of the rate of stand growth provided by the diameter, height and annual rings of the trees.

CHAPTER XIII

SUBARCTIC FORESTS

Finno-Scandian Shield

"The long road over the moors, and up into the forest...the road through the great Almenning—the common tracts without an owner; no man's land."

Knut Hamsun. Growth of the Soil.

The region described includes the northern-most parts of Norway and Finland and the entire Kola peninsula bordered by the Arctic Ocean and the White Sea. The total area comprises about 150,000 square miles. In general it is an undulating or rolling plateau, not exceeding 500 feet above sea level with a number of rivers and with numerous lakes. The climate is strongly affected by the warm current of the Gulf Stream, and the Arctic Ocean remains free of ice and is open for navigation the entire year. The mean winter temperature ranges from 10 to 18 degrees F. and the mean summer temperature from 46 to 50 degrees F. In spite of relatively moderate winter temperature, the climate is extremely severe, due to strong winds. The precipitation averages about 10 inches per year, being somewhat higher on the shore of the ocean and along the southern boundary. The greatest part of the precipitation is in the form of snow, in places reaching a depth of 15 to 20 feet. In mid-winter there are but a few hours of daylight whereas in June the sun does not disappear from the sky.

The Finno-Scandian range is composed of gneiss, granite, schists, diorite, diabase, and gabbro. In places are found volcanic tufa, dolomite, and limestone. In the majority of cases, the rocks are covered with a thick layer of glacial deposits.

The northern part is occupied by tundra or muskeg; the southern by taibola or forest. The boundary between these two formations ranges between 66 to 69 degrees north latitude, following closely the isothermal line of 56 degrees F. for the month of July.

Tundra is a treeless, swampy plain, supporting mosses, lichens, species of Ledum, Vaccinium, and other heath plants. The surface soil is formed by a layer of peat of varying thickness. The mineral substratum remains, in many cases, permanently frozen below a depth of a few inches.

Along the forest boundary of the tundra occur small groups of dwarfed spruce, with some birch, swamp birch, and crowberry. Alder and willows are also found along the rivers and creeks.
The development of forest stands is strongly influenced by the conditions of climate. Because of this, the soils of the same origin and texture in different latitudes and on different exposures support stands of different composition. Thus, for example, in the proximity of tundra and on exposed sites, stands of larch occupy sandy soils which otherwise support stands of Scotch pine. In general, the stands of better quality are confined to narrow strips along the rivers. Such strips do not exceed 7 miles in width. The stands of plateaus, as well as the stands on poorly drained lands, have but low productivity. A brief description of the most important forest types of the range and adjacent islands is given below.

Well-drained Soils

1. Pine and birch on granitic rock outcrops. The northern and eastern slopes of granitic rock outcrops or "sheep-backs" are usually bare, whereas the western and southern slopes covered with Scotch pine stands. The roots of Scotch pine on such sites show an amazing ability to penetrate small cracks and gain a foothold on practically barren surfaces. Curiously, the growth of pine on these locations is considerably better than on the coarse sandy soils of the region. With increasing age the pine suffers from windfall. However, even after the stems are blown down they continue to grow, with the branches forming new upright stems. The ground cover consists of lichens and heath plants, and the remains of these together with the pine needles form a peat-like layer which rests directly upon unweathered granite and can be easily removed in large sheets. In the understorey are found Juniperus communis and Betula pubescens (var. tortuosa). On the exposed tops of outcrops Betula tortuosa takes the place of the Scotch pine. In such localities the ground cover is characterized by a number of arctic plants. This type is especially common along the shore of the White Sea.

2. Birch on skeletal soils. The soils of this type are confined to islands and extreme northern part of the region. They consist of boulders of different sizes, largely of granitic origin. Severe climatic conditions of these localities ordinarily do not allow the growth of either pine or spruce, and birch (B. tortuosa) is the only occupant of these sites. The stands are dwarfed in form and do not reach more than 3 or 4 feet in height. Nephoma arcticum is the most important species among the lichens, and Vaccinium myrtillus the most important of the woody plants which form the sparse ground cover.

3. Pine on podzolic soils. The sandy and sandy loam soils of outwash and pitted outwash in the interior of the peninsula are occupied predominantly by the stands of Scotch pine. The spruce is commonly associated with pine on these localities, but remains as a suppressed and dwarfed member of the understorey. The productivity of pine stands in general is low, but it varies somewhat, depending on texture of soil and degree of podzolization. The differentiation of pine stands into a number of distinctly pronounced types takes place only in the southern portion of the region. These latter types belong rather to the temperate zone, and their description is given in the proper outline. The ground cover is characterized by the presence of lichens, mosses, Ledum palustre, Empetrum nigrum, Calluna vulgaris, Arctostaphylos uva-
ursi, Vaccinium uliginosum, V. myrtillus, V. vitis idaea, Linnaea borealis, and Andromeda polyfolia.

4. Larch on sandy podzols. This soil-forest type occurs only on exposed sites, in most northern "sub-alpine" areas, beyond the region of natural distribution of Scotch pine. The soil is strongly leached and cemented and supports larch stands of inferior quality, with an understory of spruce and birch. With age the larch suffers greatly from heart rot and loses its top foliage. The ground cover vegetation is closely related to that of pine stands occurring on podzolic sandy soils.

5. Mixed coniferous-hardwood stands on slightly podzolized loams. The soils of this type are largely derived from limestone, gypsum, or calcareous shales. The podzolic horizon is only slightly pronounced or may be entirely absent. The leaf litter does not accumulate in layers of any great thickness. This type of soil may be regarded as the most northerly variety of the mull type. The stands are composed of larch, spruce, pine, aspen, and birch, with either spruce or larch predominating. In some instances these soils support a mixture of all the tree species occurring in the north. These are the most productive stands of the entire region, but unfortunately they have only limited distribution, being confined to a certain type of soil and to narrow areas along the rivers.

The ground cover vegetation includes practically no lichens or mosses, except some of Hylocomium species. Among the rather rich ground cover association the following species are outstanding: Rubus saxatilis, Lycopodium annotinum, Geranium silvaticum, Vicia silvatica, Orobus vernus, Oxalis acetosella, Maianthemum bifolium, Pyrola secunda, Equisetum silvaticum, Trisetum europeae, Phengopteris dryopteris, Carex digitata, Luzula pilosa, Calamagrostis epigeios, Deschampsia flexuosa, Epilobium and Solidago. The shrub story is made up of Salix caprea, Sorbus aucuparia, Juniperus communis, Rosa acicularis, Rubus idaeus, and Daphne mezereum.

Periodically Wet Alluvial Soils

1. Mixed stands of flood plains. Soils of the lower terraces, subject to overflow, are usually of sandy loam texture and have a considerable percentage of calcareous particles. In the southern part of the region and along larger rivers such lands are usually cleared and utilized as meadows. The virgin forest stands are composed of spruce, pine, larch, birch, aspen, white alder, and cherry. Spruce commonly is the predominant species. Pine is confined to the drier, sandier islands. The understory is formed by several species of shrubs and shrub-like trees, particularly alder, willows, gooseberries, honeysuckles, and spiraea. The ground cover is characterized by numerous grasses. Stands of this type are of low density and occur in patches as park-like formations. The main reason for the local distribution of forest stands is the destructive action of spring floods. Toward the north this type of forest degenerates into dwarfed stands of birch and willows.

2. Willow stands on stream-bottom deposits. The narrow stream bottoms give rise to half-mineral and half-organic muck-like soils
which remain wet during most of the growing season. The stands on these sites are composed of different species of willow. The ground cover consists of grasses.

Poorly Drained Soils

1. Pine on swamp-border sands or sandy gley podzols. These soils are of a coarse sandy texture, strongly leached, and with a close gley horizon. The stands are composed of pine, of less than average productivity, with spruce and birch in the understory. The ground cover vegetation includes Sphagnum and other mosses as well as lichens. Rubus hammaemorus is the most typical species of the herbaceous plants. The shrub layer is formed exclusively by swamp birch.

2. Spruce on loam gley podzols. These soils occupy extensive flats deficient in drainage. The profile is characterized by a thick layer of raw humus, a wide leached horizon of loam texture, and a mottled gley layer which grades into the permanently frozen substratum; the upper layers of soil become free of ice only in June. The sparse forest stands are composed of spruce, usually associated with birch of sprout origin. Both species are of poor form and very slow growth. Ground cover vegetation includes Polytrichum, Sphagnum, and other mosses, ferns, horsetail, sedges, Labrador tea, and blueberries. In the understory are found willows, mountain ash, juniper, and swamp birch.

3. Pine on peat soils. The peat consists of the remains of Sphagnum mosses, sedges, and heath plants. The stands are composed of struggling Scotch pine. The ground association includes species of Sphagnum, Ledum palustre, Calluna vulgaris, Empetrum nigrum, Vaccinium uliginosum, V. vitis-idaea, Andromeda polifolia, Cassandra calyculata, Oxichocos palustris, Rubus hammaemorus, Sibirus and Carex spp. In the understory occurs Betula nana.

The subarctic forests preserve their characteristic features in the entire circum-polar region, including Siberia, Alaska, and northern Canada. These forests may not have a far-reaching silvicultural or economic importance. Yet, the simplicity of the physiographic conditions and the scarcity of species composing forest cover place them in the key position of all the studies of soil-forest relationship.

A highly instructive picture of the relation between the composition of forest associations and the rate of forest growth is presented in works of Cajander and his associates embracing the whole of Finland. The results of exhaustive investigations of Finnish foresters have been summarized in a series of excellent papers in English. An attempt to remodel these publications in an abbreviated form would hardly be justifiable (Lit. cit).

References

Pole, R. R. 1915. Index of silvicultural and geobotanical literature related to Northern Russia and Finland. Petrograd.
Figure 45

Soil-Forest Types of Finno-Scandian Shield and Adjacent Islands

So. No.

Spruce-Podzol

Larch-Podzol

Birch Skeletal Soils

Pine-Podzolic Sands

Willow and Mixed Stands - Alluvial Deposits

Mixed Stands Hull-Like Loams

Birch Pine Rock Outcrops

Spruce-Birch Gley Loam

Pine Peat

Pine Gley Sand

Pine-Sandy Loam or Sand with Loam Substratum