THE KEVO SUBARCTIC RESEARCH STATION OF THE UNIVERSITY OF TURKU

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I. HISTORY

In the years 1954—55 The Turku Zoological and Botanical Society associated with the University of Turku organised excursions to western Utsjoki in the northernmost part of Finnish Lapland to collect plant specimens from this relatively little known area. During these excursions ornithological observations were also made and attention was directed to special features of the area. Detailed reports on these excursions and some of the results have been published (e.g. KALLIO 1954; LAINE, LINDGREN & MÄKINEN 1955; TENOVUO 1955; KALLIO & MÄKINEN 1957). One practical result of these excursions was the recognition that it is possible to carry out regional floristic and faunistic basic research with the assistance of students of biology even under the fairly difficult conditions that prevail in these latitudes.

Another idea that developed during these excursions was the establishment of a permanent research centre for the promotion of studies of Lapland which would guarantee progressive work and make possible even highly specialized scientific research. The proposal was discussed with the authorities of the University of Turku in 1956 and this led to a study of the possibilities of establishing such a permanent research centre and a search for a suitable location in Finnish Lapland. In the following the planning of the resarch station and the possibilities offered by the station for carrying out research primarily in biology are outlined.

The site finally chosen for the research centre is located on the shore of Lake Kevojärvi in Utsjoki commune (Figs. 1, 2). The land was granted by the Government of Finland for the purpose in 1957, and in this way the Kevo Subarctic Research Station of the University of Turku came into existence.

Plans for the erection of the necessary buildings were drawn up with the expert assistance of Architect OLLI KESTILÄ (Turku). The whole construction programme was divided into three parts of which the first was

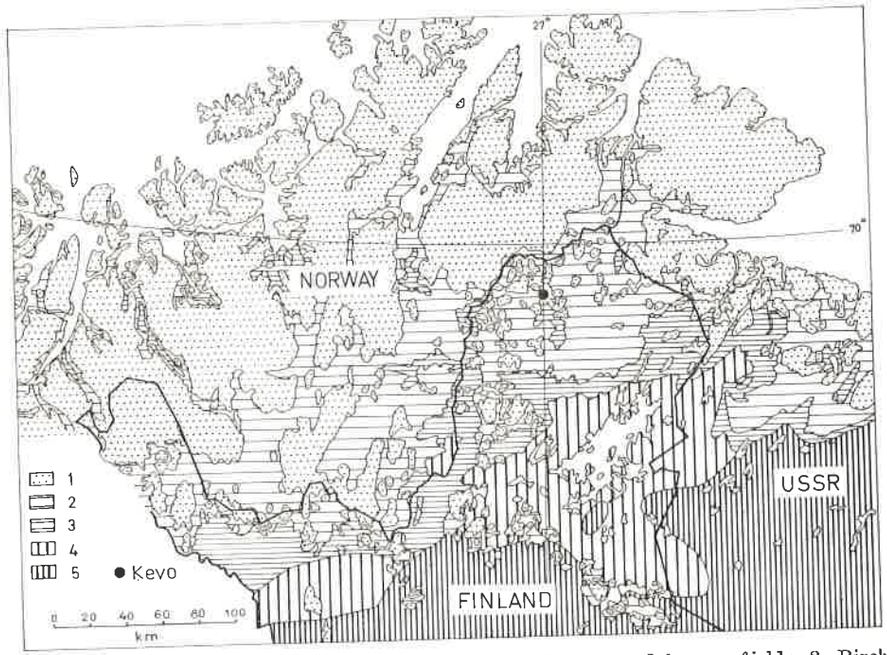


Fig. 1. — Biotic zones in northernmost Finland. 1. Tundra and barren fjelds. 2. Birch bushes and birch forests. 3. Birch forests and small groves of pines. 4. Pine forest. 5. Coniferous forest (pine and spruce). Redrawn from Atlas of Finland, 1960.

initiated in late autumn in 1957 and ended in the summer of 1958 when the Vice Rector of the University of Turku, Prof. TAUNO NURMELA, officially opened the research station at a ceremony which the President of Finland, Dr. URHO KEKKONEN, attended.

As it was obvious that biological research at the station would unconditionally require knowledge of the climatic conditions, the Finnish Meteorological Office agreed to establish a first-class meteorological station at Kevo. Because Finnish seismological research required the establishment of permanent post in its network in the extreme north of Finland, the Institute of Seismology of the Helsinki University approached the University of Turku to ask for permission to install the necessary equipment at the station to be taken care of by the personnel at the station (cf. VESANEN 1964).

The second construction stage was completed in 1961. This stage included a building to house the supervisor of the station and the caretakers of the meteorological and seismological laboratories and enabled the station to continue its operation throughout the year.

The third construction stage was begun in 1963 and continued in 1964 and included the erection of more laboratory and housing space for research

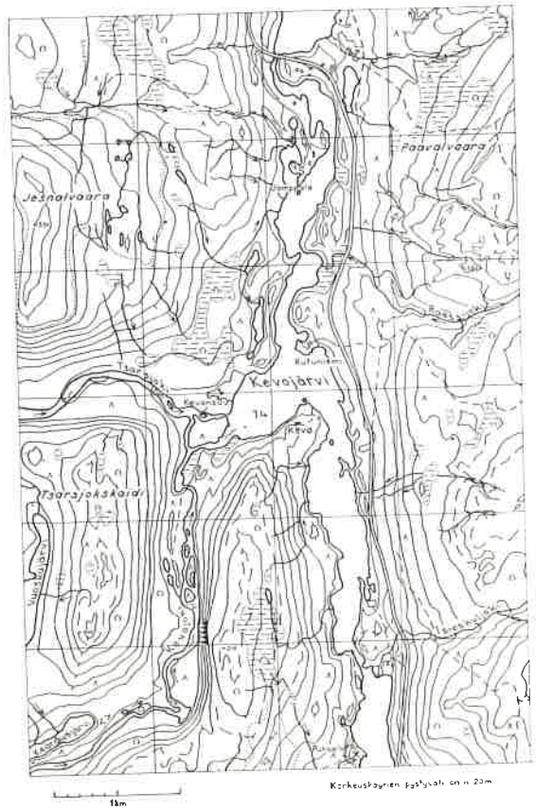


Fig. 2. — Topographic map of the surroundings of Kevo. Contour intervals 20 m. On the east side of Kevojärvi runs the highway from Rovaniemi via Inari to Norway.

workers and the drilling of a tunnel to house a laboratory for seismological investigations.

The main part of the construction costs have been defrayed by donations from private persons and companies. The greater part of the costs of the first construction stage was, however, paid by the Government of Finland.

II. GENERAL ASPECTS OF THE REGION

It was expressly desired to locate the station in the *birch zone* beyond the conifer zone in the northernmost Lapland (NORRLIN 1910, KUJALA 1936, Atlas of Finland 1925, map. 17: 1, see map 1). The area has also been named *Fjeld Lapland* (KALELA 1958, Atlas of Finland 1960) because the average

elevation is higher than elsewhere in Finland. The birch zone in Finnish Lapland is divided into two parts by a conifer zone that extends through Inari commune to the Norwegian border. The terms eastern birch zone and eastern Fjeld Lapland characterize fairly well the biotic zone where the Kevo research station is located. The western Fjeld Lapland (the Arctic Zone of HULT 1896) includes above all the edge of the Scandinavian Mountains (Scandes) with its unique topography, geology and vegetation. The research problems in this area are mainly related to those of the mountains as a whole which area with many special problems (cf. LÖVE & LÖVE 1963) has been a research field of Scandinavian investigators. Eastern Fjeld Lapland has a more monotonous topography and is poorer in plant species and biotopes. The birch zone there is the most uniform in Fennoscandia and is bounded by the most uniform and extensive "subsilvatic" pine forest zone (WAHLENBERG 1812). For this type of biotic region there has been no research centre in Fennoscandia. The topography of the region may be defined as a forest tundra as HUSTICH (e.g. 1958, map on p. 4) has done. This definition is in accord with the tundra concept which BERG (1950) has applied to the Kola Peninsula where, furthermore, two types of tundra may be distinguished, i.e. the forest tundra and the southern type of tundra proper.

It is a fact that the varied topography of Fennoscandian Lapland and the proximity of the sea (the Gulf Stream) complicate any division based solely on horizontal zonation. In this area as in similar areas elsewhere local climatic conditions impress their own atypical features. Especially the juxtaposition of vertical and horizontal zones renders difficult the formation of a general picture of the area. The pine forest limit which is a feature that greatly affects the outward appearance of the area does not reveal any abrupt limit in field vegetation, whereas changes in the vegetation clearly differentiate the areas beyond this line (KALELA 1958; HÄMET-AHTI 1963). The pine forest limit is, however, a much more significant boundary from the point of view of plant distribution than the existing floristic information has led us to believe (KALLIO 1961). The whole of Fennoscandia to Finnmark may be roughly defined as an outlying area of the taiga as POLUNIN (1951) has done. However, according to HUSTICH (1960), the subarctic zone extends to areas within the boundaries of Finland and the Kevo area is one of these. A similar interpretation of the concept of subarctic zone has been put forth by KALELA (1958). SJÖRS (1963, Fig. 3) has drawn the subarctic and the boreo-montane subzones of the boreal zone so that their southern limits extend far south of Kuusamo in a south-easterly direction and so that Utsjoki belongs to the "woodland tundra-subzone". In her excellent investigation of the zonation of birch forests, HÄMET-AHTI (1963) has called this area a subalpine area to stress the significance of local elevation. At the same time, however, the

Fig. 3. General view of Kevouniemi.

northern location as such with its special conditions of light and climate has been disregarded.

Without taking any stand as to the influence surface formations and the proximity of the sea have had on the special features of this part of Fennoscandia and as to the abstraction of "reducing" the vegetation zones to sea level, both the area and the research station will be defined as subarctic. The location of the area makes it possible to study problems that are intermediate between problems typical of forest regions and those typical of arctic regions. The location of the northernmost conifer forests and the occurrence of southern plant species and other typically southern features in the area are closely connected with local climatic conditions that are determined by the special topography. Often the conditions in the valleys and on the slopes of the fjelds in the area exert a greater effect on the natural phenomena than the actual elevations. On the other hand, typical arctic features such as, for instance, snow beds exert their own influence on the vegetation of the area.

The area which can be studied with the station as a base depends on the problem under investigation. For faunistic and floristic purposes the station makes possible excursions into the conifer forests. One general programme has been the clarification of conditions at the boundary of the birch and conifer zones which has necessitated excursions to areas far south from this boundary. The field of study thus encompasses the greater part of the geographical territory called Remote Lapland ("Hinter Lappland") by GRANÖ (1931, map VI; see also map 1), which territory includes regions

also south of Saariselkä divide. This geographical territory of GRANÖ is practically identical with the region called *Inari Lapland* (InL) on the basis of a floristic division made in the last century and which region the basin of Lake Inari divides into two parts (Atlas of Finland 1925, map 17: 3; HIITONEN 1933). The region thus includes the northernmost commune of Finland, Utsjoki, which is about 5000 sq. km in area, and a large part of the Inari commune to the south.

It may be mentioned that, when investigation has required it, the boundary of Finland has imposed no restriction and many excursions have extended to, e.g., Rastegaissa and other fjelds in Norway.

The central part of the region, eastern Fjeld Lapland, can be further divided according to the distance from the Arctic Ocean into Fjord Lapland and Fjeld Lapland proper. Fjord Lapland extends just to the northern tip of Finland and its flora differs from that of Fjeld Lapland (Fig. 15, KALLIO 1957; cf. KALELA 1958, HÄMET-AHTI 1963). The region can also be divided into several parts on the basis of its geomorphology. GRANÖ, for instance, has divided the region into three parts, the Muotka and Pulmanki fjeld tracts and the intervening Petsikko plateau.

The greatest elevations above sea level in the western parts of the region are 500—600 m and the differences in elevation are 200—400 m over wide areas. The fjelds in the eastern part are somewhat lower in elevation and the relative differences are 50—200 metres. The general topography is monotonous. The rounded fjelds rise up to approximately the same elevation, their sides slope gently downwards and their surfaces seldom exhibit greater morphological variation (Fig. 4). The region could equally well be called a peneplane that is indented by river valleys.

Teno River (Tana in Norwegian), which separates Finland and Norway, has eroded itself to a depth of 200—400 metres into the peneplane. The Teno and its tributaries, the Utsjoki (and Kevojoki), Vetsikko and Pulmanki rivers, comprise all the waterways in eastern Fjeld Lapland. The rivers in the more southern Forest Lapland belong partly to the Paatsjoki waterway whose central basin is Lake Inari (about 1000 sq. km), the third largest lake in Finland, and partly to the Näätämö (Nejden in Norwegian) waterway to the north.

The geology of the region is for the most part very monotonous. The western and southern parts are composed of acid granulite, a granitic rock, and from the biogeographical point of view represent an area with a relatively poor flora. The geology is more varied in the eastern part and the bedrock is composed of granite gneiss, migmatite and, to some extent, basic components like amphibolite and diabase, which favour the formation of more varied biotopes. One of the fjelds composed of such basic minerals is Tshuomas-

Fig. 4. — View from Jesnalvaara to the southeast. In the foreground Tsharsjoki River, on the left Lake Kevojärvi and Kevo. — May, 1963. Photo by Asko Liukkonen.

vaara fjeld. The variation of the geology in the eastern part of the region is reflected in the areas of distribution of many plant species (see Figs. 6 and 17).

For the most part the region is not suitable for farming. The agricultural region XIV of LINKOLA (1936) coincides with the area in question. The region is also of little importance as far as forestry is concerned (Atlas of Finland 1960). Northern Lapland has been occupied by man very early. The Lapps moved into this region after Finns took over their lands to the south and it is now the centre of the area inhabited by Finnish Lapps (cf. HUSTICH 1942). Permanent farmsteads were established some two hundred years ago at the southwest corner of Lake Inari (NICKUL 1953), which still is the northern boundary for agriculture. In Utsjoki commune dairy husbandry is an important source of income and the little farming that is carried out involves the cultivation of fodder crops and potatoes, the latter on a very small scale (HUSTICH 1942). Reindeer husbandry is the main occupation in eastern Fjeld Lapland. The total number of reindeer in the Utsjoki area was 12,300 in 1962—63. This occupation is the main means of livelihood alongside the less important fishing and hunting. The earlier seminomadic way of life has, however, changed in recent years. The some 1000 Lapps in Utsjoki commune have permanently settled in the valleys of the Teno, Utsjoki and Pulmanki rivers; the remaining parts of the commune are uninhabited. Fishing and hunting are more important in Forest Lapland than in Utsjoki commune

(NICKUL 1953). The way of life of the Lapps which has accommodated itself to the natural environment and its influence on nature offer interesting and unique objects for human geographic research. This study is urgent because of the great and radical changes which have occurred and are occurring in the whole economic structure of the region. The area which was previously isolated from the south is now traversed by a road that was erected during World War II from Inari to Karigasniemi in Utsjoki commune and extended to Utsjoki church village in 1957—58. The road is being continued from Kaamanen to Sevettijärvi northeast of Lake Inari which is inhabited by the Skolts. The former routes of communication to the shores of the Arctic Ocean have lost much of their importance. The new routes will have an influence not only on the human geography but also on phyto- and zoogeography and will provide an opportunity to study the resulting changes, which can hardly be expected to arise again in Europe.

III. THE IMMEDIATE VICINITY OF THE STATION

When a site was sought for the research station, particular pains were taken to find one that is located in surroundings that would offer biologists an opportunity to carry out field and laboratory investigations on a variety of problems. A great biotope variation was considered a valuable asset.

The map in Fig. 2 shows the location of the station and the topography of its immediate surrounding areas. The station lies on a slope of Puksalskaidi fjeld beside Lake Kevojärvi, one of the basins of the Utsjoki waterway. The geographical coordinates of the station are 69°45′21″ N and 27°00′45″ E. The station lies in topographically the most varied tract in eastern Fjeld Lapland. The surface of Lake Kevojärvi is 75 metres above sea level and the summits of Puksalskaidi and Jesnalvaara fjelds (Fig. 5) on the west and Juovuskalluvaara fjeld on the east rise to heights of about 210, 330 and 380 metres, respectively. In contrast to the gently sloping surface formations common in Utsjoki, the banks of the Kevo River valley (Figs. 6 and 7) close to the station are steep, almost vertical in places. Similar formations are found also around Lake Kenesjärvi, also a basin of the Utsjoki River. Owing to the special microclimatic conditions on these precipitous slopes, the cliffs (Südberge in German; south bluffs, see ANDERSSON & BIRGER 1912) are of special interest to botanists and zoologists because of the typical biotopes that are found on them (Fig. 8). In such places even the smallest variations in the bedrock are significant as revealed by KALLIOLA's (1937) description of Linkkapahta beside the Kevo River. The cliff nearest the research station is Kotkapahta.

In the valleys of the Utsjoki and Kevojoki rivers near the station is a

Fig. 5. — Jesnalvaara seen from the south (from Tsharsjoki valley). Isolated pines on the slope mostly covered by birch and a small stand of *Populus tremula*. — Photo by Asko Liukkonen.

pine forest about 600 hectares in area which owes its existence to the favourable local climate and is one of the northernmost pine stands in the whole world. This forest, which contains many of the plants common to the forest type, has been studied by HUSTICH (1940, 1944, 1948, 1958), but there are still many problems associated with the ecology of the pine that seem worth studying in this region. Two other types of zone, the subalpine birch zone and the alpine zone, are found near the station. The alpine zone does not extend to the area shown in Fig. 2 but is found 5 kilometres east of the station and somewhat nearer in the northwest.

In addition to bleak birch heaths and pine stands which differ very little in the underlying vegetation, luxuriant groves are found in nearby small valleys, at the mouth of Tsharsjoki River west of the station, along the banks of the Tshieskuljoki River east of Lake Kevojärvi and in the Kevojoki River valley. Higher up on the banks of the Tshieskuljoki River lies one of the largest (*Matteuccia*) fern stands in Lapland. Unusual heaths covered by *Arctostaphylos uva-ursi*, small grass meadows on river banks, fragmentary patches of lithophyte cryptogams, marshes around ponds, wet slopes and stands greatly affected by human activity in the vicinity of Lapp habitations can be easily reached from the station.

Many types of waterways are found in the neighbourhood of the station; rapidly flowing rivers (the Utsjoki, Kevojoki and Tsharsjoki) and their numerous tributaries (Figs. 5 and 9), Lake Kevojärvi with its rich aquatic

Fig. 6. — Lake Njaggaljärvi in Kevojoki valley. An esker covered by pine is seen in the lake.

Fig. 7. — Upper Kevojoki valley. The valley is still very narrow. The slopes are covered by birch only.

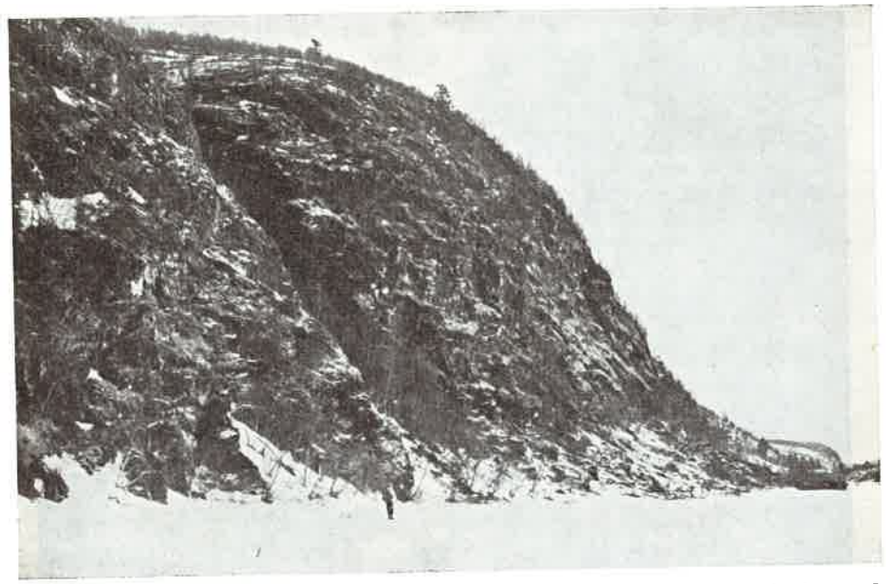


Fig. 8. — Könkäänpahta cliff in the foreground and Linkkapahta cliff in the background. These two cliffs are ecologically the most interesting places in Kevojoki valley. Isolated localities of many southern as well as northern plants are found on these cliffs. — April 1959.

flora (SILTANEN 1964), bleak, almost barren fjeld ponds at different elevations, and small ponds (Kidsalampi and Jomppalanlampi) with abundant *Nuphar* stands close to the farmsteads in the Utsjoki River valley.

Nearby is also Kevo Nature Park, 346 sq. km in area, which was established by law in 1959. It has escaped spoliation by humans if changes resulting from fishing and reindeer grazing are disregarded.

The region provides opportunities for the foundation of permanent experimental plots for quantitative biological (e.g. ornithological) research work.

The typical Lapp communities nearby permit studies of the influence of man on his environment.

IV. CLIMATE

The most important botanical and zoological boundaries in northernmost Finland are determined by the influence of the Arctic Ocean, which influence is largely superimposed on the primary solar zonation. The arctic type of climate and vegetation are clearly evident on the shores of the Arctic

Fig. 9. — Fiellu Falls in Kevo Nature Park.

Ocean in Finnmark in Norway; both are inherent in the tundra concept (JOHANSSON 1936, KALELA 1958). The arctic features of climate do not extend to the northernmost tip of Finland (Atlas of Finland 1925, map 10: 15). The shortness (less than 6 months) of the growth period, the very short period of thermal summer (average temperature over +10°C), the long period of solar radiation (60—70 days when the sun does not set in Utsjoki-Inari) and the corresponding period of darkness in winter are characteristic of the region. These conditions determine the speciality of the region and are factors that must be taken into account in ecological and taxonomic studies in botany and zoology. All these conditions undergo change over short distances in the area and as a consequence a number of zones are encountered that run parallel to the coast line (KALELA 1958, HÄMET-AHTI 1963).

The Kevo Subarctic Research Station lies in a region that is alternately exposed to the maritime influence of the Arctic Ocean and to the continental climate from the south. Large variations in temperature are quite common, the change may exceed 30 centigrade degrees during one day. Also the extreme temperatures differences may be large; on some days in winter Kevo may be the warmest place in Europe! As the meteorological data collected at Kevo by the Finnish Meteorological Office are not yet sufficient to give average figures that would characterize the climate, a probable meteorological

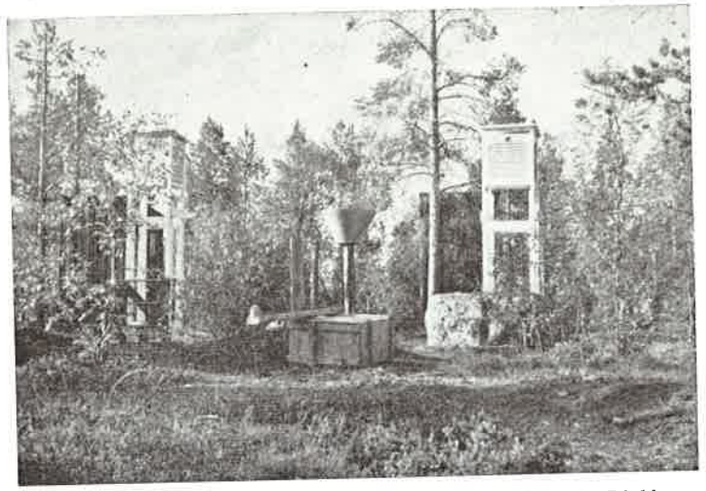


Fig. 10. — The Kevo meteorological station. — Photo by Asko Liukkonen.

map can be based only on observations made during two years at Kevo and on data collected at other meteorological stations in Lapland (the data were furnished by Dr. S. N. VENHO, Finnish Meteorological Office, Helsinki).

The synoptic observations which have been continued from the beginning of the year 1962 are made every third hour beginning at 2 a.m. The observations comprise the temperature, humidity, atmospheric pressure, the winds, the amount, type and height of the clouds, precipitation and electric discharges. Also the ground temperatures and snow depths are recorded. The photography of northern lights, measurement of radioactivity, and continuous magnetic recordings will be possible in 1964.

The international number of the Kevo meteorological station is 02805. The screens housing the equipment are located 102 metres above sea level and 27 metres above the surface of nearby Lake Kevo on a small level area on the north slope of Puksalskaidi fjeld at the boundary of birch and pine zones (Fig. 10).

Since especially biological research is concerned with temperature data, preliminary data relating to the Kevo Station are shown in Table 1. The figures are based on meteorological data collected over long periods at Ivalo (68°36′ N, 27°25′ E), Toivoniemi in Inari (69°4′ N, 27°6′ E) and Karasjoki, Norway (69°28′ N, 25°31′ E), especially at the Toivoniemi Station. The probable errors of the preliminary mean monthly temperature values at Kevo are at most half a degree for the months May to September, but may be as much as one degree for the winter months.

Local climatic and microclimatic conditions that have a bearing on biolog-

Fig. 11. — "Meteorological station" on the summit of Jesnalvaara. — Photo by Asko Liukkonen.

ical research have been studied relatively little. A meteorological observation post equipped with automatic recording instruments has been located at the summit of Jesnalvaara fjeld but this has been in operation only in summertime (Fig. 11)). Another post has been located in the yard of the Tshieskula farmstead nearby. A number of observations have been made on some cliffs during the summer months. Only random observations on the thawing of the ground have been made in the vicinity of the Kevo Station; the ground has been frozen even at the end of July in some years.

Table 1

Preliminary mean monthly temperatures at Kevo

	Mean temperature	Mean maximum temperature	Mean minimum temperature
January	—14.0	— 9.7	—20.1
February	—14.0	— 9.1	—19.6
March	— 9.7	— 4.9	—15.9
April	— 3.5	0.9	— 8.9
May	2.8	7.1	— 1.4
June	9.6	14.5	4.9
July	13.6	17.9	8.9
August	11.3	14.9	6.9
September	5.8	9.4	2.2
October	— 1.1	1.3	— 4.4
November	— 6.6	— 2.7	—10.4
December	—10.7	— 7.1	—15.3

It is highly probable that these temperature values are slightly too low because the Arctic Ocean may make itself felt at Kevo more than at the other stations, especially during the winter season.

Table 2

Mean temperatures at Kevo in 1962 and 1963

	Mean temperature		Mean maximum temperature		Mean minimum temperature	
	1962	1963	1962	1963	1962	1963
January	—19.0	—13.7	—13.2	— 7.8	—24.8	—20.3
February	—13.0	—16.9	— 8.5	—10.0	—19.4	—24.2
March	—16.5	—12.9	— 8.6	— 6.9	—24.6	—19.4
April	— 2.0	— 2.6	2.6	2.5	— 6.8	— 8.4
May	1.9	8.6	5.4	14.9	— 1.1	2.1
June	8.1	8.0	12.6	13.0	4.3	3.7
July	9.8	10.9	14.7	16.2	5.6	6.4
August	8.6	10.5	12.9	15.8	5.1	6.0
September	5.5	8.1	8.7	11.6	2.2	4.4
October	— 1.2	1.4	2.5	3.6	— 5.5	— 1.1
November	— 3.5	— 8.2	— 0.3	— 4.8	— 7.5	—12.4
December	—15.9	—13.7	— 9.9	— 9.2	—22.1	—19.2

Table 3

Precipitation in mm in 1962 and 1963 and normal precipitation at the Kevo Station

	1962	1963	Normal
January	22.0	23.5	34
February	19.3	26.7	29
March	10.2	4.7	25
April	24.3	10.2	20
May	33.2	11.7	25
June	49.3	19.0	39
July	64.2	74.3	68
August	41.3	52.7	59
September	20.8	27.8	49
October	54.6	35.5	41
November	24.3	36.3	40
December	26.5	21.0	39

V. PLANNED RESEARCH AT KEVO

"The purpose of the Kevo Station is to promote all forms of research on nature in Lapland taking particularly into consideration the conditions in Kevo Nature Park and the general requirements of research in (sub-)arctic regions" (No. 100 of the Regulations of the University of Turku, 1958). As botanists, zoologists and geographers have been primarily interested in carrying out investigations in Lapland, the requirements of these branches

of science were mainly taken into account when the station was planned and equipped. The meteorological station was also founded with the main purpose of serving the needs of biological research. Of course, the research work will depend primarily on the scientists who will use the station as their base, but it may be appropriate to review a number of possible research programmes that might be carried out at Kevo (see HUSTICH 1940, KALLIO 1959).

1. *The basic survey of the adjoining areas*

The first programme to be carried out at the station is to survey the surrounding area. Such surveys are carried out at other research stations in the north, by the Swedish Academy of Sciences at the 50-year-old station at Abisko, by Norwegians at the almost 100 years old Tromsø Museum for research in natural sciences and sociology, and by the U.S.S.R. Academy of Sciences at the Kirovsk Polar-Alpine Botanical Gardens in Kola Peninsula.

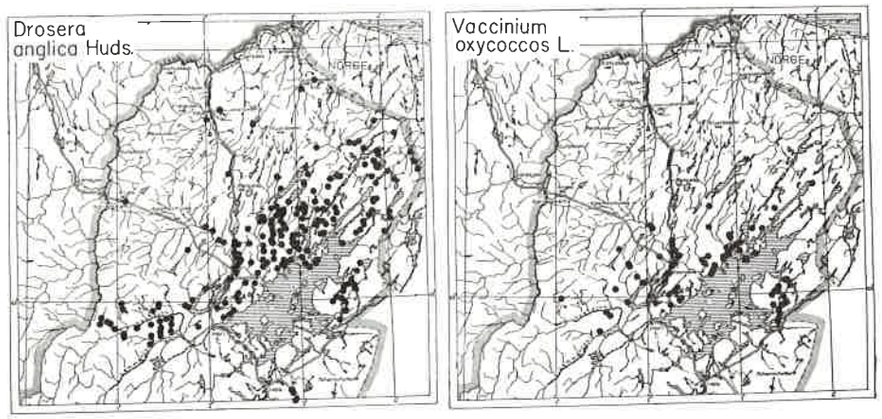
This survey involves collection of biological material, classification and mapping of distributions. The station should be a local museum that provides a clear general picture of the nature of the neighbouring regions and the possibilities it offers for research. The plant and animal specimens collected to date at Kevo are kept in the museums of the University of Turku (TUR).

One function of the field station is the collection of material for exchange. The exchange of seeds as well as shoots and other living material has proved of importance. This function, which has only begun recently, has been carried out in connection with the exchange of seeds by the Botanical Garden of the University of Turku. To a lesser extent, living cryptogams (lichens, fungi, algae) collected at Kevo have been distributed to some institutes.

The basic function, especially excursions over difficult terrain to collect specimens from distant locations, are largely dependent on the availability of suitable personnel. One difficulty is that research workers cannot be expected to participate in the collection of basic material for a general survey of the area and the information collected in connection with specialized studies is so limited that it may take a long time before any extensive distribution maps can be drawn. It has been possible, however, to enlist the aid of suitable trained undergraduate students and young scientists in the collection of material and data from the Kevo area.

2. *Special subarctic problems*

One advantage of the station is that it permits the study of special ecological problems typical of subarctic regions, for which conditions are most suitable in this part of Finland.



Figs. 12—13. — The distribution areas of *Drosera anglica* and *Vaccinium oxycoccos* are mainly south of the main pine forest limit.

Typical ecological features that distinguish this region from more southern regions are the short growth period, a low temperature during this period, the possibility of frost during the whole period, and the special conditions of light and darkness. Detailed analyses of adaptation phenomena are necessary for the clarification of the evolution of organisms in the region. The relationship between growth and temperature as a factor in adaptation is an ecological problem that can be approached in an adequately equipped field laboratory. The optimal temperature of assimilation is evidently a general feature defining zonal adaptation and has been studied to only a limited extent in these latitudies (cf. UNGERSON & SCHERDIN 1962). The annual and possibly daily thermal periodicity and its relation to growth phenomena is a special area of study for the field laboratories. Winter conditions, freeze-drying, snow cover, etc., are factors which have not been investigated more closely although their influence has long been recognized (cf. KIHLMAN 1892). The adaptation of plant proliferation to seasonal variations, the conditions of low temperatures (cf. SÖYRINKI 1939 a) and other conditions (cf. KALLIO & PIIROINEN 1959) influencing seed germination may reveal features that are specific for these northern regions (see BLISS 1958).

The adaptation of northern plant species to special photoperiodicity both as far as assimilation (cf. UNGERSON & SCHERDIN 1962) and flowering are concerned offers an opportunity to study general endogenic rhythmic variation. The problems of adaptation are largely the same in zoology and botany.

Experimental investigations of ecotypes expressly require field laboratories, which, however, must provide an opportunity to cultivate plants under constant supervision. There are limitations to this type of work at Kevo

because there is very little suitable arable land in its immediate vicinity. Plots of land for growing plants have been cleared but these have been primarily intended for the experimental study of carbon dioxide assimilation.

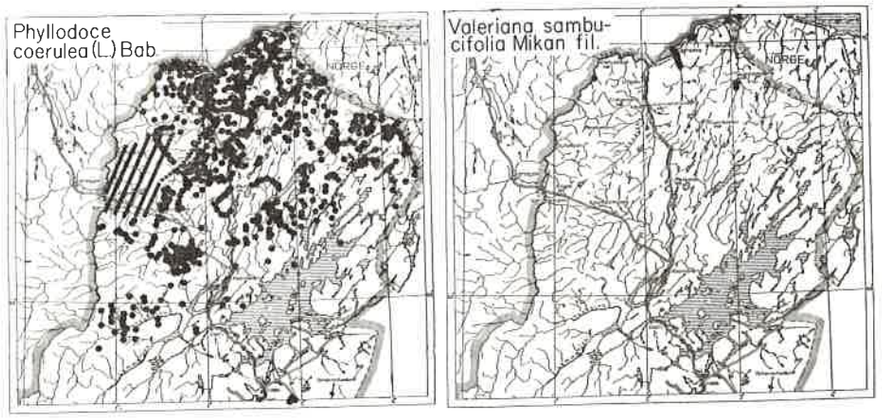
The extent to which such work can be carried out in the future will be determined by availability of facilities and scientists interested in these problems.

VI. REVIEW OF BOTANICAL RESEARCH DONE AT KEVO

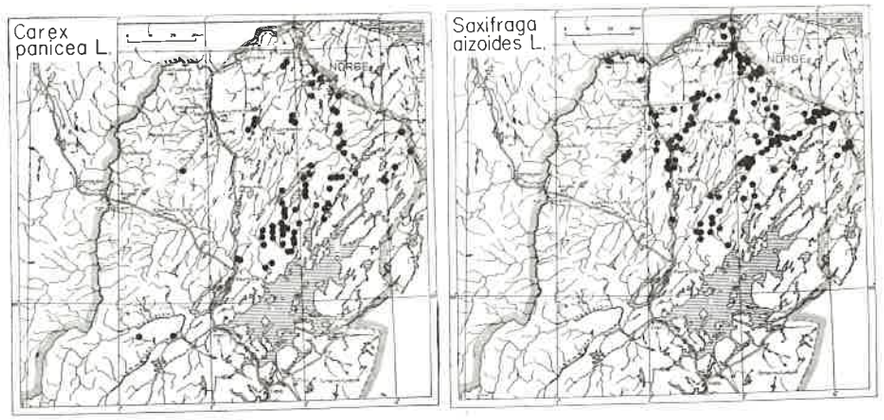
Compared with Petsamo (Petchenga) and western Finnish Lapland, the Kevo region is one of the least known areas of Finnish Lapland. Only pieces of information relating to various branches of biology have been collected and some specimens collected from the area have been deposited in several museums (H, TUR, OULU, KUO).

1. *Vascular plants*

One of the first to study the flora in this part of Finnish Lapland was WAHLENBERG (1812) who visited Utsjoki commune in July, 1802, and Ivalo in August of the same year. He made the first attempts to define the zonal distribution of the flora in the region. After the year 1819 the vicar of the Utsjoki congregation JACOB FELLMAN collected phanerogams particularly in

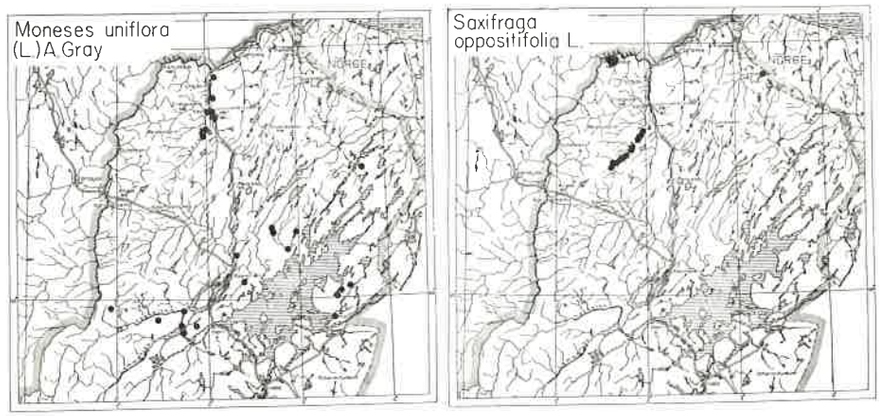


Figs. 14—15. — *Phyllodoce* is a typical "arctic-montane" species, which is common in the whole research area, but rare south of InL. *Valeriana sambucifolia* is one of the species dependent on the degree of oceanity typical Fjord Lapland.



Figs. 16—17. — *Carex panicea* and *Saxifraga aizoides* are distributed mostly in the eastern part of the area where the soil is less acid than elsewhere.

Utsjoki and Inari. His description of the flora of this area was for a long time the most important source of information. The next botanist to visit the area was A. Osw. KIHLMAN, who is well known also for his studies of the Kola Peninsula (1892) and a pioneer in the study of forest limits. KIHLMAN studied the flora and vegetation of Inari Lapland in 1880 and travelled not only along the main water courses but also along Vaskojoki River and on the fjelds. His critical and, in view of the difficult conditions, thorough paper on his findings appeared in 1885. Later general botanical surveys relating to the area are HULT's "Die alpinen Pflanzenformationen des nördlichsten Finnlands" published in 1888 and a paper on tree limits published in 1896. The paper by HULT published in 1898 contains also many notes from the area. Also the area which E. A. WAINIO describes in his paper entitled "Notes sur la flore de Lapponie finlandaise" of 1891 extends to the shores of Lake Inari. Most papers that have appeared since that time deal with relatively limited or peripheral areas. HUSTICH has written several botanical papers (1940 a, b, 1941, 1948, 1958) which also relate to the Kevo area. Also KALLIOLA (1937) has published an excellent paper on the special flora of Linkkapahta cliff beside Kevojoki River. KLOCKARS & LUTHER (1938) drew up a list of phanerogams on the Viibus-Marasto fjelds in the western part of eastern Fjeld Lapland and KUJALA (1962) a list of the species in the valley of the Ivalo River. Some special studies by many other investigators cover partly also this region. Of these may be mentioned MARISTO's (1941) studies of aquatic vegetation, KALLIOLA's (1939) study of plant communities in alpine region, the studies of KUJALA (1929), KALELA (1958) and HÄMET-AHTI (1963) on the forest vegetation and a paper of RUUHIJÄRVI (1960) on marsh



Figs. 18—19. — Moneses uniflora has the same distribution as the pine. *Saxifraga oppositifolia* is restricted to few rocks containing basic minerals.

vegetation. The guide published by the Vanamo Society (Archivum 16: suppl., 1961) in connection with the XIII International Phytogeographical Excursion in Finland in 1961 also contains descriptive papers that relate to this region.

In view of the fact that the drawing-up of a general picture of the distribution of the phanerogams of the region from available material with desirable accuracy has not been possible, which is also seen in the Atlas of HULTÉN (1950), one aim of the work done in Kevo in recent years has been to correct this situation. As mentioned, some results of work done in 1954 and 1955 have been published. Some 1700 points of field analyses clarify the distribution of phanerogams in the research area. The largest gaps in the map now exist north and south of the Vaskojoki River.

Card indexes on species and distribution maps that have been prepared provide a fairly comprehensive general picture of the flora of the region.

Collections from Saariselkä region (PERTOLA 1961) and an orientative excursion to the forest region of eastern Lapland (KALLIO 1958) have had as their aim the establishment of direct contacts with the more southern regions of Lapland.

In Figs. 12—19 some main distributional groups are seen. The climatic boundary at the pine forest limit, some aspects of the geology of the area, the influence of the maritime climate towards the north, and human influence on plants are reflected in the distribution of flora. One of the less known plant groups of Lapland are aquatic plants (cf. SÖYRINKI 1939). As the papers of NYMAN (1964), RAUTAVA (1964) and SILTANEN (1964) relating to limited areas show, new aspects of the distribution of plants have been discovered.

It may also be mentioned that Mr. UNTO LAINE, Ph.M., has listed the plant species of the whole Kevojoki River valley in a manuscript that is deposited in the archives of the Department of Botany of the University of Turku.

2. *Fungi*

There is no information on the distribution of larger fungi in Lapland and the collections of these in Finnish museums are insignificant. The excursion made by KARSTEN to eastern Lapland 1861 extended in the direction of the Kola Peninsula and the report he wrote (1882) cannot offer much more than a general orientation in the distribution of rather few species. This report and the also preliminary studies relating to Swedish Torne Lapland by different workers (LAESTADIUS 1860, ROMELL 1912, NANNFELDT & PILÁT 1916, LANGE 1946) do, however, make it possible to form some idea of the distribution of the fungi in northern Fennoscandia. The statement of NANNFELDT (1959) that the information on the fungi of northern Fennoscandia is almost non-existent is still valid to-day in Finland.

Larger fungi have been collected in limited areas near the Kevo Station in 1959—63 and specimens, some of them identified, are deposited in the Botanical Museum of the University of Turku. Only some short papers have appeared that relate to the Kevo region (KALLIO 1960, KALLIO & KANKAINEN 1964, MÄKINEN 1964c). TUOMIKOSKI (1961) has reported some data on the larger fungi in the Saariselkä area. Especially the relationship between the distribution of fungi and conifer trees can be studied with profit in the Kevo region.

The study of micromycetes has advanced no further in the research area. Isolated observations and some collections, primarily from areas at the southern limits of the region, have been reported by LIRO (1908), RAINIO (1926), LEPIK (1933), KARI (1936), and RAUHALA (1959). The results of collections in recent years are included in the paper by MÄKINEN (1964 b).

3. *Lichens*

Although the study of lichens has long been pursued in Finland, also in Lapland, the distribution of species of this plant group in eastern Fjeld Lapland has not been examined to any extent until this decade. HAKULINEN (1962 a and b, 1964) has collected some from the Kevo area and has listed also some of the material collected during excursions from the Kevo Station.

4. *Mosses*

The papers on mosses of the region and the collections are mostly so old that they are included in the book "Die Laubmoosen Fennoskandiens" written by BROTHERUS in 1923. In recent years excursions for the collection of moss material have been organised by Prof. ANTERO VAARAMA. The material collected has particularly contributed to our knowledge of the species on the cliffs alongside the Kevojoki River.

5. *Algae*

Of the papers relating to algae of eastern Fjeld Lapland LUTHER's (1937) refers to the Viibus-Marasto fjelds in northwest Inari whereas KRISTIANSEN (1964) and KUPIAS (1964) have collected mostly in the surroundings of Kevo. Older collections of blue-green algae are mentioned in the paper by KUPIAS.

VII. ZOOLOGICAL RESEARCH

The zoological investigations that have been carried out at the Station are mainly ornithological. Birds of Inari Lapland were described already by NORDLING in the year 1898 and observations on birds of the Utsjoki area in papers by FINNILÄ (1916) and MERIKALLIO (1951) as well as in many short communications of others. TENOVUO (1955) has described the bird fauna in Kevojoki valley in a paper where also references to earlier papers on the birds of Utsjoki may be found. LAINE (1962) has described the distribution of *Limosa lapponica* in Lapland and (1964) some "southern" species in the Kevo research area (1964). Some twenty short ornithological communications and reports have been published from the Kevo research area.

The problems studied by ornithologists are (1) the influence of the Arctic Ocean on the bird distribution, (2) variation of the bird population on selected plots near the station, (3) the daily variation of birds' activities, (4) the bird populations in various biotopes and (5) the biology of less well known bird species (*Falco rusticolus, Limosa lapponica, Chalidris alpina* etc.).

Very little work has been done on other vertebrates, but a number of evertebrates have been collected. *Lepidoptera* of Kevo area are described in a paper by EURANTO & al. (1957) and JUSSILA (1963), where also references are given. UUSI-HONKO has collected *Trichoptera* (1961), RUTANEN (1960) *Coleoptera* and HACKMAN has published a paper on *Diptera* (1963). LEHTINEN (1964) and LINDQVIST (1964) have studied the distribution and ecology

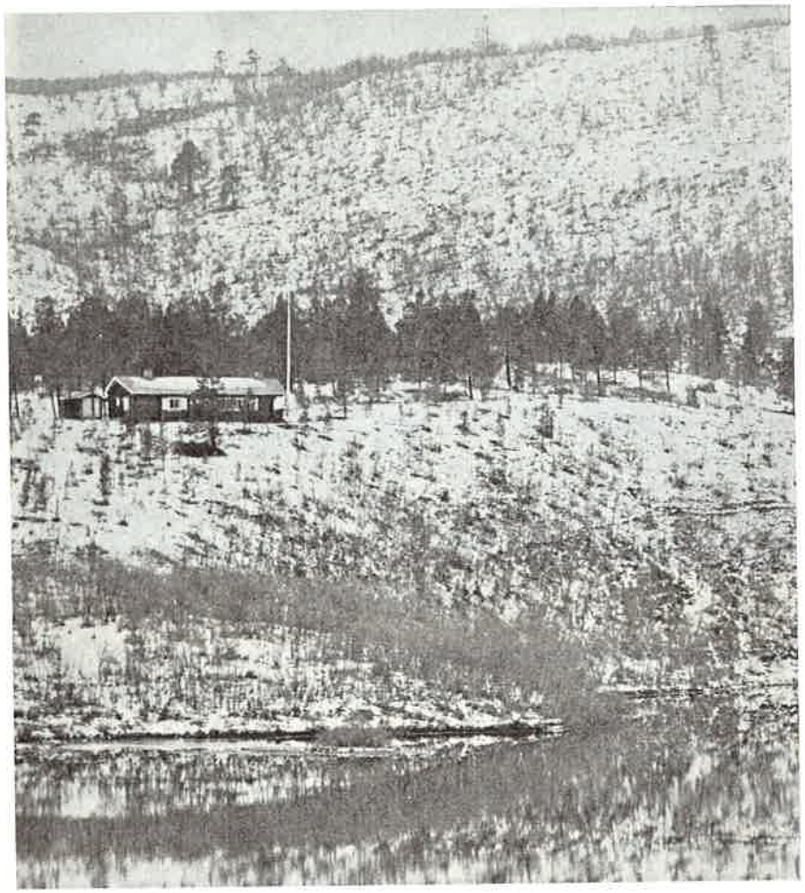


Fig. 20. — View of Kevo. The vertical pine distribution is clearly evident.

of spiders in eastern Fjeld Lapland. The *molluscs* of the Kevojoki Valley are described in a paper by SILVOLA (1964).

VIII. THE KEVO STATION

The director of the Kevo Subarctic Research Station of the University of Turku is a professor of the University of Turku. The director since 1958 has been Professor PAAVO KALLIO of the Department of Botany. Two persons hold permanent posts at the station; they are engaged chiefly as caretakers and carry out the meteorological and seismological work. During summer there is a superintendent at the station who holds an academic degree.

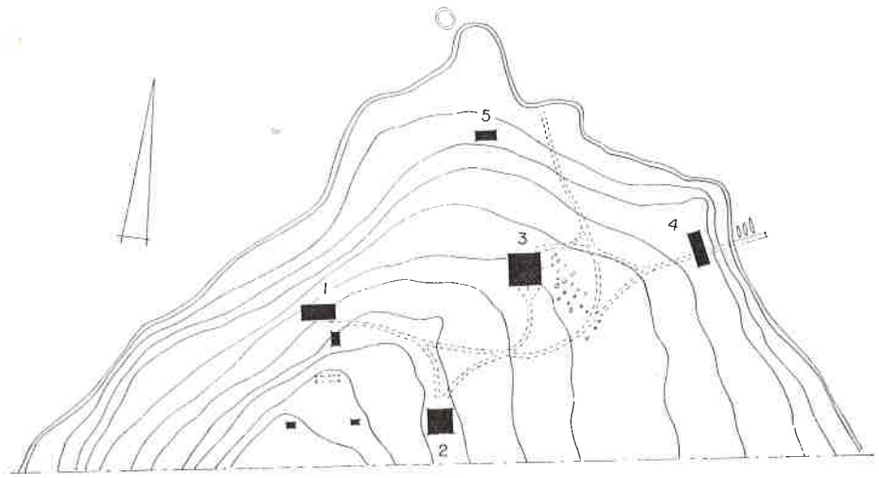


Fig. 21. — Location of buildings. The buildings numbered 1—5 are described in the text.

1. *The station site*

The lot on which the station is located (Fig. 20) — in all about 150,000 m² — is covered by pine- and subalpine birch forests of *Cladina-Empetrum-Vaccinium* (*vitis idea* and *myrtillus*) type. Some of the pines are about 200 years old but on the other hand there are many young trees from the icosaionic period of high temperature. Many age classes from the last century are missing, which reflects the occurrence of decades of low temperature (cf. papers of HUSTICH).

The birches are mostly polycormic and represent a certain type (often called as *Betula tortuosa*) of *B. pubescens* typical of the interior of Lapland. They may be up to 8 meters high in groves near the lake shore, but the height decreases rather abruptly away from the shore so that the average height is about 4 meters 40 meters higher on the slope of Puksalskaidi.

There is also a small marsh on the lot. At the shore there is a luxuriant vegetation of *Cornus suecica* and *Geranium silvaticum* and on the sandy habitat *Oxyria digyna* and *Silene acaulis*. The aquatic vegetation of Lake Kevojärvi is relatively rich as shown by the studies of SILTANEN (1964).

2. *Buildings*

The buildings of the Kevo Station comprise four houses and two storehouses. The log building (Fig. 22) marked 1 in the map in Fig. 21 was erected

Fig. 22. — House no. 1.

in 1958 and is 180 m² in area; it houses a laboratory and one apartment and is heated by woodstoves and electricity.

Building 2, finished in 1961, is a combined residence and laboratory building made of board. The area of the first floor is 140 m²; there are living quarters for the staff and four offices for research workers. The seismological laboratory is on the basement, where there are also a photography laboratory and storerooms. This building has central heating (Fig. 23).

Building 3 is the main building. Its floor area of 450 m² in two floors is taken up by a lecture and dining room for 40 persons, rooms for 10—14 research workers, the dwelling of the superintendent, the main kitchen, the dwelling of the caretaker, a library, a room for collections, two small laboratories and a room for the cultivation of cryptogams. The building was constructed of lightweight concrete and is heated by electricity (Fig. 24).

Building 4 is a Finnish bath (sauna) which was erected of logs in 1958. It comprises the sauna proper, a large dressing room and temporary accommodations for six persons (Fig. 25).

Under normal conditions the station provides accommodation and working areas for 22—26 persons in addition to the permanent staff, and in addition group accommodation for 10 persons.

In 1964 a subterranean tunnel will be built for the laboratory of the Seismological Institute of the Helsinki University.

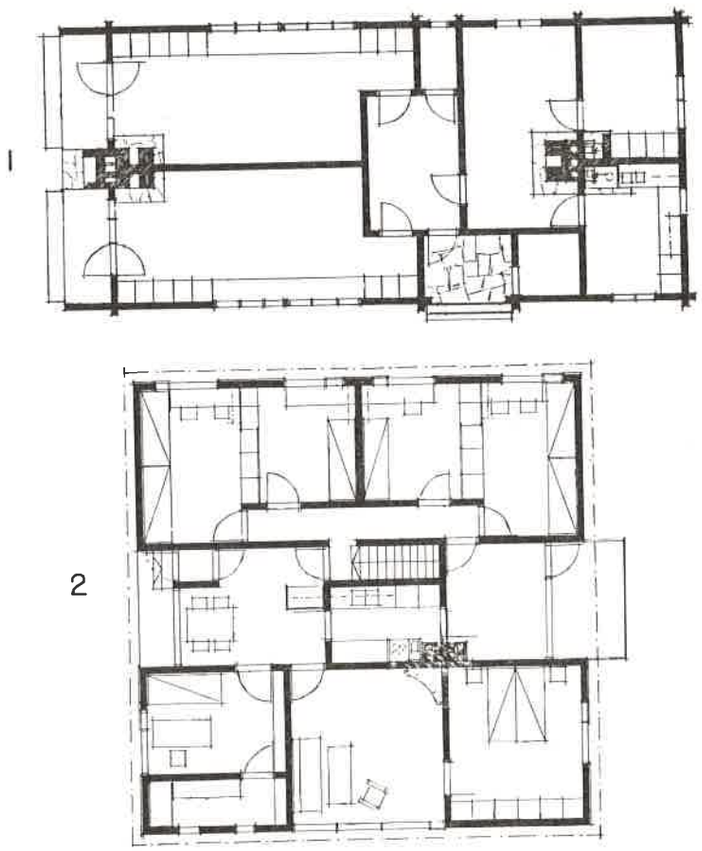


Fig. 23. — The plans of houses 1 and 2. At the east end of house 1 accommodation for one official investigator, at the west end two laboratory rooms. 2. Four rooms for research workers in the north side. The rest of the floor is occupied by the caretakers of the seismological and meteorological laboratories. Scale 1:180.

3. *Equipment and facilities*

The Station is connected to 220 volt, 50-cycle electric mains and the electricity is distributed to all rooms. Buildings 1—3 are supplied with running water.

The library is still very small and contains the major Finnish biological journals and several handbooks on botany and zoology.

Owing to lack of space, the plant and animal collections have been deposited in the museums of the University of Turku, but a small basic collection of various plant groups is in the course of preparation.

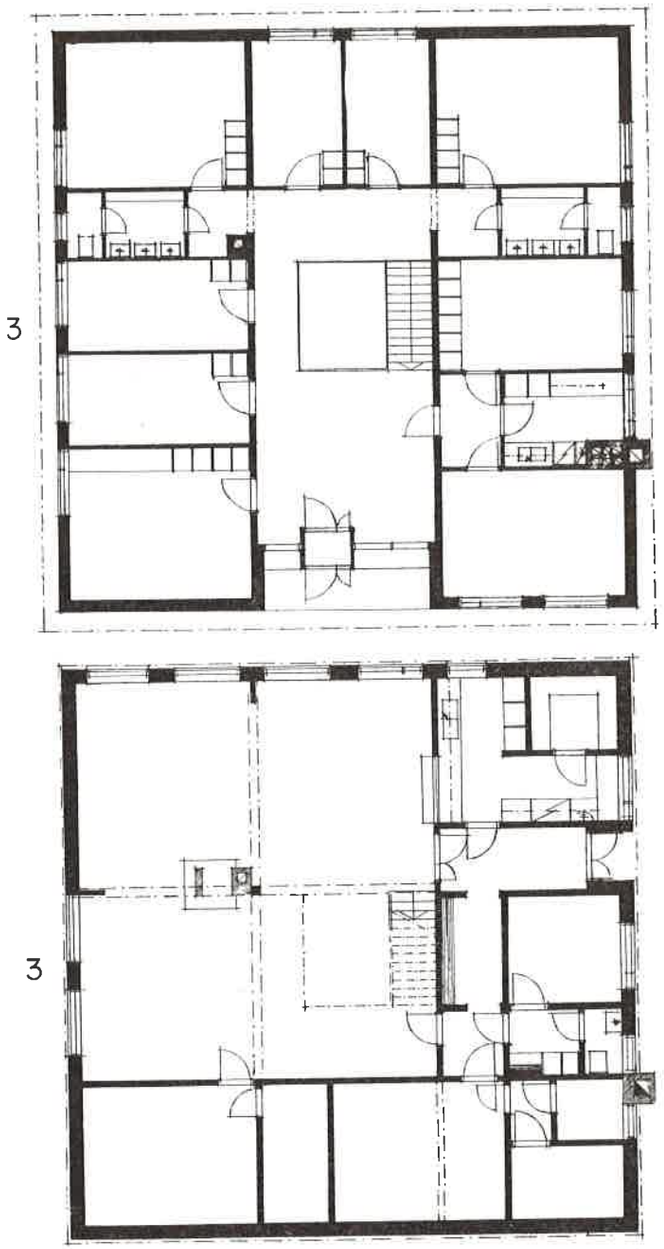


Fig. 24. — Ground plan of building 3. — Upper plan: first floor with 7 rooms for research workers and the apartment of the superintendent of the station. — Lower plan: the ground floor with lecture and dining room, library, laboratories (lower row) and kitchen (in the upper right corner). Scale 1:180.

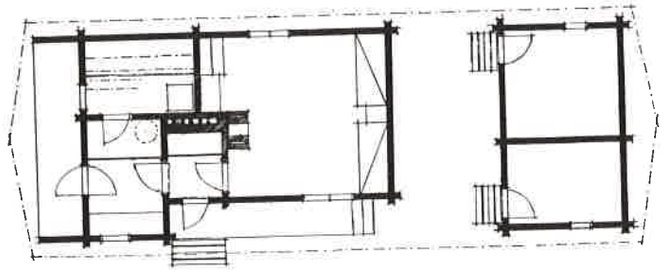


Fig. 25. — The ground plan of the sauna. Scale 1:180.

There are only a few collecting aids for limnological and botanical collection, and a drying cabinet for preparing mushrooms.

The laboratory apparatus include 4 research microscopes equipped with oil and water-immersion objectives and cameras, three stereomicroscopes, an analytical balance, a conductivity meter, two pH-meters, a photocell, a drying oven, a water still, two water thermostats, an ultraviolet sterilisation cabinet for preparing pure cultures of cryptogams, temperature recorders of different types, culture vessels and the usual laboratory glassware. For geographical studies there is a leveling instrument.

4. *Communication*

The station is separated from the highway from Rovaniemi to Utsjoki by Lake Kevojärvi and access to the station in summer is by boat. There are four small rowboats fitted with outboard motors and one is specially equipped for limnological research.

The railroad from southern Finland ends at Rovaniemi at the Arctic Circle and from Rovaniemi there is a daily bus connection to Kevo over a distance of about 500 km. Aeroplanes land at Ivalo, 160 km south of Kevo. The nearest shopping centre is in Utsjoki 20 km north of Kevo. Kevo has good road connections, north to Tana and Kirkenes and west to Karasjok in Finnmark, Norway.

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THE AQUATIC FLORA AND VEGETATION OF LAKE KEVOJÄRVI

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I. INTRODUCTION

The aquatic flora of Lapland has been studied to a very limited extent. Although the first observations on waterweeds of the region date from the early years of the nineteenth century (WAHLENBERG 1812, FELLMAN 1835, KIHLMAN 1884), only three papers solely dealing with the aquatic vegetation have been published (MARISTO 1941, NYMAN 1964, RAUTAVA 1964). More recent publications on the flora of the Utsjoki area in which also the aquatic flora is discussed are those of LAINE, LINDGREN & MÄKINEN (1955), LAINE (1956) and KALLIO & MÄKINEN (1957).

The aquatic flora in Norwegian and Swedish Lapland has been more thoroughly studied. DAHL (1934) who studied the flora in Finnmark and BENUM (1960) who studied the flora of the Troms area give fairly detailed information on the aquatic flora in these regions. Similar reports relating to the flora of northern Sweden have been written by FRIES (1913) and WISTRAND (1962). The water plants of the alpine region of Petsamo Lapland have been described by SÖYRINKI (1939).

The present study on the aquatic flora of Lake Kevojärvi was carried out to obtain supplementary information on the aquatic flora of the Utsjoki area. The field work was done during the period from July 26th to August 13th, 1960.

II. THE FIELD OF STUDY

1. General

Lake Kevojärvi is situated in Utsjoki commune in Finnish Lapland (69°45'N, 27°E). The area is a part of Fjeld Lapland (KALELA 1958) and floristically a part of Inari Lapland. The area is located in a migmatic zone between the granulite and granite-gneiss bed rock areas of North Lapland.