIC SOIL-SKELETAL SOIL ASSOCIATION

This soil association is found in areas ranging from 1,000 to 3,000 feet above sea level. The red podzolic soil is derived from gneiss, while the skeletal soil, from acid gray sandstone.

A profile of red podzolic soil is described as follows:

Location: Didarpong valley, Darjeeling

Topography: Valley, 3550 feet in elevation

Parent material: Redeposits of weathered gneiss

Vegetation: Shrubs, grasses, and ferns

Profile description:

A_1 0—1 cm. (H1—20) Very light gray brown, very friable, granular sandy loam.

A_2 1—25 cm. (H1—21) Light yellow brown, friable clay loam with cloddy structure.

B_1 25—55 cm. (H1—22) Yellow brown with reddish tint, slightly compact clay loam with cloddy structure.

B_2 55—120 cm. (Hl—23) Reddish brown, very compact clay loam with cloddy structure.

The analytical data of the above profile are given in Table 7.

Table 7. Analytical data for Sarpong red podzolic soil

(Ions extractable in 1/2 N CH_3COONa at pH 5.0 except determinations of pH and organic matter)

soil sample number	Depth in cm.	NO_3 p.p.m.	P p.p.m.	K p.p.m.	Ca p.p.m.	Mg p.p.m.	Al p.p.m.	pH	Organic matter %
Hl—20	0—1	0.0	2.5	150.0	0.0	120.0	100.0	5.08	3.37
Hl—21	1—25	0.0	2.5	30.0	200.0	20.0	140.0	4.30	0.63
Hl—22	25—55	0.0	2.5	60.0	200.0	20.0	100.0	4.03	0.40
Hl—23	55—120	0.0	2.5	30.0	400.0	20.0	100.0	4.30	0.23

Several characteristics of this soil which are different from those of the soils found at higher elevations may be mentioned as follows:

In the first place, the A_1 horizon is much thinner, and its organic matter content is much lower. Secondly, there is no clear indication of movement of active aluminum. The different horizons contain approximately similar amounts of active aluminum. Finally, the subsoil is reddish color which has not been observed at places of a higher elevation under which condition the atmospheric humidity is higher, and the rainfall is greater.

A profile of the skeletal soil is described as follows:

Location: Pankhabari, Kerseong, Darjeeling

Topography: 1500 feet in elevation

Parent rock: gray sandstone

Vegetation: Trees, shrubs, ferns

Profile description:

0—30 cm. (Hl—18) Gray brown, very loose and friable, fine sandy loam with some humus.

30—cm. downwards. (Hl—19) Weathered sandstone.

The analytical data of the above soil profile are given in Table 8.

Table 8. Analytical data for Pankhabari soil

(Ions extractable in 1/2 N CH_3COONa at pH 5.0 except determinations of pH and organic matter)

soil sample number	Depth in cm.	NO_3 p.p.m.	P p.p.m.	K p.p.m.	Ca p.p.m.	Mg p.p.m.	Al p.p.m.	pH	Organic matter %
Hl—8	0—30	60.0	2.5	200.0	200.0	20.0	100.0	4.50	4.36
Hl—19	30—rock	traco	—	0.0	0.0	0.0	20.0	4.42	—

There are many calcifuge species of tropical plants growing on the red podzolic soil and acid skeletal soil which are distributed in areas below 3,000 feet in elevation. The following species of Pteridophyta are found. Some of them are grown on the surface of gneiss.

Abacopteris multilneata, Wall. (H5166)
Adiantum philippense L. (H5196) (H5166)
Aglaomorpha Coronans (Wall.) Copel (H5194)
Adiantum Edgeworthii Hook. (H5176)
Asplenium cheilosorum Kunze (H5130)
Asplenium crinicaule Hance (H5207)
Athyrium clarkei (Atk.) Bedd. (H5182)
Athyrium macrocarpum var. Atkinsonii Clarke (H5180)
Blechnum orientale L. (H5139)
Cheilanthes farinosa Sm. (H5140) (H5160)
Cystopteris tenuisecta (Blume) Mett. (H5163)
Dryopteris serrato-dentata (Bedd.) Hayata (H5179)
Dryopteris squamiseta (Hook) Kuntze (H5144)
Dryopteris uliginosa (kunze) C. Chr. (H5146)
Equisetum diffucum Don (H5198)
Lepisorous sp. (H5201)
Leptogramme lotta Schl. (H5163)
Lycopodium cernum L. (H5171)
Lygodium flexuosum Swartz (H5242)
Nephrolepsis cordifolia Presl (H5178)
Onychium lucidum Spr. (H5141)
Onychium siliculosum (Desv.) C. Chr. (H5168)
Pityrogramme calornelanos (L.) Link. (H5197) (H5167)
Polypodium amoenum Wall. (H5187)
Polypodium lariforme Wall. (H5170)
Polypodium lucidum Roxb. (H5186) (Phymatodes lucidum Ching)
Polystichum auriculatum (L.) Presl (H5136)
Pteris biaurita L. (H5191)
Pteris longes Don (H5157)
Pteris vittata L. (H5162)
Selaginella decipiens Warls (H5151)

Selaginella monospora Spring (H5147)
Sphenomeris chinensis (L.) Maxon (H5181)
Tectaria coadunata (Wall.) C. Chr. (H5165) (H5149)
Tectaria fuscipes (Wall.) C. Chr. (H5250)
Tectaria polymorpha (Wall.) Copel (H5153) (H5158) (H5188)

On this soil the following flowering plants were collected:

Carex cruciata Wall. (H5205)
Oxyspora paniculata DC. (H5207)
Themedra arundinacea Ridl. (H5206)

SUMMARY

A. The Soils

Since the geological formation of this mountainous area is quite uniform, a vertical distribution of soils is obviously observed.

At the top of the mountain with an elevation of 8,500 feet, the podzolic soil is found. The process of podzolization is clearly shown by the translocation of clays, organic matter, and active aluminum from an upper to lower layer. The gray brown podzolic soil is distributed in areas ranging from 7,000 to 8,500 feet in elevation. It is developed under forest and has a surface covering of leaf litter and a surface soil with high content of organic matter. In places at an elevatin from 3,000 to 7,000 feet the yellow podzolic soil is dominant. At an elevation below 3,000 feet the red podzolic soil and the sketetal soil are fonnd.

The analytical data of the soils of this area may be summarized as follows:

1. pH values of the soils: In the whole area, since the parent rock (gneiss) is poor in basic constituents, soils are all acid in reaction. The pH of the different horizons of the soils ranges from 4.0 to 5.5. The A_0 and A_1 horizons are usually less acid than B horizon. the A and B horizons are much more acid than the parent rock. This shows the leaching process of the soils under such a humid atmosphere.

2. Organic Matter of the soils: The organic matter content of the soils in this area is greatlg influenced by the kind of the vegetation cover. At an elevation of 8,500 feet, the soil developed under forest has 38.92% of organic matter in the A_1, while that under grass has only 11.08% of organic matter in the corresponding horizon. However as the vegetation cover is constant, the depth of the A_1 and its organic matter content are evidently affected by the elevation. At an elevation of 3,000 feet, the A_1 horizon of the red podzolic soil is only 1 cm. in depth, and it has 3.37% of organic matter. At an elevation of 8,500 feet, however, the A_1 horizon of the podzolic soil is 7 cm. in depth, and it has 11.08% of organic matter. In addition, deposition of organic matter in the B horizon is clearly found in the podzolic soil, but it has not been seen in soils found at lower elevation.

3. Active aluminum of the soils: All the soils in this area are high in active aluminum. They contain from 20 to 160 p.p.m. of active aluminum. The content of active aluminum in the different horizons of the same profile has a very close relationship with the pH values of the corresponding horizon. The less acid the reaction the smaller is the amount of acitve aluminum. The active aluminum of the soil is usually higher in amount than that of the parent rock from which the soil is derived.

4. Available calcium magnesium, and potassium of the soils: All the soils are generally low in available calcium, magnesium, and potassium. The comparatively high content of these elements in the A horizon is derived from the leaves of the vegetation which are grown on that soil.

5. Available phosphorus of the soils: All the soils of this area are low in available phosphorus.

6. Available nitrate: All soils in this area are very low in nitrate.

B. The Vegetation

1. The plants growing on soils of this area are most calcifuge species which are acid-loving (Vaughan and Wishe, 1937). As far as the chemical analysis of the soil is concerned, those species may be assumed as not only acid-loving, but also active aluminum-loving (Hutchinson, 1943).

2. The distribution of the calcifuge plants in this area is apparently affected by the local climate in terms of elevation. Some of them (temperate plants) are confined to high elevation, others (tropical plants) being limited to low elevation, Two groups of the plants may be given as follows. Many of them are of the same species as those found in southwestern China (Hou, 1944).

(a) Plants mainly ocurring in areas at elevations from 7,000 to 8,500 feet (temperate plants):

Pteridophyta:
Dennstaedtia Scabra (Wall.) Moore
Dicranopteris linearis Under.
Hicriopteris glauca Under.
Hymenophyllum crispatum Wall.
Hymenophyllum exsertum Wall.
Lindsaya cultrata Sw.
Lycopodium clavatum L.
Plagiogyria pycnlphylla (Kunze) Mett.
Pteridium aquilinum Wightianum Trym
Pteris aspericaulis Wall.

Flowering Plants:
Castanopsis tribuloides A. DC.

Lindera pulcherrima Bth.
Osbeckia crinata Bth.
Rhododendron arboreum Sm.
Rhododendron grande Wight
Pieris formosana D. Don
Vaccinium refereseeda HK.
Vaccinium serrasum Wight

(b) Plants mainly occurring in areas at elevation from 1,000 to 3,000 feet (tropical plants):

Pteridophyta:
Adiantum philippense L.
Blechnum orientale L.
Aglaomorpha coronans Copel
Lycopodium cernum L.
Nephrolepsis cordifolia Presl
Tectaria spp.
Polypodium lucidum Roxb.

Flowering plants:
Oxyspora paniculate DC.
Themeda arundinacea Ridl.

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