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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.

Loose soil, especially moraine, covers the bed rock throughout the greater part of the area.

Above the conifer forest limit there are isolated pine forests and one of these is responsible for the exceptional vegetation in the vicinity of Kevojärvi. Pine grows over a very limited area in this region and the surrounding areas may be defined as subalpine or, more distant, alpine. The western shores rise fairly abruptly to the 210-metre-high Puksalskaidi and toward the north to the 330-metre-high Jesnalvaara. The eastern shore rises abruptly at first, but then much less rapidly to the 380-metre-high Juovuskalluvaara.

There are two settlements established by Lapps at Kutuniemi and Kevonsuu on the shore of Kevojärvi, but these are now uninhabited. There is, however, a permanent settlement at the Kevonniemi base founded in 1958 by the Kevo Subarctic Research Station of the University of Turku. The Utsjoki highway leading to Finnmark in Norway, which was built in 1957, passes along the east shore of Kevojärvi.

2. Lake Kevojärvi

A. Size, form and depth

Kevojärvi is one of a large number of lakes which form the Utsjoki waterway. The lake extends from Tshieskula on the south to Jomppala rapid on the north. It is about 3.3 kilometres wide and varies in breadth from 100 to 900 metres. The total area is about 1.8 sq. km. and the length of the shoreline about 10 km. The outline of the lake can be seen from the map in Fig. 6. This also shows that Kevojärvi is deep over its whole length. Two shallows less than 10 metres deep cross the lake. The greatest measured depth is 35 metres near the mouth of Kevojoki River north of Kevonniemi.

B. Shores and waters flowing into the lake

The shoreline of Kevojärvi is characterized mainly by slight bends. There are four more prominent points on the east shore which protect the adjoining bays from the force of the relatively strong storms that pass over the lake. Of these bays the most important from the viewpoint of vegetation are the Tshieskula and Kutuniemi bays. The most prominent point on the western shore is Kevonniemi. There is only one island 3—4 ares in area. A point where willows grow is separated by high water at the northern tip of Kevonniemi, but is joined to the latter at low water.

The beaches vary from sandy to rocky. The rocky beaches predominate,

but there are sandy beaches in many places, especially on the western shore. Abrupt rockstrewn shores are located on the northern edge of Kevonniemi and at the extreme southern end of the lake. Silt has deposited at the farthest corners of the Tshieskula and Kutuniemi bays and at the mouth of Raessijoki River.

Owing to the large size of the Utsjoki watershed, a large volume of water flows into Kevojärvi from three rivers, Utsjoki from the south, Kevojoki from the southwest and Tsharsjoki from the west. The small Raessijoki River enters the lake at its extreme north end and in spring numerous brooks flow down the slopes into the lake, but these dry up in the summer.

C. Hydrography

Geodetic surveys carried out on August 2, 1962, revealed that the surface of Kevojärvi is 75 metres above sea level. Fig. 1 shows the variation of the water level during the period when the lake was free of ice in 1962.

The water was at its highest level on the second or third day after the ice broke up and floated away and at its lowest level when the lake froze again.

Very little information is available on the ice conditions. The ice left on June 1, 1961 and on June 8, 1962, and new ice formed on October 16, 1962. According to NYMAN (1964) the ice left Lake Mantojärvi at the same time, but this lake froze three weeks later on the average than Kevojärvi. As these two lakes are only 10 kilometres apart, the freezing of Kevojärvi on October 16 took place much earlier than normally. The thickness of the ice in late winter of 1962 was about 70 cm.

The water temperatures were measured in the summers of 1960 and 1962.

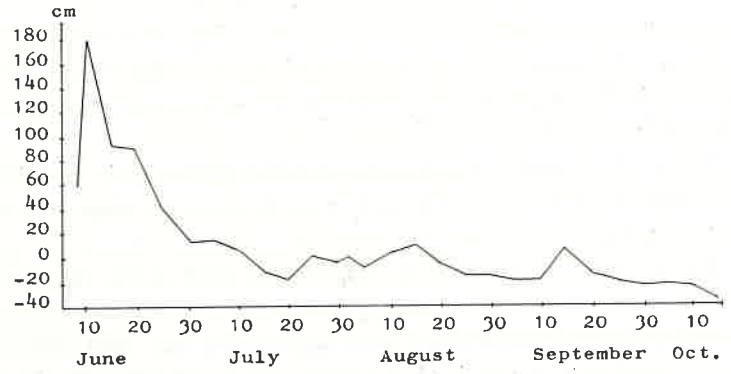

Fig. 1. Variation of water level in Kevojärvi from June 8 to October 15, 1962.

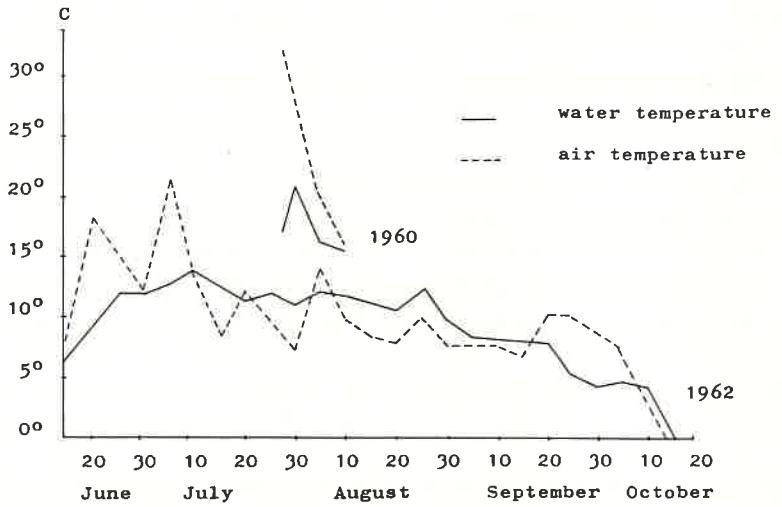

Fig. 2. Variations in temperature of air and water from July 28 to August 11, 1960, and from June 15 to October 15, 1962.

The results for the period from June 15 to October 15, 1962 are plotted together with the air temperatures in Fig. 2. Also data recorded in the summer of 1960 are plotted in the figure.

The water temperatures closely follow the air temperatures, although the curve even for the surface waters is much more uniform and the rises and falls occur later than those of the air. The data for 1960 were collected over a period of only two weeks and hence no comparison between the data for the two summers with their widely different weather is possible. The data for 1960 do, however, reveal the daily variation of the water temperature and the temperatures at different depths. Fig. 3 shows the temperature variation at depths of a) 65 cm, b) 210 cm, and c) 450 cm.

The temperatures are seen to have been very high. The temperature at a depth of 65 cm was over 20°C on two successive days; this is probably very unusual in these latitudes. The daily variation of the temperature at the three depths is shown in Fig. 4.

The variation is naturally smaller at greater depths and is less than one degree at a depth of 450 cm. The temperature is lowest at about 6 a.m. and highest at 2—6 p.m.

Fig. 5 shows the variation of the temperature with depth on August 9, 1960.

The temperature decreased about one degree over the first metre, then decreased less rapidly to a depth of 8 metres, decreased abruptly 8 degrees over a distance of 10 metres, and then fell to a minimum of 6.8°C.

3

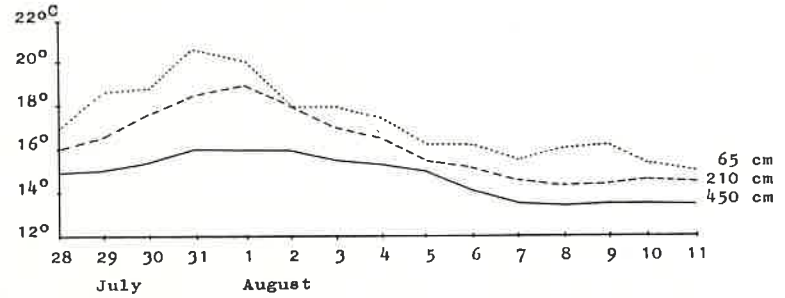

Fig. 3. The temperature variation at three depths from July 28 to August 11, 1960.

4

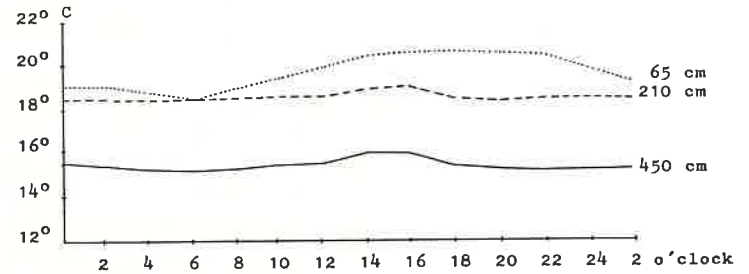

Fig. 4. Daily variation of water temperature at three depths on July 31, 1960.

5

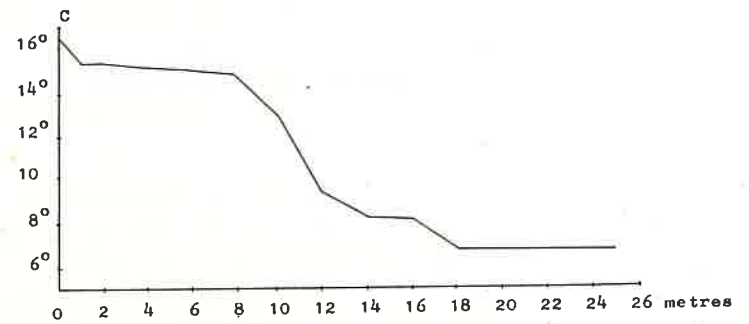

Fig. 5. The variation of water temperature with depth on August 9, 1960.

The transparency of the water was 460 cm at the south end of the lake at 12 to 3 p.m., 420 cm near Kevonniemi, 420 cm at the mouth of Kevojoki River and 440 cm south of Kutuniemi (P. BAGGE) on Aug. 4, 1962. The water was slightly greenish in colour, and its pH varied from 6.2 to 7.2 in the summer of 1962. The pH was lowest at the southern end and increased toward the north. The highest values were recorded at the mouths of Kevojoki and Tsharsjoki Rivers. The pH values rose slightly during the summer (P. BAGGE).

III. METHODS

The vegetation of the lake was mapped by recording from a boat the plants along a swath 3—4 metres wide extending from a point on the shore straight out toward the open water. It was necessary to drag the lake bottom when the depth exceeded a certain level. The depths and distances from the shoreline were measured to the nearest 5 and 50 cm, respectively.

The water temperatures were measured with a recording thermometer and an ordinary mercury thermometer. The transparency of the water was evaluated with the aid of a white plate 20 cm square. The pH values were recorded by Mr. Pauli Bagge, B.Sc., and the depths were measured by Mrs. Terttu Petäjä, M.Sc., and Mr. Aatos Petäjä, M.Sc., with a Bendix echo sounder on September 18, 1961.

Unless stated otherwise, all the observations were made in the summer of 1960. This particular summer was favourable for the growth of the plants to such an extent that, for example, the information on the flowering of the plants may seem incorrect in comparison with information collected in less favourable years. The water was probably at a low level in the summer of 1960 and for this reason the depth values are to be considered relative.

Information on the distribution of plant species in the Utsjoki area was obtained from the files of the Zoological and Botanical Society of Turku.

For the sake of brevity, the years of publication of the papers by LINKOLA (1932), SÖYRINKI (1939), MARISTO (1941) and NYMAN (1964) will be omitted in the following.

The plant map in Fig. 6 is valid only along the lines where observations were made and which are marked on this map. The distributions in the areas between the lines are estimated, but they are not expected to be in error to any greater extent.

The frequencies of the species are based on the frequency scale of NORRLIN (ULVINEN 1937): rr = very rare, r = rare, st r = rather rare, p = passim, st fq = rather common, fq = common and fqq = very common.

IV. THE VEGETATION OF KEVOJÄRVI

1. *Species*

Owing to the climatic conditions, the number of plant species growing in the lakes of Lapland is small (cf. SÖYRINKI p. 35). The mean number of species found by MARISTO (p. 164) in lakes of the *Carex* type was 16. The number of species in Kevojärvi is 19. These include all phanerogams that grow in the lake as well as two *Carex* species which LINKOLA (p. 89) does not consider true aquatic species.

Following VAARAMA (1938 p. 77), the species may be allocated to three groups: A. species with aerial shoots, B. species with floating leaves and C. submerged species.

A. Species with aerial shoots

The species with aerial shoots are very few in number. There were only four species of this group and with the exception of *Hippuris* these were found in low frequency.

Equisetum fluviatile L. — (r) This species grows in small numbers at the mouth of Raessijoki River and at the inner end of Kutuniemi Bay, but two large and luxuriant beds of the species occur in the most western part of the lake on both sides of the mouth of Kevojoki River. The depth of growth varies from 0 to 100 cm. The densest growths are on sandy bottoms. The species is widely distributed in Utsjoki commune, but mainly in bogs. The waters where it usually grows are small ponds. LINKOLA (p. 90) has mentioned that this species is one of the few aquatic plants that grow well in the fjeld regions of Finnish Lapland. SÖYRINKI (p. 36) confirms this conclusion as he found the species in the alpine region of Petsamo. The species is found only in small numbers in Lake Mantojärvi (NYMAN p. 21). MARISTO (p. 164) found the species in sheltered bays of Inari, Vastusjärvi and Talvitupajärvi lakes in Inari Lapland.

Carex aquatilis Wg — (r) This species grows only in the extreme ends of Tshieskula and Kutuniemi Bays. The populations are relatively small in area and always lie in shallow water. MARISTO (p. 164) considers *Carex* species the characteristic species of northern lakes. They were so common in the lakes he studied that he called these *Carex* type lakes. They are, however, so few in number in Kevojärvi that this lake cannot be included in this group. The species are low in frequency also in Mantojärvi (NYMAN pp. 21—22). *Carex aquatilis* was found in only three places. The species is, however, common throughout Utsjoki commune.

Carex rostrata Stokes — (r) This sedge grows in the same bays as the preceding species, but also forms a lush population at the mouth of Raessijoki River. In Mantojärvi the species is rare. MARISTO reported it to grow in all three lakes of the *Carex* type that he investigated. The species is widely distributed in Utsjoki commune. Since this and the preceding species grow only in the most sheltered waters of Kevojärvi, it must be concluded that their low frequency is due to the lack of suitable habitats. This conclusion is supported by MARISTO's finding (pp. 163—164) that the most abundant populations are located in sheltered bays.

Hippuris vulgaris L. — (p) Although this is generally included among the species with aerial shoots, it only rarely grows above the surface in Kevojärvi. The species is usually submerged at depths varying from 10 to 100 cm and occurs often singly or in small groups. Species associated with it include *Callitriche verna, Isoëtes echinospora* and *Ranunculus flammula* v. *reptans*. The species is rather rare in Mantojärvi. According to LINKOLA (p. 90) and SÖYRINKI (p. 36), it grows even in the alpine regions in our country. It is,

however, only rarely found above the tree limit in Utsjoki commune. In less elevated waterways, especially in Utsjoki and Teno Rivers, the species grows abundantly in places. It was found also in all the *Carex* type lakes studied by MARISTO.

B. Species with floating leaves

This group of plants predominates in Kevojärvi both in the number of species and in the number of individual plants.

Sparganium angustifolium Michx — (fq) As the *Sparganium* populations in Kevojärvi are mostly sterile, the determination of the species is very difficult. All species have therefore been marked *S. angustifolium* except the species mentioned below which is readily recognized as it is fertile. HUJU (1961) either did not find other species than these two in Kevojärvi. *S. angustifolium* forms raftlike or sometimes zonelike populations in coves and along sheltered shores. Usually, and especially during unfavourable summers, the species develops only to the submerged stage. The species is seldom found among other species. The growth depth varies from 0 to 100 cm; the forms with floating leaves, however, grow at depths exceeding 40 cm. The species prefers sandy bottoms, but grows also on rocky bottoms. The species is rather common in Mantojärvi. MARISTO (p. 164) considers it the main species with floating leaves in the lakes he studied. It is rare in Utsjoki although studies of its distribution are rendered difficult by its usual sterility.

Sparganium angustifolium × *simplex* Huds. — (r) This hybrid form (cf. HUJU 1961) is much larger than the preceding species and grows to the surface; it is the only *Sparganium* with aerial shoots in Kevojärvi. In the summer of 1960 it flowered everywhere where it was found. The flowering was, however, very limited in 1962 and the species was difficult to differentiate from the preceding. The populations were slightly smaller than those of the preceding species with which it usually occurred together. The growth depth varied from 20 to 80 cm. In addition to the four places (lines 19, 26, 27 and 34) in Kevojärvi, this species has been found elsewhere in Utsjoki River near the Jomppala and Jaakkola farms. In the summer of 1961 I found the species also in Lake Kidsajärvi which is situated north of Jaakkola farm near Utsjoki River.

Potamogeton pusillus L. — (fq) This is the most common pondweed in Kevojärvi. It grows at two depths. The populations at depths from 10 to 100 cm are brownish green in colour and flower abundantly in favourable summers. The second depth varies from 200 to 430 cm and the species then

has bright green shoots and is probably always sterile. The species forms pure populations which may, however, cover only small areas. At small depths it grows side by side with submerged species and at greater depths with *Ranunculus peltatus* and *Myriophyllum*. The soil where it grows is usually sandy, but the species may also grow on rocky bottoms. LINKOLA (p. 94) states that the species is basocline. The large numbers growing in Kevojärvi may be an indication of the eutrophic nature of the lake. *Potamogeton pusillus* is much less common in Mantojärvi. The species is relatively rare in Utsjoki commune. It has been found in only some twenty locations, of which half are in Utsjoki River. MARISTO (p. 315) found the species in two of his *Carex* type lakes.

Potamogeton alpinus Balb. — (st fq) This species usually grows in small numbers at depths from 20 to 100 cm. The densest and most abundant populations were in Tshieskula Bay and at location 28 near the north end of Kevonniemi. The species flowered most profusely in these areas, but it was fairly fertile also elsewhere. The species often occurred in groups of a few individuals among submerged species and sometimes together with other *Potamogeton* species. The species fares best on fine sandy bottoms. This species is much less common in Mantojärvi than in Kevojärvi. It is, however, fairly widespread in Utsjoki commune and is found in bog brooks and even in small waters. MARISTO (p. 315) found the species in small numbers in Lake Inari.

Potamogeton gramineus L. — (p) This species usually grows at the same places and depths as *P. alpinus*. It seldom occurs singly, but forms more or less dense populations which may be quite extensive. For instance, near the end of Kutuniemi point it covered an area of 75 × 10 m, in which also *P. perfoliatus* grew, especially at the periphery of the area. The species seems to prefer flowing water. It flowers profusely in favourable years. This species is the most common of its genus in Mantojärvi and it is relatively common also elsewhere in the Utsjoki and Teno waterways, but is rare in other parts of Utsjoki commune. MARISTO (p. 315) reported that the species is common in Inari and Vastusjärvi lakes.

Potamogeton perfoliatus L. — (p) This species, which LINKOLA (p. 96) states to be basocline, is the least common species of its genus in the lake. It usually occurs in groups comprising a few individuals, although single plants are found in shallow waters. The most extensive populations are at the end of Kutuniemi and in Tshieskula Bay, where the species also flowered fairly profusely. The bottoms where it grows are sandy. The growth depth varies from 20 to 80 cm; the most favourable depths are over 50 cm, because

the fertile individuals are found at these depths. The species is rather rare in Mantojärvi, but fairly common elsewhere in Utsjoki. MARISTO (p. 315) found this species in two of his lakes.

Ranunculus peltatus Schrank — (fq) This, one of the most common plants in Kevojärvi, forms large populations in many places where it also flowered profusely. The largest continuous population is in location 35 at the southern end of the lake where it grows in an area about 300 metres long and 40 metres wide. The species occurs usually on sandy and silt bottoms. The growth depth varies from 25 to 350 cm, but the species flowers only when the depth is 70—220 cm. The species occurs together with *Myriophyllum alterniflorum*, but usually in slightly deeper water; these two species rarely form mixed populations. It grows together with *Isoëtes lacustris*, however, fairly often. The species is as common in Mantojärvi as in Kevojärvi, but is rare elsewhere in Utsjoki. LAINE (1956, p. 124) states that it sometimes forms massive populations in the area of Kevojoki River. MARISTO (p. 315) found the species in all the lakes of Inari he studied.

Ranunculus trichophyllus Chaix v. *eradicatus* (Laest.) Drew — (p) LINKOLA (p. 95) states that this species is basocline. This is shown also by the distribution of the species in Kevojärvi, for almost all of the places where it was found were at the northern end of the lake where the nature of the bottom was most favourable and the pH was slightly higher than elsewhere in the lake (cf. p. 45). The species generally forms pure populations which vary from 1 to 100 dm^2 in area. Single plants may grow in unfavourable places and there together with, for instance, *Ranunculus flammula* v. *reptans* and *Isoëtes echinospora*. The most abundant populations were at the mouth of Raessijoki River, in Tshieskula Bay and in location 14. The species flowered everywhere and the growth depth varied from 10 to 70 cm. The species grows relatively abundantly in Mantojärvi. Except in the lower reaches of Utsjoki River, it is very rare in Utsjoki commune. MARISTO (p. 315) found the species in two of his *Carex* type lakes. SÖYRINKI (p. 36) also encountered it in the alpine region of Petsamo.

Callitriche verna L. — (st fq) This species seldom forms uniform populations, but occurs singly or in groups of two or three plants together with *Isoëtes echinospora, Subularia aquatica, Ranunculus flammula* v. *reptans* and *Sparganium angustifolium*. It prefers silt bottoms. The species was mostly fertile and its growth depth varied from 0 to 80 cm. It is much less common in Mantojärvi, for NYMAN (p. 9) reported its frequency to be st r. The species is rare throughout the Utsjoki commune, although it has been found in several

places in the Utsjoki and Teno Rivers. MARISTO (p. 315) found the species in two of the *Carex* type lakes and it has been found also in Petsamo.

Myriophyllum alterniflorum DC. — (fqq) If one were to choose a type species among the weeds of Kevojärvi, this would be *Myriophyllum alterniflorum*, for it is by far the most common and typical plant there. It forms a band along the shoreline which is less uniform in unfavourable locations. It was not found in 6 locations of which two were barren. The band varies from single plants on barren and deep shores to zones 40 metres wide. The species grows best on fine sandy bottoms, but grows also between rocks on rocky bottoms. The growth depth varies from 50 to 350 cm, but the species grows mostly at depths from 80 to 230 cm where it also flowers. The flowering varies greatly from year to year, undoubtedly depending on the temperature. The populations are usually dense, and hence other species are rarely found together with this species. The boundary between different species is less distinct at greater depths, and *Ranunculus peltatus* and *Potamogeton pusillus* are then interspersed with *Myriophyllum. Isoëtes lacustris* and *Myriophyllum* do not grow together. The species is very common in Mantojärvi and throughout Utsjoki River. It is probably the most widely distributed aquatic plant in Finnish Lapland. MARISTO (p. 315) found the species in abundance in all four *Carex* type lakes. The species forms very dense populations in places in Kevojoki River.

Utricularia minor L. — (rr) I did not find this species in Kevojärvi, but in the summer of 1961 it was found (Y. Mäkinen) in Tshieskula Bay, where it grew near the shore on a muddy bottom. Most of the places where the species has been found in Utsjoki have been in the Utsjoki River and Vetsikkojoki River waterways. The species is, however, nowhere common.

C. Submerged species

The contribution of submerged species to the vegetation of Kevojärvi is considerable, although smaller than that of the preceding species. These species cover about one fourth of the area where growth is possible. The number of species in this group is five.

Isoëtes lacustris L. — (p) This species occurs in extensive beds which almost without exception are located in the southern half of the lake. It was found only in locations 44 and 46 north of Kevonniemi. The species is not basocline as far as the nature of the soil is concerned. It grows at depths varying from 50 to 300 cm; the level is the same as that of *Myriophyllum*

which it has displaced in many places. This is seen in, for instance, location 44 where *Isoëtes* has spread into a *Myriophyllum* zone at the most favourable depth of the latter species. Its distribution may also be determined by edaphic factors since P. Bagge found in 1962 that there was a high content of iron oxides in the soil where the species grew in the south end of Kevojärvi. The species often grows together with *Ranunculus peltatus*. It is more common (fq) in Mantojärvi than in Kevojärvi. It has been encountered in several places elsewhere in Utsjoki commune and SÖYRINKI (p. 36) found it in the Petsamo alpine region. MARISTO (p. 315) found the species in all the lakes of Inari he studied.

Isoëtes echinospora Dur. — (fq) This species grows widely in Kevojärvi. It does not form dense populations, but grows as single plants among *Ranunculus flammula* v. *reptans* and *Subularia aquatica*. It differs from the typical form in that it is brighter green in colour. Also its leaves are more rigid and do not collapse like a brush when the plant is removed from the water. The species prefers a silt bottom, but grows also on gravel beds. Its growth depth varies from 10 to 90 cm. NYMAN (p. 10) found the species in only two places in Mantojärvi. With only a few exceptions, the species has been found in the commune only in the Utsjoki River valley. MARISTO (p. 315) encountered the species in Inari and Vastusjärvi lakes.

Eleocharis acicularis (L.) R.Br. — (p) It is probable that this species grows in more than the nine locations where I found it, because it is difficult to locate it under a gel-like layer of algae owing to its small size. This brownish gray alga mass covers all the submerged species and at the end of summer also the leaves of *Myriophyllum*. The species was concentrated on the northwest shore of the lake where it was found in six locations, in all of which the bottom was covered by fine sand. The species usually grows in small plots adjoining or surrounded by populations of *Ranunculus flammula* v. *reptans* and *Subularia aquatica*. I did not find the species growing above the waterline and submerged it was always sterile. Its growth depth varied from 15 to 70 cm. NYMAN (p. 10) reported that the species is st r in Mantojärvi, but he remarked that it is possibly more common. In Utsjoki commune the species has been found only in the Utsjoki, Teno and Inarinjoki rivers and once in Lake Pulmankijärvi. SÖYRINKI (p. 36) encountered the species in the Petsamo fjeld region and MARISTO (p. 315) in every one of the *Carex* type lakes.

Ranunculus flammula L. v. *reptans* (L.) Hartm. — (fq) This species is second in abundance in Kevojärvi. Its long stems which throw off roots from the joints form tangled, often extensive matlike populations which usually

are pure. In places where its populations are less dense, *Isoëtes echinospora* and *Subularia aquatica* and other waterweeds may also be present. The densest populations are at the north end of the lake. The species generally grows in shallow water at depths between 0 and 50 cm, although it may be found at a depth of one metre. Sometimes the submerged population may continue on the adjoining bank where it usually flowers. The submerged plants are always sterile. The frequency of the species in Mantojärvi is p. It is fairly common in all river valleys of Utsjoki commune and it grows also in the alpine region in Petsamo. MARISTO (p. 315) found the species in all the *Carex* type lakes.

Subularia aquatica L. — (st fq) This species grows all over the lake although, like the other species, its density decreases from the north to the south end of the lake. It often forms small isolated pure populations, but grows also among other species, especially *Isoëtes echinospora* and *Ranunculus flammula* v. *reptans*. The species flowered profusely in the summer of 1960. It grows at depths varying from 10 to 100 cm. The frequency of the species in Mantojärvi is p. All places where it has been found in Utsjoki commune are in the Kevojoki, Utsjoki and Teno Rivers. MARISTO (p. 315) found the species in two of the *Carex* type lakes.

D. Water cryptogams

Information on the occurrence of cryptogams in the area of study is meagre except for *Nitella*. It has, however, become evident that the mosses are of minor importance. The only populations were in the mouth of Raessijoki River and in Tshieskula and Kutuniemi Bays. A part of the species collected by dragging the bottoms have drifted into the lake from other locations. The number of species found was 6.

Scorpidium scorpioides (Hedw.) Limper. — This species occurs as an extensive mass among the sedges in the inner end of Tshieskula Bay. The species grows throughout the country, but it is most common in the north.

Drepanocladus tundrae (Arn.) Loeske. — This species was found in one location. Two stems were detached from a depth of four metres with a drag. Also this species has spread all over the country, but is probably less common than the preceding species owing to its basoline character.

Drepanocladus trichophyllus (Warnst.) Mikut. — This is the most common moss in Kevojärvi as it was found in five locations. It occurred as mass

populations near the shore at the mouth of Raessijoki River and Kutuniemi Bay. Single plants were caught in a drag in three locations in different part of the lake. Also this species is distributed throughout the country.

Drepanocladus revolvens (Sm.) Warnst. — This species had probably been washed by spring floods into the lake for it is one of the most common calciphilous mosses in bogs.

Hygrohypnum smithii (Sw.) Broth. — This species usually grows in brooks and has probably been washed into the lake from its normal habitats.

Amblystegium riparium (L.) Br. eur. — One plant was caught in a drag on the western shore of the lake near its southern end. This is the northernmost place where it has been found, for it has previously been found only in Lake Inari. The species is more abundant on going south and is most prevalent in the southernmost regions of Finland.

Of other cryptogams only the genus *Nitella* of *Characeae* will be discussed. Probably the most common species is *N. wahlenbergii*, but it is possible that also *N. flexilis* grows in Kevojärvi, although it escaped discovery. *Nitella* represents an important group among the waterweeds of the lake as it was found in 19 locations. The populations are usually very dense. The plant grows, with the exception of five locations, at the north end of the lake where it probably forms a continuous zone. I found the species at a depth of 500 cm, whereas P. Bagge reported that he had found it at a depth of 900 cm. The populations at the greatest depths were near the mouth of Tsharsjoki River. In most cases *Nitella* grows at depths of 300—400 cm outside a zone of *Myriophyllum*.

2. *Plant zones and their location*

As Kevojärvi is deep throughout its length, regions favourable for plants are found only near the shores. The width of this sublitoral zone (cf. VAARAMA 1938 p. 84) varies from 0 to 65 m and it extends to a maximum depth of 5 metres. As the annual freezing and wave erosion greatly influence the plant growth on the shores, the sublitoral zone may be divided into erosive and inerosive zones (THUNMARK 1931, p. 40) which differ decisively in the conditions they offer for plant growth.

The slope of the shore determines the width of the sublitoral zone. The shores at the southern end of Kevojärvi are steeper than those at the northern

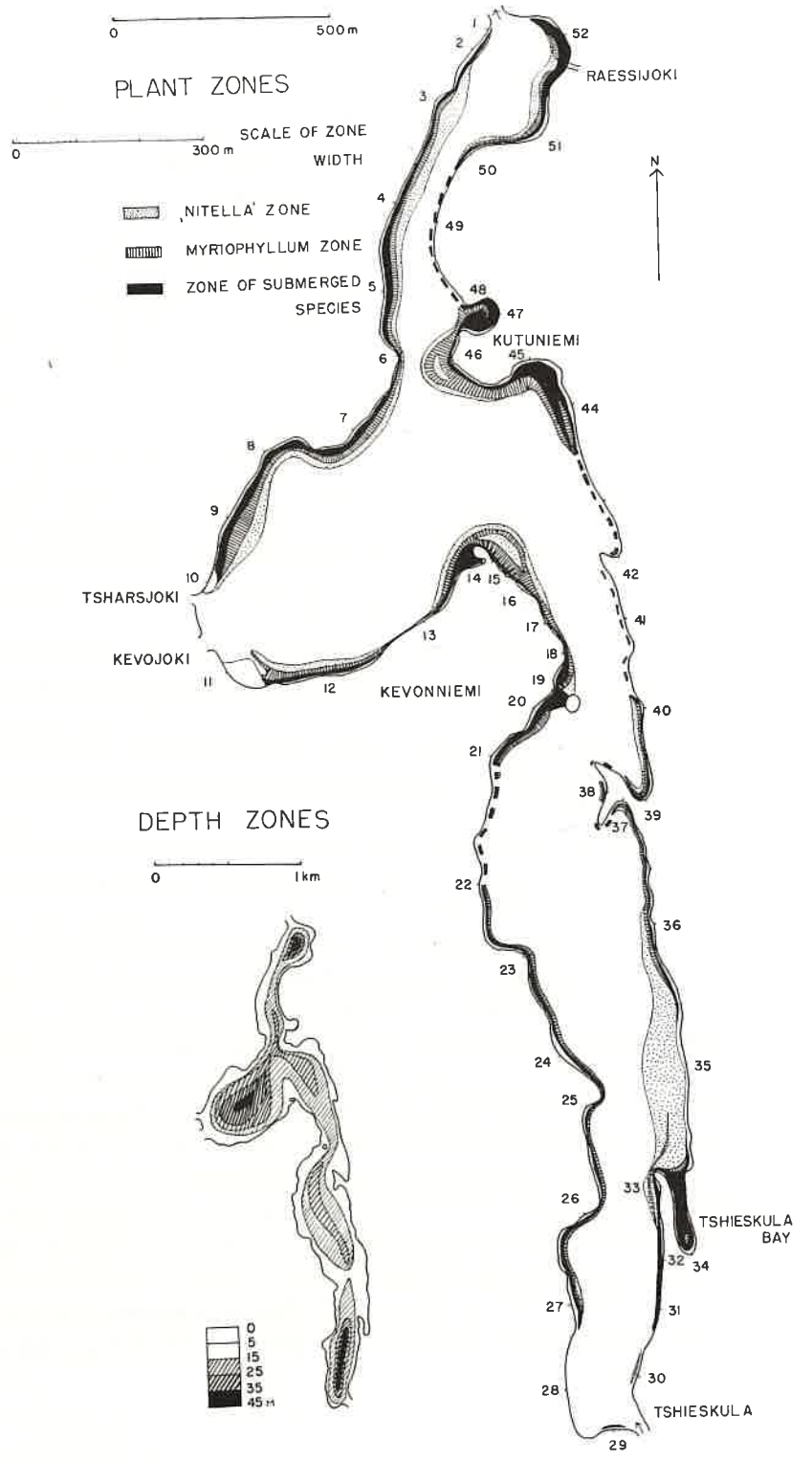

Fig. 6. Map showing the plant and depth zones in Kevojärvi. The numbers indicate locations where more detailed vegetation analyses were made.

end and as a consequence the vegetative zone decreases in width toward the south.

The nature of the soil of the sublitoral zone largely determines the density of the vegetation, but the latter is also influenced by how sheltered the location is. The growth is most profuse in shallow silt-covered bays where the action of waves is slight. Such bays are Tshieskula and Kutuniemi Bays and the cove into which Raessijoki River flows at the northern end of the lake. Completely plantless sublitoral zones are rare in the lake. On the eastern shore opposite Kevonniemi, however, the vegetation is sparse over a distance of almost one kilometre and even lacking in places. One plantless shore is at location 17 where the bottom is very steep. Also on rock-covered erosive zones the vegetation is often sparse.

The map showing the vegetation zones reveals that the zones north of Kevonniemi are much better developed than those south of the point. This is probably due not only to the smaller slope of the sublitoral zone but also to the more finely divided bottom soil and the slightly higher pH.

The growth zone seldom begins at the waterline, but (in the summer of 1960) at a depth of 10—20 cm. The plantless zone averaged two metres in breadth, but was 9 metres wide at location 24.

Only a few species are able to form extensive pure populations. The majority of the species occur mixed, or the pure populations they form are small in area. The conditions are, however, so favourable for *Myriophyllum* that its stands seldom contain other species. *Myriophyllum alterniflorum* was found almost everywhere in the sublitoral zone and its growth zone lies between two other zones.

The growth zone on the shore side of the *Myriophyllum* zone may be called the zone of submerged species. In addition, species of all the three groups are represented in this zone, which is hence non-uniform. It is common to all these plants that they grow on erosive bottoms. The main species inhabiting the zone are the most common submerged species of the lake: *Isoëtes echinospora, Ranunculus flammula* v. *reptans* and *Subularia aquatica,* of which at least one is represented in every population. In the areas they grow are often found *Hippuris vulgaris, Potamogeton perfoliatus* and *Callitriche verna,* and less frequently *Ranunculus trichophyllus* v. *eradicatus* and *Eleocharis acicularis.* The zone often contains pure populations of *Potamogeton pusillus* and *P. gramineus.* Also *Sparganium angustifolium* grows in this zone.

The width of the zone of submerged species varies from 0.5 to 15 metres, and its greatest depth is 70 cm on average, which also is the limiting depth between the erosive and inerosive bottoms.

The variation of the density in the zone of submerged species is shown by the data in the following table. The data give cover of individual plants in

plots 0.25 sq.m in area in different parts of the lake. The figures refer to the following percentages of the plot areas covered by the plants:

+ = 1 %	2 = 5—25 %	4 = 50— 75 %
1 = 1—5 %	3 = 25—50 %	5 = 75—100 %

The numbers in the column headings denote the numbers of individual plants.

Location (see map)	1	2	3	4	7	9	20	30	50	51
Hippuris vulgaris	—	—	—	—	5	—	—	—	—	—
Sparganium (submerged)	50	20	60	—	35	100	—	—	15	6
Potamogeton pusillus	1	—	3	—	—	—	—	—	—	—
P. alpinus	—	6	—	—	—	7	—	—	—	—
P. gramineus	24	—	—	—	—	—	—	2	—	—
P. perfoliatus	—	—	—	—	8	—	—	—	—	—
Ranunculus trichophyllus v. eradicatus	—	—	—	—	1	2	—	—	—	100
Callitriche verna	—	2	—	15	—	9	—	—	—	18
Isoëtes echinospora	6	—	2	6	4	3	25	—	—	—
Subularia aquatica	—	—	—	2	70	9	—	—	—	30
Total cover	2	+	1	+	3	5	+	+	+	3

The density varies not only between the strips but also within the strips and hence the above density figures do not give the true mean densities in the strips.

The coverage in the growth zone of *Myriophyllum alterniflorum,* the dominating species in Kevojärvi is usually 5, which means that no other species survives in a growth as dense as this. The *Myriophyllum* zone generally ends abruptly on the side toward the shoreline, but its outer boundary is more or less distinct. There are sometimes less dense areas in the zone, as at location 15, and these are usually populated by *Ranunculus peltatus,* although its main habitat is outside the *Myriophyllum* zone. This zone is densest and widest in the northern end of the lake where it is up to 40 metres wide in places. At the southern end of the lake the zone is 2—3 metres wide and non-uniform in many places. South of location 37 *Myriophyllum* and *Isoëtes lacustris* alternate.

The vegetation outside the *Myriophyllum* zone can be included in one zone, which I choose to call the *Nitella* zone owing to the dominance of this species. In most cases this zone forms the outer edge of the sublitoral although the *Myriophyllum* zone may sometimes extend to this edge. Species that occur in the *Nitella* zone in addition to the main species are *Ranunculus peltatus* and *Potamogeton pusillus,* and very infrequently also *P. alpinus* and *P. gramineus.* Of these species only *Ranunculus peltatus* grows up to the surface, and as this zone lies so deep that it cannot be seen from the surface, the

examination of the other species requires the use of a drag. The distribution of different species was discussed already when the species were considered individually and therefore we shall note their locations in the zone. The species that grows closest to the *Myriophyllum* zone is *Potamogeston pusillus* and outside this *Ranunculus peltatus*. The outer edge of the zone is formed by *Nitella* species. The mean width of the zone is approximately that of the *Myriophyllum* zone.

The allocation of some species to one of these zones is difficult. In view of its morphology *Isoëtes lacustris* should be included in the zone of submerged species, but its occurrence would require it to be included in one of the inerosive zones.

A similar zonal vegetation is found also in Mantojärvi, but in the *Carex* type lakes studied by MARISTO the zones are very indistinct.

V. THE LAKE TYPE OF KEVOJÄRVI

Lake Kevojärvi should be placed among the oligotrophic lakes. The oligotrophy is revealed, e.g., by the following facts: the depth of visibility is ca. 4.5 m (2.5—13 m in oligotrophic lakes), the pH value is close to neutral (ca. 7 in oligotrophic lakes); the typical oligotrophic species *Myriophyllum alternifolium* and *Isoëtes lacustre* characterize also Kevojärvi. In the quantitative respect, however, the vegetation differs from that of typical oligotrophic lakes, which are characterized by a poorly developed higher vegetation. This does not apply to most parts of Kevojärvi.

According to MARISTO (p. 163), Kevojärvi should belong to the *Carex* type which is typical of Finnish Lapland. However, the aquatic sedges are very poorly developed. The most common species in Kevojärvi, as well as in Mantojärvi and in many other lakes of Lapland is *Myriophyllum alterniflorum*. The best solution would be to call these lakes with their rich vegetation a special *Myriophyllum alterniflorum* type.

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