

THE CORRELATION BETWEEN THE SIZE OF FINNISH
BRACKEN (*PTERIDIUM AQUILINUM* (L.) KUHN.) CLONES
AND CERTAIN PERIODS OF SITE HISTORY

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1. Introduction

In a previously published paper on the *Sporal regeneration of bracken* (*Pteridium aquilinum* (L.) KUHN.) in Finland in the light of the dimensions and the age of its clones (OINONEN 1967) it was found that the characteristics used for differentiating between individuals have been correctly chosen and that the correlation between the size and the age of the clones is fairly good. It was also found that sporal regeneration was almost entirely connected with fire. The size of the bracken clones was usually related to the time from the fire. Where this relationship was not found, the sites were usually in areas disturbed by human activity where the probability of fire was high. Repeated fires on the same sites have resulted in the arrangement of the clone sizes in classes corresponding to the times from burning and in replicates within these classes. All fires have not, however, left behind bracken clones commemorating the occasion. In areas severely burned in the latest fires, irregularities are sometimes seen in the clonal dimensions — especially among the clones dating from before the latest fire — probably mainly due to the partial reduction of the vegetation units resulting from the fires and the invasion of the site by spruce. While the fire resistance of the species is good, it is, of course, not perfect. The best evidence for the authenticity of the dimensions is provided by replicates of the same diameter, and these have often been found even among vegetation units dating from before the latest fire. Bracken may thus survive light burns.

In solving the size-age problem in the study mentioned, the most easily dated part of the data was used, i.e. the cases that could be checked on the same site by comparing the size of the bracken vegetation units to the burning dates calculated by borings in the tree stand. Since this was possible only in a relatively limited number of sample areas, due to the scarcity of old, fire-scarred trees, and even in these only for the youngest clones, the age of a substantial part of the measured clones could not be directly determined. In some cases it was possible to compare the dimensions to recorded past events and the history of the areas and sites occupied by the clones.

Since data became available on as many as ca. 1450 units interpreted to be clones, and since these were recorded fairly evenly and randomly in the whole area of Finland (over 150 communes) where bracken commonly occurs, according to KUJALA (1964 and 1965), it seemed reasonable and in some ways

promising to search the historical sources for recorded events that could be compared to the parts of the data that had not been used earlier.

Although relatively little exact information useful in this context was found from the references, especially on the earlier periods, a number of interesting concurrences were discovered. Exact records on time and place are available especially for war events, and the best coincidences are connected with wars. Settlement history data are usually too general to be of use in most cases. It must be, however, admitted that not all historical sources were searched; the review was rather general. Incomplete place names have caused a number of limitations. Rough road maps were primarily used in the collection work.

2. Size-class distribution of the clones in the data

In the search for data, special attention was paid to single clones as small as possible. Due to the selection method, the portion of small clones is considerable. Large clones were usually examined only, when the specimen characteristics were attractively distinctive, and the vegetation unit consisted of only one or very few clones. Experimentally, a number of clones were also studied in difficult mixed stands, and the characteristics that identified the specimen were determined as completely as possible.

In the identifiability of the clones, the data are somewhat variable. Some errors may be left, some of which may be technical errors in measuring the dimensions of especially the clones with a diameter of several hundred meters. Since the purpose was to measure the largest diameter of the clone, the direction in which this was to be found had to be estimated first. These estimates may not always have been correct, as was found in checking the measurements of some difficult clones. Since the large ones could be compared only with the other replicates of the same size, the exact metric figure for the largest diameter was not, at this stage of the work, considered important enough to necessitate the time-consuming checking — by, for instance, measurements at right angles — of all the large clones. The possible errors in the data resulting from this omission are not exaggerations of the actual sizes, rather they give a minimum largest diameter.

Figure 1 shows the size-class distribution of the clones up to the diameter of two hundred meters*. Very few clonal units belonging to the smallest size-class (Δ —4 m) were found; the number of units increases considerably with increasing dimensions and age. Quite obviously sporal regeneration has become less common with time. The decrease in the number and area of wildfires and the end of burning for crops are possibly responsible for this. In the next size

* Since the data have been collected during four years, it should be noted that this can result in a maximum error of about 1.5 m. A somewhat erroneous shift in the weights of the frequency columns towards the next smaller size class has taken place.

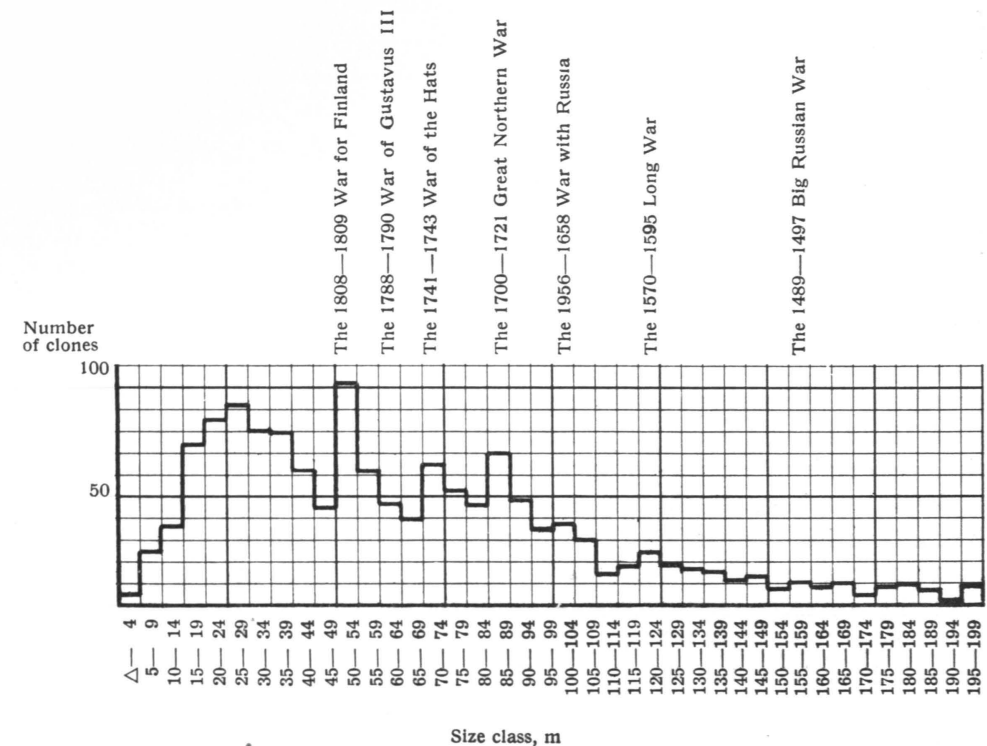


Figure 1. Number of clones by size classes for the diameters to 200 m. The tallest columns coincide with war periods. The smallest size classes are more heavily weighted than the large ones, because especially small detached clones were searched for.

class (5—9 m), the number of clones is six times that in the smallest, but still small. In the next class (10—14 m) the number is already nine times the first, and in the next one (15—19 m) eighteen times — twice the number in the preceding class. The number still rises slightly in the next two classes; here, a slight decline to the diameter of 49 meters follows. The frequency in the last of these classes is only $1\frac{1}{4}$ times that in the 10—14 m one. At 50—54 m, the frequency rises abruptly. This class has the highest sample frequency.

From the schedule previously shown for the growth rate of the clonal vegetation units (figure 12, p. 44; see also OINONEN 1967), it can be seen that this class corresponds to an age of about 145—157 years; 95 per cent of the observations on average sites are expected to fall within the ages 133—175. It is obvious that fire has been used unusually often and widely during this period. The reason can probably be found in the 1808—1809 war (the War for Finland), which was fought in the whole area of bracken distribution. The war was characteristically mobile, and considerable numbers of troops were around (see e.g. MICHAILOFSKI-DANILJEFSKI 1850, BJÖRNSTJERNA 1851, BJÖRLIN 1883, *Generalstaben* 1895—1922, DANIELSON 1896, SCHULMAN 1909, HANNULA 1934,

OSMONSALO 1947, WALLER 1949, GOTTLIEB 1954, HORNBORG 1955). The maximum registered strength of the Finnish forces was about 24 000 men, the Russian forces, over 50 000. The numbers of refugees going from place to place was also considerable. In these conditions, campfires were lighted in more places than usually, both in the summer and in the winter (cf. e.g. BJÖRNSTJERNA 1851, p. 218). Especially the roadsides, where the bulk of the data comes from, naturally abounded with resting- and campsites. This could well be seen in our last wars. Attention should also be given to the old habit of the Russian soldiers to bake their bread in small ground-pits (*Generalstaben* 1923, pp. 92—93). Fire was used for destruction and sometimes for tactical purposes (see, for example, *Generalstaben* 1921, p. 77), and certainly fire has occasionally also unintentionally run wild in the battles.

After the war, the old fields must have first been worked over to restore their productivity, clearing forests for new cultivated areas by burning has probably not been as widespread. This same development can also be seen just after other destructive wars (ALANEN 1948, p. 266) before the everyday life returns to normal. The sharp drop in the frequency of bracken clones right after the war may result from such a rehabilitation period. The rise from this point in the frequency columns with time is probably the consequence of an increase in activity, but this part of the data is affected by the method of selecting the clones for measurement to the extent that the picture is not convincing. In the histogram, the best parts to compare are those next to each other, and for example the frequencies in the under 50 m and over 100 m size-classes have much too different weights to allow comparison.

The data on the clones corresponding in size to the time from the 1808—1809 war are distributed over the whole area, where bracken is common. The northernmost clone on the western coast was recorded in Luvia, in the east, at the northwestern end of Pielisjärvi Lake, on the western side of Porokylä, Town of Nurmes. These, like many others of the same size, are single clones in large areas and situated on high forest lands excellent for camping.

An abrupt drop can be seen in clone frequency, as we go to the time before the 1808—1809 war; a distinct minimum is seen in the 65—69 m class, in other words, the rise towards the maximum begins in the 60—64 m class. It may be noted that the 1788—1790 war (the War of Gustavus III) falls within this class. This war was mainly stationary and limited to areas at the south-eastern border, from the Kymijoki River basin to Savo (see e.g. EKMAN 1900, *Generalstaben* 1923, HANNULA 1934, BIRCK 1944). The time from the war, 175—177 years, corresponds to an average bracken clone size of 61 m, 95 per cent of the cases falling within 54—67 m. Thus, it can be seen that the clone dimensions corresponding to the time from these two wars partly overlap. Their limit is diffuse, since the interval between the wars is very short, only about 20 years. The size class 55—59 m may thus include clones developed

during both wars, and clones dating from the 1788—1790 war are probably also found in the 65—69 m class. It should be mentioned that almost a half of the 60—64 m clones are from the area east of the line Loviisa—Mikkeli—Kuopio (the battle area and its rear) despite that the emphasis in the search was on the western part of the country, especially in the south-southwestern area.

The minimum at 65—69 m is similar to the one occurring after the maximum during the 1808—1809 war. It is possible that also the causes are the same, since the next size-class 70—74 m falls again into a war period, the 1741—1743 war (the Little War = the War of the Hats). According to the schedule of the spreading of clones, the average size of the clones dating from this period is 76 m, 95 per cent of the cases falling between 67 and 84 m. The maximum at 70—74 m is thus slightly below the average. The reasons for this small deviation can be guessed, but not shown. It is hypothesized that fires have been so common in the sites of stands as old as these that they have caused an unreal decrease in the average*. — The effect of this same factor already seems to show to a small extent in the data connected with the 1808—1809 war for Finland. — It may, however, be seen that the sample frequency was considerable also in the 75—79 m class, and that a rise can be seen to this one from the next larger (80—84 m) class. Since the 1700—1721 war (the Great War of the North), there have been gigantic fires in Finland in 1730 (ALANEN 1948, p. 244, KAILA 1931, p. 24) probably resulting in an increased clonal frequency in the 70—79 m classes. This explanation seems the most appropriate; the abundance would be due to two factors having an effect in the same direction.

The histogram slope continues beyond the 1741—1743 war in a similar manner as until here. A minimum at 80—84 m is followed by a steep rise to the second highest frequency encountered. According to the time schedule, this class corresponds to an average age of 233—244 years and falls within the time of the 1700—1721 war. The main war incidents occurred in 1713 and 1714, but there were local war incidents especially in the areas close to the eastern border. The latter part of the war (1713—21; known as the Big War) is known as a highly destructive and ravaging era, possibly the worst, in Finnish history. It threatened the survival of our nation (KOSKINEN 1865, LINDEQVIST 1919, KOSKULL 1953). The Russian troops moved extensively about, and their patrols raided even out-of-way settlements and the hiding places of the settlers.

The two last-mentioned wars occurred so close to each other (twenty-year interval) that the 95 per cent probability ranges overlap considerably. Apparently partly for this reason the columns between the maxima are remarkably high. The maximum size of the clones dating from the 1700—1721 war is 100 m, and clones dating from the time of the two wars are found in the whole bracken distribution area from the coast of Ostrobothnia to the eastern border.

* See also footnote on p. 6.

Clones of this magnitude are common around old settlement sites and sites corresponding to those of the clones dating from the 1808—1809 war; sometimes both are found side by side.

Two important minor maxima can be seen beyond the 1700—1721 war. A small knob at 100—104 m indicates the 1656—1658 war, and at 120—124 m the 1570—1595 war. In between, there is a fairly distinct minimum at 110—114 m. The maximum in the histogram in the part corresponding to the sizes of 115—150 m well corresponds to the 25-year period of the 1570—1595 war (the Long War), when the entire 95 per cent probability range is considered. The dimension limits of the clones marking the years 1656—1658 are diffuse in both directions. It should be noted that the biased selecting of the individual clones no longer occurs at 100—150 m. In covered and often uneven terrain, vegetation units of this size are relatively seldom entirely visible. For the same reason, selection is unbiased in the larger size-classes.

The frequencies of the clones over 150 m in diameter are too small to merit closer examination. This part of the data has to be expanded by new collecting.

The connections found are quite understandable. Bracken reproduces mainly by spores in conditions created by fire. Natural wildfires have always occurred, but man has through the use of fire increased their frequency and the size of the area burned, both in peace and in war. The war periods are, compared to the whole, relatively short, but fire has been used during them, in limited areas, to a much greater extent than usually. Suitable bracken germination sites have been exceptionally abundant. Roadsides, road junctions and crossings (large battles have been fought for these in the wars) and settlements and their surroundings have especially been sites of frequent fire use in the wars. Clone dimensions corresponding to the time from war periods have been most frequently found in these sites. Already during the collection work, *the usuality of certain size classes in the vicinity of old settlements and roadways and their rarity along recently constructed roads going through large forested areas* attracted attention. If the data had not been searched for by criss-cross driving by car in the road network, but instead by for instance running straight compass lines, the frequency columns would probably have emphasized the war periods less. It should also be observed that *the clonal density or the number of clones per unit area, in other words, the frequency of bracken is much smaller in out-of-way areas than in populated districts*. LINKOLA (1921) pointed to this, but only on the basis of the general picture he had of the frequency of the vegetation units.

The occurrence of distinct maxima in the histogram, coinciding with war periods, indicates that although the diameter/age-ratio of the clones may in extreme cases be rather loose, the majority is well concentrated in the region of the average values. Since such maxima are found in the part of the data over 200 years old, the dimensions of even large clones can be used as fairly

reliable data on the age and the time of burning. Total size reductions in the clonal stands are thus not decisively common and disturbing. The possible replicates of the same size, when they are found, *provide the best possible confirmation to the estimates. A considerable number of replications of large clones are already included in these data.*

3. Examples of coincidences of clone sizes and dates given in the historical sources

A number of 15—17 and 8—9 m clones have already been described in the earlier paper (OINONEN 1967), the dimensions and sites of which point out that action during World Wars I and II probably created suitable conditions for sporal bracken regeneration. In addition to these clones, the data also include a number of others of the same size, for which the causal relationships responsible for development are unclear. It is natural that a part of such units have nothing to do with war; wars only seem to emphasize certain size classes. When an increased frequency is encountered, war has probably been responsible for this. The data so far are so few and so widely distributed that regional and local increased frequencies that have come up may at least in part be apparent and due to sampling variations. Only when the clones were measured at known battle-sites, and the dimensions and the time from the battle exactly correspond to each other, the effect of the war can not very seriously be considered hypothetical. *When a whole series of such coincidences is found in randomly compiled data, war is a very probable cause.*

31. The 1808—1809 War for Finland

During the 1808—1809 war*), the Kemiö** area was a battle stage in July and August of the first year of war. A Russian coastal fleet squadron tried to steal past the Swedish fleet patrolling in the Kemiö waters, to Turku through the Kemiö strait, but got into battle at its northern mouth (see MICHAILOFSKI-DANILJEFSKI 1850, *Generalstaben* 1921, SCHULMAN 1909, HORNBERG 1955). In this so-called Sandö battle (9 July 1808) the Russians were supported by infantry on both sides of the strait. Both parties used artillery. The Swedish lost after heavy firing and had to withdraw. Another — poorly trained — Swedish detachment landed in Kemiö (see BJÖRNSTJERNA 1851, pp. 298—303) and threatened the Russian command post at Västankärr, but were beaten back.

In the area, where the Kemiö—Sauvo road continues after the ferry (the

* See JUTIKKALA 1959: Atlas of Finnish history. Porvoo—Helsinki.

** See Suomi—Finland generalkarta 1: 400 000. 1950. Maanmittaushallitus, Helsinki.



Figure 2. Map of Sandö battle (July 9, 1808) area (MICHAILOFSKI-DANILJEFSKI 1850). The sites of the bracken clones dating from the time of the battle are marked with circles. Two clones, 51 and 55 m, are located in the southern area and one, 55 m, in the northern one. Kimitto = Kemiö.

Swedish forces invaded this area in the early part of the battle; *Generalstaben* 1921, p. 67) for a little over a kilometer into Sauvo commune, 51 and 55 m clones were found (figure 2; see also OINONEN 1967, p. 62, no. 163). 141 annual rings were counted by boring, at the 30–40 cm level, a sample tree of the oldest generation of the pine forest. This portion of the forest had thus pro-

bably regenerated during the 1808–1809 war, after a fire. The clone dimensions correspond well to this time. The first clone is limited by a rock at one end; this may have caused a small reduction in size. The latter has been fragmented by a more recent fire, but since it was of a special sparse-leaved specimen type, its delimitation was not difficult. I called this type »model Tvärminne» because it was first found or first recorded in this area (on Hanko peninsula; see p. 28).

A 55 m clone, in a heath depression on the side of the same road about three kilometers towards the Sauvo communal center (the closest kilometer-post: 15–23), of a specimen type with semi-dark petioles, should also be mentioned. Nothing was to be found here to tie the origin of the clone to time; the area had burned again about a hundred years ago, and the old tree stand had either burned or been clearcut. This road already served during the 1808–1809 war to connect Kemiö and Turku (*Generalstaben* 1895–1922, maps) and was thus also used for marching and servicing troops. The infantry and artillery reinforcements were quickly sent to Kemiö strait from Turku (op.c. 1921, p. 67, SCHULMAN 1909).

In war conditions and especially in the battles the chances for fire to run wild are especially great. Incendiary ammunition was already known and used — especially in the naval battles (cf. *Generalstaben* 1905, bilagor, p. 93) — long before the 1808–1809 war. According to MICHAILOFSKI-DANILJEFSKI (1850, p. 114) they were used, during this war, at for example Jungfrusund, Grönviksund in Kustavi, and the battle at landing at Lemu (*Generalstaben* 1905, p. 270, 1921, p. 116), but the sources do not mention them in the battle at Sandö. On Sandö island, the Swedish set the forest on fire by other means to protect their retreat (op.c. 1921, p. 77), thus the weather conditions must have been favorable for forest fires. Fire and smoke may also have been intentionally used for cover in other phases of the battle. It is known that the Swedish forces carried out forceful landings to prevent the installation of the enemy batteries. The Swedish fleet kept these areas, and the infantry troops on the shore, under heavy artillery fire (op.c., p. 68). Many other causes for a forest fire are naturally possible, but it seems evident that military action has been the cause here. Later on, the Russians partially fortified the surroundings of Sandö to get a sheltered place for their fleet in Kemiö strait (op.c., p. 97).

Earlier in the same summer, when there were battles in the Kemiö area, the Swedish coastal fleet had tried to attack a squadron of the Russian fleet that had retreated to the outside of Turku (figure 3) in the area limited by Ruissalo, Bockholmen, and Hirvensalo (4 July, 1808). The Russians had artillery batteries on the shores of these islands, plus a 150-man detachment and cosack patrols (MICHAILOFSKI-DANILJEFSKI 1850, p. 72, *Generalstaben* 1905, p. 292). Plenty of firewood had been gathered on the shores and to the highest points of the islands for watch and alarm fires. The hard naval battle started early in the morning and ended at midnight in a Russian victory; according to the

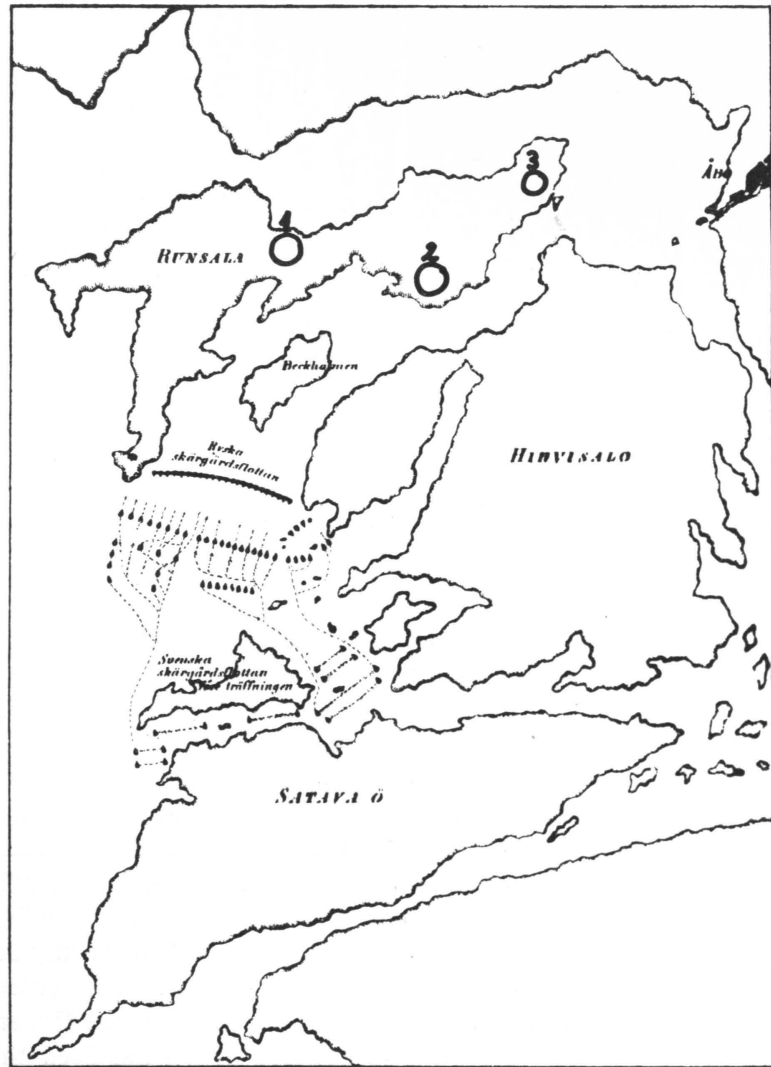


Figure 3. The battle (July 4, 1808) between a Swedish and a Russian coastal fleet squadron in the Ruissalo (=Runsala)—Hirvensalo area (MICHAILOFSKI-DANILJEFSKI 1850). 55 and 56 m clones were found in area number one, two 50 m clones in area number two. The third unit has a diameter of 90 m. It is connected with the 1700—1721 war, probably the raids in Turku and the surrounding area in 1713.

opponents views, the Swedish tried to land on the island of Ruissalo, but did not get an opportunity for this. — After the battle, the king of Sweden blamed his ships for wasteful ammunition use and the lack of fire control (ca. 2400 cannon balls; *Generalstaben* 1921, p. 60).

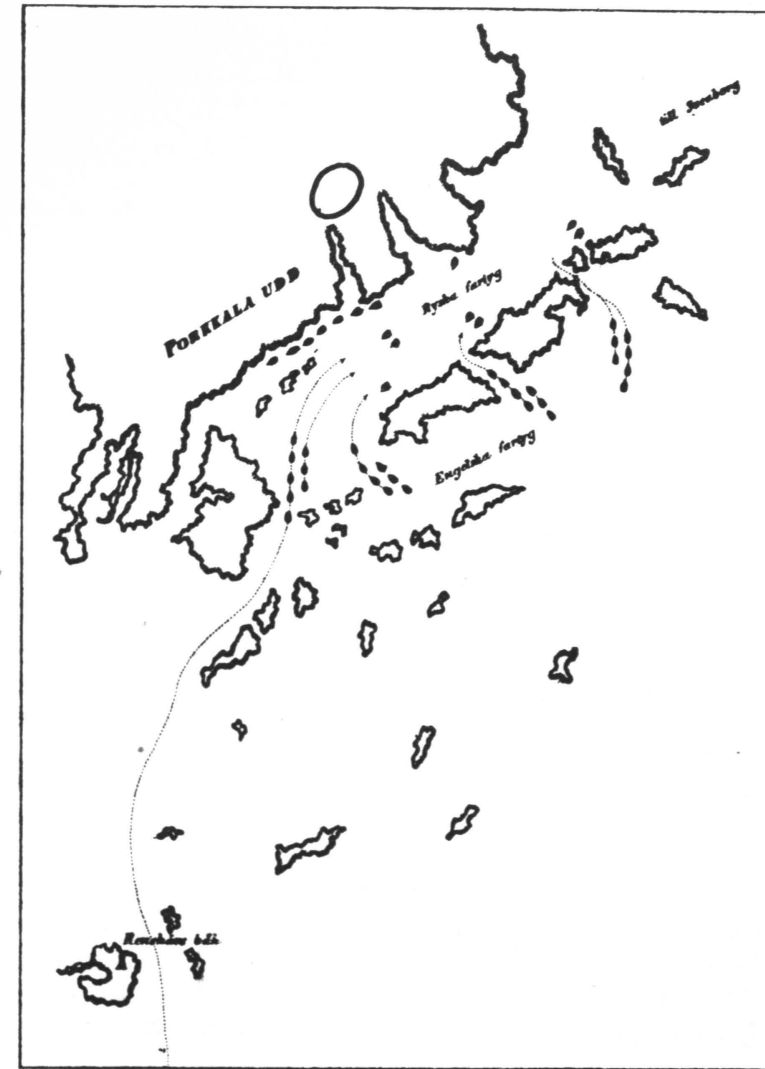


Figure 4. The battle between an English and a Russian squadron outside of the Porkkala peninsula on June 26, 1808 (MICHAILOFSKI-DANILJEFSKI 1850). A 50, a 52, and a 53 m bracken clone in the oval area.

On the battle side of the island of Ruissalo (the public park), two 50 m bracken clones were recorded, and 55 and 56 m clones were found in the central part (see OINONEN 1967, p. 62, no. 162). The two former have not been dated, but both of the latter regenerated after a fire that, according to borings, occurred in 1808. These areas have also burned later on. The latter two clones are of a dark-petioled type. It should also be mentioned that a 43 m clone of »model

Tvärminne» was measured in the public park area: this may have been born simultaneously with the tree stand (99+ years), but its dimensions may have been reduced by a rock limiting it on one side.

The third area where the 1808 naval events coincide with the data is at the tip of the Porkkala peninsula. Here a squadron of the English navy attacked a Russian coastal fleet squadron on June 26, 1808 (figure 4), landed on nearby islands and on the peninsula, where it installed a battery to prevent the sailing of the Russians in the shelter of the coast. The English burned the ships they captured in the battle. They also cleared coastal forest areas (according to MICHAJLOFSKI-DANILJEFSKI 1850, p. 193), apparently with the help of fire. This is revealed by the trees bored and the bracken clones measured in the area. The data include 50, 52, and 53 m clones from here (the vicinity of the TV link station). The observations show an excellent time-relationship.

Under the landing threat of the Swedish fleet, the Russians had during the 1808—1809 war carried out an extensive survey of and organized an efficient lookout chain on the entire coastline from Viipuri to Vaasa (MICHAJLOFSKI-DANILJEFSKI 1850, DANIELSON 1896, *Generalstaben* 1905, p. 198). To economize in the use of troops, the lookouts were manned by small mounted patrols, and the plans called for beating the possible landing troops by the troops (especially cavalry) stationed further inland. These activities are probably responsible for a 54 m bracken clone in Jomalvik, Snappertuna (see *Generalstaben* 1895—1922, maps), a 55 m clone in Hagen Park, Tammisaari, and two 52 m and one 54 m clone in Källvik, Tammisaari Rural District. The last-mentioned site is known to seafarers as a good place to get water, and its location on the road to Hanko may have caused its frequent use as a resting place by the road users. A considerable portion of the goods transported from the Russian harbors to Turku were (according to MICHAJLOFSKI-DANILJEFSKI 1850) taken to the Hanko peninsula by sea and from there on by horses. During the war, troops were permanently stationed in Tammisaari and its surroundings to beat off all possible landings (*Generalstaben* 1895—1922, maps).

Near the coastline, a further two 52 m clones on the southern edge of Stormossen, Inkoo, deserve to be mentioned (a narrow-ringed growth term, starting in 1808, can be seen in a number of bored holdover trees). The Russians had a fortress in Inkoo (*Generalstaben* 1895—1922, maps). A 56-meter clone (age of tree stand 124+ years) was recorded on the side of the road from Isnäs to Gammelby, Pernaja, and a 55 m one (age of tree stand 110+ years) near the highway to Helsinki, at the Pohjois-Sarvilahti road crossing. There were battles in Pernaja in the beginning of the war. On the side of the same road, at the border of the City of Loviisa, there is a 56 m clone. The Russians had a permanent garrison in Loviisa (op.c.). A 52 m clone was found in Huruksela, Anjala (defense stations in the beginning of the war) and a 54 m one in the area of the

Purola—Länsikylä road crossing, Pyhtää (age of tree stand 139+ years, see OINONEN 1967, p. 62, no. 161).

Clones connected to the 1808—1809 war are also abundantly found further inland. Many of them are in areas, where troops are known to have been active. The data also include a number of clones from areas not disturbed, according to the references, by war. It is clear that clones have regenerated during this period, as always, independently of the war. It is not possible to distinguish the part played by war in individual cases, but the possible effect of war can be seen in the doubled regeneration frequency in the 50—54 m class as compared to the 45—49 m class. In other words, every other 50—54 m clone implies the effect of war. This effect seems quite possible in connection with the following clones.

A single 51 m clone in Surnuinmäki, north of Pieksämäki coincides with the movements of a large Russian column through the area, a patrol had been sent to flank these forces (SCHULMAN 1909, p. 140). Further to the north (ca. 10—15 km), along the same road, in Kutumäki, there were Finnish field stations (*Generalstaben* 1902, p. 346).

To suppress the risings of the North Carelian population, the Russians sent a strong military detachment to e.g. Kovero, Tuupovaara, and later on, a mounted squadron to protect its retreat (op.c., p. 288, BJÖRLIN 1883, p. 259, *Generalstaben* 1910, p. 390 and maps). They considered the threat imposed by the Carelian guerrilla troops quite grave. The uncertainty and seriousness is described by the order (general Alekseyev) to the Russian forces that the villages were not permissible quarters, only camps were allowed (MICHAJLOFSKI—DANILJEFSKI 1850, p. 108). A single 54 m clone was found in Öllölä, Tuupovaara (Öllölä—Luutalahti road, km 17—41). In this area, a Carelian peasant group had succeeded in defending their independence during another war in 1742 (the battle of Öllölä, see e.g. KARTTUNEN 1932, p. 225, and KOISTINEN 1932, p. 911). No clones coinciding with the 1741—1743 war were, however, found in the area, but a 95 m clone coinciding with the 1700—1721 war was found in Luutalahti. Records for this period of history in Carelia are scanty (KOISTINEN 1932, p. 910), but heavy raids were recorded from the neighboring commune of Tohmajärvi in 1708—1709 (*Suomenmaa* 1927, p. 287). The appearance of the last-mentioned clone is peculiar; the petiole is darkish, the leaflets unusually narrow, the nectaries dark. A detached vegetation unit well suited for visiting; a similar narrow-leaved clone was found in Noormarkku (OINONEN 1967, p. 39, no. 45).

The following clones also mark the eastern routes used during the 1808—1809 war (*Generalstaben* 1895—1922, maps): 50 m clones in a camping area on the side of the Kesälahti—Kerimäki road, near the Koli—Harivaara road junction, Pielisjärvi, and on the side of the road to Joensuu, about 3 km from the communal center; a 51 m clone in the Pankkakangas graveyard between Mänty-

harju and Tuohikotti (about 32 km from the communal center, near the Pahkajärvi road junction); 52 m clones to the west of Porokylä, Nurmes, and at Putikko, Punkaharju; 54 m ones on the side of the Hatsola—Maivala road (ca. 2 km from Juva) and in Länsi-Vuokko, Juuka; a 55 m one on the Tuusniemi—Rikkalahti road (2—3 km before the narrow sound connecting Rikkavesi and Juojärvi). Three 56 m clones were found, one in Alakuona, Kerimäki, one at the junction of the road from Kerimäki to Enonkoski (km 32—119), and one in Murtokangas, Laukansaari, Punkaharju (data independently compiled by REIJO MIETTINEN, a forestry student assisting in the field work).

Clones of about the same size marking the western routes of the war are best represented in the surroundings of Pori. Considerable numbers of troops were long centered in these areas at various stages of the war (*Generalstaben* 1895—1922, maps). A 54 m clone was found on the side of the Luvia—Pori road (ca. 7 km; Russian coastal defense troops were stationed in the area, op.c. 1905, pp. 191—192) and a 53 m one in the commune of Pori, on the side of the Ruosniemi—Noormarkku road (ca. 20 km) near the Pirttinen road junction. A 52 m clone was found to the east of these, near the Kuru road junction (ca. 6 km southeast of the communal center), a detached 58 m clone in Kuru (Kaitalahti—Toikko, 28 km) — Russian cavalry searched the area for guerrillas, destroying and burning places (*Generalstaben* 1910, p. 102), a 57 m one on the side of the Jämsä—Koskenpää road (km 15—32) and a 53 m one in Juokslahti, both in the commune of Jämsänkoski. Jämsä was an important center of Russian action at some stages of the war (op.c.). Three 50—55 m roadside clones were recorded both in Yläne and in Säkylä in southwestern Finland.

It is noteworthy that the smallest relative number of single clones of this size was recorded in the province of Häme. This part of Finland was disturbed by this war — as by many other wars — to a much smaller extent than the coastal areas and the Savo—Carelia areas (figure 5). Another reason for this result may be that bracken vegetation units are so abundant and widespread in Häme that it was not easy to pick out small clones. Also, the roads commonly go through fields, villages, and broken, patchy forests areas. More clones dating from the 1808—1809 war will probably be found in this area hidden in large mixed vegetation units.

Some well-known battle sites at the time of the 1808—1809 war were unsuccessfully searched for clones. For example, the surroundings of Nummijärvi, Kauhajärvi — the village was burned by the Russians (*Generalstaben* 1910, p. 132) — were carefully searched, but no bracken was found. Very little bracken was found in the area between Kauhajoki and Kristiina; large clones were only found on Lauhanvuori hill on the Kauhajoki—Isojoki border (site found by professor PAAVO YLI-VAKKURI) and on Pyhävuori hill on the Lapväärti—Karijoki border. Except for a couple of small clones, the vegetation units examined in these areas were born before the 1808—1809 war, partly

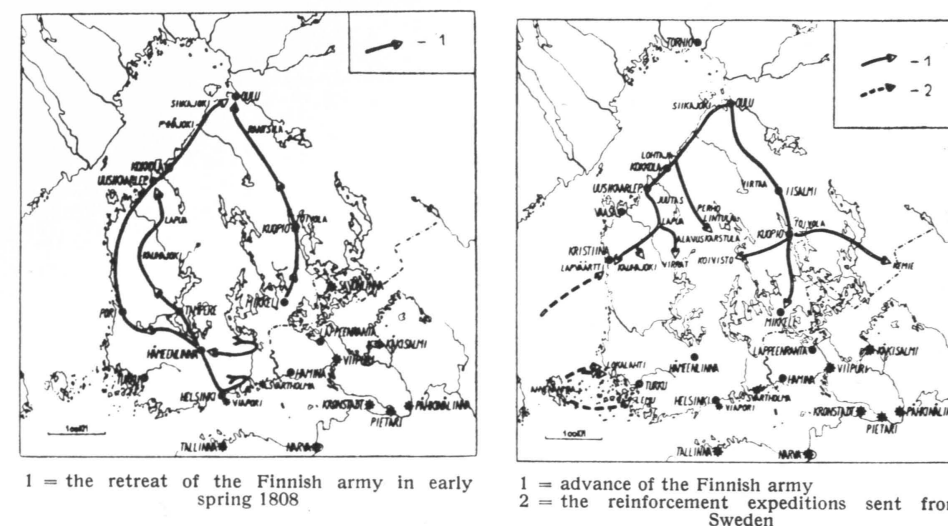


Figure 5. General map of the 1808—1809 war (JUVA 1942), showing the main direction of the forces over an extensive area and their rolling movements back and forth. The maximum of the frequency histogram is at the time of this war.

during the crusades, if the dimensions are authentic. — Since these studies were carried out mainly on the roadsides, it is possible that by combing the battle sites more carefully, more of these peculiar war monuments could be found.

32. The 1788—1790 War of Gustavus III

The site of the battle at Laitaatsilta on the outskirts of Savonlinna (3 October 1789, *Generalstaben* 1923, p. 82) is pretty well described by the appended old map (figure 6; EKMAN 1900, p. 140). The Russian troops came in boats by way of the Sammal islands to the flanks of the Finnish defense stations, attacked artillerybattery 2 through the area marked 3, took over the battery and got considerable reinforcements along a bridge pushed over Laitaatsalmi; at this point a reinforced field guard battalion beat back the attackers to their starting stations. These stations were held to the end of the war. The Russians had strong batteries of artillery on the other side of the sound; these prepared the ground with grenades and bombs for the attack (*Generalstaben* 1923, p. 82).

In the central battle area, on the site of battery number 2, there is a 64 m brown-petioled bracken clone coinciding in age with the time from the battle. Since the battle took place in late autumn, there was probably no wildfire, but campfires were presumably kept burning. Here the bracken regeneration site



Figure 6. Map of the Laitaatsilta battle (October 3, 1789; EKMAN 1900). A 64 m bracken clone with brown petioles occupies the area marked 2.

may have been sterilized early enough to be ready to accept spores in the spring. It is obvious that the regeneration of bracken is not necessarily connected with a fire during the battle. Campfires may have been burned both before and after the battle. The coincidence is, however, good enough to indicate a close connection to that time. The explosion holes of the cannon shots must also be considered (cf. LOUSLEY 1946).

This bracken clone is like a historical monument of the battle site, and it is hoped that it will be left undisturbed. The vegetation unit is worth visiting. It is not a single clone, but this one is easily distinguished in the partly mixed vegetation by its characteristic appearance.

The other clones measured on this site are considerably larger (a 47 m one is limited by a trench and its dimensions are probably not authentic) and coincide with the 1700—1721 war (82 m — limited by a rock — and 92 m). All these vegetation units are partly mixed. The Savonlinna area was a battle stage during this period (the siege of Olavinlinna June 19 — July 28, 1714). The Russians tore the logs for building the rafts for the attack from e.g. the

buildings of the Sääminki parsonage accessible through Laitaatsilta bridge (LINDEQVIST 1919, p. 414). Arson was an essential feature in this war. In 1716, for instance, the Russians burned the Sääminki church, which was rebuilt and burned again by lightning in 1719 (op.c., p. 448).

The battles of Porrassalmi and Parkuinmäki in 1789 were, from the Finnish point of view, highlights in the battles of the Savo area. The clones recorded from the battle sites were large enough to date from a much earlier period. A 63 m clone on the side of the road from Puntala to Parkkila, Ristiina commune (ca. 7 km), dates, however, from about the time of the Porrassalmi battle. On Hukkala hill (Parkuinmäki, Rantasalmi commune), the last, decisive encounter of the battle took place (*Generalstaben* 1923, SOININEN 1954); a memorial has been erected here for the battle, and a 142 m clone grows on the site (extremely regular greyish green leaves and «framed» nectaries); the battle (21 July) was apparently fought among bracken. The clone size coincides with 1570—1595, during which time Rantasalmi was hit by war (in the 1580'ies; SOININEN 1954, p. 259). Another clone of almost the same size (129 m) is limited by a field and may therefore be reduced in size. If this is not the case, the size points to the 1596—1597 war, during which the peasant troops from the Savo area gathered at Parkuinmäki; a battle was fought at nearby Putkilahti (KOSKINEN 1859, p. 73). The peasant troops tried to take possession of the fort of Olavinlinna. All houses of the Crown were burned on the roadsides, and in revenge the Crown soldiers burned the peasant houses. Several communes were badly desolated (op.c., p. 80).

To give some kind of a general picture of the distribution of the clones coinciding with the 1788—1790 war along the military routes in Savo, figure 7

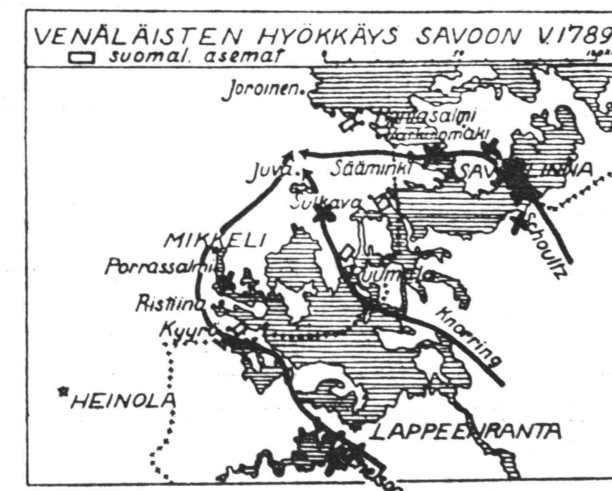


Figure 7. A general view of the military operations in Savo in 1789 (ALANEN 1948). The locations of all 60—67 m bracken clones found in the area are shown in the map by crosses.

has been included to show the location of all recorded vegetation units in this area. Only 60—67 m clones have been counted; the largest clones coinciding with the 1808—1809 war will thus be excluded. It can be seen that the coincidence is remarkably accurate. In addition to the clones already described, two were found in the commune of Kerimäki, a 61 m one on Patasalo island, and a 61 by 54 m one in Ruokolahti. The last mentioned clone is one of the curiosities in the data. When found (August 11, 1964), the tip parts of all leaves (about a half of the leaf) had dried, turned greyish brown, and curled. Although other clones were abundant in the area, their leaves did not show this defect. If the defect resulted from fungus or insect damage, attacking a single specimen among a multitude of clones indicates a surprising extent of host selection, and a more exacting characterization than was possible in this project. Chromatographic methods could prove helpful in specimen identification (cf. KANGAS, PERTTUNEN, OKSANEN, and RINNE 1965). A vegetation unit similar to the one above was found in the upland forest bordering Mustakorpi swamp, Karjalohja, in the west (ca. 160 m). Here, all bracken leaves were curled entirely to the bottom leaflets, but had not browned in the middle of July, 1964. — A 62 m clone grew in the vicinity of the Enonkoski road junction, Alakuona, and a 63 m one in Kaijansaari, both in the commune of Kerimäki. A 62 by 61 m clone was found in Putikko, Punkaharju, a 66 m one in Lappee, ca. 3 km from the Ylämaa border, and a 67 m one on the side of the Juva-Sulkava road.

The same clone size-class has a remarkably high frequency in the northern Savo and southern North Carelia areas, but coinciding war events were not found from the sources.

A 64 m clone was found in the southern part of the war area in a rock outcrop area north of the outer fortification of the so-called Rosen fortress, Loviisa. No battles were fought there, but military units were stationed there behind the lines (BJÖRNSTJERNA 1851, p. 133, EKMAN 1900, BIRCK 1944). We can suppose that the rock forest was cleared for a wider firing sector and an improved view in case this area would become necessary for defense (cf. the written order of Gustavus III on May 26, 1788; BIRCK 1944, p. 154). The clone is detached, but exhibits no unusual features.

A 66 m clone grew on the side of the highway to Helsinki near the western border of the City of Loviisa in the commune of Pernaja (OINONEN 1967, p. 65, no. 171). Another 66 m unit was found in Heinosniemi, Virolahti. This part of the coast has often been important for military purposes. The Russians had prepared to beat off all landings on the coast by large numbers of troops especially in the Virojoki area (BIRCK 1944, p. 449).

The fortification of the Hanko peninsula was started in 1789. A 62 m bracken clone (spotted nectary axils) near the trenches now under forest some kilometers from Hanko toward Tvärminne may date from this period. A 63 m clone

(petiole yellow-brown in late summer) was found on the side of the Pohja inlet opposite of Tvärminne, in Jomalvik, Snappertuna. Presumably this area, also, was disturbed by military activity in this period, but no information on such was found in the historical references. It is known that the Russians occupied several islands in the Porkkala—Inkoo area during the war (MANNINEN 1948). It should be noted that a 54 m clone described earlier coinciding with a more recent war, that of 1808—1809, was found in the Jomalvik area. It is quite common and logical to find bracken clones dating from several wars in the same sites that have been strategically significant repeatedly. A 62 m clone was found on the side of the important road connecting Hanko and Tammisaari, in Källvik; 52 and 54 m clones, as mentioned earlier, were also found here.

33. The wars of 1741—1743 (War of the Hats) and 1700—1721 (Great Northern War)

The war of 1741—1743 did probably most damage in northern Carelia and a part of Savo (KARTTUNEN 1932, MANNINEN 1948). The extension of the military activities also to other parts of the country is indicated by the high frequency of clones in various parts of the main distribution range of bracken. Distinct local clone concentrations do not emerge, partly because of this, and partly as a result of the small amount of data. Furthermore, the historical sources do not contain sufficiently detailed information on the events in the areas, where the clones were found. The 95 per cent probability ranges for the clones from the wars interlap considerably, and great difficulties were encountered in the exact dating of the clones. Since the same areas suffered repeatedly during both wars, and the troops partly traveled along the same routes (figures 8 and 9), the clone dimensions coinciding with the wars are often found next to each other in common sites or areas.

It is known that both wars badly damaged e.g. the communes of Iломantsi, Liperi, and Kitee (HÄRKÖNEN 1932, MANNINEN 1948, and others). The history is reflected in the bracken clones of the area, as is seen from the following account. A total of 37 clones were measured randomly in the communes. With a few exceptions, they are pure units. The data were divided by size into five classes. Class one includes the units under 50 m in diameter, class two those from 68 to 75 meters — 95 per cent of the cases will not date from the 1700—1721 war. Class three (76—85) includes the units that may date from either war. Class four is composed of the clones not regenerated during the 1741—1743 war (86—99 m), and the last class includes the leftovers (50—67 m and over 100 m). The data are distributed like this:

| | Under 50 | 68—75 | 76—85 | 86—99 m | Others | Total |
|----------------------------|----------|-------|-------|---------|--------|-------|
| Ilomantsi | 1 | 2 | 2 | — | 6 | 11 |
| Liperi (+Polvijärvi) | 1 | 4 | 4 | 3 | 3 | 15 |
| Kitee | 3 | 1 | 1 | 3 | 3 | 11 |
| Total | 5 | 7 | 7 | 6 | 12 | 37 |
| 68—99 m, total | | 20 | | | | |

The table shows that about a half of the studied vegetation units coincide in size with the 1741—1743 and 1700—1721 wars. The scarcity of the units less than 50 m in diameter is striking. There are few large clones, but this results rather from the method of sampling than from their scarcity. As already has been stated, as small detached units as possible were looked for. There are about as many clones coinciding with the wars and their diffuse intermediate limit. Among the other clones, there is a considerable variability.

The clones in Ilomantsi dating from the 1741—1743 war include a 70 m one at the Punavaara road junction and a same-sized one near (1—2 km) the orthodox house of worship in Huhus. These may also date from the peasant uprisings of 1778, which were suppressed by the military (*Suomenmaa* 1927, p. 316). The first of these clones is detached and pale-colored, the other one grew in a mixed unit and had brown petioles. One of those in the intermediate class (82 m) was found south of the bridge over Koitajoki river, Mekrijärvi (a detached light-colored heath specimen), and the other (76 m) north of the same bridge, next to settlements (leaflets slightly curled). The minimum diameter of another much larger clone in the same area is 85 m, which also deserves to be mentioned.

The clones from the same period in Liperi (and Polvijärvi) are: 1) the southernmost one in Onkisalmi in a settled area (83 m, detached, petiole and nectaries deep green), 2) a detached 79 m clone at the hospital road junction in the communal center (possibly reduced in size, limited by a road and a field), 3) a pure 73 m unit (green, rotund nectaries) on the side of the road 8 km from Liperi towards Sotkuma, 4) a 69 m pure unit (10 km) and 5) a 77 m unit near the Liperi railroad station, both along the road to Sotkuma, 6) an 87 m unit with very dark petioles, a model specimen, at the 23-km point, 7) an 86 m clone (light-colored) at the 28-km point, 8) 69 m one (nectaries with dark spots), and 9) a 61 m sparse-growing clone probably reduced by fire, these three in Sotkuma, Polvijärvi, on the same heath. A curious pair was found on this heath: 183 and 185 m. No connections have been established to local history, but the dimensions indicate simultaneous regeneration and a fire ca. 540 years ago. A corresponding peculiar series is in the data from Mäkrä island in *Puruvesi*, Kerimäki commune: 189 × 173, 189 × 112, 188 × 122, 184 × 139. The first of these (recorded in 1958) is a dark-petioled model clone. The other three are from the data collected independently by my research assistant, REIJO MIETTINEN (1964). A 180 × 103 m clone grows ca. 60 meters away on Kaijansaari

island, on the other side of a narrow sound, and a 185 m one on the side of the Kerimäki—Punkaharju road, at the junction of the road to these islands. A similar group is found on Laukansaari island, Punkaharju: 189, 182, and 180 m (and in western Finland, Vähäröyhiö, Viljakkala: 189 and 186 m). An interesting 183 m detached vegetation unit was found in Savo, in a formerly burned and cultivated forest on a good site in *Putkilahti*, Rantasalmi (34 km from Savonlinna toward Rantasalmi). Considering the limits of the growth rate variation of the clones, this unit probably dates from the year 1475, when the Russians raided Savo and disturbed the construction of Olavinlinna Castle (there were earlier raids, at least in 1464, cf. MANNINEN 1948). SOININEN (1954, p. 258) mentions that Rantasalmi was possibly also raided in this period. According to RINNE (1947, p. 120), military troops from the other side of the border raided Savo in 1468, and the operations were concentrated in the area of *Puruvesi*. According to a later treaty, the Russians surrendered their prisoners and the stolen property at *Putkilahti*, Rantasalmi (op. c., p. 120), where, apparently, a part of the booty was from. In 1478 the men from Novgorod extended their raids to the western coast, but the areas that suffered are unknown. — On the side of the Liperi—Ylämylly—Joensuu road, at the junction of highway 17 (Ylämylly), the following clones have been recorded: a 77 × 76 m (with slightly brownish petioles and light-colored nectaries) pure circular vegetation unit growing on a *Vaccinium vitis-idaea*-type dry site, and a 68 m (reduced size) light-colored clone close by, a narrow unit between a field and a local road. Further in the direction of Joensuu, there is an 89 m clone in a pine swamp at Lautasuo.

According to SVINHUFVUD (1881, p. 5), cosack troops were stationed in Liperi in March 1713 and driven away by Finnish forces. The damage was considerable, e.g. the churchyard was destroyed and the church tilted (LINDEQVIST 1919, p. 449).

Kitee was twice raided by the cosacks during the 1741—1743 war (in 1741 and 1742), practically all houses were burned. A battle was also fought here, in which a poorly led peasant body suffered a crushing defeat (March 10, 1742; *Suomenmaa* 1927, p. 265, MANNINEN 1948). A Finnish patrol is said to have raided the commune in 1719 (LINDEQVIST 1919, p. 355).

A single 76 × 56 m model clone (brown petiole, dark small nectaries) grows on both sides of the Kesälahti—Kitee road (km 68—88, Heinoseniemi road junction, Puhos, Kitee). Its smaller diameter curiously coincides with the 1808—1809 war. A 74 m brown-petioled, dark-nectaried clone grows on the side of the Kitee—Närsäkkälä road (km 23—8). It is a part of a mixed vegetation unit. Since it grows on both sides of the highway, it dates from an earlier period than the road. A 96 × 72 m brown-petioled clone was found from the well-known larch stand in Kitee (see PALOSUO 1938) in a dense and large mixed bracken stand; another detached, light-colored and sparse-leaved one with a

maximum diameter of 96 m was found from the same area. The clones grew close to each other. The first one is peculiar in that the smaller diameter coincides with the 1741—1743 war and the larger one with the 1700—1721. The largest clone found in this stand has a diameter of 160 m, coinciding with the 1489—1497 war, and may also be connected with the earlier raids mentioned above. Other causes for regeneration are also possible. The 48 m clone mentioned in the previous publication (OINONEN 1967, p. 60) is probably connected with the time preceding the establishment of the stand. There was a considerable bracken vegetation already before planting; thus the larches planted at the age of four years (PALOSUO 1938) have, judging by the outcome, reasonably well managed to get out from under the bracken canopy and the falling leaf masses in the autumn.

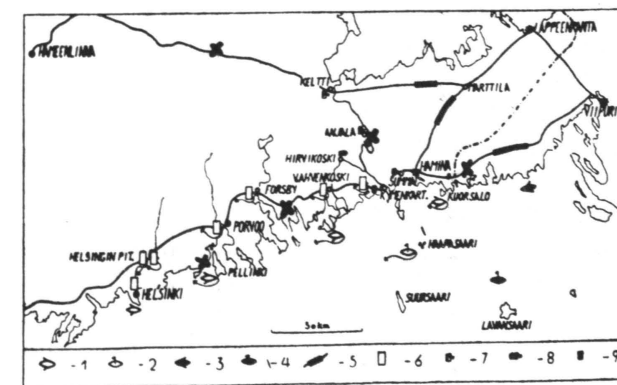
The clone composition in some other Carelian communes resembles that described above. Five clones were recorded from Pielisjärvi, one coincides with the 1741—1743 (Lamminkylä, Lieksa; 74 m) and one with the 1700—1721 war (the Harivaara roadside in the vicinity of Koli; 88 m). Six clones were found in Rääkkylä, near the border of Kitee commune; one of these falls into the intermediate class (Rääkkylä—Muljala roadside, km 22—18; 78 m) and one into the 1700—1721-war class (the same road, km 12—28; 89 m). Four clones were found in Tuupovaara; one of these coincides with the 1700—1721 war (Luutalahti, 95 m). — Further to the south, in Kerimäki, a total of 68 clones were found; 14 of these coincide with these wars (one in the 68—75 m, five in the intermediate, and eight in the 86—99 m class). According to the historical sources, this commune has also suffered in these wars, especially in the 1700—1721 war (GRANIT 1877, pp. 5, 13, 14, LINDEQVIST 1919, p. 432, *Suomenmaa* 1924, MANNINEN 1948). It is also mentioned that the Finnish defeated a Russian cavalry detachment in this area in 1742 and pursued it to Parikkala. The troops have probably gone through Punkaharju. Some details on the Russian evils in the area were recorded and have been preserved (HEIKINHEIMO 1927, p. 14). On Laukansaari island, Punkaharju, six 68—75 m, three 76—85 m, and four 86—99 m bracken clones were recorded. Only three clones have a diameter less than 68 m, thirty-seven over 99 m. Thus every fourth recorded clone dates from the time of these two wars. There were military operations in the Punkaharju—Kerimäki area in 1710, 1712, and 1714.

A considerable clonal aggregation in Ruovesi deserves to be mentioned as a specialty. On the side of the Kuru—Ruovesi road, in the vicinity of the Rajalahti junction (km 18—10 and 19—9), the following clone dimensions have been recorded on about a kilometer stretch: 68, 70, 72, 73, and 77 m. The references do not mention an event that might be responsible for this. The closest recorded units of the same magnitude are on the sides of the roads coming from Kuru and Orivesi, one between Kaitalahti and Toikko, Kuru (73 m), the other near the Orivesi border in the vicinity of Ryövärinkuoppa, Ruovesi (70

× 61 and 73 × 68 m, both from the data of REIJO MIETTINEN). Both roads were, as is well known, quite important in several wars, and have probably been used for marching troops and servicing them also during the 1741—1743 war. The smallest of these clones is limited by a rock outcrop and probably reduced in size. With this exception, all clones are detached, pure vegetation units. The largest (at the Rajalahti junction) is easily identified by its light color and its sparse, levelly projecting leaves. The next clone recorded north of the Rajalahti group, on the way to Virrat, grows in Vaskivesi (Puru junction), a detached 74 m one.

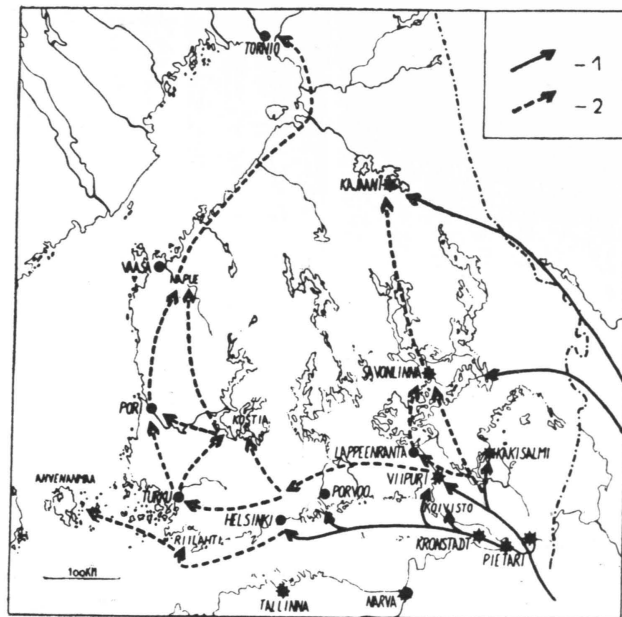
A 74 m brown-petioled clone was found near the Kumia mill, Nastola. It is located on the route of the troops that marched from Kouvola to Hämeenlinna (figure 8). A 75 m clone was found in Huruksela, Anjala, on the side of an important road connecting the one mentioned above with the Viipuri—Helsinki road. The Finnish also had defense stations in this area during one stage of the war. The dimensions of these clones coincide well with the average dimensions for the time.

During the 1700—1721 war (figure 9), a Swedish squadron in front of Hanko and Tvärminne was a serious obstacle to the Russian coastal fleet trying to get to Turku and Ahvenanmaa along the coast (UDDGREN 1906, LINDEQVIST 1919). To overcome the obstacle, the Russians tried an astonishing operation under the orders of Tsar Peter I: to pull the galleys from Tvärminne through the Hankoniemi narrows (Draget) to open water (UDDGREN 1909, p. 123). The operation was, however, discontinued for an unknown reason after a couple of days. According to the same source, the Russians also decided to try slipping



1 = Swedish coastal fleet, 2 = Swedish open-sea fleet, 3 = Russian coastal fleet, 4 = Russian open-sea fleet, 5 = advance of the Russian army, 6 = defense stations of the Finnish army during retreat; 7 and 8 = defense stations of the Finnish army at Kymijoki, 9 = the Finnish army in June 1742.

Figure 8. The military operations in southern Finland in 1742 (War of the Hats; JUVA 1942, according to WIKANDER). The crosses in the map show the bracken clones dating from that period.



1 = Russian attacks in 1704—1710, 2 = Russian attacks in 1713—1716

Figure 9. Battles for Finland in 1704—1716 (Great Northern War; JUVA 1942). The figure shows the main directions of the widespread movement of the forces.

past by the shore side of the fleet with the help of smoke, and they lighted a number of large fires on the Tvärminne shore. Two infantry regiments were called for assistance from Pohja commune. A third method was actually used: in calm weather, the galley fleet passed the Swedish sailing fleet on the sea side. — The following clones were found in this area: 82, 88, 92 × 86, 93 m. The second last clone is the prototype of «model Tvärminne». It is located in a herbaceous forest site with old grown-over ditches near the junction of the road to the biological research station. The leaves are very regular, sparse, flat, and slightly bending. The leaflets are long, the petiole darkish, as also are the nectaries with striped axils. The characteristics of none of the other specimens (all along a stretch of road less than one km long) are extraordinary. Three other clones, rather small, were recorded from the area. Between Tvärminne and Hanko, a 138 m clone was found growing around old earthworks hidden in the forest. It coincides with the early events of the 1570—1595 war, during which the coastal area of Uusimaa was severely raided (JUVA 1965).

The Russian troops stationed in Tvärminne were serviced in the beginning of the 1700—1721 war from stores in the communes of Karjaa and Pohja and later from Tammisaari, where the service center was moved (UDDGREN 1909, p. 122). A 91 and a 96 m clone were recorded in Hagen Park, Tammisaari. On the side of the Tammisaari—Tvärminne road, 86, 87, and 88 (2 specimens)

m clones were recorded in Källvik (see OINONEN 1967, p. 68, no. 186) and an 84 m one in Skogby. In Tenhola, a 90 m clone was found on the side of the Prästkulla—Vimonböle road (ca. 3 km), and a 92 m one between Prästkulla and Tammisaari (km 7—7). At the three-way corner of the boundaries of Karjaa, Snappertuna, and Pohja (Kaskimaa), an 88 and a 90 m clone were found. In Pohja, the Russian troops are said to have had an 18 000 man camp in 1719—1720. Considerable damage was inflicted on the communes in the 1700—1721 war (LINDEQVIST 1919, p. 433 and 556), but hardly a commune could have escaped damage during this period. The forests were extensively cut down or burned, a part of the burning was intentional (op.c., pp. 344, 467).

A considerable aggregation of clones from 1700—1721 was also found in the border-area of Ruovesi and Orivesi at Siikakangas and its vicinity. A total of twenty-two clones were measured in this area; eight of these coincide with this time: 86 × 48 m, 87 × 35, 89 × 56 and 94 × 64 m (Siikakangas), 81 × 68 and 83 × 46 m (near the University of Helsinki Forest Field Station, on the shore of Kuivajärvi), 99 × 88 m (Metsäsaramäki), and 92 × 74 m (between Susimäki and Kuivajärvi). The first seven are in the data independently compiled by REIJO MIETTINEN in 1964, the last was recorded by the author a year earlier. Seven of these twenty-two clones are from 32 to 70 m in diameter, the others from 104 to 149. This series coinciding with the 1700—1721 war continues northwest of the Murole canal; close to the canal, a 95 m unit was found in Kuru, at some distance towards Virrat, an 88 and a 91 m clone were found near the Aurejärvi road junction. On the side of the Ruovesi—Pohjaslahti road (km 23—39, in Pohjaslahti commune), a detached 93 m clone was found. — Large numbers of Russian troops are said to have gone through Ruovesi on their way to East Bothnia (UDDGREN 1909, p. 65), and also northern Häme was a center of the guerrilla war (e.g. ALANEN 1948, pp. 128, 137).

The Karjalohja area was also badly damaged in the 1700—1721 war (LINDEQVIST 1919, p. 433, *Suomenmaa* 1919, p. 57). This is clearly shown by the bracken clones. Five dating from this period were found in the village of Härjänvatsa: 84 × 62, 86 × 25, 90, 90 × 60, and 92 m. At a distance of 4—6 km from these (Oino road junction and Luskala heath, Sammatti communal center), the following clones were recorded: 86, 86 × 36, 88 (a brown-petioled model clone, see OINONEN 1967, p. 68, no. 184), 90, 93 × 63, 94, 95, and 98 m.

The Russians are said to have raided the communal center of Siuntio (*Suomenmaa* 1919, p. 86). An 84 × 40 and an 89 m unit were found in the vicinity of the communal center (Lappers); the latter is of a brown-petioled type. On the side of the road leading from there to Lohja, an 85 m unit was found at Grönberga and an 80 and two 86 m units in the vicinity of the trotting course work area on Lohjanharju.

During the 1713—1721 war, a Russian camp is said to have been located at Lägermalm, North Sarvilahti, Pernaja (JUTIKKALA and NIKANDER 1939,

p. 652), and an important base in Tervik on the shore of Pernaja inlet; troops and stores were brought here from St. Petersburg and Viipuri (LINDEQVIST 1919, p. 317). In the Sarvilahti area, also, two Finnish battallions were put together at the early stages of the war. An 88 m clone was recorded at the North Sarvilahti road junction. A 55 m clone was recorded on the same site, as has already been mentioned; troops have probably been stationed in this area again during the 1808—1809 war. A 79 m and a 56 m clone were found on the side of the highway at the Pernaja—Loviisa border.

In 1713, Finnish guerrilla troops patrolled the surroundings of Sipoo bay. They are said to have burned three ships transporting to Helsinki materials taken from the torn-down buildings of Hiitto manor (LINDEQVIST 1919, p. 345). A 98 m clone was found in the Eriksnäs area on the other side of the bay, a 97 m one to the east of this one, on the side of the Spjutsund road, and a 78 m one at the Nikuby—Kärby junction of the same road. The last-mentioned clone has grown poorly under a spruce canopy, and is recovering after a recent cutting. — The extent to which the military operations are responsible for the regeneration of these bracken units is, of course, quite uncertain. Their dimensions do, however, coincide with those expected for this war period, and since three out of five of the smallest single clones found on the Spjutsund roadsides fall into this class, the war probably is responsible. In addition to the more extensive than normal use of fire in wartime camping, another characteristic feature of the 1700—1721 and many other wars, described in detail in the historical references, must be considered. The guerrilla troops and the patrols have often inflicted, in the Finnish wars, a serious threat to the Russian servicing system and sometimes even to the fighting troops. These victories were, however, expensive. Helping the guerrillas in one way or another meant severe punishments and a cruel revenge collectively on entire villages or even larger communities. Those forests were put on fire, where guerrillas were suspected or known to hide (see e.g. KOSKINEN 1865, LINDEQVIST 1919, pp. 99, 344, 405). The villagers that had fled to the forests were searched for, and their campsites were demolished. According to the last-mentioned source, the main purpose of the occupation during the 1700—1721 war was raiding, not the permanent occupation of the country. Many areas became quite desolate, and the effects of fire were everywhere evident (op.c., p. 466). The city of Porvoo was completely destroyed and burned (op.c., p. 457). The Russians landed in this area already in 1708 and also inflicted a lot of damage (MANNINEN 1948).

In 1712, the war was going on, on the coast, but somewhat further in the east. Russian troops came to Vehkalahti. During their return march — along both the coastal road to Viipuri and the Kouvola—Lappeenranta road further north — the cavalry had orders to raid the areas within a zone forty versts wide (LINDEQVIST 1919, p. 409). An 86 m clone was found in this area, at the Vilniemi road junction, a 72 m clone (limited by the road) on the side of the

highway at the Vehkalahti—Virolahti border, and an 85 m one between Alapihlaja and the Vehkalahti communal center (with brown petioles and nectaries). Guerrillas still acted in Vehkalahti as late as 1715 (op.c., p. 347). KARTTUNEN (1932, p. 792) mentions that Virolahti was also severely damaged in the 1741—1743 war.

A total of 51 clones were recorded in the coastal area between Helsinki and Virojoki. Twenty-two of these date from the time after the 1808—1809 war, six are from this period, three from the 1788—1790 war, two from the 1741—1743 war (68—75 m), four fit the intermediate (76—85 m) class, and four date from the 1700—1721 war (86—99 m). Ten larger ones were found. Thus almost a half of the less-than-one-hundred-meter vegetation units are probably connected with these wars (19 out of 41).

For comparison, let us take a look at the coastal area to the west of Helsinki, up to the town of Kristiina. A total of 275 clones were recorded on this stretch. These are distributed as follows: 177 date from the period after 1743, 50 from the 1700—1743 period during which two wars were fought, and 47 are from earlier periods. Twenty-two date from the 1808—1809, nine from the 1788—1790, and eight from the 1741—1743 (68—75 m) war, seventeen fall in the intermediate class for 1721—1741 (76—85 m), and twentyfive date from the 1700—1721 war. Thus every third clone (81 out of 228) seems to be connected with these war periods. This gives a relatively smaller number of clones for the war periods from the western area; this agrees with the areal distribution of the battle intensity. It should, however, be noted that a much greater amount of data was compiled in the west than in the east. In the western area, some large continuous areas have also been searched for clones, along compass line transects (on foot), and only roadside clones are included in the eastern data. Despite the methodic difference, the result should be considered suggestive.

The number of clones dating from the 1700—1721 war is also considerable in central Finland. The area surrounding Kuopio is said to have suffered badly in this war, while the rest of northern Savo was only slightly damaged (LINDEQVIST 1919, *Suomenmaa* 1927). A total of fifty-four clones were found in twelve communes in the Kuopio—Rautalampi—Joroinen—Kaavi region. The size-class distribution is this: thirty less than 68 m (of these, five date from the 1808—1809 war and seven from 1788—1790 — there was no war here during that period), two in the 68—75, six in the 76—85, three in the 86—99 m class, and thirteen were larger than this. Thus, the 1700—1743 period is represented in the less-than-one-hundred-meter size group by every fourth clone. The two later war-periods are represented by twenty-three clones, a little over a half of those less than 100 m in diameter. The northern Savo areas are according to these figures represented by a slightly larger relative number of clones (23 out of 41) than the coastal areas of southern Finland. Burning for crops is well

known to have been more common and has continued later in Savo than on the coast.

When they came to Turku (1713), the Russian cavalry raided and damaged both the city and its surroundings (LINDEQVIST 1919, *Suomenmaa* 1921, MANINEN 1948, and others). In the same year, a Russian naval squadron that had broken through at Hankoniemi came to Turku (GARDBERG 1954, p. 84). The area suffered during the war to the extent that it was granted an exemption from taxes for eight years following the war. Three clones dating from this period were found on Ruissalo island, which must have suffered as badly: a 90 m, at the Ruissalo manor road junction (brown type), and two 85 m clones, in the area of the invalid home road junction.

A considerable group of clones of this size was recorded at Pyhävuori in the vicinity of the city of Kristiina: 84, 89, 93, 93 m. Fairly large numbers of troops moved in the vicinity of the city in 1713 and inflicted heavy damage

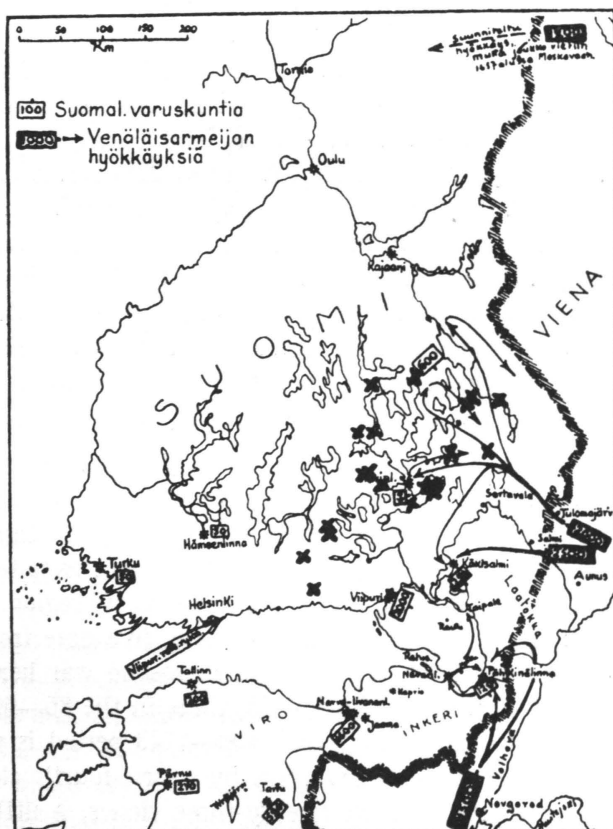


Figure 10. Russian military operations in Finland and the Baltic in 1656—1658 (JUVA 1942, according to KUUSSAARI). The crosses in the map show all bracken clones dating from that period in the eastern-southeastern part of the country.

(LINDEQVIST 1919, ALANEN 1948). The settlements in the commune of Isojoki are said to have been completely wiped out. According to the latter source, large fires occurred in 1703; the seafarers in the waters of the Gulf of Bothnia were bothered by the smoke. Detailed data on the extent of the fire are not available.

An interesting coincidence was found in Ampiala, Keuruu. In 1715, the Herpman brothers, the peasant leaders, who successfully led the defense of the commune, spent their Christmas here (*Kansallinen elämäkerrasto* 1929, p. 418). Russian troops, guided by an informer, attacked them by surprise, and they were killed during the battle and the subsequent events. Two clones are included in the data from Ampiala hill, both from near the house. One has a diameter of 81 m (dark nectaries, stripes on the nectary axils); it is limited by a road and as complete would be at least five meters larger. A 67 m clone was found close by, limited at one edge by a field. — It can only be guessed whether the Russians raided the area in revenge for the upkeep of the guerrillas. The development of the clones may naturally be connected with e.g. burning cultivation that was practiced on the site, judging by the stage of vegetational succession. It is still curious that no other bracken clones were found. — During the 1700—1721 war, about 10 000 Russian troops were stationed in Jämsä. They e.g. extensively raided the Keuruu—Koskenpää area (HALLONGREN 1905, p. 65) and apparently also patrolled in the areas to the south, in the direction of Längelmäki. A 97 m clone was recorded between Keuruu and Koskenpää (km 28—31), and a 96 m one on the Jämsä—Ouninpohja road (Mustajärvi local-road junction).

34. The 1656—1658 War with Russia

The areas of Savo and Carelia were in war in 1656—1658 (figure 10). The Russian troops came from Tulomajärvi to Tohmajärvi, where the forces were divided into three. A detachment left for Savonlinna (burned it), another left for Kuopio (occupied it) via Vehmersalmi, and the third marched in the direction of Joensuu, Lieksa (burned), and Nurmes (AMINOFF 1943, JUVA 1965). Kerimäki (*Suomenmaa* 1924, p. 357, SOININEN 1954, p. 184), Nurmes, and Juuka (*Suomenmaa* 1927, p. 357, KOKKONEN 1941, p. 50) were also raided.

A 104 × 62 m clone was found at the Petrovaara road junction, Tohmajärvi; the dimensions indicate regeneration almost exactly during this war. The clone is detached. The smaller diameter corresponds to the time of the 1788—1790 war, indicating a fire during this period, which possibly reduced the vegetation unit into a strip along the slope. About ten kilometers away, at Jouhkola, Tohmajärvi, there was a permanent command post of the Finnish border guards (CEDERBERG 1910, p. 11). It deserves to be mentioned that a

clone dating from the 1788—1790 war also found from the nearby border between Värtsilä and Tuupovaara (km 21—21).

A 109 m clone was found at the Jaama—Taitinniemi road junction, Rääkkylä, on another route used in the 1656—1658 war. A 100 m clone grew in Eno (km 29) on a meadow next to a house. On the side of the road from Ilomantsi to Hattuvaara (km 8—33), a 115 m clone was found. Near Kuopio, a 103 m detached clone was found on a slope burned for crops (*Vaccinium myrtillus*-type and *Vaccinium vitis-idaea*-type), between Kaavi and Sivakkavaara (km 4—16). In the city of Kuopio, near the observation tower on the upper slope of Puijo hill, a 112 × 101 m fragmentary clone was found also dating from this war. Records of a fire during this period were not found, but it is known that a Carelian patrol burned the church of Kuopio in 1610(?) (*Suomenmaa* 1927, p. 100). A part of the site is better than average, but the spruce stand is quite dense and may have caused the fragmentation of the vegetation unit.

A series of recorded bracken units extending from the mouth of Kymijoki towards Kuopio is curiously suggestive, but may of course be a chance phenomenon. This size is also common in the western parts of the country. The following clone diameters deserve to be mentioned: 102 and 105 m at Huruksela, Anjala, 110 at Mankala, Iitti, 110 and 113 × 74 on the Mäntyharju—Tuohikotti roadside, 101 and 115 on the Maivala—Hatsola roadside, Juva, 109 at Kaskinen, Juva, 109 at Huutokoski, Joroinen, and 107 at Vehmaskylä, Pieksämäki.

Clones of this size are remarkably common in the communes around Savonlinna, where the southernmost considerable military operations took place. A 116 × 115 m clone was found at the junction of the Ruokolahti—Mäkrä island road and a 108 m one on Patasalo island, both in Kerimäki (from the data of R. MIETTINEN); the following clones were recorded by R. MIETTINEN in Punkaharju: 109 × 82 at Takaharju, 111 at Seppälänmäki, 109 × 86 in the Karjalankallio area, and 104 on the peninsula southeast of the Karsikonlahti bay. A 108 m model clone was recorded on the Kiviapaja—Lohilahti (5 km) roadside, Sääminki. The specimen has very dark petioles, probably the darkest in the data; it has spread uphill from and along the edge of a lake-margin bog.

The 95 per cent probability range for vegetation units as old as these is so broad that only the units within five meters of the average can be justifiably considered a result of the war period. Replicates are of ever increasing value in weighing the data, and there happen to be quite a few in this size class. — Growth and the uniformity of spreading in optimum conditions is well shown by the already mentioned 116 × 115 m unit at Ruokolahti, Kerimäki.

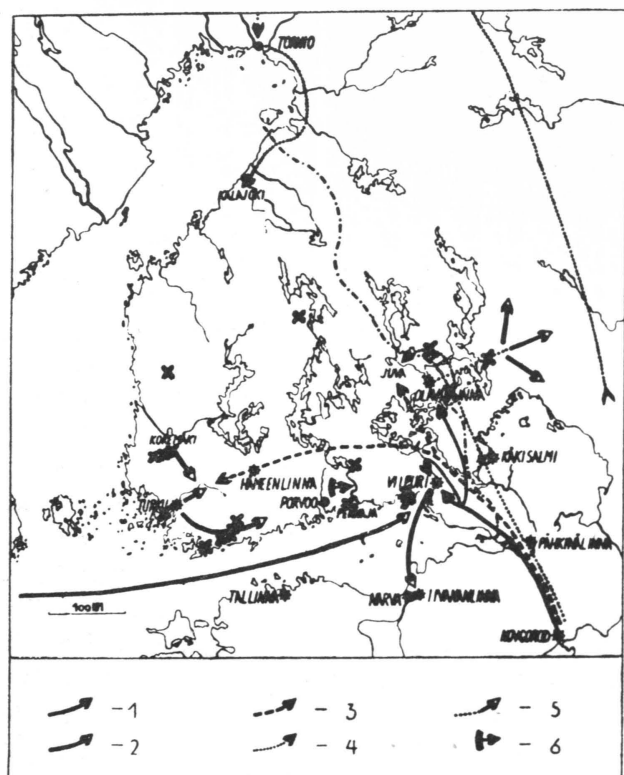
35. The 1570—1595 Long War

A detached 129 m unit on the side of the road to Hanski, Virolahti, probably dates from the 1570—1595 war, but may have also been decreased in

size in more recent fires (old tar-pits were found in the area). In 1571, 1582, and 1590, this commune and the Kymenlaakso area suffered very badly (LINDBERG 1881, p. 12, SAARINEN 1881, p. 6, MANNINEN 1948). In 1571, 230 houses were burned in Virolahti, 236 in Vehkalahti, 385 in Pyhtää, 70 in Pernaja, 11 in Sipoo, and all in the Porvoo area (JUVELIUS 1927, p. 230). Virolahti was a landing area for Russian troops during the war, and in 1578 the Finnish troops left for Inkeri over the ice from here or from Vehkalahti. A 131 m vegetation unit in the area of the Purola—Länsikylä road junction, Pyhtää, and a 142 m one on the Vehkalahti—Virolahti border on the Viipuri—Helsinki roadside date from this period. A single 141 m unit was recorded by the Luumäki—Lappeenranta road in Lappee. The Russians are said to have raided and burned parts of Lappee in 1571 and 1592 (MANNINEN 1948). In 1592, a large Russian army marched to Valkeala (JUVELIUS 1927, p. 268). In Sippola, a 130 m clone was recorded between Utti and Hirvelä and a 138 m one at Voikkaa. In the provinces of Savo and Carelia, most of the clones of this size were recorded at Punkaharju (12) and Kerimäki (7); one or two clones were found in several communes on the way to Ilomantsi. A 142 m clone was found north of the Ilomantsi communal center, on the side of the road to Mekrijärvi (at km 8—33) and a 140 m one nearby, in the Ryökkylä road-junction area, on a narrow strip of land between lakes. Historical sources state that the troops from Savo under the leadership of Ambrosius Henrikinpoika defeated a Russian guerrilla detachment that had made its way to Ilomantsi, on December 29, 1587 (see MANNINEN 1948). In the Savo area, a single 142 m model clone with brown petioles and pale nectaries, on the side of the Parkkila—Puumala road (ca. 42 km), deserves to be mentioned. — All of these areas suffered badly during the war (STENROTH 1880, AMINOFF 1943, MANNINEN 1948).

Clones of the size dating from the 1570—1595 war were also sparsely found in the other parts of the country. A part of these may be connected with the 1596—1597 war (cf, e.g. KOSKINEN 1857—1859, JUVA 1965). This could be the cause for the birth of e.g. the following clones: two 132 m clones at Lauhanvuori, Isojoki, a 129 × 89 m and a 130 × 121 m clone in the Siikakangas area, Ruovesi (from the data of R. MIETTINEN), a 127 m clone at the Murole canal, Ruovesi, a 131 m clone at Jylhämaa, Kiiikoinen, a 126 m one in Noormarkku, and a 134 m one in Huittinen (road 2, Kevalava junction).

A 130 m clone with quite extraordinary specimen characteristics was found at Grönberga, on the border of the communes of Siuntio and Lohja. The petiole was reddish and cross-striped behind the nectaries in the autumn. In sunshine, it was easy to see the bright spots from a distance of several meters. The clone had spread on a formerly burned and cultivated field; its one end was limited by a brook. No connections to war are known. Clones of this size were also found in the area of Sammatti and Karjalohja and in the vicinity of the boundary intersection of the communes of Pohja, Karjaa, and Snappertuna.



1 = attack in autumn 1495, 2 = relief troops to Viipuri and the counterattack from Viipuri, 3 = Russian patrols in winter 1495—96, 4 = Russian patrols in spring 1496, 5 = Finnish counterattacks from Olavinlinna, 6 = Finnish defense stations at Kymijoki

Figure 11. The Russian attack in the 1490's (JUVA 1942). The crosses in the map show all bracken clones dating from this period.

36. The 1489—1497 Big Russian War

The map (figure 11) constructed by JUVA (1942, p. 74) gives us an overall view of these distant events. The possibilities for detailed study are already rather small, but it may still be useful to examine the distribution of the clones in the map. All 155 to 165 m diameters have been marked. The sites and the sizes of the clones are: Siikainen—Honkajoki road (km 26) 159 m, Huittinen—Säkylä (km 9—5) 162 m, Säkylä—Eura (km 7—8) 155 m and (km 8—7) 157 m (a distance of about one kilometer between these two), Källvik, Tammisaari rural district, 160 m, Härjänvatsa heath, Karjalohja, ca. 160 and 162 m, Lus-

kalannummi, Sammatti, 160 × 106 m, Sarvilahti, Pernaja, 159 m, the road to Heinoseniemi, Virolahti, 163 and 164 m (both on the same heath), the junction of the road to the parsonage, Valkeala, 164 m (a 118 m model clone with reddish-brown petioles and nectaries that may be connected with the 1570—1595 war, also grows on the same heath), Laukansaari, Punkaharju 163 × 96 and 164 × 68 m, the larch stand at Kitee 160 m, Sappu, Heinävesi, 163 m, and the Jyväskylä—Saarijärvi road (km 47) 156 m.

The coincidence may be by chance, but a degree of causality may also prevail. Among the clones on the map (figure 11), only two are located at a considerable distance from the routes and areas that were disturbed by military activities. Especially Carelia, Savo, and a part of Häme are said to have suffered greatly in the 1489—1497 war. According to an old chronical rhyme, these areas were entirely devastated (RINNE 1947, p. 128, MANNINEN 1948). The Russians landed in 1495 on the coast of the Finnish Carelia of that time, but the site can not be located by the help of the references searched (MANNINEN 1948). The forces started on the raid from Ivangorod. In 1497, the Juva area was completely devastated, and huge fires raged in the area (RINNE 1947). The war reached the coast of Uusimaa in 1487 and again in 1520—1523 (the Raasepori castle was sieged; HARTMAN 1896). In 1507—1522 the Danes raided and inflicted damage on the coastal areas of Uusimaa and Varsinais-Suomi (Finland Proper). After the 1489—1497 war, people moved from the west to e.g. Punkaharju, where Lehtisalo (=Laukansaari) was permanently settled (Suomenmaa 1924, p. 176). The main result of the war was the heavy damage to Finland (JUVELIUS 1927, p. 103).

Among the clones mentioned, the 163 m one at Heinävesi is peculiar. The historical sources date the settlement of the area to the beginning of the 16th century. Some houses are mentioned (SOININEN 1954, p. 563); one of these — Hasumäki — from where the clone was found. In my notes, the site is described as a formerly burned and cultivated, later forested area in the vicinity of a house. The size/age-ratio average almost exactly coincides with the ca. 465 years from the settlement. According to JUTIKKALA (1933, p. 94), these areas had just been settled before 1540; thus it is possible that the first burning-farmers (cf. PÄRNÄNEN 1947, p. 63) came here in about 1500.

The time preceding the 1489—1497 war was restless and warlike. Especially the Savo area was repeatedly raided during the years 1464—1478 by the Russians (RINNE 1947, pp. 120, 125, MANNINEN 1948). Some of the clones mentioned may also date from these raids, and so may the following: Mäntyharju—Tuohikotti road (km 16) 169 m, the same road (km 28) 171 m, Porrassalmi, south of Mikkeli, 168 m, and Laukansaari, Punkaharju 170 × 130 m. In the other parts of Finland, eight 168 × 175 m clones were found, the connection of these to war events is unknown.

37. Some large clones

A number of large clones deserve a preliminary discussion in this context. They will be discussed on a broader basis after the number of data has been increased by new collections in the sector indicated by this discussion.

The ancient fortress of Sulkava was built in the late part of the time of the crusades to Finland (1050—1300) during the later iron age, and certainly before the beginning of the fourteenth century (*Suomenmaa* 1924, p. 168, RINNE 1947, p. 102). The site of the fortress signifies, according to KIVIKOSKI (1961, p. 279), that the area around or in the vicinity of it was settled. She considers it a mere chance that no graveyard dating from this period has been found.

Next to the fortress, at the bottom of the hill, there is a 217 m bracken clone with brown petioles. The average age, calculated from the average growth rate and the clone dimensions, is 630 to 640 years, and the time of birth thus between 1325 and 1335. This agrees well with the information on the site history. Fires have probably been lighted, and they may have run wild in the fortress area at about this time; both sides of the evidence indicate a high probability of a coincidence. The fortress was probably used at the time of building and for some time afterwards. No information on the defense of the fortress is available. Still, the case can be considered a replicate of the Laitaatsilta one (p. 19). Even the identifying features of the clones happen to be similar.

Lesser natural monuments than these have been protected. Despite that bracken is considered a bad weed, good reasons can be given for protecting it. Similar reasons outweigh silvicultural harmfulness in many other cases. Several of the large clones are natural wonders that should not be disturbed before thorough consideration.

The commune of Hausjärvi was settled in the fourteenth or fifteenth century (LUUKKO 1958, p. 10, JUVA 1964, p. 374). On the road from Seppälä to the Hausjärvi communal center (km 28, before reaching Highway 4) a single 208 × 187 m bracken clone grows on a poor heath plateau. Its dimensions indicate an approximate age of 610 years and regeneration in about 1350, which coincides with the time of settlement.

The Novgorodians came to the Turku area by sea in 1318, occupied the city, and raided and damaged the surroundings (MANNINEN 1948). E.g. the bishop's castle of Kuusisto was burned. The historical sources used do not say anything about the Russians going to the island of Ruissalo outside of Turku, but the estimated age of the 227 m bracken clone found there points to this possibility. Born about 660 years ago, the clone dates from 1305. The difference between the dates is only thirteen years, which is not very large for a unit of this size and age; actually, the correlation is excellent. — The identifying marks are not among the best in the data. The clone type is commonplace, of a pale color; the extreme end of the unit grew on a poor rocky slope, where

the identification marks became indistinct. The site borders a field near the invalid-home road junction.

In 1311, the Russians landed on the coast of Uusimaa, and raided the southeastern areas of Häme way inland to the castle of Hakoinen (AILIO 1915, AMINOFF 1943, p. 109, MANNINEN 1948). Häme also suffered in 1292. There were some landing sites in the Pyhtää—Pernaja areas, which also suffered in 1311 (*Suomenmaa* 1919, p. 150, JUVELIUS 1927, p. 45, VOIONMAA 1933, p. 443, JUVA 1964, p. 151). The mouth of the Kymi river was a harbor for Savo from the thirteenth century to the treaty of Pähkinäsaari (1323; RINNE 1947, p. 263). The commune of Jaala was settled during this period or slightly later, (in the 14th or 15th century; LUUKKO 1958, p. 10, JUVA 1964, p. 373).

A 230 m bracken clone, dating from 670 years ago (1295) was recorded at the Korkeaharju road junction, Pyhtää, close to the main road to Helsinki. Only three years had passed since 1292, and an interval of only sixteen years separates 1295 from 1311. A 232 m unit was found between Jaala and Selänpää (km 10), another 232 m one a short distance to the east (Selkäharju—Savitaipale, km 28, Lemi). These two were thus also born at the end of the 13th or the beginning of the 14th century, if their dimensions are reliable.

The objects found in Carelia show that it was settled in and after the 12th and 13th centuries; the settlement expansion reached its peak in the 13th and 14th century (JUVA 1964, p. 72). The effects were seen as far as northern Häme and Satakunta, and population centers sprang up in Savo (JUTIKKALA 1933, p. 69, 1952, SOININEN 1954, p. 35, SOIKKANEN 1962, p. 18, and others). Communities of settlements were born at the northern border of Carelia at Kitee, Ilomantsi, and Pielisjärvi. The settlements were not left to develop in peace. In 1278, Dmitri Alexandrovich, Prince of Novgorod, »punished the Carelians, destroyed their land, and took the inhabitants as captives» (MANNINEN 1948). The Swedish settled East Bothnia in the latter part of the 13th century (LUUKKO 1958, p. 59, JUVA 1964, p. 372). At the dawn of the Christian era, settlers also left the Kokemäki river basin for southern Ostrobothnia (JUTIKKALA 1933, p. 64). The coastal areas of Uusimaa left depopulated after the Viking era (800—1050) got their Swedish population somewhat earlier, after the crusade of Earl Birger (1249; JAAKKOLA 1958, p. 300, LUUKKO 1958, p. 8, JUVA 1964, p. 372). Life was insecure here, also. In 1256, Alexander Nevski led a revenge raid to Uusimaa and Häme. Such raids had been frequent in this area since 1042 (MANNINEN 1948). With a number of crusades in between, the settled areas of Finland suffered from continuous war and raids.

The following clones dating from these periods were recorded in Carelia: Mekrijärvi, Ilomantsi, 250 and ca. 300 m, near the Ryökkylä road junction, Ilomantsi, 231 m, the side of the road to Koli, Juuka, 250 m (land relocation in connection with road works has caused an unauthentic continuation of the clone along the roadside — the transplanted rhizomes had rooted anew), Tuu-

povaara—Kiihtelysvaara road (Kovero—Huhtilampi, km 49—27), Juuka, 244 and about 250 m. The average age of the 250 m units is 730 years and the 300 m about 870 years; the corresponding years of birth are 1235 and 1095. On the road from Kitee to Kaurila, Tohmajärvi (km 20—17), a 321 m clone was found, which dates from approximately 1035. All of these are in burned and cultivated sites next to settlements. They are also the largest clones recorded in the boundary zone between Tohmajärvi and Nurmes. The sizes seem to be well correlated with the times of historical events. Although still larger clones will probably be found in the area, the uniformity of this random population can be considered to render it highly representative. — Further to the west, near the border against Savo, three clones of this size were found at Rikkaranta, Kuusjärvi: 229 (road cuts both extreme ends), 244, and 247 m.

In Savo, a total of nineteen 200—330 m clonal units were distinguished in Kerimäki, Punkaharju, Sääminki, Ruokolahti, Sulkava, Ristiina, Juva, and Pieksämäki. The following clones serve as examples of the area: 210 m (basal part of petiole and nectaries brown), Suomenniemi—Mikkeli, km 69 (Ristiina), 214 m (petiole brown, nectaries green), Ruokolahti—Sulkava, km 24 (Ruokolahti), 247 m (petiole slightly brownish, nectaries green) at the Likaistenperä road junction, Suurkempäälä (Ruokolahti), and 330 m, Sääminki—Lohilahti, km 61 (single, light-colored clone with large-sized, coarse, curving leaves).

In the central parts of southern Finland, fewer (only ten) 200—300 m clones were found; this is probably due, not to their rarity, but to the areal differences in the intensity of the survey. The locations and dimensions of the clones are: Suovanlahti, Viitasaari, 200 m, the Laukaa—Toivakka border at the Lievestuore—Toivakka road (km 28), Laukaa, about 200 and 213 m, Mänttä—Jämsä (km 34), Jämsä, 222 m. Äänekoski—Saarijärvi (the Parantala road junction, km 47), Äänekoski, 230 m, Valkeeluomi—Vedenpää road (km 1), Koskenpää, 263 m, the ridge between the Pirttijärvi and Valkeajärvi lakes and the vicinity of the Koskenpää—Vedenpää—Jämsä road junction, Koskenpää, 213, 296, about 300, and 300 m (this one is a detached model clone with slender, curved leaves and dark nectarium axils). — Jämsä is said to have been settled at the end of the pagan era (JUTIKKALA 1933, p. 65), and the 300 m bracken clones have been born in about 1100. The coincidence is good.

In the border area between southern Ostrobothnia and Satakunta, 240 and 247 m clones were found at Lauhanvuori, on the border of Isojoki and Kauhajoki, 226 and 244 m clones at Pyhävuori, Lapväärti, and a 233 m one on the Honkajoki—Siikainen roadside (km 22), Siikainen. The last of these is a brown-petioled model clone mixed with a light-colored clone of the same size and growing on the same site (the germination sites have apparently been very close to each other). According to the average schedule, all these clones were born between 1240 and 1300, which is well in accordance with the data on the settling of the area (see p. 39). A 202 m clone with dark-based petioles was

found in the same general area (Heittola—Lentola, 1—2 km, Viljakkala commune). The area of Ikaalinen west of Kyrösjärvi lake became settled in about 1300 and the southern parts of Parkano in the beginning of the modern times (*Suomenmaa* 1921, p. 26). The site of the clone is between these areas; settling was probably started there after 1300. The iron-age fortress of Isoröyhiö is located on the same stretch of road, a little over ten kilometers away; this also indicates that the area east of Kyrösjärvi was settled during this period. The 202 m clone dates from about 1380. — It should be mentioned in this connection that during the 1700—1721 war the area of Ikaalinen was on the march route of the Russian troops (op.c.). That war also touched the Parkano—Viljakkala area is suggested by three bracken units: 95 m, Parkano—Heittola (km 1), Parkano, 90 m, Heittola—Viljakkala (km 1), Viljakkala, and 95 m at the Sorvalahti—Lentola road junction of this road. All three are thus along the same road between Parkano and Viljakkala.

A number of 200—300 m clones were also found in the southwestern and southern coastal area. A single 232 m light-colored clone was found in Kalanti (Uusikaupunki—Pyhärinta, km 9). Some other large clones were found in its neighborhood. Between Merimasku and Askainen (km 8—8), 217 m, in Hagen Park, Tammisaari, a 216 m, and in Siuntio (Kirkkonummi—Inkoo, km 23—36), a 239 m clone were found. The last-mentioned has light yellow-brown petioles and large pale nectaries and is suitable for visiting. It dates from approximately 1235; the clone was thus born at the time the coastal areas of Uusimaa were settled by the Swedish.

Among the clones considerably larger than the ones listed, some deserve a comment. On the border of the provinces of Mikkeli and Häme, in Vierumäki, Heinola commune (Vierumäki—Suppi, 3—4 km, Vierumäki sport institute road junction), a 358 m darkish-petioled clone was found; it dates from about 950, the Viking era in western Finland. The data include also 379 and 360 m clones from here. A 489 m clone was found in Rääkkylä, southern North Carelia (Rääkkylä—Kitee, km 21—19, near Muljula road junction) on a *Vaccinium vitis-idaea*-type upland site, on the margin of a large pine swamp. The specimen was characterized by slightly undulating leaves (not smooth and level), broad leaflets, light-colored petioles and nectaries, and an indistinct spot on the nectaries. On the Kitee side of the border, only ten to fifteen kilometers further south, a 474 × 292 m mixed-growing clone with brown petioles and reddish-brown nectaries was found at the Pajarinniemi camping area road junction (Puhos—Kesälahti, km 72—161). Both dates from about 550—570 A.D. These years were in the middle iron age and the time of the migrations (400—800 A.D., see e.g. JUVA 1964, p. 50). According to KIVIKOSKI (1961, p. 257), the marks of permanent iron-age settlement point to the late part of the time of the migrations in Carelia. A number of finds were made in this area; they indicate that it (e.g. Pajarinniemi) was settled in the stone and iron ages. One of

the finds dating from the same time as the clones is a javelin head from the iron age (*Suomenmaa* 1927, p. 265).

4. Conclusions

The good agreement in the dating by the clonal dimensions and the historical information is in accordance with the results of the earlier study (OINONEN 1967) on the rate of clone development. The coincidences are seen on three scales: the frequency histogram (figure 1), the exact areal coincidences (cf. examples), and the concentrations of the data especially along the marching routes of the troops (see maps). The three-way coincidences can not be mere chance — even though chance may be responsible for a part of the individual coincidences — since all of these include replicates, partly complete series of them.

Absolute proof for the immediate reasons of clone birth can not be given in individual cases, but where higher clone frequencies are found for the sizes coinciding with the war periods than for those dating from the years after the wars, the use or the spread of fire is probable. The difference in frequencies is especially clear for the clones dating from the 1808—1809 war and those from the period immediately following. The profile of the frequency diagram is clearly similar to that for the 1700—1721 and 1741—1743 wars. The marked rises seen for the war periods are partly result from the method of sampling. The main part of the data is from roadsides and their vicinity, and a part of these roads already existed (according to VOIONMAA 1933) and were already used during these wars (see e.g. *Generalstaben* 1895—1922, maps). A compass-line survey of forested land areas would probably give a more random and smooth-crested size-class frequency distribution.

By comparing the birth frequency of clones during and after the 1808—1809 war, it can be seen that the war has approximately doubled the frequency, which indicates a corresponding increase in the use and the spread of fire. The result may be somewhat accentuated by the rehabilitation or inactivity period after the war that might have decreased the frequency of clone regeneration to a little below average. The rise in the columns towards our time may partly result from the renormalization of life and partly from the method of searching for the clones. In any case, the maximum in the 25—29 m class is less weighted by the method of selection than the frequency columns in the smaller size classes, in which the largest percentage of the existing clones was recorded. The steep decline from the 25—29 m maximum indicates changes in the agricultural methods. According to JUTIKKALA (1934, p. 127), one half to one third of the Finnish grain in the 18th century came from burned and cultivated lands; in 1880, only three per cent was grown in such areas. A clear change has also taken place

in the use, care, and prevention of fire; this too must have decisively decreased the bracken regeneration frequency in Finland.

The data presented indicate that the cross diameters of large clones are sometimes almost exactly the same. Also, some fairly large clones grow in the vicinity of others of the same size. These facts serve to illustrate the smooth spreading rate of clones in both uniform and fairly heterogeneous habitats. Even large clones are thus at their best — especially when replicates are found — excellent cronometers, which provide a reasonably good estimate of the date of their own birth and the time of the fire preceding it. A factor of uncertainty is connected with the single clones that have been exposed to fire after their birth: the clones may have been reduced by the fires. Partial size reductions like these are common, as has been seen by the numerous examples, in which the cross diameters of the clones have differed considerably. Among these, peculiar cases were found, in which the larger diameter corresponds to an earlier and the smaller diameter to a more recent war or fire. In these cases, the vegetation unit has probably been reduced by the last fire into a narrow strip along the wettest depression in the area, a bend of a slope, the edge of a swamp (the perpendicular diameter is about a half of the theoretic one, when water logging has prevented growth in the direction of the swamp), a highway ditch, etc.

Bracken individuals may have variable spreading rates, but the data revealed no such differences. The variation is probably not great, judging by the distinct frequency-histogram maxima; likewise, site differences seem to have little effect on the spreading rates. Since the average ages for several of even the large clones have almost exactly coincided with past events, the averages are probably quite useful in estimating age (see e.g. the settling history of Sappu, Heinävesi, the case of Putkilahti, Rantasalmi, and the close correlation between the age estimate for the 217 m clone recorded from the vicinity of the Sulkava fortress and the dates given by historical records, pp. 37—38, and figure 12). The compatibility of the specimens is well shown by the mixed stands of large clones, in which the clones have grown intermingled for hundreds of years.

The largest distinctly identifiable clones in the data have a diameter of between four and five hundred meters. Some still considerably larger clones have been recorded, but their characteristics have been so commonplace that their identification has been somewhat uncertain. Other methods must be used for checking these. The clones described here already show the remarkable degree of permanence exhibited by the bracken stands and suggest that larger clones exist. Some of these natural specialties should be protected, when possible. For the time being, they are best protected by the expenses required by their control and the difficulty of their total eradication.

In this study, the coverage of the compiled data is reasonably good over the entire area, where bracken is common. The method resembles line survey, but

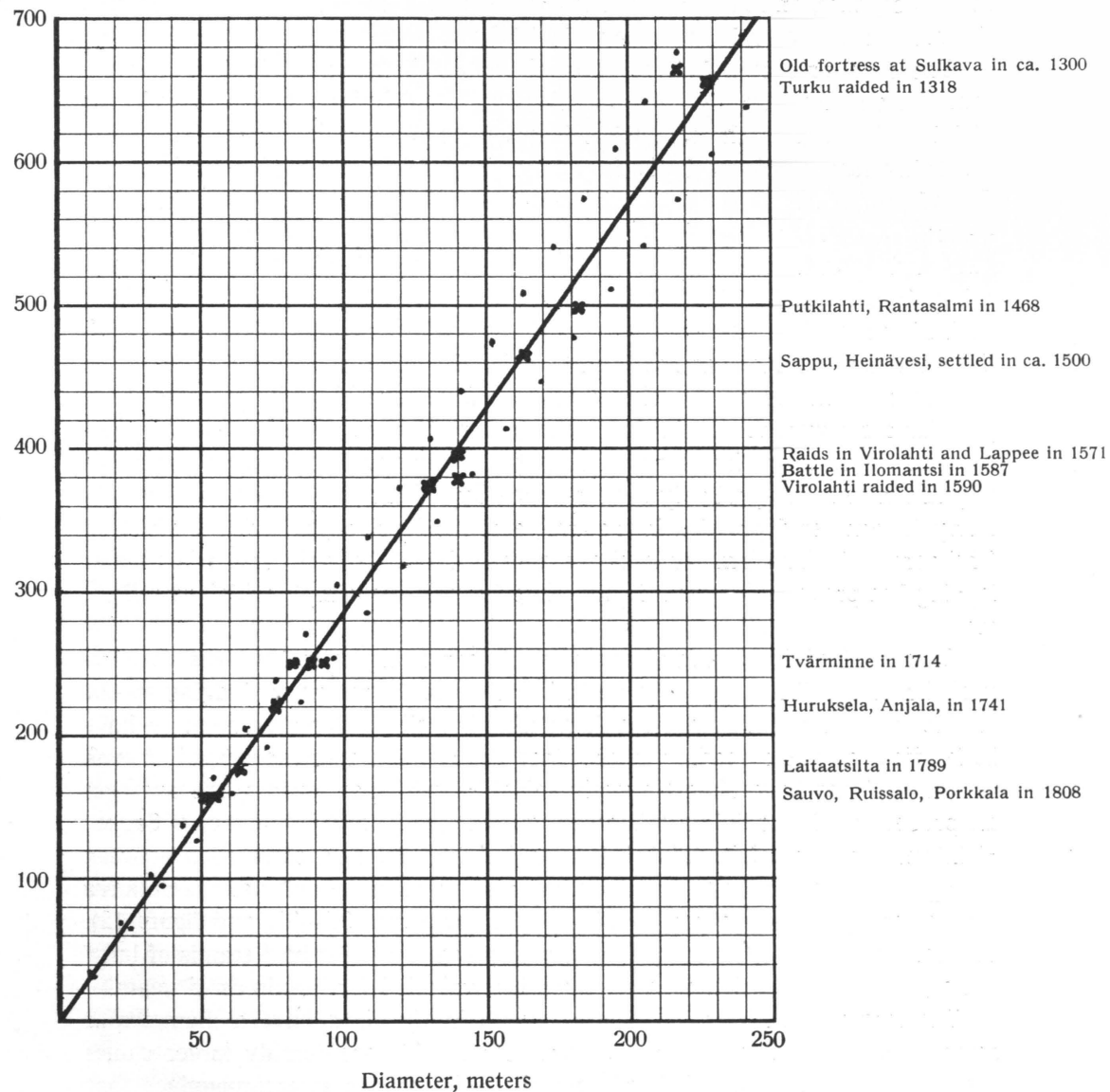
Age,
years

Figure 12. Schedule of the spreading of bracken clones; some representative clones are pointed out. The dotted lines are the 95 % probability limits.

the transects are substituted by roads. The data distinctly show the northern distribution limit, as can be seen in figure 13. It can also be seen that the northern limit of bracken quite well follows the 1749 population limit between one to two and less than one person per square kilometer. A continuous, spar-

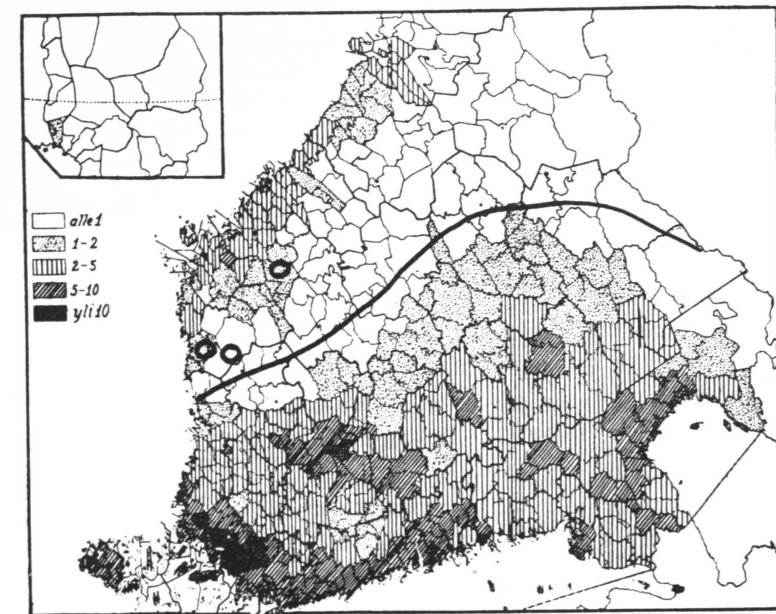


Figure 13. Population density in Finland in 1749 (people/sq.km; JUTIKKALA 1934). The bracken clones were found almost uniformly, although sparse, south of the continual border-line (Merikarvia—Nurmes—Ilomantsi). North of this limit, bracken was found in three places (Pyhävuori, Lapväärti; Lauhanvuori, border of Isojoki and Kauhajoki; and Simsiönvuori, Lapua). Accidental vegetation units occur further north, but they were not found during this search. The units are commonly composed of single or few clones in a wide zone (100 km or more) south of the limit. The connection to the distribution of settlement is obvious except in the coastal area of the Gulf of Bothnia. The burning-cultivation practices in Savo have best promoted bracken spreading to the north.

sely dotted bracken distribution limit is slightly to the north of this. Further north, single chance units are known to exist at a fairly long distance.

Three hundred of the northernmost clones were selected as evenly as possible along the northern distribution limit; when their ages were estimated according to the average spreading rate, the results showed that a little over a half, 167, had been born before 1749. Some regeneration has taken place all the time, and the area has become settled more densely and further to the north during this period. The East Bothnian coast differs from all the other areas studied in that only three separate growing sites were found there, although it has been settled for a considerable length of time. The spreading of bracken towards the north in Savo is more obvious in the field than on the appended map. Burning cultivation has been exceptionally intensive here and is probably responsible for the spreading of bracken. Except for some solitary sites, the composition of the vegetation units commonly changes from complex, mixed ones to units composed

of one or a few clones only. This change takes place north of the area around Uusikaupunki on the narrow western coastal strip and north of the Tohmajärvi region near the eastern border. — The significance of the factors of the settling history and the climate in determining this limit can not be accurately assessed before the vegetation units of the northern limit and their distribution among size classes are better known. The same requirements could be set for the commonness limit.

Estimating or determining bracken frequency — the degree of specimen density — by the frequency of fronds and without distinguishing between the clones is misleading (cf. analogical determination of the commonness of ant species on the basis of worker numbers and not the density of colonies, OINONEN 1956, pp. 26 and 183, see also ARRHENIUS 1922, p. 190). It can be compared to e.g. estimating the density of a *Betula verrucosa* stand by the foliar density. The birch stand may be composed of a large number of small or variable-sized trees and a small number of large dense-leaved trees. An even better related object for comparing with bracken is e.g. *Populus tremula*, which may regenerate vegetatively from a single seed-born specimen to form a multistemmed stand.

In quadrat sampling or other plant cover analyses, the values for bracken and, in principle, also for other plant species spreading in the same way may only express the internal variation in the quadrats or on the whole sample plots of a single clone. The elements of the vegetation cover mosaic are very superficially described by a quadrat or other rigid routine method especially, when the plant cover is primarily composed of vegetatively spreading species regenerating seldom by spores or seeds. Besides bracken, many other species also behave like this (cf. e.g. RESVOLL 1925, SALISBURY 1925, KUJALA 1926, STALLARD 1929, WHITFORD 1949, 1951, RITCHIE 1955, 1956, PETTERSSON 1958, MUKULA 1963).

It is clear that in descriptions of the vegetation of a sample plot or tree stand, its degree of primary-secondaryity is an important component essentially affecting the results (SALISBURY 1931, p. 188, AICHINGER 1954, p. 26, 1960, p. 12, see also OINONEN 1961, pp. 78—79). If the change caused by time is not considered in the analyses, the sample plots or stands with a great number of young or variable-aged specimens of a species as a layer or vegetation unit and the sites where the vegetation formed by the species is single- or few-cloned and old, become of equal value in respect to the species in question. These problems must be solved, not avoided or silently put off (see also WATT 1947, p. 1, WHITFORD 1949, 1951, PELTON 1953, p. 624, POORE 1955, p. 236, 1958, p. 38, BURGESS 1960, p. 282). An excessive accent on the difficulties and deciding them impossible to tackle will not spur further study.

The comparisons in this study have for their part confirmed the results achieved by comparing the dimensions of the bracken clones to the fire dates

and stand ages determined from tree borings (OINONEN 1967). It was found that the wars have caused an increase in the regeneration frequency of bracken. In this respect, the results agree with the observations of LOUSLEY (1946) and BRAID (1947, 1952) on the mass occurrence of sporelings in the English cities bombed and burned in World War II. According to BRAID'S (1935) assumption, even large bracken vegetation units are sometimes formed by a single specimen. This assumption has been found correct in numerous Finnish vegetation units.

References

- AICHINGER, ERWIN 1954. Statistische und dynamische Betrachtung in der pflanzensoziologischen Forschung. Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich 29.
- 1960. Können wir eine gemeinsame Plattform für die verschiedenen Schulen in der Waldtypenklassifikation finden? Symposium on forest types and forest ecosystems. IX international Bot. Congress, Montreal, August 24, 1959. *Silva fenn.* 105.
- AILIO, JULIUS 1915. Novgorodilaisten retki Hämeeseen v. 1311. Historiallinen aikakauskirja 13.
- ALANEN, AULIS J. 1948. Isostavihasta Suomen sotaan 1700—1809. Etelä-Pohjanmaan historia IV. Vaasa.
- AMINOFF, TORSTEN G. 1943. Karjala lännen etuvartiona. 700-vuotinen taistelu Karjalasta. Translated into Finnish by *Antero Manninen*. Helsinki.
- ARRHENIUS, O. 1922. A new method for the analysis of plant communities. *J. Ecol.* 10.
- BIRCK, ERIK LUDVIG 1944. General Tolls krigsplan år 1788, dess utförande och sammanbrott. Svenska litteratursällskapet i Finland 296.
- BJÖRLIN, GUSTAF 1883. Finska kriget 1808 och 1809. Stockholm.
- BJÖRNSTJERNA, MAGNUS 1851. Anteckningar. Stockholm.
- BRAID, K. W. 1935. The eradication of bracken by cutting. *Scot. J. Agric.* 18.
- 1947. Bracken control — artificial and natural. *J. Brit. Grassl. Soc.* 2.
- 1952. Bracken — a botanist's plaything and an agricultural pest. *The Glasgow Naturalist* 16.
- BURGES, ALAN 1960. Time and size as factors in ecology. *J. Ecol.* 48.
- BURMAN, JOHAN JAKOB 1965. Anteckningar, förda under tiden år 1785 till år 1816 jämte Relation om Savolaks-brigadens operationer under 1808 och 1809 års krig. Stockholm.
- CEDERBERG, A. R. 1910. Kuvauksia 1788—90 vuosien sodasta. III. Kapinallisia hankkeita Pohjois-Karjalassa. Historiallinen aikakauskirja 8.
- DANIELSON, JOH. RICH. 1896. Suomen sota ja Suomen sotilaat vuosina 1808 ja 1809. Helsinki.
- EKMAN, CARL CHRISTOPHER 1900. Dagbok fördd under kriget i Finland 1788—1790. Utgifven af *Reinh. Hausen*. Helsingfors.
- GARDBERG, CARL JAKOB 1954. Fyratusen år i Åboland. Åbo.
- Generalstaben* 1895—1922. Sveriges krig åren 1808 och 1809. I—IX. Generalstabens krigshistoriska avdelning. Stockholm.
- 1923. Georg Karl von Döbelns berättelse om fälttåget i Savolaks 1789. Generalstabens krigshistoriska avdelning. Stockholm.
- GOTTLIEB, BJÖRN 1954. Krigsnyheter från Finland 1808 i Svensk press. Svenska litteratursällskapet i Finland 346.
- GRANIT, BRUNO 1877. Muutamia tietoja Savon oloista v.v. 1710—1714. Historiallisia Tutmuskokeita 6. Kuopio.
- HALLONGREN, EDV. 1905. Sotamuistoja Jämsän ja Korpilahden pitäjistä. Historiallinen aikakauskirja 3.
- HANNULA, J. O. 1934. Sotalaitos ja sotataito 1600-luvun alusta vuoteen 1809. Suomen kulttuurihistoria II. Jyväskylä—Helsinki.
- HARTMAN, TORSTEN 1896. Raseborgs slotts historia. Skrifter utgifna af svenska litteratursällskapet i Finland 33. Helsingfors.
- HEIKINHEIMO, OLLI 1927. Punkaharju. Helsinki.
- HORNBERG, EIRIK 1955. När riket sprängdes. Fälttågen i Finland och Västerbotten 1808—1809. Helsingfors.
- HÄRKÖNEN, IIVO 1932. Karjalan kunnat ja kaupungit. Karjalan kirja. Porvoo—Helsinki.
- JAAKKOLA, JALMARI 1958. Suomalaisen kääntymisen kristinuskoon. Oma maa 1. Porvoo—Helsinki.
- JUTIKKALA, EINO 1933. Asutuksen leviäminen Suomessa 1600-luvun alkuun mennessä. Suomen kulttuurihistoria. Jyväskylä—Helsinki.
- 1934. Väestö ja asutus 1500-luvulta 1800-luvun puoliväliin. Suomen kulttuurihistoria. Jyväskylä—Helsinki.
- 1952. Development of settlement in the historical era. Suomi. A general handbook on the geography of Finland. *Fennia* 72.
- 1959. Suomen historian kartasto — Atlas of Finnish history. Second, revised edition. Porvoo—Helsinki.
- JUTIKKALA, EINO and NIKANDER, GABRIEL 1939. Suomen kartanot ja suurtilat. I. Helsinki.
- JUVA, EINAR W. 1942. Suomen taistelu itää vastaan. Helsinki.
- 1964. Suomen kansan historia I. Esihistoria ja keskiaika. Helsinki.
- JUVA, MIKKO 1965. Suomen kansan historia II. Uskonpuhdistuksen aika ja suurvallan synty. Helsinki.
- JUVELIUS, EINAR W. 1927. Suomen sotahistorian pääpiirteet. I. Aika vuoteen 1617. Yleisesikunnan sotahistoriallisen toimiston julkaisuja 1, 1. Helsinki.
- KAILA, E. E. 1931. Tervanpolton leviäminen Suomessa 1700-luvun puolimaissa. Summary: Tar-burning in Finland in the middle of the 18-th century. *Silva fennica* 21.
- KANGAS, ESKO, PERTTUNEN, VILHO, OKSANEN, HELMER & RINNE, MATTI 1965. Orientation of *Blastophagus piniperda* L. (Col., Scolytidae) to its breeding material. Attractant effect of α -terpineol isolated from pine rind. *Ann. ent. fenn.* 31, 1.
- Kansallinen elämäkerrasto* II. 1929. Porvoo.
- KARTTUNEN, U. 1932. Suomen Karjalan historiaa. Karjalan kirja. Porvoo—Helsinki.
- KIVIKOSKI, ELLA 1961. Suomen esihistoria. Suomen historia I. Porvoo—Helsinki.
- KOISTINEN, OLLI 1932. Karjalaisia talonpoikaissankareita. Karjalan kirja. Porvoo—Helsinki.
- KOKKONEN, HEIKKI 1941. Juuan pitäjän historia. Helsinki.
- KOSKINEN, YRJÖ 1857—1859. Nuija-sota, Sen syyt ja tapaukset. I—II. Turku.
- 1865. Lähteitä Ison vihan historiaan. Turku.
- KOSKULL, WALTER von 1953. Ockupationstrupper och civilbefolkning i stora ofredens Finland. Svenska litteratursällskapet i Finland 338.
- KUJALA, VILJO 1926. Untersuchungen über die Waldvegetation in Süd- und Mittelfinnland. I. Gefässpflanzen. *Comm. Inst. forest. Finl.* 6.
- 1964. Metsä- ja suokasvien levinneisyys- ja yleisyysuhteista Suomessa. Vuosina 1951—1953 suoritetun valtakunnan metsien III linja-arvioinnin tuloksia. Referat: Über die Frequenzverhältnisse der Wald- und Moorpflanzen in Finnland — Ergebnisse der III. Reichswaldabschätzung 1951—1953. *Comm. Inst. forest. fenn.* 59,1.
- 1965. Metsäkasviemme esiintymätajuudesta. Suomalainen tiedeakatemia — Finnish Academy of Science. Esitelmät ja pöytäkirjat 1964.
- LINDBERG, R. O. 1881. Henrik Klauunpoika Horn'in elämän vaiheita. Historiallisia Tutkimuskohteita 14. Helsinki.
- LINDEQVIST, K. O. 1919. Isonvihan aika Suomessa. Porvoo.

- LINKOLA, K. 1921. Studien über den Einfluss der Kultur auf die Flora in den Gegenden nördlich vom Ladogasee. II. Acta Soc. F.Fi.Fenn. 45,2.
- LOUSLEY, EDWARD 1946. Bracken on bombed sites. School Nature Study 41.
- LUUKKO, ARMAS 1958. Suomen asuttaminen. Oma maa 1. Porvoo—Helsinki.
- MICHAILOFSKI-DANILJEFSKI 1850. Beskrifning öfver Finska kriget till lands och sjös åren 1808 och 1809. Öfversättning ifrån ryskan. Tavastehus.
- MUKULA, JAAKKO 1963. Studies on the biology and control of marsh horsetail (*Equisetum palustre* L.). Ann.agric.fenn. 2. Seria Agricultura 10.
- OINONEN, EINO A. 1956. Kallioiden muurahaisista ja niiden osuudesta kallioiden metsittymiseen Etelä-Suomessa. Summary: On the ants of the rocks and their contribution to the afforestation of rocks in southern Finland. Acta ent.fenn. 12.
- 1961. Die Ameisenhaufen als Wuchsplätze von Bäumen und als Dolmetscher der Geschichte des Waldstandortes. Waldhygiene 4.
- 1967. Sporal regeneration of bracken (*Pteridium aquilinum* (L.) KUHN.) in Finland in the light of the dimensions and the age of its clones. Acta forest. fenn. 83,1.
- OSMONSALO, E. K. 1947. Suomen valloitus 1808. Porvoo.
- PALOSUO, V. 1938. Tutkimuksia lehtikuusen luontaisesta uudistumisesta eräissä suomalaisissa lehtikuusimetsissä. Referat: Die natürliche Verjüngung der Lärche in einigen finnischen Kulturbeständen. Comm. Inst. forest.fenn. 27.3.
- PELTON, JOHN 1953. Ecological life cycle of seed plants. Ecol. 34.
- PETTERSSON, BENGT 1958. Dynamik och konstans i Gotlands flora och vegetation. Resumé: Dynamik und Konstanz in der Flora und Vegetation von Gotland, Schweden. Acta Phytogeogr. Suecica 40.
- POORE, M. E. D. 1955. The use of phytosociological methods in ecological studies. I. The Braun-Blanquet system. J.Ecol. 43.
- 1956. The use of phytosociological methods in ecological studies. IV. General discussion of phytosociological problems. J.Ecol. 44.
- PÄRNÄNEN, J. A. 1947. Savon asuttaminen keskiaikana. Savon historia I. Esihistoria ja keskiaika. Kuopio.
- RESVOLL, THEKLA R. 1925. *Rubus chamaemorus* L. Die geographische Verbreitung der Pflanze und ihre Verbreitungsmittel. Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich. Carl Schröter Festschrift.
- RINNE, JUHANI 1947. Puolustus, rajankäynnit, rajalinnat. Savon historia I. Kuopio.
- RITCHIE, J. C. 1955. *Vaccinium vitis-idaea* L. Biological flora of the British Isles. J.Ecol. 43.
- 1956. *Vaccinium myrtillus* L. Biological flora of the British Isles. J.Ecol. 44.
- SAARINEN, SANTERI 1881. Muutamia Virolahden pitäjistä koskevia tietoja vuodelta 1571. Historiallisia Tutkimus-kohteita 19. Helsinki.
- SALISBURY, E. J. 1925. The structure of woodlands. Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich. Carl Schröter Festschrift.
- 1931. The standardization of descriptions of plant communities. J.Ecol. 19.
- SCHULMAN, HUGO 1909. Taistelu Suomesta 1808—1809. Translated into Finnish by *Werner Anttila*. Porvoo.
- SOIKKANEN, HANNU 1962. Varkauden historia. Helsinki.
- SOININEN, ARVO M. 1954. Rantasalmen historia. Pieksämäki.
- STALLARD, HARVEY 1929. Secondary succession in the climax forest formations of Northern Minnesota. Ecol. 10.
- STENROTH, OTTO E. 1880. Sotatapaukset Etelä-Suomessa ja Inkerinmaalla 1590. Historiallisia Tutkimus-kohteita 11. Helsinki.
- Suomenmaa 1919. I. Uudenmaan lääni. Helsinki.
- 1921. III. Turun ja Porin lääni. Helsinki.

- Suomenmaa 1924. VI. Mikkelin lääni. Helsinki.
- » 1927. VIII. Kuopion lääni. Helsinki.
- Suomi—Finland Yleiskartta 1:400 000 Generalkarta 1950. Maanmittaushallitus. Helsinki.
- SVINHUFVUD, P. E. 1881. Majuri Juhana Henrik Fieandt'in elämäkerta. Historiallisia tutkimuskohteita 18. Helsinki.
- UDDGREN, H. E. 1906. Kriget i Finland år 1713. Stockholm.
- 1909. Kriget i Finland år 1714. Stockholm.
- VOIONMAA, VÄINÖ 1933. Liikenne ja kauppa. Suomen kulttuurihistoria. Jyväskylä—Helsinki.
- WALLER, STURE 1949. Finska arméns reträtt från Tavastehus till Österbotten våren 1808. Scandia 19.
- WATT, ALEX S. 1947. Pattern and process in the plant community. J.Ecol. 35.
- WHITFORD, PHILIP B. 1949. Distribution of woodland plants in relation to succession and clonal growth. Ecol. 30.
- 1951. Estimation of the ages of forest stands in the prairie-forest border region. Ecol. 32.