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ESA HYYPPÄ

WITH 57 FIGURES IN THE TEXT, 21 TABLES AND 2 APPENDICES

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CONTENTS.

PREFACE.

The post-Glacial changes (or displacement) of the shore-line in South Finland was first dealt with in G. De Geer's paper (1894), in which he mentioned a number of observations concerning raised shores on either side of the Gulf of Finland. Soon after (1896) H. Berghell's study dealing with the Quaternary changes of the shore-line in South Finland was published. Both De Geer's and Berghell's studies were based on scanty materials and the age of the ancient beaches was established according to the custom prevailing at that time on the basis of the altitude of the shores. At that time the history of the development of the Baltic was divided into three epochs: the Yoldia Sea, the Ancylus Lake and the Littorina Sea. It was thought that the shore-surfaces of these three stages were situated at definite, successively lower levels, beginning with the Yoldia which at that time represented the earliest phase in the development of the Baltic. In determining the age of the shore-levels De Geer's and Berghell's conclusions naturally contained errors and the maximum limit of the Littorina Sea, in particular, was placed in most of the observation sites at too high a level.

Nevertheless, these researches provided a basis wanted for the subsequent unravelling of the movement of the shore-level in Finland. In 1920 Professor W. Ramsay published a paper, in which he dealt with the highest limit of the Littorina Sea in South Finland. This study was principally based on diatom researches made by H. Lindberg, on the basis of which Ramsay establishes the maximum limit of the Littorina Sea in various districts in South Finland. These observation data were also scanty and only a few actual identifications of ancient shores are brought into connection with them. The result, however, is correct in its main features as regards the maximum limit of the Littorina Sea. In 1926 a fresh study by Ramsay on the displacement of the Littorina Sea shore-level appeared, in which the relation of Stone Age settlement to the changes of the shore-line was subjected to detailed examination throughout the whole region of the Baltic.

Professor Ramsay's work was prematurely interrupted by his death in 1928, so that he had only had time to treat the problem in broad lines and to establish, in an ingenious way, the general natural causes of the changes of level. After him Professor M. Sauramo, in particular, has done productive and thorough work in explaining the development of the whole of the Baltic (M. Sauramo 1918, 1923, 1928, 1929 a, 1929 b, 1930, 1933, 1934, 1937). During the last ten years his pupils have carried out studies concerning the post-Glacial changes of the shore-line in various parts of Finland.

In Ramsay's researches referred to above some stratigraphical evidence was brought forward for the first time in Finland in support of the chronology. Similar studies had already been made earlier in Sweden. The stratigraphical investigation gained in importance especially after L. von Post in 1916 had published his age division of the peat deposits of South Sweden based on investigations into their quantitative pollen contents. He himself and several other Swedish geologists have subsequently developed this chronological system and applied it to researches into the Quaternary displacement of the shore-line in connection with subfossil diatom flora.

I will only refer in this connection to B. Halden's paper of 1917, in which he studied the post-Glacial displacement of the shore-level in Hälsingland as recorded by the subfossil diatoms. In his study the beginning of the common occurrence of *Picea* and the corresponding position of the sea-level formed an important chronological point. U. Sundelin (1919) also made use simultaneously of the evidence supplied by the pollen flora and the diatoms in studying the late-Quaternary history of East-Götaland (Gothia) and Småland. Since these researches very many studies of the post-Glacial changes of the shore-line have been published in Sweden, in which micropalaeontological dating occupies a very prominent position. I shall have an opportunity of referring to these investigations in connection with my treatment of the present subject.

In Finland Professor Väinö Auer laid the foundation for the quantitative investigation of pollen grains contained in the late-Quaternary deposits and the dating based on them. Already in 1923 he published a scheme for future peat-geological research in Finland and laid particular stress on the first appearance of spruce for establishing the position of the contemporaneous shore-level in different parts of the country. Auer extended this plan for the peat-geological work in 1924, when he published a pamphlet on the subject: »Eräitä vastaisia tehtäviä suotutkimuksen alalla Suomessa» (Some future problems in the investigation of peat bogs in Finland). In this scheme Auer further emphasised the necessity of determining the absolute date of the immigration of spruce as a definite chronological point. By making investigations at sufficiently close intervals from the sea coast towards the interior it should be possible to ascertain the position of the sea-level at the time of the appearance of spruce. The inclination of the shore-level at the time of the isolation of lakes and the composition of the pollen flora that corresponds to the isolation should also afford definite chronological data according to Auer. By the correlation of pollen diagrams on the basis of sufficiently extensive materials the different positions of the shore-line during the post-Glacial epoch should be ascertained for the whole country.

At Auer's instigation and guided by his valuable studies (V. Auer 1923 a, 1923 b 1924 a, 1924 b, 1927 a, 1927 b, 1928, 1933) peat-geological research was started vigorously in Finland and proved of very great benefit in establishing the post-Glacial shifts of the shores as well as the development of forests and climate. We can, indeed, no longer speak of the first appearance of spruce and of its pollen limit exactly in their former meaning. Instead there are some other synchronous phases in the development of the pollen flora that provide important bases for dating in Quaternary geological research.

I employed this stratigraphical method of investigation for the first time in a paper that I published in 1932 on the post-Glacial changes of the shore-line on the Karelian Isthmus. This study advanced our knowledge of the displacement of the shore on the Isthmus and of the development of the forests a step further, though in many respects it was still imperfect. After publishing my paper on the Karelian Isthmus and partly even before, I continued my studies of the movement of the shore-line along the coast of the Gulf of Finland westward from the Isthmus. At the same time I carried out further investigations on the Karelian Isthmus in order to check my former results.

I carried my researches in the west as far as the Helsinki district, so as to include the greater part of the coastal district of South Finland, as the accompanying map (Appendix I) shows. The special object of my study was the change of the Littorina Sea shore. In addition, however, I devoted my attention to pre-Littorina and even post-Littorina beaches and the establishment of their age. My abundant pollen and diatom materials also enabled me to touch on some questions concerning the chronological employment of the subfossil microflora. While working on my pollen materials I was also induced to consider the development of post-Glacial forests and climate in South Finland. I have, however, not been able to deal with these latter questions in detail in this connection.

It was already obvious from my study of the Karelian Isthmus that the Littorina Sea was transgressive there towards the land. The question arose whether the Littorina Sea was also transgressive within the province of Uusimaa as Ramsay, for instance, had assumed, at any rate as regards the eastern part of the district. It was specially important, too, to ascertain whether the Littorina maximum limits of the Karelian Isthmus and Uusimaa were synchronous and whether other delays occurred in the retreat of the shore in South Finland besides the one that represents the Littorina transgression maximum. In trying to solve the latter question I also studied the mutual relation between the Stone Age coastal settlement and the retreat of the shore.

To these principal questions in my study I provided a partial answer already in 1935, when I published preliminary data regarding the post-Glacial changes of the shore-line in the Helsinki district. Now I am able to deal with these questions on the basis of my entire material. My work is not complete even now in regard to many details of the questions to be settled. I believe, however, that I am able to give a correct idea of the post-Glacial displacement of the shore in South Finland on the basis of it, at any rate in its main features.

I began the field work for the present investigation in the summer of 1931 after obtaining a grant from the N. Helander foundation. I continued the work during the following summer, when the Helsinki Municipality appointed me to study the post-Glacial development of the Helsinki district. Subsequently I was able to complete my studies in Uusimaa and on the Karelian Isthmus and to work up my material and prepare it for printing in the service of the Geological Survey of Finland. For all this I am greatly indebted to Professor A. Laitakari, Director of the Survey. I began this work at the suggestion of my teacher, Professor M. Sauramo. He has shown great interest in following the progress of my work and encouraged it by valuable advice, for all of which I am very grateful. The pollen and diatom analyses for my studies were mostly made by my assistant, Miss Kyllikki Salminen, for whose valuable labours my special thanks are due. Mr. A. Valanne acted as my assistant in the peat-geological field work and identified many of the ancient shores described in the present paper. Dr. A. Äyräpää, Dr. S. Pälsi and Dr. J. Leppäaho, officials of the Finnish National Museum, spared no efforts in supplying me with information concerning Stone Age coastal settlement in South Finland. Dr. E. Mikkola, of the Geological Survey, was helpful in matters concerning the English terminology. Last, but not least I wish to thank Mr. Edward Birse for translating the present paper into English.

Helsinki, December 1937.

Esa Hyyppä.

CHRONOLOGICAL PRINCIPLES.

Before proceeding to deal with my material I must briefly state the principles on which I base the determination of the relative age obtained from the stratigraphy of sediments. I have made parallel use of L. von Post's pollen analysis method and of the evidence provided by the subfossil diatom flora for determining the age of sediments. The parallel employment of these two methods will be presented in connection with the treatment of the material in detail. First, however, it is necessary to recall the results of pollen chronological research that are considered certain and that lead to the division of the post-Glacial epoch in the whole of the Baltic region into definite periods offering different conditions for the development of flora and vegetation.

In regard to the development of the flora as recorded by the pollen grains in sediments a very distinct division can be made within the whole of the Baltic region into three parts: 1. the Pre-Littorina period, 2. the Littorina period and 3. the Post-Littorina period. The Littorina period is conspicuous by the luxuriant growth of mixed oak forests and of deciduous trees in general. It is preceded by a comparatively long period of development, not uniform as regards the composition of the forests, that includes the phases of the Ancylus Lake, the Yoldia Sea (collectively) and the Baltic Ice Lake (collectively). The Post-Littorina period is succeeded, again, by a fairly clearly defined period of spruce, pine and birch forests, which is characterised by the mass-appearance of *Picea* in particular.

This division into three periods, though in itself very reliable and independent of local factors, does not suffice for a more detailed dating. From the point of view of an investigation dealing with changes of shore-line it is even deficient in this respect that the important limit in it, drawn between the Littorina and the Ancylus periods according to the pollen content, does not in reality correspond exactly to the time, when the brackish water entered the Baltic. The continuous appearance of mixed oak forests that culminates in the Littorina period, begins, at any rate in South Finland, in some cases already during the Ancylus regression, in others again a little later than the time, when the salt water penetrated into the Baltic. Nor does the beginning of the uninterrupted appearance of *Tilia* correspond exactly to the beginning of the Littorina Sea. An exact limit can only be drawn between the Littorina and Ancylus periods in such profiles where it can be established by means of diatoms. On the other hand it is quite certain that the maximum of mixed oak forests and particularly of *Tilia* falls within the Littorina period.

It was L. von Post (1925) who first employed a considerably more accurate dating of a pollen diagram when studying the peat bogs of Gotland, a division also succesfully used and further developed by many other Swedish investigators. This »zone division» of the Swedish geologists is very good and useful in itself, if we can really determine the synchronous limits of these zones with complete certainty in each individual diagram and also complete and modify this zone division so as to make it applicable on a regional basis, as L. von Post has done.

Such a pollen diagram division, based on significant changes in the composition of the pollen flora, has not yet been made in Finland. The material at our disposal has hitherto seemed too small for this purpose. So much material, however, has already been collected in South Finland that a division into zones might well be expected in the present investigation. One would further expect L. von Post's Gotland division to have been employed, as it is apparently also applicable to South Finland, at any rate as well as to Estonia and the neighbourhood of Leningrad, to which such a division has been applied (K. K. Markov 1931, K. K. Markov and W. S. Poretzky 1935, P. W. Thomson 1935).

In spite of my attemps, however, I have not succeeded in applying this zone division to the material dealt with in this paper. In many cases it is, indeed, possible. On the other hand it has been impossible to carry out a division into zones consistently, as the same age would have been assigned to beds partly of different ages, and the whole pollen chronology would have become doubtful on the basis of such a zone division. This is due to the great local influence exercised by various shore conditions upon the pollen composition of the sediments formed near the shore-line during its retreat, as we shall see later in connection with each individual case.

The chronological bases for the employment of the pollen diagrams presented in this paper are broadly as follows. An endeavour is made in the first place to identify in each diagram, on the basis of the composition of the pollen, the time portions, or fields, corresponding to the various stages of development of the Baltic. The pollen composition of these fields in South Finland is already known in broad lines on the basis of the investigations made hitherto. I need only refer in this connection to the following papers: L. Aario (1932, 1933, 1935, 1936), V. Auer (1924, 1928), A. Hellaakoski (1936), E. Hyyppä (1932, 1933, 1934, 1935, 1936), M. Sauramo (1934). According to these studies, the results of which are supported by investigations made in several corresponding areas in the region of the Baltic (E. Granlund 1932, 1936, B. Halden 1929, G. Lundquist 1928, K. K. Markov 1931, K. K. Markov and W. S. Poretzky 1935, L. von Post 1924, 1925, 1927, 1928, 1933, 1935, R. Sandegren 1932, U. Sundelin 1919, H. Thomasson 1927, 1932, 1934, P. W. Thomson 1929, 1935 etc.) the pollen flora of South Finland corresponding to the various stages of development of the Baltic is as follows from the earliest upwards:

1. The Baltic Ice-Lake and Yoldia Sea period. This phase of development is characterised by birch, pine and spruce pollen. The pollen flora representing it is on the whole fairly typical. Nevertheless, it is difficult and even impossible in some cases to divide this long period into subdivisions on the basis of the pollen analysis. This refers especially to the aqueous sediments, owing to the retreat of the shore-line having affected the accumulation of pollen grains. In many cases, however, the Yoldia field which is rich in birch, can be distinguished from the field of the Baltic Ice-Lake, in which pine and spruce are more plentiful. The very oldest deposits of the Baltic Ice-Lake on the Karelian Isthmus contain birch almost exclusively according to observations made up to the present. For this period as a whole the appearance of late-Glacial *Picea* is very characteristic, being most abundant during the latter half of the Baltic Ice-Lake period. There are also appearances of pollen grains of alder and rarer deciduous trees during the Baltic Ice-Lake and Yoldia Sea periods.

2. The Ancylus Lake period. This phase of development of the Baltic is an age of pine and birch forests. It is characterised by the predominance of *Pinus* in the pollen composition which often appears as a prominent maximum of pine. The continuous curve of alder and the isolated appearances of rarer foliferous trees begin during the latter half of this period. The maximum of the Ancylus transgression is a fairly pure period of pine and birch forests, *Pinus* regularly forming a clear maximum. Post-Glacial *Picea* has now disappeared altogether with the exception of disconnected scattered appearances.

3. The Littorina Sea period. This field is characterised by the maximum of mixed oak forests and among these particularly of *Tilia*, while at the same time deciduous trees generally tend to become the dominant trees during this period. In the first half of the period the pollen grains of *Pinus*, however, are fairly plentiful, but in this respect local factors exert a considerable influence, especially in the case of aqueous sediments. An abundance of rare deciduous trees and particularly of *Tilia* is a sure and infallible sign of the Littorina period. The beginning of an uninterrupted appearance of *Tilia*, however, does not always coincide with the beginning of the Littorina Sea. *Picea* also comes back now, though this appearance does not occur simultaneously throughout the whole region, for in East Finland spruce appears earlier in the Littorina period than in West Finland, where the continuous appearance of *Picea* only begins at the end of the Littorina period.

4. The Post-Littorina period. The Littorina is considered to come to an end, where the uninterrupted appearance of mixed oak forests ends and *Picea* begins to attain its post-Glacial maximum. This limit, too, is not always sharply defined in the coastal region. The post-Littorina field represents a period of spruce, pine and birch forests; pollen of *Alnus* appear sparsely and there is now and then a scattered appearance of rarer deciduous trees. Within this comparatively long phase of development it is possible in some cases to distinguish subdivisions. I will, however, postpone the questions concerning a more detailed timing until I deal with my material.

The general outline I have given here of the type division of the South Finnish pollen flora corresponding to the development of the Baltic is intended to facilitate the reading of the pollen diagrams, besides which it saves the author from recapitulating the preliminary principles employed in the dating of these pollen diagrams in each case. As a substantial example of the above division I give two diagrams of the Viipuri district, Fig. 1 and 2, which at the same time represent the diagram type of the Karelian Isthmus particularly with regard to *Picea*.

I should mention, too, that the employment of diatoms occupies an important position in this study for a more precise delimitation of the periods. In those pollen diagrams, the field division of which is based solely on the composition of the pollen flora, the limits of the time fields cannot be maintained quite exactly. Nevertheless, one does not run the risk of making any grave errors in dating the normal diagrams.

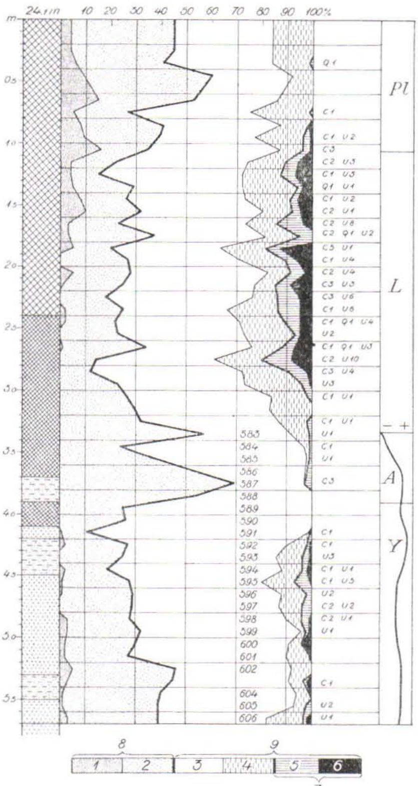

Fig. 1. Profile of the Pienjärvi bog. 1 = Picea, 2 = Pinus, 3 = Betula, 4 = Alnus, 5 = rare deciduous trees excepting Tilia, 6 = Tilia, 7 = total of rare deciduous trees, 8 = total of conifers, 9 = total of deciduous trees, C 1 = Corylus 1 %, U 1 = Ulmus 1 %, Q 1 = Quercus 1 %. The curve on the right in the diagram reflects the changes of level above the bog basin, + indicating the rising, — the sinking of the water-level. Analyst H. Lavanni.

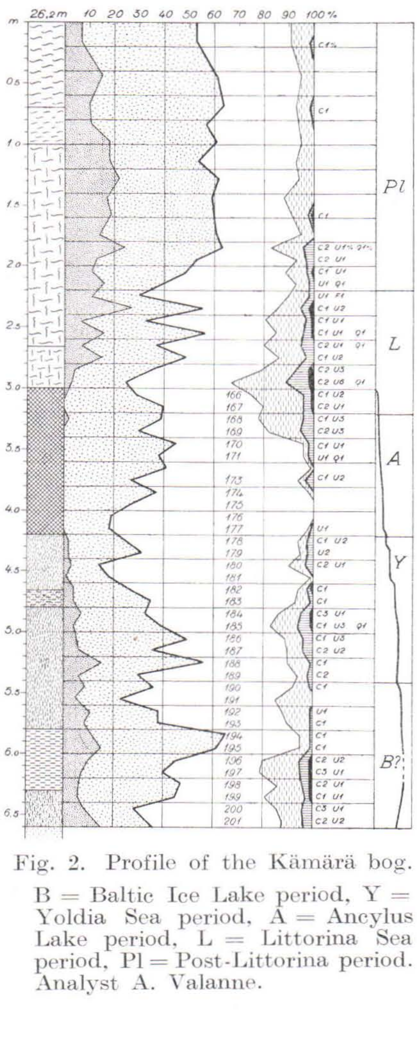

Fig. 2. Profile of the Kämärä bog. B = Baltic Ice Lake period, Y = Yoldia Sea period, A = Ancylus Lake period, L = Littorina Sea period, Pl = Post-Littorina period. Analyst A. Valanne.

In making the diagrams of the pollen analyses I have employed the same methods of drawing as in my papers: E. Hyyppä 1935, 1936. The explanations of the designations for loose deposits and other signs used will be found in Fig. 3.

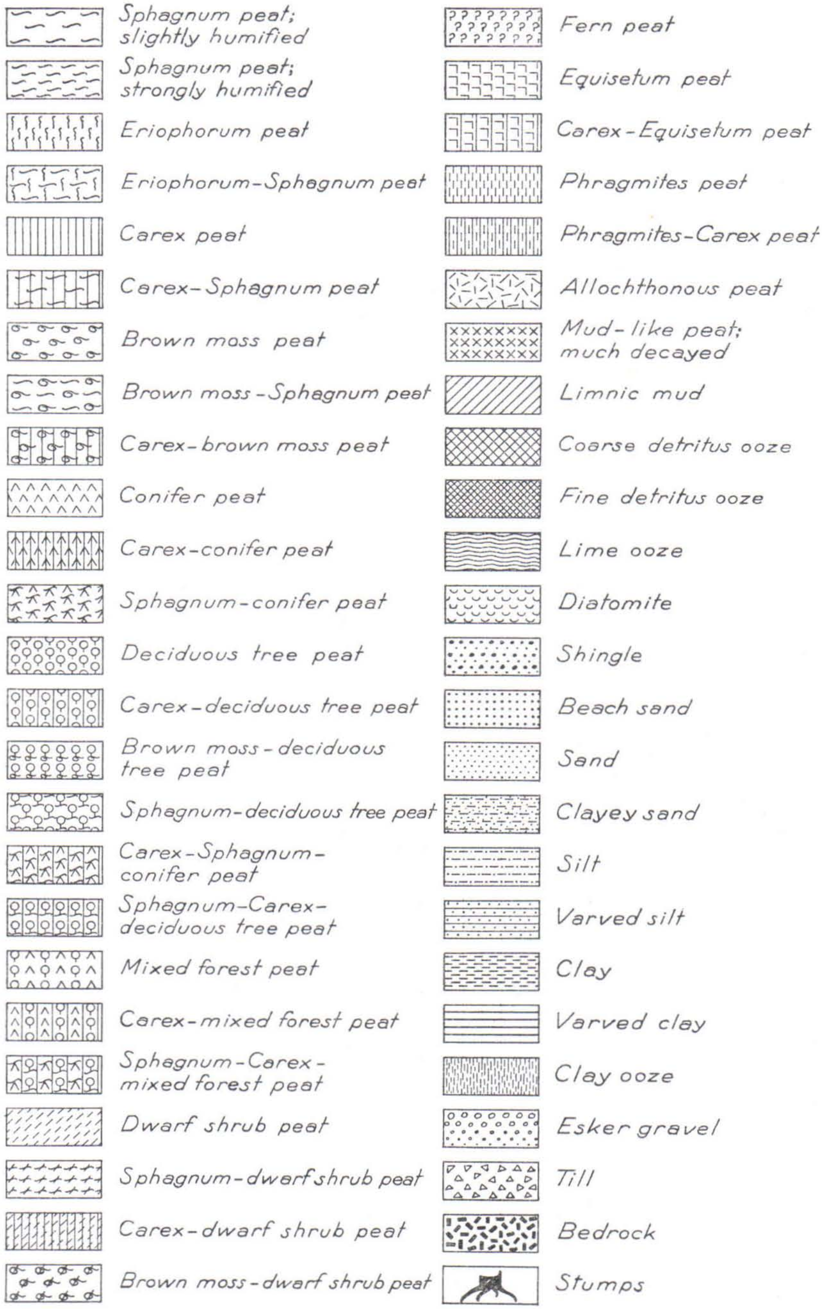

Fig. 3. Explanations of the soil designations used.

HELSINKI DISTRICT AND AREAS TO THE NORTH OF IT.

RAISED SHORES.

The localities investigated in this area are indicated on the map (Appendix I) by numbers in black circles. The numbers refer to smaller areas studied in some detail, in which ancient shores were established (one or several) and the peat bogs were investigated. The shores were in general levelled from fixed points of the precision

Photo E. Hyyppä.

Fig. 4. Wave-cut cliff (LI) in Puodinkylä, 30.3 m. above sea-level.

levelling (Suomen Tarkkavaakitus 1910). In some cases fixed points on the topographical map were used as a starting point in the survey, as will be seen in the list of shore observations below (Table I). The ancient shores are rather ill developed in the investigated areas, as in the South Finnish coastal district in general, especially at the lower levels. Most commonly they appear as boulder rims and ramparts washed by waves and piled up by ice, more rarely as distinct wave-cut cliffs in the slopes of eskers or of sandy accumulations.

The numerous ancient shore-levels (or shore-lines) determined by me in the surroundings and neighbourhood of Helsinki group themselves at some defined levels. These are on an average at the following heights above sea-level: 8 m., 10 m., 13.5 m., 17.5 m., 21.5 m., 24.5 m., and 30—34 m. Besides these there are some isolated raised beaches at lower levels remaining below these figures, as well as a series of higher shores that also occur in several localities. The

Photo E. Hyyppä.

Fig. 5. Boulder rim (L I) on the E. edge of Tattarisuo bog, 30 m. above sea-level.

heights of the latter average 42 m., 46—47 m., 52 m. and 59 m. above sea-level. In addition to these observations a number of shore-lines were determined in the northern parts of the region, some of which, however, are rather doubtful. These average 70 m., 85 m., and 90 m. above the level of the sea.

The series of shore-levels referred to, which are repeated in different places of investigation, as the list shows, obviously mark delays that occurred in the change of the shore-line or actual transgressions and thus seem to represent ancient shore-surfaces, or sea-levels. In the following pages I try to determine the age of these raised shores by means of the stratigraphical evidence obtained by the investigation of bogs.

THE STRATIGRAPHY OF THE PEAT BOGS.

Kauniainen, the Gallträsk Bog.

The pollen diagram. In 1935 I already published a pollen diagram and diatom statistics of the Gallträsk bog (investigation area No. 16). The same diagram is reproduced in Fig. 7. The chronological division on the right of the diagram represents the following:

Photo E. Hyyppä.

Fig. 6. Raised shore bar (Lg VIII) built up of cobblestones on the high rock hill E. of Tattarisuo bog, 59.4 m. above sea-level.

Lg = Late-Glacial Period, A = Ancylus Period, L = Littorina Period, and Pl = Post-Littorina Period. The curve in the same column reflects the changes of the shore-level above the bog, — being a negative change, + a positive change. This curve is based on the diatom analyses of the aqueous sediments of the bog shown in Table II, Gallträsk I. The numbers 694—711 in the diagram refer to the samples analysed and their vertical position in the profile. The same numbers indicate the analysis columns of the samples in the section entitled Gallträsk I in the diatom table. The figures 1—5 next to the species in the columns indicate the frequency of the diatom species.

Table I.

Sites on map	Locality and appearance of raised shores	Altitude in metres
	Mellunkylä:	
1	South slope of the hill of Borgs prehistorical fort, lower edge of a boulder shore	13.3
»	Foot of upper boulder rim at same place	17.4
	Puodinkylä:	
2	N.W. shore of Puodinkylä bay, slopes of hills S.W. of Puodinkylä manor, several raised boulder shores, partly fairly pronounced, occur above each other. Here the following heights were obtained for the lower edge of each	9.7
	......	12.3
	......	13.3
	......	16.8
	......	17.8
3	About 700 m. N.W. of Puodinkylä manor, close to the country road leading to Malmi, there is a strong stony shore cliff, the foot of which averages	17.5
»	In the same area two more rather poorly developed boulder shores, the feet of which have a height of	13.5
	......	9.5
»	Bouldery ground washed on the beach about 1.5 km. from Puodinkylä manor on the slope of an elevation close to the same road, the foot being roughly	17.9
»	About 400 m. from the former towards Malmi, foot of a slight wave-cut cliff	17.5
»	Foot of a abrasion cliff (Fig. 4) situated across the road about 2 km. N.W. of the sea-coast	30.3
	Agricultural Training Station of Wik's Farm:	
4	Foot of bouldery beach close to the sea-coast	13.6
	Tattarisuo neighbourhood:	
5	W. of the old Porvoo road, about 500 m. N. of Tattarisuo bog, foot of stony wave-cut cliff	24.3
»	Foot of abrasion cliff about 100 m. S. of the former	21.6
»	Foot of fairly large abrasion cliff about 100 m. N. of Tattarisuo bog	24.2
»	Shore bar formed of cobblestones, on the esker top at the N. end of a large gravel pit, the crest of which is	46.0
6	Small boss of rock on the extreme E. edge of Tattarisuo bog, boulder rim on the slope of the swell (Fig. 5), the foot of which is	30.0
7	Eastern side of the old Porvoo highroad close to Tattarisuo bog, bouldery beach, the height of which averages	30.0
»	Crest of a high rock rising on the E. edge of the Porvoo highroad, on which there is a conspicuous cobble bar thrown up by waves (Fig. 6), the crest averaging	59.4
»	Slope of the same rock towards Tattarisuo, shore boulders ...	44—46
8	By the side of the road leading to the spring of Tattarisuo bog where a wave-cut notch is	21.7
»	Tattarisuo spring, near which a strongly wave-washed stony slope rises, the rough base of which is	17.4
»	Stony rampart piled up by ice on the former slope	21.7
»	Ice-pushed rampart higher up the same slope	24.1

Sites on map	Locality and appearance of raised shores	Altitude in metres
9	South side of Östersundom road, about 1 km. E. of Pottmossen bog, foot of a distinct shore cliff, the height of which according to the levelling based on the topographical map is	42.0
	Tuomarinkylä:	
10	Torpparinmäki hill, N.W. of Tuomarinkylä, on the slopes of which, especially at the N. end of the swell, there are several very distinct bouldery shore-lines, the seaward edges of which have been accentuated by ice pressure. Here the following heights of ancient shores have been levelled starting from points on the topographical map	ca. 32.0
	....	» 24.0
	....	» 24.4
	....	» 20.5
	....	» 21.0
	....	» 21.6
	Neighbourhood of Hanaböle:	
11	Ice-pushed boulder ramparts and ancient stony shore zones on the slope of the elevation about 1 km. S. of Rekola halt and about 200 m. E. of the railway, of the following height	32.7
	....	32.2
	....	32.2
»	Boulder cliff on the side of the elevation about 300 m. S.E. of the former, its foot being	32.2
12	S.E. edge of the cultivated area around Hanaböle, close to the village, lower edge of a strong boulder pavement formed at the shore	32.3
»	Lower edge of distinct boulder rim about 400 m. S. of the former	32.4
»	Country road side between Hanaböle and the Porvoo road, about 500 m. from the latter, bar-like shore accumulation of cobblestones close to the road, the foot of which is	52.0
»	Boulder shore near the former	46.4
»	Hanaböle road side close to the Porvoo road, foot of an abrasion cliff	52.2
»	Porvoo road side opposite Hanaböle Lake, foot of a roughly defined wave-cut cliff	46.5
	Korso:	
13	Cliff along the S. and S.W. slopes of a partly drift-blanketed rock hill about 1 km. S.E. of Korso station, about 3 m. in height, consisting of large boulders, its foot being	47.0
	On the same hill there is another more indistinct boulder shore	43.3
	Pitkäjärvi (Långträsk):	
14	E. shore of Lake Pitkäjärvi close to the highroad, foot of a distinct stony wave-cut cliff	34.4
	Viherlaakso:	
15	Bouldery shore accumulation on the N. slope of the top of the long rock hill N.E. of Viherlaakso, showing an ice pressure limit, the levelling of which based on the topographical map gave	ca. 55.0
»	Lower edge of the same boulder accumulation	» 50.0

Sites on map	Locality and appearance of raised shores	Altitude in metres
	Kauniainen:	
16	Foot of a slight abrasion cliff about 1 km. E. of Kauniainen station S. of the railway	33.4
17	By the side of the Kauniainen—Viherlaakso road, foot of wave-cut cliff	33.0
»	Side of the Maisterintie street in Kauniainen, lower edge of boulder rim	33.3
»	S.E. end of the large rock swell N. of Kauniainen, crest of a cobble bar thrown up by waves	48.0
	Hagalund:	
18	S. of Hagalund manor, foot of wave-cut cliff	21.0
»	Another smaller notch above the former	25.0
»	W. shore of the bay of Iso Huopalahti, lower edge of boulder shore	7.8
»	Lower edge of boulder beach on the former place	13.8
»	Foot of abrasion cliff	21.1
	Ohkola:	
19	Mound of till on S.E. edge of the road about 2 km. from Hirvihaara towards Ohkola, on the slope of which there is an indistinct boulder rim. Its lower edge according to the levelling based on the topographical map is	ca. 84.0
»	N.E. edge of the fields around Ohkola village, lower edge of boulder shore, levelled from a point on the topographical map	» 88.0
	Keravanjärvi:	
20	Ancient strongly wave-washed shore zone S. of Lake Keravanjärvi, quite on S. edge of the country road leading to the Ridasjärvi road, the lower edge of which, according to the levelling based on the topographical map, is	ca. 85.0
»	Upper limit of the same boulder zone	» 94.0
»	Stony shore cliff in the neighbourhood of the former	» 84.5
	Kalalampi:	
21	About 1 km. W. of Lake Keravanjärvi along the country road. By the side of the road there is a boulder rampart, the foot of which, according to the topographical map, is	ca. 90.0
	Nukari:	
22	On the esker slope by the side of the Hyvinkää road where it follows an esker between Nukari and Tuusula, two wave-cut cliffs appear one above the other, the lower of which, according to the topographical map, is	ca. 68.0
»	The foot of the upper cliff is	» 73.0
	Terrilä:	
23	About 4 km. due N. of Rusutjärvi, about 0.5 km. W. of the Hyvinkää highroad. A bouldery wave-cut notch on the W. edge of a bog, the foot of which, according to the levelling based on the topographical map, is	ca. 69.0
	The same beach runs across the highroad on the edge of the cultivated plain S.E. of the bog.	»

Of these 1 = very scarce, 2 = scarce, 3 = general, 4 = abundant, and 5 = very abundant.

P r i n c i p l e s a n d m e t h o d s o f t h e d i a t o m a n a l y s i s. As to the diatoms, I have in the first instance taken into consideration those species and ecological associations which are of the greatest importance in respect to the displacement of the shore-

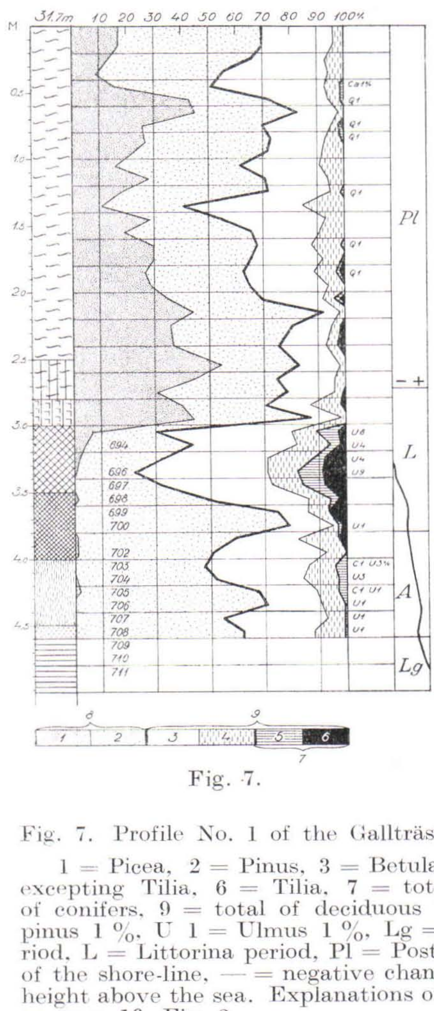

Fig. 7.

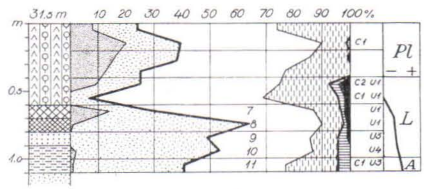

Fig. 8.

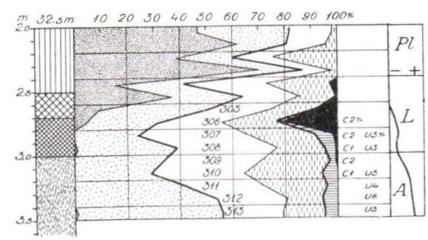

Fig. 9.

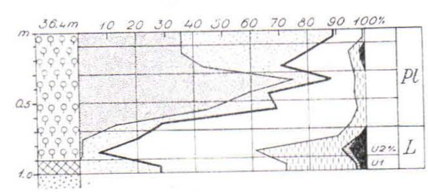

Fig. 10.

Fig. 7. Profile No. 1 of the Gallträsk bog. Analyst E. Aurola.

1 = Picea, 2 = Pinus, 3 = Betula, 4 = Alnus, 5 = rare deciduous trees excepting Tilia, 6 = Tilia, 7 = total of rare deciduous trees, 8 = total of conifers, 9 = total of deciduous trees, C 1 = Corylus 1 %, Ca 1 = Carpinus 1 %, U 1 = Ulmus 1 %, Lg = Late-Glacial period, A = Ancylus period, L = Littorina period, Pl = Post-Littorina period. + = positive change of the shore-line, — = negative change. 694—711 Nos. of samples. 31.7 m. height above the sea. Explanations of signs for the different kinds of deposits on page **16**, Fig. 3.

Fig. 8. Profile of the Gallträsk bog No. 2. Analyst Kyllikki Salminen.

Fig. 9. Profile of the Hanaböle bog. Analyst E. Hyyppä.

Fig. 10. Profile of the Korso bog No. 1. Analyst E. Hyyppä.

Table II.

											Gall-
Anal. K. Salminen	694	696	697	698	699	700	702	703	704	705	706
Amphora arenicola v. major	—	—	—	1	4	3	—	—	—	—	—
» *capitata*	—	—	—	—	—	1	—	—	—	—	—
» *commutata*	—	—	—	3	2	3	—	—	—	—	—
» *ovalis*	1	—	—	—	—	1	1	1	—	1	1
» » *v. libyca*	1	3	2	—	—	2	—	—	—	—	—
» » *v. pediculus*	—	—	—	—	—	—	—	1	—	—	—
Anomoeoneis sphaerophora	—	—	—	—	—	—	—	1	—	—	1
» » *v. polygramma*	—	—	—	1	4	2	—	—	—	—	—
» » *v. sculpta*	—	—	—	2	3	2	—	—	—	—	—
Caloneis amphisbaena	—	—	—	—	—	—	—	—	—	—	—
» *formosa v. holmiensis*	—	—	—	—	—	1	—	—	—	—	—
» *latiuscula*	—	—	—	—	—	—	—	—	—	—	—
» *Schumanniana v. biconstricta*	—	—	—	—	—	—	—	1	—	1	1
» *silicula*	—	1	—	—	—	1	1	1	—	1	—
Campylodiscus echeneis	—	—	1	1	2	3	—	—	—	—	—
» *clypeus*	1	2	1	5	5	5	—	—	—	—	—
» » *v. bicostata*	—	—	—	—	—	—	—	—	—	—	—
» *noricus*	—	—	—	—	—	—	—	—	1	1	1
» » *v. hibernica*	—	—	—	—	—	1	1	1	1	1	2
Cocconeis disculus	—	—	—	—	—	—	—	—	—	—	—
» *pediculus*	—	—	—	—	—	—	1	1	—	1	1
» *placentula*	—	—	—	1	—	2	—	—	—	—	1
» *scutellum*	—	—	—	—	—	1	—	—	—	—	—
Chaetoceros sp.	—	—	—	1	1	2	—	—	—	—	—
Cyclotella bodanica	—	—	—	—	—	—	—	—	—	—	—
» *ocellata*	—	—	—	—	—	—	—	1	—	—	—
Cymatopleura elliptica	—	—	—	—	—	1	1	1	1	1	—
» » *v. hibernica*	—	—	—	—	—	—	1	—	—	—	—
» » *v. nobilis*	—	—	—	—	—	—	—	1	1	1	—
» *solea*	—	—	—	—	—	—	1	1	1	—	1
Cymbella aspera	—	—	—	—	—	1	1	—	1	1	1
» *cuspidata*	4	3	—	—	—	—	—	1	—	1	1
» *Ehrenbergii*	—	—	—	—	—	—	—	1	—	1	—
» *lanceolata*	—	—	—	—	—	1	1	1	1	—	—
» *prostrata*	—	—	—	—	—	—	1	1	—	—	—
» *spp.*	2	1	1	—	—	1	1	—	—		
Diploneis domblittensis	—	—	—	—	1	—	1	1	—	—	1
» » *v. šubconstricta*	—	—	—	—	—	—	—	—	—	1	—
» *elliptica*	—	—	—	—	—	1	—	1	—	—	—
» *finnica*	3	5	2	—	—	—	—	—	—	—	—
» *Mauleri*	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	—	—	1	1	—	—	—
» » *oblongella*	—	—	—	—	—	—	—	1	—	—	—
» *Smithii*	—	—	—	—	—	2	—	—	—	—	—
» » *v. rhombica*	—	—	—	—	1	—	—	—	—	—	—
Didymosphenia geminata	—	—	—	—	—	—	—	—	—	—	—
Epithemia argus	—	—	—	4	—	1	—	—	1	—	—
» *Hyndmanni*	—	—	—	—	1	—	3	4	4	2	4
» *intermedia*	—	—	—	—	—	—	—	1	—	1	—
» *Muelleri*	—	—	—	—	1	2	—	1	—	1	1
» *sorex*	—	—	—	2	—	2	1	1	—	1	1
» *turgida*	—	—	—	1	—	4	5	5	3	2	4
» » *v. granulata*	—	—	—	—	—	—	—	—	—	1	—
» » *v. Westermanni*	—	—	—	2	1	3	4	5	5	4	5

träsk I					Gallträsk II					Hanaböle								
707	708	709	710	711	7	8	9	10	11	305	306	307	308	309	310	311	312	313
—	—	—	—	—	1	3	1	1	—	—	1	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—
—	—	1	1	—	—	1	1	1	—	—	—	1	1	—	—	—	—	—
—	1	1	—	—	—	—	1	1	1	—	—	—	1	2	1	1	1	1
—	1	1	—	—	—	—	1	—	1	—	—	1	—	1	1	—	—	1
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	1	—	—	—	1	1	—	—	—	—	—
—	—	—	—	—	—	1	2	—	—	—	—	2	1	—	—	—	—	—
—	—	—	—	—	—	3	2	1	1	—	1	1	2	—	—	—	—	—
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	1	1	1	—
—	—	—	—	—	3	5	2	2	1	—	1	2	2	—	—	—	—	—
—	—	—	—	—	5	5	5	5	2	1	5	5	5	—	—	1	—	—
—	—	—	—	—	—	1	2	—	—	—	—	1	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
3	2	—	—	—	—	—	—	1	1	—	1	—	1	1	2	1	2	1
—	1	1	—	—	—	—	—	1	1	—	—	—	—	—	1	1	—	1
1	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	1	1	1
—	1	1	—	—	—	—	1	1	—	—	—	1	5	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	1	—	—	1	2	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	1	1	—	—	1	1	1	1	1	1	1
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	1	1
1	—	—	—	—	—	—	1	1	1	—	—	—	1	1	1	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	1	—	—	—	1	4	—	—	—	1
1	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	1
1	—	—	—	—	—	—	—	1	1	—	—	—	—	1	—	1	1	—
1	1	1	—	—	—	—	1	—	1	—	—	1	—	—	—	—	1	1
—	3	1	—	—	—	—	—	1	—	—	—	—	—	1	1	1	1	1
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	1	1	1	—	—	4	3	—	—	—	—	—
—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	1	1	2	2	1	—	—	3	1	—	—	—	—	—
5	2	—	—	—	—	—	1	3	5	—	—	—	1	1	5	1	3	1
1	1	—	—	—	—	—	—	1	1	—	—	—	1	—	—	2	2	1
1	1	1	—	—	1	1	3	4	2	—	1	2	2	1	1	4	1	1
1	1	—	—	—	—	—	1	—	1	—	—	2	—	—	—	1	1	1
5	1	1	—	—	1	1	2	5	3	—	1	2	4	2	5	5	5	4
5	1	—	—	—	—	1	2	5	5	—	1	2	4	1	5	5	5	5

	Gall-										
	694	696	697	698	699	700	702	703	704	705	706
Epithemia zebra	—	—	—	—	1	2	3	5	3	5	5
» » *v. porcellus*	—	—	1	3	1	5	—	2	2	1	1
Eunotia Clevei	—	—	—	—	1	1	2	3	2	—	—
» *spp.*	3	1	1	—	—	—	—	—	—	—	—
Fragilaria spp.	—	1	1	—	—	—	—	—	—	—	1
Gomphonema acuminatum	1	1	1	—	—	—	—	—	—	—	—
» » *v. coronata*	—	1	1	—	—	—	—	—	—	—	—
» *augur*	—	—	—	—	—	—	—	—	—	—	—
» *constrictum*	—	1	—	—	—	—	1	—	1	—	—
» *spp.*	—	—	—	—	—	—	—	—	—	—	—
Gyrosigma acuminatum	—	—	—	—	—	—	—	—	—	—	—
» *attenuatum*	—	—	—	—	1	1	1	2	2	2	2
Hantzschia sp.	—	—	1	—	1	—	—	—	—	—	—
Mastogloia Braunii	—	—	—	2	1	1	—	—	—	—	—
» *elliptica*	—	—	—	2	—	2	—	—	—	—	—
» » *v. dansei*	—	—	—	—	2	2	—	—	—	—	—
» *pumila*	—	—	—	1	—	—	—	—	—	—	—
» *Smithii amphicephala*	—	—	—	2	1	3	—	—	—	—	—
Melosira ambigua	5	2	3	—	—	—	—	—	—	—	—
» *arenaria*	—	—	—	1	1	3	3	3	4	5	5
» *distans*	1	5	5	—	—	—	—	—	—	1	—
» *granulata*	—	—	—	—	—	—	—	—	—	—	—
» *islandica subsp. helvetica*	—	—	—	—	1	2	3	5	3	5	5
» *italica v. valida*	5	—	4	—	—	—	—	—	—	—	—
» *Juergensi*	—	—	—	—	—	1	—	—	—	—	—
» *moniliformis*	—	—	—	—	1	1	—	—	—	—	—
» *Westii f. parva*	—	—	—	1	—	—	—	—	—	—	—
Navicula americana	—	—	—	—	—	1	—	—	—	—	—
» *bacillum*	—	—	—	—	—	—	—	1	—	—	—
» *digitoradiata*	—	—	—	—	1	—	—	—	—	—	—
» *gastrum*	—	—	—	—	—	—	—	—	—	—	—
» *Jentzschii*	—	—	—	—	—	—	—	—	—	—	—
» *libellus*	—	—	—	—	1	1	—	—	—	—	—
» *mutica*	—	—	—	—	—	—	—	—	—	—	—
» » *v. Cohnii*	—	—	—	—	—	—	—	—	—	—	—
» *placentula*	—	—	—	—	—	—	—	—	—	—	—
» » *f. latiuscula*	—	—	—	—	—	—	—	1	—	—	—
» » *f. rostrata*	—	—	—	—	—	—	—	—	—	—	—
» *peregrina*	—	—	—	—	—	1	—	—	—	—	—
» *pusilla*	—	—	—	—	—	—	—	—	—	—	—
» *radiosa*	1	1	—	—	—	—	—	—	—	—	—
» *scutelloides*	—	—	—	—	—	—	—	—	—	—	—
» *tuscula*	—	—	—	—	—	1	—	—	—	—	—
Neidium spp.	1	—	—	—	—	—	1	1	—	—	—
Nitzschia navicularis	—	—	—	—	—	—	—	—	—	—	—
» *obtusa*	—	—	—	1	—	—	—	—	—	—	—
» *scalaris*	1	3	5	5	5	2	—	—	—	—	—
» *tryblionella*	—	—	—	—	—	1	—	—	—	—	—
Opephora Martyi	—	—	—	—	—	1	—	—	—	—	—
Pinnularia spp.	5	2	1	—	—	2	—	1	1	1	—

träsk I					Gallträsk II					Hanaböle								
707	708	709	710	711	7	8	9	10	11	305	306	307	308	309	310	311	312	313
1	3	1	—	1	—	—	1	5	5	—	—	3	5	—	—	5	5	5
1	2	1	—	—	—	—	1	1	1	—	—	5	5	5	2	3	2	1
—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	1	—	1	—	—	—	—	—	5	3	—	—	—	—	—	—	—
—	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	1
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	5	—	—	—
4	1	1	—	—	—	—	—	1	2	—	—	—	1	5	—	3	3	5
—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
—	1	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	1
—	1	—	—	—	—	1	1	1	—	—	—	3	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	5	5	—	—	1	1	1	2	2	—	1	—	1	1	3	2	1	—
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
5	3	1	—	—	1	1	—	2	5	—	—	1	1	1	3	4	3	5
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	4	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	1	1	—	—	—	—
—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	1	—	—	—	—	2	—	1	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	—	—	—	—	—	1	1	—	—	—	—	1	—	—	—	1
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	1	1	5	5	2	1	1	—	2	5	5	—	—	—	—	—
—	—	—	—	—	—	—	1	—	1	—	—	1	1	—	—	—	—	—
—	3	5	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	1	1	1	1	3	—	1	1	1	5	5	—	5	2	1	1	—	1

											Gall-
	694	696	697	698	699	700	702	703	704	705	706
Rhoicosphenia curvata	—	—	—	—	—	1	—	1	—	—	—
Rhopalodia gibba	—	—	—	—	1	1	1	1	—	1	—
» » *v. ventricosa*	—	—	—	—	—	1	—	—	—	—	1
» *musculus*	—	—	—	2	1	1	—	—	—	—	—
Stauroneis acuta	—	—	—	—	—	1	—	—	—	—	—
» *anceps v. gracilis*	1	—	—	—	—	—	—	—	—	—	—
» *phoenicenteron*	3	—	1	—	1	—	—	1	1	—	—
Stephanodiscus astraea	—	—	—	—	—	1	2	2	1	2	2
Surirella biseriata	—	—	—	—	—	—	1	—	1	—	—
» » *v. bifrons*	—	—	—	—	—	1	—	1	—	—	—
» *Capronii*	—	—	—	—	—	2	1	1	—	—	—
» *elegans*	—	—	—	—	—	—	—	1	—	1	1
» *ovata*	—	—	—	—	—	1	—	—	—	—	—
» *peisonius*	—	—	—	—	1	—	—	—	—	—	—
» *striatula*	—	—	—	—	1	2	—	—	—	—	—
Synedra pulchella	—	—	—	—	—	1	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	—
Tabellaria spp.	1	1	1	—	—	—	—	—	—	—	—
Tetracyclus lacustris	2	—	2	—	—	—	—	—	—	—	—
» » *v. rhombica*	—	2	—	—	—	—	—	—	—	—	—
Tropidoneis sp.	—	—	—	—	1	—	—	—	—	—	—

line. I have tried to group the species both on the basis of their halophility and of bathymetrical relations as far as possible with the help of the available literature and my own experience. Diatoms have thus been used firstly as indicators of salt (or brackish) water and fresh water and secondly for determining the depth of the ancient water body and the changes that have occurred in it. Here I have directed my attention not only to the number of species, but also to the frequency of each species in the different samples. In calculating the vertical grouping of the forms of large and small water bodies I have considered their relative amounts or the figures 1—5. A comparison of the frequency figures thus obtained results, of course, in certain arithmetical values. It is possible, *e. g.*, to calculate the percentage figures for the large-water and small-water forms respectively. I have actually made such a calculation from the samples, but as the original analysis only shows the relative frequency of species, the result of the calculation cannot be regarded as exact.

Therefore I have used the bathymetric curve obtained by calculating in this manner only as a basis and have tried to improve it by taking into consideration the ecological type of the whole diatom

träsk I					Gallträsk II					Hanaböle								
707	708	709	710	711	7	8	9	10	11	305	306	307	308	309	310	311	312	313
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	—	—	—	—	—	—	1	1	1	—	—	1	1	—	—	1	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	1	—	—	—	—	1	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	1	—	—	—
2	—	—	—	—	—	—	—	1	1	—	—	1	—	—	1	1	1	2
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	5	1	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	1	5	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	3	5	2	1	—	—	3	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—

flora of each sample and the fact, as to how reliable an indicator of the deep or shallow, brackish or fresh water each species concerned is. In this connection I have, too, paid special attention to local conditions, for a certain species may, *e. g.*, in one case indicate an increasing depth and salinity, while in some other instance and in a different association it may indicate the reverse. Quite particularly I have taken into account the presence or absence of 1) deep-water bottom forms, 2) euhalobic forms and 3) pelagic plancton. In this connection I refer to the studies of B. Halden (1929), U. Sundelin (1919) and H. Thomasson (1927, 1932, 1934).

The curve describing the changes of the water-level of Gallträsk, as in the other diagrams to be dealt with below, is therefore by no means a graphic reproduction of any mathematical result. Its object is to give the reader a visual idea of the character of the displacements of the shore-level, according to the evidence of the diatoms, on each site of observation. At the same time it saves the author from going through the extensive material regarding the diatoms in detail, which is to be published in connection with this paper. The reader will, however, be able to check my conclusions in each individual case on the basis of the diatom tables. The diatoms have been determined principally according to F. Hustedt (F. Hustedt 1930, 1930—1937).

The stratigraphy of the Gallträsk bog. The pollen diagram of the Gallträsk peat bog can easily be divided into three large portions. The zone with the broad percentage field of mixed oak forests represents the Littorina period, below which is the pre-Littorina and above it the post-Littorina period. The diatoms accentuate this division. The limit between the Ancylus and Littorina periods is drawn at the point in the profile, at which the freshwater diatom flora that is typical of the final phase of the Ancylus Lake passes over into brackish-water flora.

In the sediment itself no visible change occurs in the transition from the Ancylus to the Littorina period. The fine detritus ooze only becomes gradually richer in organic remains upwards and at the same time darker. Such an even change of the sediment from the deep water type to the shallow water type would point to no considerable transgression having occurred at this place between the Ancylus Lake and the Littorina Sea epochs and to the shoreline not having advanced towards the land during the later phases of the Littorina Sea either.

What do the diatoms say about this? Besides samples at intervals of 10 cm. taken from the whole section, I took a complete sample of a length of 30 cm. from the contact zone between Ancylus and Littorina and investigated the diatoms at an average interval of 2 cm.

The table III shows, how the change proceeds from the freshwater flora typical of the Ancylus regression (samples I—III) to a transition horizon (sample IV), in which, besides brackish forms (*Amphora arenicola* v. *major*, *Anomoeoneis sphaerophora* v. *polygramma*, *A. sphaerophora* v. *sculpta*, *Campylodiscus clypeus*, *C. echeneis*, *Nitzschia scalaris*, *N. tryblionella*), there are many species typical of the former (final phase of Ancylus) horizon: *Campylodiscus hibernica*, *Eunotia Clevei*, *Melosira arenaria* and especially *Surirella Capronii*. Then comes a purer, though still very slightly brackish Littorina, represented by a sandy diatomite layer formed chiefly of *Campylodiscus clypeus*. The three uppermost samples (VI, VII, VIII) already represent true Littorina, in which the salinity has obviously increased slightly. Above this the diatoms were examined at 10 cm. intervals and from sample 698 onwards they indicate a continuous fall of the sea-level. The isolation of the basin from the Littorina Sea occurs about the 3.50 m. point of the section.

m. Samples — Table III.

3,70

VI—VIII — Fine detritus ooze

Clear Littorina

Anomoeoneis sphaerophora v. polygramma — Campylodiscus clypeus — Mastogloia — Nitzschia scalaris horizon.

Amphora arenicola v. major 4, A. commutata 3, Anomoeoneis sphaerophora v. polygramma 4, A. sphaerophora v. sculpta 3, Campylodiscus clypeus 4, C. echeneis 3, Cymbella lanceolata 1, Epithemia spp. 4, Gyrosigma attenuatum 1, Mastogloia baltica 1, M. Braunii 2, M. elliptica 2, M. Smithii v. amphicephala 4, M. Smithii v. lacustris 2, Melosira arenaria 1, M. moniliformis 3, M. Jürgensi 2, Navicula oblonga 1, N. peregrina 1, Nitzschia circumsuta 1, N. scalaris 3, N. tryblionella 2, Pinnularia spp. 3, Pleurosigma sp. 1, Rhoicosphenia curvata 3. Stephanodiscus astraea 1, Surirella Capronii 1, S. striatula 3.

3,76

V — Diatom earth mixed with sand

Faint Littorina

Campylodiscus clypeus horizon.

Amphora arenicola v. major 3, Anomoeoneis sphaerophora v. polygramma 3, A. sphaerophora v. sculpta 2, Campylodiscus clypeus 5, C. echeneis 1, Cymatopleura elliptica 1, Epithemia spp. 3, Eunotia Clevei 1, Gyrosigma attenuatum 1, Melosira arenaria 2, Nitzschia circumsuta 1, N. scalaris 2, N. tryblionella 1, Surirella Capronii 1, S. striatula 2.

3,78

IV — Fine detritus ooze

Early Littorina

Campylodiscus clypeus — Surirella Capronii horizon.

Amphora arenicola v. major 1, Anomoeoneis sphaerophora v. polygramma 2, A. sphaerophora v. sculpta 1, Campylodiscus clypeus 4, C. echeneis 1, C. noricus v. hibernica 2, Cymatopleura elliptica 2, C. solea 2, Cymbella aspera 2, C. Ehrenbergii 2, Epithemia spp. 4, Eunotia Clevei 1, Gyrosigma attenuatum 2, Melosira arenaria 2, Navicula gastrum 2, N. oblonga 2, Nitzschia scalaris 2, N. tryblionella 1, Pinnularia spp. 3, Stauroneis acuta 1, S. phoenicenteron 1, Stephanodiscus astraea 2, Surirella Capronii + Surirella spp 5.

(VI—IV: Littorina)

3,80

I—III — Fine detritus ooze

Ancylus regression

Campylodiscus noricus v. hibernica — Diploneis domblittensis — Eunotia Clevei — Surirella Capronii horizon.

Campylodiscus noricus 2, C. noricus v. hibernica 3, Cymatopleura elliptica 3, C. solea 2, Cymbella aspera 2, C. Ehrenbergii 3, C. lanceolata 2, Diploneis domblittensis 3, Epithemia Hyndmanni + Epithemia spp. 4, Eunotia Clevei 2, Gyrosigma attenuatum 3, Melosira arenaria 3, Navicula gastrum 2, N. oblonga 2, Pinnularia major + Pinnularia spp. 3, Stauroneis acuta 3, S. phoenicenteron 2, Stephanodiscus astraea 2, Surirella Capronii + Surirella spp. 4.

(I—III: Ancylus)

3,86

Degrees of frequency: 1 = very scarce, 2 = scarce, 3 = general, 4 = abundant, 5 = very abundant.

Fig. 8 illustrates another pollen diagram of the Gallträsk bog. The profile is taken from quite close to the threshold (or pass-sill) at the eastern end of the bog. This threshold is 31 m. above sea-level. The same chronological division recurs in the diagram as in the previous one. The diatom flora (Table II, Gallträsk II) gives the same result as regards the changes of the shore-line as the diatoms of the previous profile did, as the curve at the side of the diagram shows.

In the neighbourhood of Gallträsk several raised shore-lines were measured (see list), the altitude of one of them being 33 m. above sea-level and therefore slightly above the level of the bog. In an earlier paper (E. Hyyppä 1935) I described this shore as the Littorina Sea maximum. W. Ramsay (1926) fixed the Littorina maximum in the Helsinki neighbourhood at 32 m. above sea-level and M. Sauramo (verbal statement) measured a wave-cut cliff at Tikkurila at 32 m. above sea-level which he considers to represent the Littorina Sea peak in the Helsinki neighbourhood. The Littorina ooze of the Gallträsk bog, which indicates shallow water by its lithology and its diatoms, proves conclusively that the 33 m. shore in the neighbourhood of the bog represents the Littorina maximum. The question arises, what part of the profile corresponds to this Littorina Sea maximum and was this sea clearly transgressive here in regard to the land as, *e. g.*, on the Karelian Isthmus (E. Hyyppä 1932).

The curve describing the changes of the water-level in the diagrams of Gallträsk (Fig. 7 and 8) provides an apparently plain answer to this. We see, how the retreat of the shore-line during the Ancylus regression period still continued for a short time at the beginning of the Littorina period and how subsequently the Littorina Sea rises to its maximum at the beginning of the period of mixed oak forests. After that the bog separates rapidly from the sea. According to the diatoms, then, the shore encroached during the transgression maximum upon the land. In the transition from Ancylus to Littorina, however, the petrographical structure of the sediment itself does not indicate a transgression. In order to settle the question we must return to Table III.

Samples IV and V indicate slight salinity and shallow water. The following horizon (VI—VIII) shows the salt contents to have increased, which might also signify a slight rise of the water-level or at any rate a delay in the regression. As, however, the basin of Gallträsk, judging by the diatoms, had not separated from the sea before this and as the difference in height between the threshold

(31 m. above sea-level) and the beach (33 m. above sea-level) is only 2 metres, the possible transgression is small or within the limit of 2 metres. It therefore seems more correct in this case to speak of a delay having occurred in the retreat of the shore-line than of a distinct transgression. In my opinion the sea-level was, indeed, rising at that time, but the shore-line had not shifted landwards to any extent worth mentioning.

The diatoms of the Gallträsk bog indicate, at any rate apparently, as already mentioned, that the shore-line still retreated slightly at the beginning of the Littorina period. This is seen by the shore displacement curve of the diagram (Fig. 7). In the former paper (1935) I had expressed this opinion, but now I am doubtful, for it must be assumed that the penetration of the brackish water into the basin of the Baltic at first destroyed the former flora to a great extent and a new flora developed comparatively slowly. This ecological transition zone is thus generally poor in diatoms, which leads statistically to the decline of the curve for the change of the shore-level based on the diatoms, although no negative change of the shore may have occurred. I shall have an opportunity of reverting to this important circumstance in connection with other profiles.

The diatoms of the Gallträsk bog are also of interest in another respect. B. Halden (1917) in Hälsingland and L. Aario (1932) in Satakunta (South-West Finland) established a *Mastogloia* limit still lying above the *Clypeus* limit. According to Halden the *Mastogloia* species are the first newcomers of the Littorina Sea in the Baltic region. This seems really to be the case in Sweden, at any rate in some profiles below the *Clypeus* limit (B. Halden 1917, G. Brander 1935), in which *Mastogloia* species, such as *M. Braunii* and *M. baltica*, appear before *Campylodiscus clypeus*. These cases do not, however, in my opinion prove anything beyond the fact that the water was at first too deep for the *Clypeus* flora, but the *Mastogloia* flora was already able to flourish there. On the other hand, as far as I know, so far not a single case has been reported in the whole region of the Baltic, in which the *Mastogloia* species of the Littorina period had appeared at a higher level than the *Clypeus* limit of the respective districts.

The species, on the basis of which Halden assumed a *Mastogloia* limit in Hälsingland 5—10 m. above the *Clypeus* limit, are as follows: *Mastogloia elliptica*, *M. elliptica* v. *punctata* and *M. Smithii* v. *lacustris*. According to Cleve-Euler (A. Cleve-Euler and A. L. Backman 1922), these species appear in the Baltic region already before the Littorina and belong to what this author calls the *Rhoicosphenia* flora. Halden's samples, besides, are not from complete profiles, nor has their age been fixed with sufficient exactitude on the basis of pollen analyses. Aario's (L. Aario 1932) *Mastogloia* limit in Satakunta (South-West Finland) is on an equally insecure basis. So far it is founded on a single profile (No. 80 Rynkäkeidas), the discovered species of which: *Mastogloia elliptica, M. ellipt.* v. *Dansei. M. Grevillei, M. Smithii* v. *amphicephala*, and *M. Smithii v. lacustris* appear in Finland already among the pre-Littorina flora. Aario, too, did not determine the age of these occurrences of *Mastogloia* by means of the pollen analysis, but from the paper referred to the impression is obtained that, according to Aario, they should be placed at the beginning of the Littorina period.

In Aario's profiles the *Mastogloia* flora also appears at lower levels in association with *Campylodiscus* species and, what is most significant, it is only now that *Mastogloia Braunii*, for instance, shows itself, a species which may be considered a much better index fossil for the Littorina Sea than the former.

In the profile of Gallträsk (diatom tables II and III) the Littorina Sea begins with a distinct *Clypeus* flora and the *Mastogloia* species only begin to appear in greater abundance later. In the pre-Littorina deposits, in samples 707, 708, 709 (Fig. 7), *Mastogloia* species appear very scarcely, too, in the Gallträsk sequence, but these are either impurities coming from the Littorina horizon or else they belong primarily to pre-Littorina flora. The diatoms of the Gallträsk bog lead to the conclusion that there is no particular *Mastogloia* phase belonging to the Littorina Sea, but that the highest limit of the Littorina Sea coincides here with the *Clypeus* limit. This conclusion seems all the safer as regards Gallträsk, seeing that the gradual change of the diatom flora from Ancylus to Littorina as well as the even petrographical structure of the contact zone prove that there is no unconformity or hiatus in the profile at this point. I shall have an opportunity of reverting to this question in connection with other profiles and of dealing with the so-called *Mastogloia* Sea on the basis of my whole material also in a regional respect.

The pre-Littorina portion in the profile, Fig. 7, begins with varved late-Glacial clay, which is sterile, however, so that it is impossible to fix its age more precisely. Above the clay there is a thin layer of sand which, according to the diatoms, may signify a small regression in the displacement of the shore-line. This is succeeded by the Ancylus transgression which in turn is converted into the Ancylus regression that leads to the Littorina Sea period just described.

The change of the shore-line. During the late-Glacial period the water-level lay appreciably above the level of the pass-sill of the Gallträsk bog or 31 m. The limit between the late-Glacial period and the Ancylus is not quite sharply defined. However, a regression has possibly occurred at that time that is succeeded by the peak of the Ancylus transgression. The latter is to be placed in the former half of the Ancylus period. The Ancylus regression does not descend below the 31 m. level and its limit practically coincides with the Littorina maximum, the latter lying in time at the very beginning of the Littorina period. The maximum limit of the Littorina Sea is represented in this place by an ancient shore-line which is in round figures 33 m. above the sea. The basin of Gallträsk is isolated from the sea in the first half of the Littorina period and the shore-line is situated throughout the whole of the post-Littorina period below the threshold of the bog.

Hanaböle Bog.

The Hanaböle peat bog lies on the west of the old Porvoo high-road, about 1 km. north of Lake Hanaböleträsk (investigation area No. 24). In type it is a *Sphagnum* »Highmoor», on which pine grows sparsely. Fig. 9, page 23 illustrates its stratigraphy. The upper part of the profile, which is superfluous in this case as regards the displacement of the shore-line, has been omitted. The boring does not extend to the bottom of the bog. The oldest sediment bored (clay ooze) belongs to the Ancylus regression period. According to the evidence of the diatoms, the contact between Ancylus and Littorina occurs at the 3 m. point of the profile or on the boundary of the clay ooze and the fine detritus ooze. In this horizon (diatom table II, Hanaböle) there is a distinct ecological limit between the diatoms of samples Nos. 308 and 309. The diatoms also prove that the water-level has subsided above this place in exactly the same way as at Gallträsk. This is comprehensible, as both bogs are on almost the same isobase of the land uplift and at the same altitude.

Ancient shore-lines were measured in the neighbourhood of the Hanaböle bog, the levels of which are 32 m. above sea-level (see table I, sites Nos. 11 and 12). The fine detritus ooze that represents the Littorina Sea maximum (samples 307, 308) lies only 3 m. below this shore-level (32 m). If, then, this 32 m. shore-line represents the Littorina maximum, the water was shallow at this place, at most 3 m. The diatom flora representing the Littorina maximum (samples 307, 308) fully confirms this view, as it is a typical *Campylodiscus* *clypeus—Nitzschia scalaris* flora that proves shallow water. Therefore it must be considered quite certain that the 32 m. shore referred to was formed at the level of this particular water body and thus represents the maximum limit of the Littorina Sea at this place.

According to the evidence of the diatoms and the pollen flora of the Hanaböle bog, the maximum of the Littorina Sea occurs at the beginning of the Littorina period. The mixed oak forests only culminate after this. The regression that had begun during the Ancylus period would seem here, too, to judge by the diatoms, to continue at the beginning of the Littorina period. The result yielded by the diatoms would, however, in that case be due, at any rate partly, to the fact that, when the water became brackish, the Ancylus diatoms disappeared and the new marine flora developed slowly. The intervening zone is therefore poor in diatoms, which causes the diatom curve for the change of the water depth to fall. The threshold of the Hanaböle bog is about 30 m. above sea-level. The place did not separate from the sea during the possible regression period preceding the Littorina maximum. As the level of the Littorina maximum in the neighbourhood is 32 m. above sea-level, the transgression here, as at Gallträsk, is within a range of 2 m. This figure, however, is not exact as regards Hanaböle, as the height of the pass-sill there was only determined on the basis of the topographical map.

About 2 km. north of Tikkurila station and about 1 km. west of the railway there is a shore cliff of the Littorina Sea, established by Sauramo and already referred to, the foot of which is approximately 32 m. above sea-level. The shore-line has been cut into an esker slope and a distinct beach plain has been formed of esker gravel on the east side of it. From this beach gravel, which is thus directly connected with the 32 m. wave-cut cliff referred to, I found a little *Campylodiscus echeneis, Diploneis incurvata* and *D. interrupta.* A pollen analysis of the same samples also proves that this is a case of a beach accumulation of the Littorina period.

Korso.

Investigation area No. 13, see map. No Littorina shore-line was established here, but the site almost corresponds as regards the land upheaval to Lake Pitkäjärvi (Långträsk), where the Littorina shore is 34.4 m. above sea-level. From Korso I have instead a couple of peat bogs, on the basis of which the height of the local Littorina maximum can be estimated. Fig. 10, page 23, illustrates the pollen diagram made on the south-east of Korso station, of the bog quite close to the railway. There are no salt-water diatoms in the aqueous deposit on the bottom of the bog, only some scarce fresh-water species, most of which are typical of the Ancylus Lake. The formation of terrestrial peat began at this place at the beginning of the Littorina period, so that at that time the sea had receded away from the bog. The bed of the bog, which likewise represents the height of the threshold, is 35.4 m. above sea-level. The maximum limit of the Littorina Sea at Korso is therefore below this level. Another bog, about 1 km. north of the former one, gives the same result. Fig. 13, page 39, illustrates the pollen diagram of this bog which proves still more clearly that the accumulation of terrestrial peat began at Korso at the 35 m. level already at the beginning of the Littorina period or at the time of the maximum extent of that sea.

Puodinkylä Bog.

The peat bog investigated lies on the south-west of the road from Puodinkylä to Malmi (investigation area No. 3) and its surface at the point of boring is 29.6 m. above sea-level. In the sand at the bottom of the bog there is an abundant flora of brackish-water diatoms, of which the following, characteristic of the Littorina Sea, may be mentioned: *Campylodiscus clypeus* 1; *C. echeneis* 1, *Cocconeis scutellum* 4, *Diploneis didyma* 1, *D. incurvata* 1, *D. Smithii* 1, *Epithemia turgida* v. *Westermanni* 4, *Grammatophora oceanica* 3, *Navicula elegans* 3, *N. humerosa* 2, *Nitzschia scalaris* 4, *Rhabdonema arcuatum* 1 and *Surirella striatula* 1. These species are sufficient to prove that the sand on the bottom of the bog was deposited at a place that was in open connection with the Littorina Sea. The bottom of the bog, too, descends evenly from the point of boring towards the sea, both to the south and to the south-east, while the edge of the bog towards the mainland rises to the 30 m. level which corresponds to the local maximum limit of the Littorina Sea. Fig. 15 illustrates the stratigraphy of this bog. The Littorina Sea sand at the bottom of the bog is very poor in pollen grains. In the mud above the sand there are still few salt-water diatoms, so that this layer indicates in the profile the level, at which the boring point was shut off from the sea. The separation level is 26.5 m. above sea-level. In the pollen diagram of the bog this level falls chronologically into the first half of the Littorina period. Further it is evident from the pollen diagram that the Littorina period only ended considerably later than the isolation occurred. This leads to the conclusion that at the end of the Littorina period the shore-line was situated appreciably below the separation level (26.5 m. above sea-level).

TATTARISUO BOG AND ITS SURROUNDINGS.

In this area raised shores were identified at several places (investigation areas Nos. 5—9). On the eastern edge of the Tattarisuo bog there is a raised shore (Fig. 5) 30 m. above sea-level which, on the basis of its altitude, is already equivalent to the maximum limit of the Littorina Sea established at Kauniainen, Hanaböle and Tikkurila. There are several other ancient beaches, too, in the neighbourhood of the Tattarisuo bog both above and below this shore-line. In endeavouring to establish the age of these shores by means of the stratigraphy of the bogs let us first devote our attention to the maximum limit of the Littorina Sea and the beaches below it.

Pottmossen Bog.

Fig. 11, page 39, illustrates the pollen diagram of the Pottmossen bog. The bog is a *Sphagnum-Pinus* »Highmoor» and is situated about 2 km. E.S.E of the Tattarisuo bog, No. 26 on the map. There is clay on the bottom of the bog which grades over at a depth of 4.5 m. into fine detritus ooze, the latter changing further to terrestrial peat. On the basis of its pollen and diatom flora the fine detritus ooze above the clay is a Littorina Sea sediment. When the upper part of the fine detritus ooze was deposited, the place was isolated from the sea and the formation of peat began. The pollen diagram also leads to the conclusion that the separation may only have occurred at the end of the Littorina period. On the basis of the height of the threshold of the bog the isolation occurred at the time, when the Littorina Sea stood at this place at least 27 m. above sea-level. The Littorina Sea would then still at the end of this period have been almost at its maximum level, which is 30 m. above the sea at this place. This, however, contradicts the result obtained from the Gallträsk, Hanaböle and Puodinkylä bogs. According to the evidence of the diatoms and pollen of these latter the maximum limit of the Littorina Sea is situated in time at the very beginning of the Littorina period, after which the retreat of the shore-line appears to have occurred with comparative rapidity. The separation level of the Puodinkylä bog, for instance, which is only 26.5 m. above sea-level, still falls into the first half of the Littorina period.

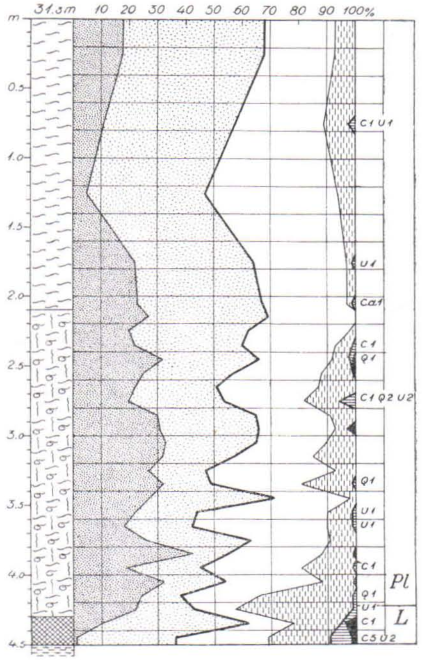

Fig. 11.

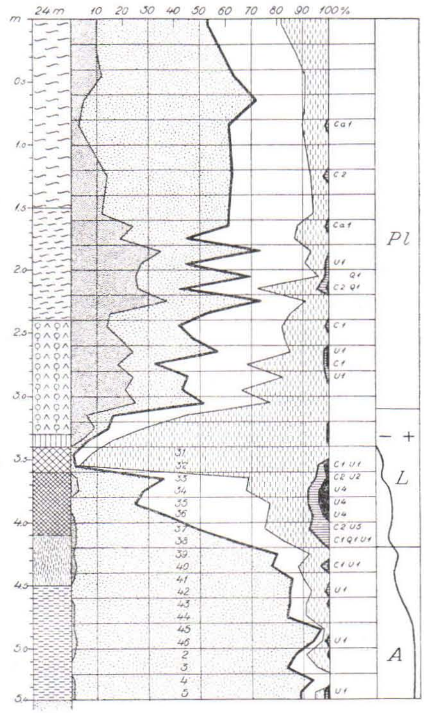

Fig. 14.

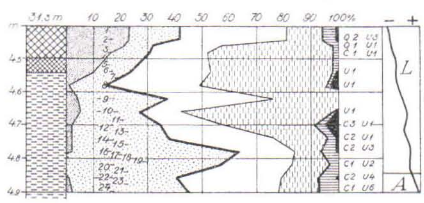

Fig. 12.

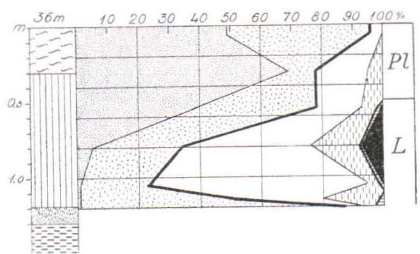

Fig. 13.

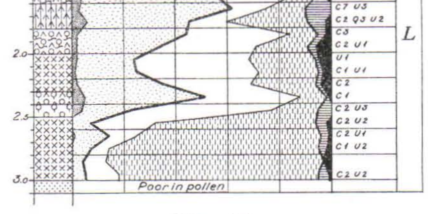

Fig. 15.

Fig. 11. Profile No. 1 of the Pottmossen bog. Analyst Kyllikki Salminen.
Fig. 12. Profile No. 2 of the Pottmossen bog. Analyst Kyllikki Salminen.
Fig. 13. Profile No. 2 of the Korso bog. Analyst K. Jokela.
Fig. 14. Profile of the 24 metre bog. Analyst Kyllikki Salminen.
Fig. 15. Profile of the Puodinkylä bog. Analyst Kyllikki Salminen.

The pollen diagram of the Pottmossen bog does not display an entirely normal composition of the pollen flora. In looking for the sources of error the thought occurs that the growth of peat on the site of the Pottmossen bog may have only begun a long time after the area had been separated from the sea, in which case there would be a gap in the pollen diagram. This explanation does not seem credible, as the upper part of the fine detritus ooze already contains an unusual quantity (10 %) of *Picea* pollen and on the other hand there is a distinct maximum of *Alnus* in the lower part of the terrestrial peat, which proves that the shore-line had not yet retreated far from the bog, when the formation of peat began already at this place. It may be considered a better attempt at an explanation that the pollen grains were embedded in the deposit during a heavy local influence of the shore-zone so that an exact pollen chronology is impossible in this case.

In order to elucidate the question I investigated the basal layers of the bog and some other adjacent peat bogs. Fig. 12, page 39 illustrates the stratigraphy of the deepest layers of the Pottmossen bog. Boring could be extended to a depth of 4.9 m., at which the clay still seemed to continue downward. The clay could, however, be bored to a thickness of close on 40 cm. and it was possible to make both diatom and pollen analyses of the samples obtained. The diatom analyses were carried out at average intervals of 2 cm. The results of the analysis are shown in the diatom table (Table IV, Pottmossen bog 1—24). On the basis of it the limit between the Ancylus and Littorina periods was drawn in the diagram as well as the curve for the change of the shore-level above the place, on exactly the same principles as in the former bogs. Sample 22 still belongs to the Ancylus regression period, containing, among others, *Diploneis domblittensis*, *D. Mauleri* and *Eunotia Clevei*. In this sample, indeed, and below it, there are isolated appearances of *Campylodiscus clypeus*, which is, however, entirely incompatible with that association of diatoms and must certainly have come with the borer from the upper Littorina sediments. Sample 21 represents the beginning of the Littorina period and a new assemblage of diatoms, although the ecological limit towards the former sample is not very abrupt. The composition of the pollen flora coincides with the evidence of the diatoms. The contact zone is dominated by pine, and the uninterrupted appearance of *Tilia* begins shortly above the contact. Both these features regularly characterise the beginning of the Littorina period.

The Littorina Sea maximum is situated in this case, judging by the diatoms, at the very beginning of the Littorina period (samples 15—21), after which the shore-line retreated gradually. According to the evidence of the diatoms, the displacement of the shore-line occurred at this place in exactly the same way as in the former areas (Gallträsk, Hanaböle, Puodinkylä) all of which are at the same proportional altitude to the Littorina maximum as Pottmossen. It also seems certain, therefore, that the Pottmossen bog was separated earlier from the sea than its pollen diagram would indicate.

The diagram referred to (Fig. 12) shows a particularly large quantity of *Picea* above the clay in the fine and coarse detritus ooze, during the deposition of which the shore was very close to the boring point. This high quantity of *Picea*, however, is exceptional in this case and is obviously due to the *Picea* pollen having been concentrated locally on the shore, for we see on the recent beaches that *Pinus*, in particular, accumulates at times in enormous quantities in the littoral zones. The frequency of *Picea* does not, therefore, signify the end of the Littorina period in this case. We will obtain additional evidence bearing on this important question in connection with the stratigraphy of some neighbouring peat bogs.

The 24 Metre Bog.

About 2 km. due east of the former bog there is a narrow *Pinus* »Highmoor» (investigation area No. 9) the stratigraphy of which is illustrated by Fig. 14, page 39. The results of the diatom analyses of the aqueous deposits of the bog are shown in Table IV, the 24 metre bog, 31—46 and 2—5. The bottom layers of the bog are Ancylus clay, which is proved by the pollen flora dominated by *Pinus* and the lacustrine diatom flora of a large water body, in which there are several species typical of the Ancylus Lake. The Ancylus regression is clearly recognised in the level of sample No. 42. Shortly after the clay deposited in the deep water passes over into a shallow water sediment or clay ooze. Between samples Nos. 39 and 38 there is a very distinct ecological limit in the development of the diatom flora caused by the penetration of the brackish water into the Baltic in the initial stage of the Littorina Sea. In the quality of the sediment itself no change is noticeable in this important contact zone. The curve for the displacement of the shore-line in the diagram shows the regression still to have continued at the beginning of the Littorina period or in the horizon of sample No. 38. The evidence of the diatoms is not unimpeachable, however, in this case either. I will only

Table IV.

	Pott-												
Anal. K. Salminen	1	2	3	4	5	6	7	8	9	10	11	12	13
Achnanthes brevipes	—	—	—	—	—	—	—	—	—	—	—	—	—
» *calcar*	—	—	—	—	1	—	—	—	—	—	—	—	—
» *Clevei*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. rostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *lanceolata v. elliptica*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Östrupi*	—	—	—	—	—	—	—	—	—	—	—	—	—
Amphora arenicola v. major	—	—	—	—	—	—	—	—	—	—	—	—	—
» *commutata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	—	1	—	—	—	—	—	—	—	—	—
» » *v. libyca*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. pediculus*	—	—	—	—	—	—	—	—	—	—	—	—	—
Anomoeoneis serians	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sphaerophora*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. sculpta*	—	—	—	—	—	1	—	—	—	—	—	—	—
Caloneis Schumanniana v. biconstricta	—	—	—	—	—	—	1	—	—	—	—	—	—
» *silicula*	—	—	—	—	—	—	—	—	—	—	—	—	—
Campylodiscus clypeus	2	2	1	1	2	3	2	3	2	1	2	1	5
» » *v. bicostata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *echeneis*	—	1	—	—	1	1	—	1	1	—	1	—	2
» *noricus*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. hibernica*	—	1	1	—	1	—	—	1	—	1	—	—	1
Chaetoceros sp.	—	—	—	—	—	—	—	—	—	—	—	—	—
Cocconeis diminuta	—	—	—	—	—	—	—	—	—	—	—	—	—
» *disculus*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pediculus*	—	—	—	—	—	—	—	1	—	—	—	—	—
» *placentula*	—	—	1	—	1	1	1	1	1	1	—	1	1
» *scutellum*	—	—	—	—	—	—	—	—	—	—	—	—	—
Coscinodiscus lacustris v. septentrionalis	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyclotella comta	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Kützingiana*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ocellata*	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymatopleura elliptica	—	—	—	—	—	—	—	—	—	—	—	—	1
» » *v. nobilis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *solea*	—	—	—	—	—	1	—	—	—	—	—	—	—
Cymbella aspera	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Ehrenbergii*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *lanceolata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *prostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *spp.*	—	—	—	1	—	—	—	1	—	—	—	—	1
Diatoma spp.	—	—	—	—	—	—	—	—	—	—	—	—	—
Didymosphenia geminata	—	—	—	—	—	—	—	—	—	—	—	—	—
Diploneis didyma	—	—	—	—	—	—	—	—	—	—	—	—	—
» *domblittensis*	—	—	—	—	1	—	—	—	—	—	—	—	1
» » *v. subconstricta*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elliptica*	—	—	—	—	1	—	—	1	—	—	—	—	—
» *incurvata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *interrupta*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *marginestriata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Mauleri*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	—	—	—	—	—	1	—	—	—
» *pseudovalis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Smithii*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. rhombica*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	—	—	—

mossen Bog											The 24 metre Bog																			
14	15	16	17	18	19	20	21	22	23	24	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	2	3	4	5
—	—	—	—	—	—	—	—	—	—	—	—	2	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	1	2	1	—	1	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	—	1	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
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1	—	1	1	—	—	1	1	1	1	1	—	—	—	—	1	1	1	2	—	—	—	1	—	1	1	—	—	1	1	1
—	—	—	1	1	—	—	—	—	—	1	—	—	—	1	—	—	1	—	1	1	1	—	—	—	—	—	—	—	1	1
—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	3	1	2	1	1	—	1	—	—	1	—	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
1	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—
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5	2	2	2	1	2	3	2	1	1	1	—	5	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	—	1	1	—	1	—	—	—	1	1	1	1	1	1	3	—	—	—	—	—	—	—	—	—	—	—	1
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—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	2	1	—	3	2	1	1
—	—	1	1	—	—	1	1	1	2	1	—	—	—	—	1	1	2	1	—	1	—	1	1	1	—	—	—	—	—	—
1	5	4	3	4	4	4	5	3	4	2	—	2	1	—	2	1	1	—	1	1	1	—	1	1	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	3	1	2	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	1	1	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
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1	—	1	1	1	1	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—	1	1	—	1	—	—	1	1	—	1
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—	2	2	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	1	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	1	1	1	2	—	2	2	2	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	1	1	—	1
—	—	1	1	—	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—
1	—	1	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	1	—	1	1	1	2	2	1	—	1	2	1	1
1	—	1	1	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	2	2	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
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	Pott-												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Epithemia argus	—	—	—	—	1	—	—	—	—	—	—	—	—
» *Hyndmanni*	—	—	—	—	1	—	—	—	—	1	—	—	—
» *intermedia*	—	—	—	—	—	1	—	—	—	—	—	1	—
» *Muelleri*	—	—	—	1	—	—	—	1	—	—	—	—	—
» *sorex*	—	—	—	—	—	—	—	—	1	1	—	—	—
» *turgida*	—	—	—	—	1	1	1	1	—	1	1	1	2
» » *v. Westermanni*	—	1	—	—	—	—	—	1	—	—	—	—	—
» *zebra*	1	1	1	1	—	1	1	—	1	1	1	—	1
» » *v. porcellus*	1	—	—	—	2	1	—	1	1	1	—	1	2
Eunotia Clevei	—	—	—	—	—	—	—	—	—	—	—	—	—
» *spp.*	2	2	3	4	1	2	1	1	1	1	1	1	2
Fragilaria spp.	—	—	—	—	1	1	—	1	1	1	—	—	—
Gomphonema acuminatum	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. coronata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *augur v. Gautieri*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *constrictum*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *spp.*	—	—	1	—	—	1	2	2	—	1	—	1	—
Grammatophora oceanica	—	—	—	—	—	—	—	—	—	—	—	—	—
Gyrosigma acuminatum	—	—	—	—	—	—	—	—	—	—	—	—	—
» *attenuatum*	—	—	1	1	—	1	1	1	1	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	—	—	—
Hantzschia spp.	—	—	—	—	1	1	—	—	—	—	—	1	1
Mastogloia Braunii	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elliptica*	—	—	—	—	—	1	—	—	—	—	—	—	—
» » *v. dansei*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Grevillei*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pumila*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Smithii*	—	—	—	—	—	—	1	—	—	—	—	—	—
» » *v. amphicephala*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. lacustris*	—	—	—	—	—	1	—	—	—	1	—	—	—
Melosira arenaria	1	1	1	—	1	1	—	1	1	1	1	—	1
» *Juergensi*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *moniliformis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *islandica*	1	—	—	—	—	—	—	—	—	—	—	—	—
» » *subspec. helvetica*	—	—	1	—	1	1	—	—	1	—	—	—	—
» *italica*	—	—	—	—	1	—	—	—	—	—	—	—	—
Meridion circulare v. constricta	—	1	1	2	—	1	1	1	1	1	2	3	2
Navicula americana	—	—	—	—	—	—	—	—	—	—	—	—	—
» *amphibola*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *bacillum*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *cocconeiformis*	—	—	—	—	1	—	—	—	—	—	—	—	—
» *costulata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *cuspidata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *dicephala*	—	—	2	1	1	1	—	1	—	—	1	2	1
» *digitoradiata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elegans*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *humerosa*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Jentzschii*	—	—	—	—	—	1	—	—	—	—	—	—	—
» *libellus*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *menisculus*	—	—	—	—	—	—	—	—	—	—	—	1	—
» *mutica*	—	—	—	—	1	—	—	—	—	—	—	—	—
» » *v. Cohnii*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *peregrina*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *placentula*	—	—	—	—	—	—	—	—	—	—	—	—	—

mossen Bog											The 24 metre Bog																			
14	15	16	17	18	19	20	21	22	23	24	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	2	3	4	5
1	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	1	1	—	1	—	—	—	—	1
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1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—
1	1	1	1	1	1	1	2	1	2	1	—	1	1	1	2	1	1	1	1	1	1	2	—	1	—	—	—	1	1	—
1	—	1	3	1	1	5	4	3	2	1	—	—	1	5	4	4	3	1	3	1	—	—	2	2	2	—	1	1	1	1
1	1	1	3	1	—	1	1	2	1	2	—	4	2	3	5	5	2	1	1	1	—	2	1	3	1	—	2	1	—	1
2	1	1	3	2	2	3	2	3	3	2	—	—	1	—	1	1	—	2	3	1	1	3	5	5	3	—	3	3	2	1
3	2	4	5	3	1	4	3	5	2	4	—	2	1	1	1	1	1	1	1	1	—	2	1	1	1	—	—	1	—	—
—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	1	1	—	1	1	1	—	—	—	—	—	—
1	1	1	—	—	1	—	1	—	1	—	4	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
—	1	1	—	4	1	1	1	—	1	1	—	5	5	—	—	1	—	1	1	5	3	2	1	1	—	1	—	—	1	—
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—	1	—	1	1	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	1	1	1	1	2	1	2	2	—	—	—	—	—	—	2	—	1	1	1	1	3	4	4	1	2	3	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	2	1	2	2	—	—	1	1	1
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1	2	1	3	1	1	3	3	5	3	3	—	—	—	1	1	—	—	1	1	1	1	—	3	3	4	—	5	5	5	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
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—	—	1	1	1	1	—	1	1	2	1	—	—	—	—	—	—	—	—	1	4	1	3	2	3	2	—	—	1	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	2	1	1	1	1	1	1
1	1	—	—	—	1	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	1	—	—	2	4	2	1	5	3	2	—	2	1	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
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1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	—	—	—	—	1	—	1	1	—	—	—	—	—	1	—	—	—	1	1	1	2	2	1	—	2	2	2	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	1	1	—	1	1	1	1	1	—	—	—	—	—	—	—	—	1	—	—	1	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	1	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	2	2	3	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
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	Pott-												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Navicula placentula f. lanceolata	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *f. latiuscula*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *f. rostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *platystoma*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *punctulata v. cluthensis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pupula v. capitata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. rectangularis*	—	—	—	—	—	—	—	—	—	—	1	1	—
» *pusilla*	—	—	—	—	1	—	1	1	—	—	—	—	—
» *radiosa*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Reinhardtii*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *rhynchocephala*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *scutelloides*	—	—	—	1	—	—	—	—	—	—	—	—	—
» *tuscula*	—	—	—	—	—	—	—	—	—	—	—	—	—
Naviculae lyratae?	—	—	—	—	—	—	—	—	—	1	—	—	—
Neidium sp.	—	—	1	—	1	—	—	1	—	—	1	1	1
Nitzschia angustata	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. acuta*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *apiculata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *circumsuta*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *hungarica*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *punctata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *scalaris*	—	—	—	—	—	1	—	1	—	—	—	—	1
» *sigma*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *tryblionella*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *levidensis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *victoriae*	—	—	—	—	—	—	—	—	—	—	—	—	—
Opephora Martyi	—	—	—	—	1	—	1	—	—	—	—	—	—
Pinnularia spp.	3	3	4	4	3	3	2	2	2	1	2	3	5
Pleurosigma sp.	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhoicosphenia curvata	—	—	—	—	1	1	1	—	1	1	—	—	—
Rhopalodia gibba	—	—	—	—	1	—	—	1	—	1	—	—	—
» » *v. ventricosa*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *musculus*	—	—	—	—	—	—	—	—	—	—	—	—	—
Stauroneis acuta	—	—	—	—	—	—	—	—	—	—	—	—	1
» *anceps f. gracilis*	—	—	—	—	—	—	—	1	—	—	—	1	1
» *phoenicenteron*	1	1	1	1	—	—	1	—	—	—	1	1	2
» *Smithii v. incisa*	—	—	—	—	—	—	—	—	—	—	—	—	1
» *sp.*	—	—	—	—	—	—	—	—	—	—	—	—	—
Stephanodiscus astraea	—	—	1	1	1	—	—	2	1	1	1	—	1
» *dubius*	—	—	—	—	—	—	—	—	—	—	—	—	—
Surirella didyma?	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *robusta*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *striatula*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *turgida*	—	—	—	—	—	—	—	—	—	—	—	—	—
Synedra affinis	—	—	—	—	—	—	—	—	—	—	—	—	—
» *crystallina*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pulchella*	—	—	—	—	—	—	—	1	1	1	1	—	—
» *sp.*	—	—	—	—	—	—	—	1	—	1	—	—	—
Tabellaria spp.	—	—	—	—	—	—	—	—	—	1	—	—	—
Thalassiosira baltica	—	—	—	—	—	—	—	—	—	—	—	—	—
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mossen Bog											The 24 metre Bog																			
14	15	16	17	18	19	20	21	22	23	24	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	2	3	4	5
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		1															1													
		1	1																1		1	1	1	1	1		1	1	1	
	1	1			1	1		1											2	3	2	2	1	1	1		1	2	1	1
	1																					1								
1	1					1		1	1		1		1									1								
								1														1								
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												1	1																	
												1		1																
												1	1	1		1	1	1												
	1					1						2	3		1															
													1		1															
1			1		1												1													
																	1													
																1		1												
		1																	1	2	1	1	1	2	1		2	2	3	1
5	3	2	4	2	1	2	2	2	3	2	4	2	2			1	1	1		1		1			1					1
																1	1													
	1	1	2	1	3	1	2	1	1			1		1	1	1	2	1				1		1						
1		1	1	1	1	1	1	1	1	1				1			1	1	1	1		2	1	1				1		
			1				1					1					1			1			1	1						
												3	2	1	1	1														1
1	1																													
1		1	1			1	1	1	1	1					1															
				1																	1	1								
													1																	
2	1	1	3	1	1	3	2	2	2	4								1	4	2		3	4	5	2		1	1	1	2
																						1								
																												1		1
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								1																						
												1	1	1				1												
																					1	1								
																							1	1						
												2	1	4	4	4	3	1												1
												1	1																	
	1			1	1		1					1	1	1		1	1													
1				1						1										1		1	1						1	
	1		1	1	1	1	1		1	1								1		1	1	1	1	1	1				1	
															1	2	1													
	1																													

repeat what I emphasised in connection with Gallträsk and Hanaböle. The fall of the curve (minus direction) may only mean a decrease of the diatom flora, when the ecological conditions changed rather suddenly — fresh water changed to brackish. This conclusion is supported by the fact that no change occurs in the quality of the sediment itself during this apparent regression. On the contrary, sample No. 38, in my opinion, indicates rather deeper water than sample 37 above it (fine detritus ooze), though the curve drawn on the basis of the diatoms tends to rise at the point of the latter or to prove a transgression. I am inclined, however, to explain this rise by the marine conditions being stabilised at the level of sample 37 and the diatom flora corresponding to these new conditions at the same time having had time to develop fully.

In any case it should be considered certain that the time of the Littorina Sea maximum, according to this diagram too, is situated in the beginning of the Littorina period. The point of the profile separates from the sea, when the shore-line was still at least 20.4 m. above sea-level. This figure corresponds to the level of the threshold of the bog and of the separation contact of the profile which is now at a depth of 3.4 m. in the profile. It is evident from the pollen diagram that the shore of that time receded past the place, at a slow rate, as the dominant *Alnus* maximum in the coarse detritus ooze (3.4—3.6 m.) proves that the shore-line lay, at any rate for some time, in immediate proximity to the bog. We must remember that two raised beaches exist in the neighbourhood of the Tattarisuo bog: 21.5 m. and 24.5 m. above sea-level. The *Alnus* maximum of the pollen diagram, formed when the local shore-line was close to the bog, slightly above the 20 m. level, corresponds chronologically, if not to both, at least to the lower of these raised shores. In the retreat of the shore this phase signifies at least a short intermission in the regression, possibly even a small transgression. The diatom curve for the displacement of the shore-level rises slightly at the *Alnus* peak (sample 32) and is in agreement with the above conclusion.

On the basis of the pollen diagram dealt with above I place both these shore phases (21.5 m. and 24.5 m. above sea-level) in the Littorina period. The *Alnus* maximum, indeed, renders the dating more difficult in this case, as it interrupts (arithmetically) the continuous field of the mixed oak forests too early in the diagram, whereas in reality the warm period of the Littorina Sea still continued. I can still more convincingly prove this conclusion of mine to be correct by the stratigraphy of another bog at a lower level which I investigated. Before passing on to this it is necessary to revert, in connection with the bog under consideration, to a methodological question concerning the pollen analysis which remained unsettled, when the stratigraphy of the Pottmossen bog was discussed (page 38, 40—41).

It will be recalled that the pollen diagram of the Pottmossen bog (Fig. 11, page 39) apparently leads to the conclusion that the Littorina Sea remained at about a level of at least 27 m. up to the end of the Littorina period. If we compare the isolation contacts of Pottmossen and of the bog we are dealing with, we find that in regard to their pollen content they are nearly of the same age. The separation contact means in both bogs the separation from the Littorina Sea, which occurred on the Pottmossen bog, when the shore-line was at least 27 m. above sea-level, and in the latter bog 20.6 m. above sea-level. As the isolation contact at Pottmossen is thus over 6 m. higher in level than the latter, it is also respectively older than the 20.6 m. separation level. Consequently, the employment of pollen statistics solely in dating does not lead to an exact result in this case either. In connection with the Pottmossen bog I have already dealt with the possibilities of error in pollen chronology, when it is a case of pollen accumulation influenced by the conditions on the shore. The pollen correlation established above, on the basis of which two isolation levels of different age appear to be contemporaneous, leads to the following further conclusions.

Pollen sedimentation in the shore zone is affected very much by the local forest of the shore zone (cf. E. Hyyppä 1932, p. 18, U. Sundelin 1919, Malmström 1923, Lundquist 1925). Pollen assemblage that is embedded in the accumulating soil under the close influence of such a shore stand is dominated by deciduous trees as a rule and contains a disproportionate quantity of *Alnus* in particular. At times, however, as we have already seen in connection with the Pottmossen bog, conifers can be concentrated in shore sediments. When the shore-line subsequently retreats from the place, an actual zone of deciduous trees follows after, but the former shore zone becomes comparatively richer in conifers. The association of tree species in the shore zone and in the zone further inland may thus in certain cases be locally so different that the synchronous deposits representing them may have a pollen composition widely differing from each other. The divergence of the pollen flora is also increased by the accumulation itself, which may occur in a very haphazard manner in the shore zone, favouring a disproportionately large share of deciduous trees in one place and of conifers in another in its composition. Localities subjected to the influence of the shore have nevertheless been able to grow forests of the same type and be in other respects in the same sedimentation conditions in quite different periods, so that in regard to their pollen composition they appear to be misleadingly synchronous. These sources of error do not affect a rough determination of age, but especially in investigating the displacement of the shoreline of the Littorina Sea, particularly when it is a case of exact dating and small differences in time, this possibility of error should be carefully borne in mind. For it is obvious that in such cases a zone division based on the pollen flora cannot be employed for an exact chronology. This question will be further elucidated in connection with the stratigraphy of the next bog.

Tattarisuo Bog.

Fig. 16, page 56, illustrates the stratigraphy of the bored profile on Tattarisuo bog itself (*Pinus* »Highmoor», investigation area No. 6). On the edge of the bog there is a raised shore, 30 m. above sea-level, which represents the local maximum limit of the Littorina Sea, as has already been demonstrated (page 38). There is a little Ancylus Lake clay ooze on the bottom of the bog, followed by a layer of sand. According to the evidence of the diatoms the contact between Ancylus and Littorina is in the upper part of the sand bed. Thus this layer represents the last phase of the Ancylus regression. According to the evidence of the diatoms (Table V, analysed by A. Cleve-Euler) the development of the Littorina Sea proceeded in the same way as was established by the former bogs. The curve for the fall of the water-level is more even, however, so that it is not easy to determine the point for the period of the Littorina maximum in the profile by means of it. This is, of course, due to the fact that the water was comparatively deep on the site of the bog throughout the whole of the first half of the Littorina period. The lowering of the shore-level and its delays are not felt so sensitively in the development of the diatom flora as in the shallow water zones close to the limit of the Littorina Sea.

In this case it is therefore more important to pay attention to the point in the profile formed when the separation from the sea occurred. The threshold of the bog is about 15 m. above sea-level. The coarse detritus ooze, 3.0—3.2 m., represents the isolation phase, when the shore was thus situated about 15 m. above sea-level. The diatoms of sample 452 are already proof of fairly shallow water. The continuous field of mixed oak forests ends at the separation zone.

This points to the fact that the Littorina period ends approximately at the time, when the site was separated from the sea or the shore-line stood at about 15 m. above sea-level. We must remember that on the area of the Tattarisuo bog, as in many other places in the neighbourhood of Helsinki, there is an ancient shore situated at 17.5 m. above sea-level. This beach phase is therefore situated in a period preceding the isolation and belongs to the period of the Littorina Sea. It represents the last delay in the retreat of the shore-line that occurred during the time of the Littorina Sea or a slight transgression.

According to G. Brander (1933) the Fredriksberg bog, lying about 4 km. to the north of Helsinki, separates from the sea, when the shore-line is situated 17.5 m. above sea-level. This level represents the final phase of the Littorina period in Brander's pollen diagram and thus leads, as regards the 17 m. shore-line, to precisely the same chronological result as the Tattarisuo diagram. The stratigraphy of the Fredriksberg bog is very similar to the Tattarisuo bog in other respects, too.

Above I came to the conclusion that the Littorina Sea period ended forest-historically in the Helsinki neighbourhood, when the shore-level was situated about 15 m. above the sea. This dating is based principally on the fact that the mixed oak forests now finally decrease and spruce rises rapidly in association with pine, both of which become the dominating trees. This great change in the composition of the pollen flora is not due, *e. g.* in the case of the Tattarisuo bog, to local factors, but means that a regional change occurred in the climate itself.

The Littorina sequence of Tattarisuo comprises all the four shore phases of the Littorina Sea: 30 m., 24.5 m., 21.5 m. and 17.5 m. above sea-level. The lithology of the deposit and the diatoms do not present any feature that would warrant the conclusion that any considerable transgression occurred at this place during the existence the Littorina Sea. I interpret the beaches referred to as having been formed during the intermissions in the lowering of the shore-line. The latter left no signs suggesting a transgression in the deposits, as is the case, for instance, on the Karelian Isthmus (E. Hyyppä 1932).

Before leaving the Tattarisuo diagram I will compare it with the diagram of the previous bog, Fig. 14, page 39. If we correlate these diagrams solely on the basis of the similarity of the pollen spectrum we will again conclude that the separation from the sea occurred on both bogs more or less simultaneously, whereas actually it occurred

Table V.

rr = 1, r = 2, + = 3, c = 4, cc = 5 Anal.: A. Cleve-Euler	Tattari-					
	452	453	454	455	456	457
Achnanthes brevipes Ag. and v. intermedia Kg.	—	—	—	r	r	r
» *longipes Ag.*	—	—	—	r	—	—
Amphora commutata Grun.	—	—	—	—	—	—
» *mexicana v. major (Cl.)*	—	—	—	—	—	—
» *libyca E.*	r	—	—	—	—	—
» *pediculus Grun.*	r	—	—	—	—	—
Anomoeoneis sculpta (E.) Cl.	r	—	—	—	—	—
Caloneis amphisbaena v. subsalina Donk.	—	—	—	—	—	—
» *bacillaris v. lacunarum Grun.*	—	—	—	—	—	r
» *formosa v. holmiensis Cl.*	r	+	—	—	—	—
» *silicula (E.) Cl.*	r	—	—	—	—	—
Campylodiscus bicostatus W. Sm.	r	r	—	r	r	—
» *clypeus E.*	r	r	rr	—	—	—
» *echineis E.*	c	cc	cc	r	+	r
Cocconeis pediculus E.	—	—	—	+	r	r
» *scutellum E. and v. ornata Grun.*	—	—	—	r	+	c
Coscinodiscus asteromphalus E.	—	—	—	—	rr	rr
» *septentrionalis Grun.*	—	—	—	—	r	—
Diploneis Boldtiana Cl. v. robusta A. Cl.	—	—	—	—	—	—
» *didyma (E.) Cl.*	—	r	rr	r	—	—
» *incurvata (Greg.) Cl.*	—	—	—	—	—	—
» *interrupta (Kg.) Cl.*	—	—	—	—	—	—
» *Smithii Breb.*	—	—	—	—	—	r
» » *v. rhombica A. Cl.*	—	r	rr	r	—	—
Epithemia sorex Kg.	r	—	—	—	—	—
» *turgida (E.) Kg. and v. Westermannii Kg. (B)*	r	r	—	c	c	c
» *zebra (E.) Kg. and v. proboscidea Grun.*	r	r	—	—	—	—
Eunotia exigua Breb. and v. paludosa Grun.	r	—	—	—	—	—
» *lunaris (E.) Grun.*	+	—	—	—	—	—
» *septentrionalis Ostr. v. Clevei A. Cl.*	r	—	—	—	—	—
Fragilaria mutabilis Grun.	—	—	—	—	—	—
» » *v. intercedens Grun.*	—	—	—	—	—	r
Grammatophora oceanica E.	—	—	—	r	r	+
Gyrosigma balticum (E.) Cl.	—	—	—	—	r	—
» *attenuatum (Kg.) Cl.*	—	—	—	—	—	—
» *scalproides v. eximia Thw.*	—	—	—	—	—	—
Hyalodiscus scoticus (Ag.) Grun.	—	—	—	—	—	—
Mastogloia Braunii v. pumila Grun.	r	—	—	—	—	—
» *elliptica Ag.*	—	—	—	—	—	—
» *Smithii Thw.*	r	—	—	—	—	—
Melosira arenaria Moore	—	—	—	—	—	—
» *Borreri Grev.*	—	rr	—	c	c	+
» *Jürgensii Ag.*	r	r	—	—	—	—
» *nummuloides (Dillw.) C. Ag.*	—	—	—	—	—	—
Navicula cincta E.	r	—	—	—	—	—
» *digito-radiata Greg.*	—	—	—	—	—	—
» *humerosa Breb.*	—	—	—	—	—	—
» *rhombica Greg.*	—	—	—	—	—	—
» *rhynchocephala v. amphiceros Kg.*	r	—	—	—	—	—

suo Bog

458	459	460	461	462	463	464	465	466	467	468	469	470	471	473	474
—	r	r	r	r	—	—	—	—	—	—	—	—	—	—	—
—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—
—	r	—	r	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	r	r	—	—	—	—	—
—	—	—	—	—	—	r	r	—	r	—	—	r	r	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
rr	r	r	r	—	+	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
rr	r	r	r	—	r	—	rr	r	r	—	r	r	r	—	r
r	r	—	r	—	r	rr	—	—	—	—		r	r	—	—
c	+	+	+	r	r	+	+	r	r	r	r	—	r	—	—
rr	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	r	r	+	+	—	—	r	r	r	r	+	+	r	—	—
—	—	—	—	—	—	—	—	—	—	—	—	rr	—	—	—
—	r	—	r	r	r	r	—	—	—	r	—	—	r	—	—
—	—	r	—	—	—	—	r	r	+	—	—	—	r	—	—
—	r	—	—	—	r	r	—	—	—	—	—	—	r	—	—
r	r	—	r	r	r	r	r	r	r	+	r	r	r	—	rr
—	r	r	r	r	—	r	r	r	r	+	+	r	r	—	rr
—	—	—	—	—	r	—	r	—	—	—	—	—	—	—	—
+	c	c	c	+	+	c	+	c	+	c	c	c	cc	r	+
—	r	—	r	r	r	r	—	—	—	—	—	—	r	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—
r	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—
r	r	r	+	+	r	r	r	r	+	+	+	r	r	—	r
—	r	r	—	+	+	c	c	c	+	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	+	+	+	+	—	—	r
—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—
r	r	r	r	—	—	r	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—
—	—	—	—	—	—	rr	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—
+	c	+	+	+	+	r	+	r	r	+	+	+	+	—	r
r	r	—	r	—	—	—	—	—	—	—	—	—	r	—	—
—	—	—	—	r	r	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	r	r	—	—	—	—
—	r	—	—	—	—	—	—	—	r	r	r	r	r	—	—
r	r	—	r	r	r	r	+	r	—	—	r	—	r	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

rr = 1, r = 2, + = 3, c = 4, cc = 5, Anal.: A. Cleve—Euler	Tattari-					
	452	453	454	455	456	457
Navicula peregrina E.	+	—	—	r	—	—
» » *v. kefvingensis E.*	c	—	—	—	—	—
» *punctulata v. cluthensis Greg.*	r	r	—	—	—	—
» *pusilla W. Sm.*	c	—	—	—	—	—
Nitzschia acuminata (W. Sm.) Grun.	—	r	—	—	—	—
» *circumsuta (Bail.) Grun.*	—	c	+	—	r	—
» *hungarica Grun.*	+	—	—	—	—	—
» *marginulata Grun.*	r	—	—	—	—	—
» *navicularis (Breb.) Grun. v. elongata A. Cl.*	—	—	—	—	—	—
» *obtusa W. Sm.*	c	—	—	—	—	—
» *punctata (W. Sm.) Grun.*	r	r	r	—	—	—
» » *v. elongata Grun.*	—	—	r	+	+	+
» *sigma W. Sm.*	—	—	—	—	r	—
» *socialis Greg.*	—	—	—	—	—	r
» *tryblionella Hantzsch*	+	r	—	—	—	—
» *(» v. ?) littoralis Grun.*	—	—	—	—	—	—
» » *v. Victoriae Grun.*	—	—	—	—	—	r
Pinnularia quadratarea A. S. v. subproducta Grun.	—	—	—	—	—	—
» *brevicostata Cl., cuneata Ostr., esox. E., Lagerstedtii*	—	—	—	—	—	—
(Cl.), major Kg., stauroptera v. parva V. H., viridis	—	—	—	—	—	—
Nitzsch.	c	—	—	—	—	—
Rhabdonema arcuatum (Ag.) Kg.	—	—	—	—	—	r
» *minutum Kg.*	—	—	—	—	—	—
Rhoicosphenia curvata (Kg.) Grun.	—	—	—	—	—	r
Rhopalodia gibba (E.) O. M. and v. ventricosa Grun.	—	—	—	—	—	—
» *musculus (Kg.) O. M.*	—	—	—	—	—	—
Surirella ovalis Breb.	r	—	—	—	—	—
» *striatula Turp.*	r	r	r	r	r	r
Synedra affinis Kg.	r	rr	—	r	r	+
» *crystallina (Lyngb.) Kg.*	—	—	—	r	r	r
Thalassiosira baltica (Grun.) Ostf.	—	—	—	—	—	—
Terpsinoë americana Bail.	—	—	—	—	—	—

in the case of the former profile at the 20 m. level and in the Tattarisuo profile at a level of about 15 m. This is obviously a case of a facies of pollen assemblage accumulated under similar conditions, though they are not quite equal in age. In the Tattarisuo bog the upper limit of the mixed oak forests and of the mass-appearance of deciduous trees is slightly later than on the former bog. If, finally, we compare the Pottmossen bog (Fig. 11, 12, page 39) with these two bogs, we find that their isolation contacts do not present any considerable difference in age in the light of the pollen statistics, notwithstanding that the difference in the level of the separation contact, and consequently the actual difference in age, is appreciable. The separation contact of the Pottmossen bog (27 m. above sea-level) belongs to the early part of the Littorina period, while the same suo Bog

458	459	460	461	462	463	464	465	466	467	468	469	470	471	473	474
—	r	r	+	+	+	c	+	+	+	c	c	+	r	—	r
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
r	r	—	r	—	—	—	—	—	—	—	—	—	r	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
r	—	r	r	—	—	r	—	—	—	r	—	—	—	—	—
—	—	r	—	—	—	—	—	r	—	—	—	—	—	—	—
—	r	r	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	r	—	—	r	—	—	—	r	r	r	—	—	—
—	r	rr	—	r	—	—	—	—	r	r	r	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	rr
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
r	+	+	+	+	+	+	+	+	+	+	+	+	c	r	rr
rr	—	r	—	—	—	+	r	r	—	—	+	r	—	—	—
—	—	r	—	—	r	r	—	—	—	—	—	—	—	—	—
—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—
—	—	—	r	r	r	r	r	r	—	—	r	—	r	—	—
—	r	—	—	r	r	—	r	—	—	—	r	—	—	—	r
—	—	—	—	—	—	r	r	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	r	rr	—	r	rr	r	r	r	r	—	—	—	—	—	—
—	r	—	—	—	—	—	r	—	—	—	—	—	—	—	—
r	r	r	r	—	—	r	—	—	—	—	—	—	—	—	—
—	—	—	r	—	r	r	r	r	r	r	—	r	+	—	—
r	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—
—	—	—	—	—	r	—	—	r	—	—	—	r	—	—	—
—	r	—	r	r	r	—	r	r	r	—	r	r	—	—	—
c	c	+	c	—	r	c	+	—	r	r	r	—	r	—	—
r	+	r	—	—	—	—	r	—	—	—	—	—	—	—	—
—	—	r	r	—	r	r	r	—	—	—	—	r	r	—	—
—	r	—	—	—	—	—	—	—	r	—	—	—	—	—	—

of the Tattarisuo bog, for instance, (about 15 m above sea-level) represents the end of the Littorina period. Here it seems fairly evident that pollen content sedimented under the influence of the shore is not suitable by itself as a basis for a zone division that assumes fully synchronous limits nor for any other chronological division that demands great accuracy.

THE STRATIGRAPHY OF THE PEAT BOGS ABOVE THE MAXIMUM LIMIT OF THE LITTORINA SEA.

About 5 km. N.N.W. of the Helsinki parish church (investigation area No. 27) lies a large convex »Highmoor», the stratigraphy of which is illustrated by Fig. 17, page 56. The upper part, which is

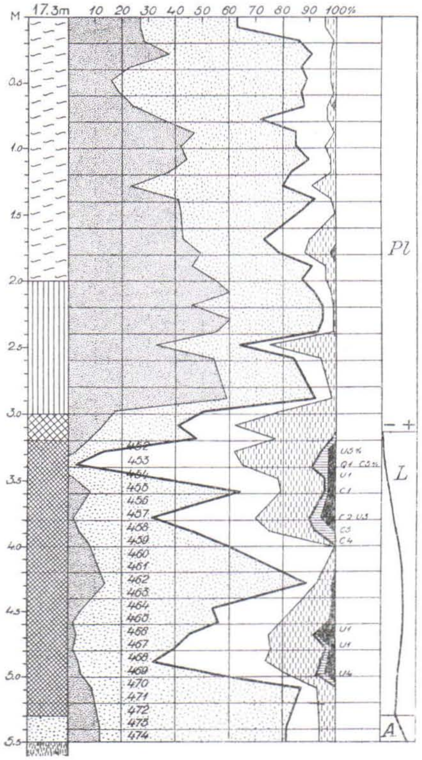

Fig. 16.

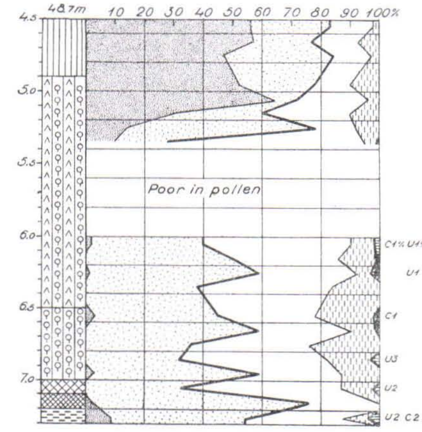

Fig. 17.

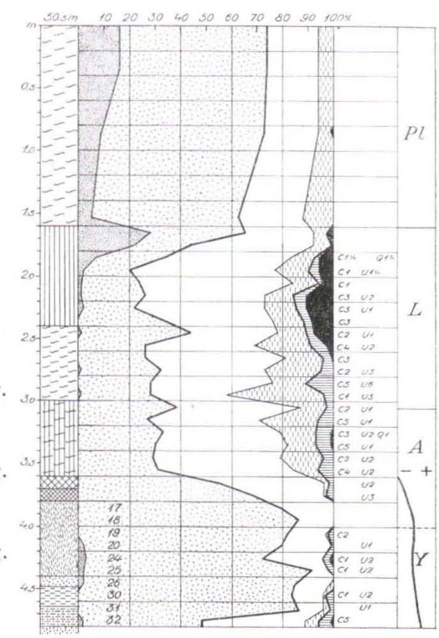

Fig. 18.

Fig. 16. Profile of the Tattarisuo bog. Analyst E. Hyyppä.

Fig. 17. Profile of the 48.7 metre bog. Analyst E. Hyyppä.

Fig. 18. Profile of the Rusutjärvi bog. Analyst E. Aurola.

superfluous in this case for the chronology, has been omitted. On the bottom of the bog there is clay containing a low quantity of *Gyrosigma attenuatum* and *Melosira arenaria*. The pollen flora in the same layer of clay is late-Glacial in type, chiefly owing to the comparatively high quantity of *Picea*. The scarcity of pollen contained in the clay does not contradict this conclusion, but the age of the deposit cannot be established with certainty. The fine detritus ooze above the clay, on the contrary, certainly belongs to the Ancylus period and in my opinion rather to its first half. Whether it represents the peak of the Ancylus transgression or a later level, cannot, however, be concluded on the basis of this profile. The lower limit of the fine detritus ooze is 41.5 m. above sea-level. The threshold of this bog basin is at approximately the same level. The fine detritus ooze therefore represents a phase of the Ancylus Lake, when the shore-level was, at an estimate, about 45 m. above the sea. In Korso, which is on nearly the same isobase as this bog as regards the land uplift, there are two raised shores, the lower one 43.3 m. and the higher one 47 m. above sea-level. It seems certain, therefore, that these beaches represent delays or transgressions that occurred in the change of the shore-line during the Ancylus Lake period. The stratigraphy of this bog, however, does not provide any certainty as to whether the higher or 47 m. shore represents the Ancylus transgression maximum in this area or whether that transgression peak possibly stands still higher.

R u s u t j ä r v i. At Tuusula, at the N.W. end of the small Rusutjärvi lake, (investigation area No. 28), there is a shore swamp the profile of which is illustrated by Fig. 18. At the bottom of the swamp there is at first sand mixed with clay which soon grades over into pure clay, the latter being succeeded by a thin sand bed (sample 26). The whole of this succession of layers represents, according to the diatom flora (Table VI, Rusutjärvi swamp 17—32), deep fresh water, though this grows shallower gradually. The layer of sand referred to seems to signify a change in the conditions, for from this point a regression is seen more clearly in the composition of the diatom flora, and special attention is attracted by some *Mastogloia* species which begin to appear more abundantly among the diatoms, starting from the sand layer, up to sample 18. The sediment also passes above the sand bed into clay ooze. These *Mastogloia* species: *M. elliptica*, *M. elliptica* v. *dansei*, *M. Grevillei*, *M. Smithii* v. *amphicephala*, *M. Smithii* v. *lacustris*, however, appear very sparsely, with the exception of *M. Grevillei*. Of these *Mastogloia* species not a single one is a convincing proof of brackish water at that time, especially as there are no other salt-water species in association with them in the sediment mentioned. It is, nevertheless, possible that they indicate a very faint saline stimulation and evidently at any rate the fact that a change occurred in the ecological conditions, when the sand bed (sample 26) was deposited.

Table VI.

Anal. K. Salminen.	Rusutjärvi Swamp									
	17	18	19	20	24	25	26	30	31	32
Achnanthes calcar	—	—	—	—	1	—	—	—	—	—
» *lanceolata v. elliptica*	—	—	—	1	1	1	1	1	1	—
Amphora ovalis	3	2	2	1	—	2	2	1	2	1
» » *v. libyca*	—	2	—	1	1	1	2	1	2	1
» » *v. pediculus*	—	—	—	—	1	—	—	—	—	—
Caloneis latiuscula	—	—	—	1	—	1	1	—	—	—
» *Schumanniana v. biconstricta*	—	1	1	—	—	1	—	—	—	—
» *silicula*	—	1	—	1	—	—	—	—	—	—
Campylodiscus noricus	1	1	1	1	—	—	—	—	—	—
» » *v. hibernica*	1	1	2	2	1	1	3	1	2	1
Cocconeis diminuta	—	1	1	—	—	—	—	—	—	—
» *pediculus*	—	—	—	—	—	1	—	—	—	—
» *placentula*	—	1	1	1	3	—	—	—	1	—
Cyclotella bodanica	—	—	—	—	—	1	—	—	—	—
» *Kützingiana*	—	—	—	—	—	1	—	—	—	—
Cymatopleura elliptica	1	2	1	1	1	—	2	—	1	1
» » *v. hibernica*	—	—	—	—	—	—	—	—	1	—
» » *v. nobilis*	—	—	1	—	—	—	—	—	—	—
» *solea*	—	—	1	—	—	1	—	—	—	—
Cymbella aspera	1	—	—	1	—	—	—	—	—	—
» *cuspidata*	—	1	—	1	—	—	—	—	—	—
» *Ehrenbergii*	1	—	—	—	—	—	—	—	—	—
» *lanceolata*	—	—	—	—	—	2	—	—	—	—
» *lata*	—	1	2	—	—	—	—	—	—	—
» *prostrata*	1	2	1	1	1	1	1	1	2	1
» *spp.*	—	—	2	1	1	4	—	1	1	1
» *tumida*	1	—	—	—	—	1	—	—	—	—
Diploneis domblittensis	1	4	2	4	1	1	5	4	4	4
» » *v. subconstricta*	1	—	—	1	—	1	1	1	1	—
» *elliptica*	—	1	2	1	1	1	1	—	1	1
» » *v. ladogensis*	—	1	1	—	—	—	—	—	—	—
» *Mauleri*	1	1	2	1	1	1	2	1	—	—
» *ovalis*	—	—	—	—	—	1	—	—	—	—
Epithemia argus	—	1	1	—	1	2	2	—	1	—
» *Hyndmanni*	1	1	1	—	1	1	1	1	—	—
» *intermedia*	—	2	1	1	—	—	—	—	1	—
» *sorex*	—	1	1	—	—	2	—	—	—	—
» *turgida*	1	2	2	1	1	2	1	—	1	1
» » *v. granulata*	—	1	2	1	—	—	—	—	—	—
» » *v. Westermanni*	—	2	3	—	1	1	2	1	1	—
» *zebra*	—	5	5	5	4	3	3	1	2	—
» » *v. porcellus*	—	3	3	1	—	1	—	—	1	—
Eunotia spp.	—	—	1	—	—	—	—	—	—	—
Fragilaria spp.	—	—	—	—	1	2	—	—	—	—
Frustulia sp.	—	—	1	—	—	—	—	—	—	—
Gomphonema constrictum	—	—	1	—	—	1	—	—	—	—
» *spp.*	—	—	1	—	—	1	—	—	—	—
Gyrosigma acuminatum	—	1	2	1	1	2	—	—	—	—
» *attenuatum*	5	3	3	4	1	3	5	5	5	4
Hantzschia sp.	—	—	—	—	—	—	—	—	1	—

	Rusutjärvi Swamp									
	17	18	19	20	24	25	26	30	31	32
Mastogloia elliptica	—	1	1	1	—	—	1	—	—	—
» » *v. dansei*	—	—	—	1	—	—	—	—	—	—
» *Grevillei*	—	4	3	1	1	1	2	—	—	—
» *Smithii v. amphicephala*	—	1	1	—	—	—	—	—	—	—
» » *v. lacustris*	—	1	2	1	—	1	1	—	1	—
Melosira arenaria	—	1	1	1	1	1	1	1	—	—
» *islandica subspec. helvetica*	1	5	5	5	2	3	3	2	5	5
Navicula bacillum	—	—	—	—	—	—	—	—	1	—
» *cocconeiformis*	—	1	1	1	5	2	3	1	2	—
» *gastrum*	—	1	—	—	—	—	—	—	—	—
» *Jentzschii*	—	1	1	1	—	1	5	—	—	—
» *placentula*	—	1	—	1	—	1	1	—	1	—
» » *f. rostrata*	—	—	1	—	—	—	—	—	—	—
» *platystoma*	—	1	1	—	—	—	—	—	—	—
» *mutica v. Cohnii*	—	1	—	—	—	1	2	—	—	—
» *radiosa*	—	1	1	—	—	—	—	—	—	—
» *Reinhardtii*	—	—	1	—	—	—	—	—	—	—
» *tuscula*	—	1	2	1	5	1	—	—	—	—
Neidium spp.	—	1	1	2	—	1	—	—	1	—
Nitzschia sigmoidea	—	—	1	—	—	—	—	—	—	—
» *tryblionella v. debilis*	—	1	—	—	—	—	—	—	—	—
» » *v. victoriae*	—	—	—	—	—	1	—	—	—	—
Opephora Martyi	—	1	1	1	2	1	2	1	—	1
Pinnularia spp.	1	—	—	1	1	1	—	1	—	—
Rhoicosphenia curvata	—	—	—	—	—	1	—	—	—	—
Rhopalodia gibba	—	1	1	1	—	2	—	—	—	—
» *musculus*	—	—	1	—	—	—	—	—	—	—
Stauroneis Smithii	—	—	1	—	—	—	—	—	—	—
Stephanodiscus astraea	—	2	1	—	—	1	—	—	1	—
Surirella biseriata	—	—	1	—	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	1	—	—	—	—
Synedra spp.	—	—	1	—	—	—	—	—	—	—
Tabellaria spp.	—	1	1	1	—	1	—	—	—	—

From the point of view of the development of the Baltic the formation of the sandy layer may signify one of those numerous falls in the water-level which M. Sauramo has shown to be included in the changes of the late-Glacial shore-line (M. Sauramo 1934, 1937). Such a layer of sand may, however, originate otherwise during a regression or transgression, without any sudden fall of the water surface and they are fairly general in the aqueous sediments laid down during various phases of the Baltic (cf. B. Halden 1917). The significance of the sand layer as regards the displacement of the shore-line cannot be explained with certainty in this case. On the basis of the pollen analysis, however, it seems certain that the succession of strata, reckoning from the bottom to the sand bed, belongs to the late-Glacial period and particularly to the Yoldia period. I have referred the upper part of the layer of ooze to Ancylus. Sample 18 should represent the maximum of the Ancylus transgression. The curve for the changes of the water-level based on the composition of the diatoms rises at this point, and the pine maximum as well as the absence of alder and mixed oak forests occur at the same level. The peak of pine and the contemporaneous absence of alder and rarer deciduous trees, or at any rate their very scarce appearance, are typical in South Finland of the Ancylus transgression period.

The limit between Ancylus and Yoldia is, however, uncertain in this case and is marked in the diagram by a line of dashes. The *Mastcgloia* species referred to appear on both sides of this limit, *i. e.*, both in Yoldia and Ancylus, so that they cannot be considered, at any rate in this case, to prove any special *Mastogloia* phase in the history of the Baltic. Least of all can they be regarded in this place as the first newcomers of the Littorina Sea, as the Littorina period begins after their appearance, at a time, when Lake Rusutjärvi had for a long time been separated from the sea and when the formation of terrestrial peat on this site had had a good start. The Littorina period looks in the diagram as a very prominent field of mixed oak forests.

Close to the Rusutjärvi swamp there is a large abrasion cliff at the N.W. end of the lake cut into an esker slope facing the lake, its foot being 64.8 m. above sea-level according to the measurements of G. Rudeberg (1925 a). This beach, according to Rudeberg, is the Ancylus limit, though he has no stratigraphical evidence for his dating. Neither does the Rusutjärvi swamp prove the age of this shore-line with complete certainty. The threshold of the swamp is about 42 m. above sea-level. The level of clay ooze belonging to the Ancylus period is 46 m. above the sea. The Ancylus transgression maximum therefore in any case rose above this level.

In this connection it should also be mentioned that boulder rims formed on an ancient shore appear in the Helsinki neighbourhood at an average level of 37 m. above the sea. G. R. Rudeberg (1925 a) established this shore-line to the N.E. of Tikkurila. I have myself found this beach in the same area, but it was badly developed.

I will return later to these shores of the Helsinki neighbourhood and to the, lying above the Littorina limit, in connection with the relation diagram. The peat bogs at my disposal at present do not yield any further evidence relating to their age relations.

THE CHANGES OF THE SHORE-LINE IN THE HELSINKI NEIGHBOURHOOD SINCE THE LITTORINA PERIOD.

In this chapter I will briefly recapitulate the results arrived at.
1. The maximum limit of the Littorina Sea in the Helsinki neighbourhood is 30 m. above sea-level in the S.E. part of the area and 34.5 m. above sea-level on its N. W. boundary. Fig. 19 illustrates the respective areas of land and water at that time and the isobases of the highest level of the Littorina Sea. The possible transgression on the maximum limit of the Littorina Sea does not exceed 2 m. according to the evidence of the stratigraphy of the bogs. In any case an intermission occurred then in the retreat of the shore-line. Judging by the diatoms, the regression seems to have continued for a short time after the brackish water had penetrated into the Baltic. This result provided by the diatoms is, however, not quite certain, as it may merely be due to an ecologically abrupt change in the salinity of the water, which would result in a temporary decline in the development of the diatom flora. The maximum limit of the Littorina Sea falls in time within the very beginning of the Littorina period, and the *Clypeus* limit is here the same as the Littorina limit or LI. No *Mastogloia* phase belonging to the Littorina period can be distinguished in the Helsinki neighbourhood.

2. The Littorina period of the Helsinki neighbourhood further includes three phases of delay in the changes of the shore-line, which neither signify any considerable encroachment of the sea upon the land. At places, where the Littorina maximum is 30 m. above sea-level, these later shores are 24.5, 21.5, and 17.5 m. above sea-level. The last of these beach phases is situated close to the end of the Littorina period, which I place at that point of the pollen diagram, at which the uninterrupted appearance of mixed oak forests ends and spruce is rising to its post-Glacial maximum. This boundary point is not always easy to determine exactly, as the shifts of the shore-line often permit the appearance of local factors affecting the deposition of the pollen too greatly.

3. After the Littorina period at least one more delay seems to have occurred in the displacement of the shore. The beach representing this is 13.5 m. above sea-level, where the Littorina limit is 30 m. On the basis of archaeological finds this shore phase is to be placed at the end of the Stone Age (see next chapter). Raised beaches are still to be found below this level, but in this connection nothing certain can be said of their significance.

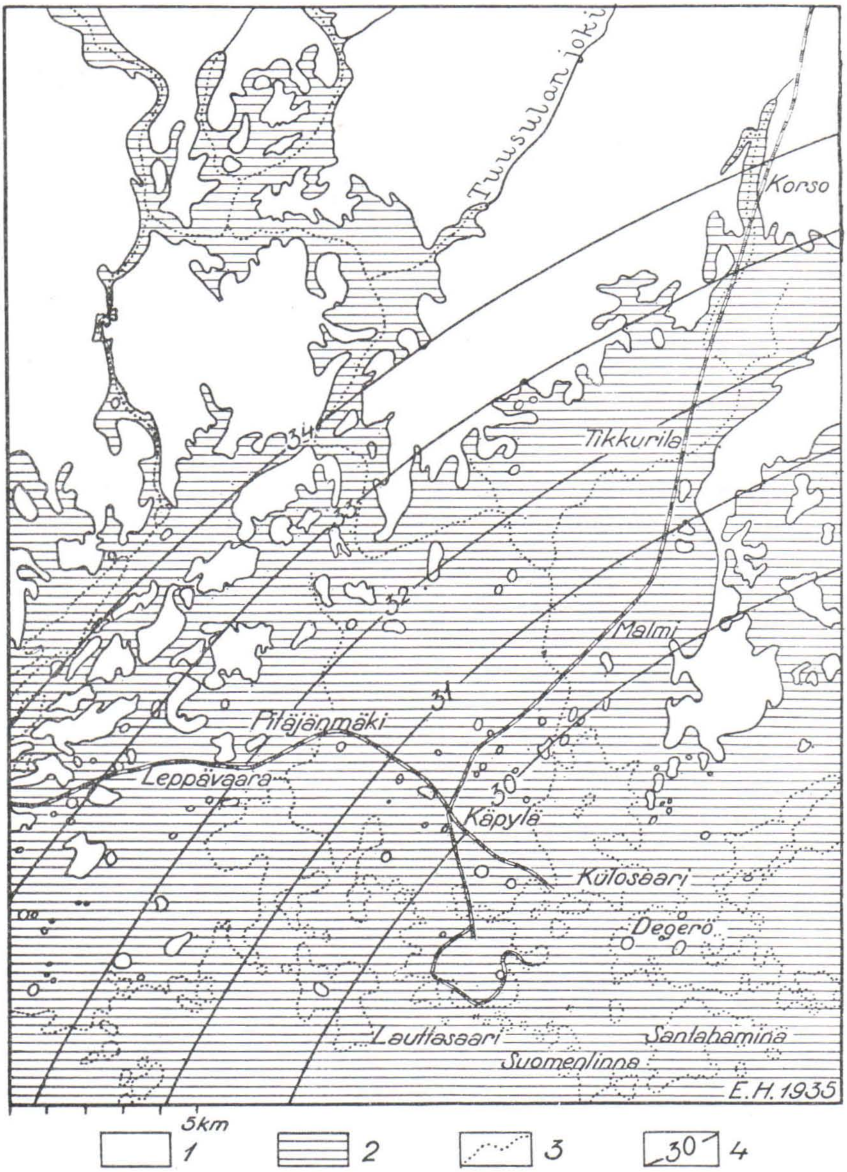

Fig. 19. Distribution of land and sea during the Littorina maximum (L I) in the Helsinki district. Explanation of sings:
1 = land, 2 = sea, 3 = present shore-line, rivers and lakes, 4 = L I isobases.

THE RELATION OF STONE AGE SETTLEMENT TO THE RETREAT OF THE COAST.

The displacement of the shore-line has been studied not only on the basis of the geological records, but also archaeologically, by investigating the Stone Age sites of settlement which are most frequently situated on the beach. A. Äyräpää (1926, 1930) has divided the Stone Age coastal sites of settlement, on the basis of the method of ornamentation of the pottery discovered on them, into style stages and has calculated the height of the dwelling sites that represent the different style stages in each district in percentages of the height of the oldest Littorina shore of the same neighbourhood. The percentages thus obtained, corresponding to the dwelling sites, one below the other, are nearly the same in the whole western part of South Finland. If, *e.g.*, we have in Espoo a Stone Age coastal dwelling site, the height of which is about 80 % of the highest Littorina shore of Espoo, then a coastal dwelling site belonging to the same style stage at Helsinki and therefore of the same age is also 80 % of the highest Littorina shore-line in the Helsinki neighbourhood. This must, of course, be the case, provided the equal-aged Stone Age coastal dwelling sites were originally situated at the same level.

Stone Age coastal dwelling sites belonging to different style stages thus represent beaches of different age, so that it is worth while examining, how they correspond in height to the shore-levels established on the basis of the geological records.

Up to the present only one certain Stone Age dwelling place has been discovered in the Helsinki neighbourhood (Storskogen between Tikkurila and Rekola). There are, indeed, plenty of scattered finds of solitary implements, but as they do not indicate the position of the beach with sufficient precision, it is impossible to correlate the beach-levels of the Stone Age coastal dwelling places and the geological shore-lines by means of them. In the adjacent district of Espoo, however, Stone Age dwelling places are known on the basis of Äyräpää's investigations (1922) from the maximum limit of the Littorina transgression to the end of the Stone Age, so that they are very suitable for comparison with the raised shores in the Helsinki area. As the highest Littorina, owing to the different extent of land uplift, is 35 m. above sea-level at Espoo and 30 m. above sea-level at Helsinki, we cannot correlate the measured levels of the shores and dwelling places in themselves. The shore-levels of the Helsinki neighbourhood were first calculated in percentages of the highest Littorina shore-line of the neighbourhood (Littorina I = 30 m. above sea-level) and compared with the altitudes of the Espoo Stone Age coastal dwelling places, which were also calculated in percentages of the highest Littorina shore-line at Espoo (Littorina I = 35 m. above sea-level). The following table gives the results of the comparison.

Espoo Stone Age ornamental styles calculated in percentages of the highest Littorina shore at Espoo (35 m. above sea-level).		Raised shores of the Helsinki neighbourhood calculated in percentages of the highest Littorina shore of the area (30 m. above sea-level).	
I Early comb-ceramic ornamental style: 28—30.5 m. above sea-level	80—87 %	L II: 24.4 m. above sea-level	81 %
II Typical comb-ceramic ornamental style 26 m. above sea-level	74 »	L III: 21.5 m. above sea-level	72 »
III Debased comb-ceramic ornamental style: 23.5 m. above sea-level	67 »	No distinct shore-line.	
IV Cord-ceramic ornamental style: 21 m. above sea-level	60 »	L IV: 17.5 m. above sea-level	58 »
V Kiukainen culture: 16 m. above sea-level	46 »	Shore-line 13.5 m. above sea-level	45 »

This table shows that the Espoo Stone Age cultures actually correspond to the ancient shore-lines of the Helsinki neighbourhood. The corresponding percentages are almost the same, which is by no means due to chance, but to the fact that in South Finland the Stone Age settlement was concentrated on the coast and mostly at those levels, at which the beach remained on the same place for a long time. If there is any error, it is in the right direction, because a dwelling site is always situated somewhat above the edge of the water, so that it has a slightly higher percentage figure than the corresponding beach. No delay of the shore-line during the debased comb-ceramic period (III) has been established so far in the Helsinki neighbourhood. Possibly the shore did not remain at the same level for any length of time during this phase of culture, but the regression went on at a uniform rate from 21.5 m. (L III) to 17.5 m. (L IV).

The Storskogen Stone Age dwelling place (J. Leppäaho 1933 KM. 9663) discovered between Tikkurila and Rekola belongs, on the basis of its ornamental style, to the final phase of the early comb-ceramic ornamental style (I:2) or to a group, the level of which at Espoo is 80 % of the Littorina shore. The altitude of the Storskogen dwelling place (25.5 m. above sea-level) is also 80 % of the highest Littorina limit on the same site (32 m.), so that in regard to its level, too, it corresponds to the ornamental style referred to and at the same time is connected with Littorina II. The Suomusjärvi culture which is older and more primitive than the comb-ceramic settlement in South Finland, is associated with the earliest Littorina. The scattered finds representing this form of culture indicate that in the Helsinki neighbourhood, too, they were situated at the level of the earliest Littorina beach. Thus, *e. g.*, the dwelling place discovered at the village of Nisback in Tuusula (J. Leppäaho 1936 KM. 10336/36), which represents a typical Suomusjärvi culture, is 34—35.5 m. above sea-level or at the level of the local Littorina maximum.

The retreat of the coast described above, explained on a geological basis, is thus in complete agreement with the data regarding the phases of Stone Age settlement that are based on archaeological research.

PORVOO, VÄVARSBACKA.

The locality lies 12 km. N.E. of the town of Porvoo. M. Sauramo and A. Hellaakoski determined boulder ramparts on this site at 27—28 m. above sea-level (A. Äyräpää 1929). This level has been regarded as the Littorina limit of the district. I do not possess any shore-line data regarding this site, but there are three peat bogs that supply additional information concerning the changes of the shore.

STRATIGRAPHY OF THE PEAT BOGS.

Vävarsbacka Bog.

Fig. 20, page 67, illustrates the profile bored at one point on the cultivated bog situated N.W. of Vävarsbacka manor and its pollen diagram (investigation area No. 29). For the greater part the bog is a drained lake bed, the level of which is about 15 m. above the sea at the boring point according to the topographical map. The force of the evidence provided by the profile is detracted from by the fact that the boring does not extend to the bottom of the aqueous sediment. The boring had to be discontinued in this case at a depth of 4.7 m. Down to that depth at any rate the sediment, according to the evidence of the pollen, is still clay ooze of the Littorina

Sea, and 10 cm. higher the diatoms of the ooze were also investigated and are of the Littorina type. The diatoms were investigated at almost every 10 cm. The diatoms of the succession of layers are given in Table VII, Vävarsbacka I. In connection with the diagram the curve for the displacement of the shore-level in passing the site was drawn on the basis of the diatoms.

The clay ooze in the lower part of the profile represents the first half of the Littorina Sea. According to the evidence of the diatoms, the water depth was then greater than when the fine detritus ooze above the clay ooze was deposited. The quality of the latter sediment, too, proves shallower water than formerly.

Although the beginning of the Littorina period is missing from the diagram, the sequence of strata is fairly illuminating from the point of view of the question of transgression. The composition of the Littorina sediment in the profile and the diatoms do not support the view that any considerable transgression occurred in this neighbourhood during the Littorina period. But it seems likely on the basis of the diatoms that delays occurred in the retreat of the shoreline, seeing that the curve for the changes of the shore-level remains on several occasions in a definite position for some time. The regression would then have occurred by stages from one phase of intermission to another. I have marked these delay zones of the beach by the letters a, b, c, d, in the diagram. It is possible that these correspond to the four stops of the shore of the Littorina Sea period in the Helsinki neighbourhood: LI, L II, L III, L IV.

The succession of layers referred to does not, however, rule out entirely some very small advance of the shore-line towards the land during some delay. On the contrary, it lends some slight support to this view, for the diatom curve that indicates the shifting of the shore-level rises in the a and b zones to a small culmination that might signify a slight invasion of the shore landwards.

The maximum limit of the Littorina Sea, as already stated, is here 27—28 m. above sea-level as established by Sauramo and Hellaakoski. This figure can, in my opinion, be regarded at any rate as the minimum in this district, considering the highest limit of the Littorina Sea in the neighbouring areas. The dwelling sites that represent the later comb-ceramic cultures discovered in the area (A. Äyräpää 1929), which are situated 18—19 m. above sea-level, are also in favour of the above-mentioned level of the maximum limit of the Littorina Sea according to Äyräpää's system.

So far I have no more stratigraphical evidence from the Porvoo neighbourhood of the course of development of the Littorina Sea.

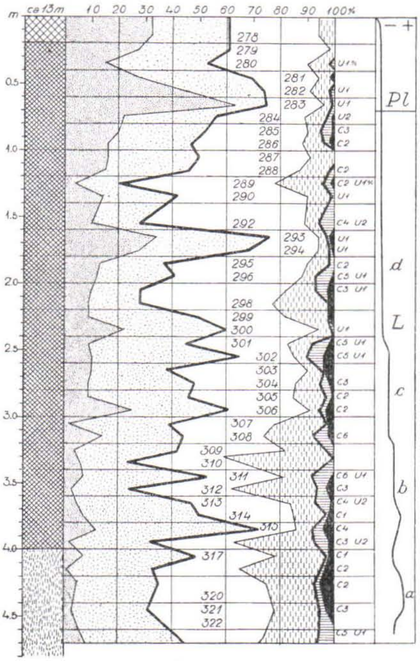

Fig. 20.

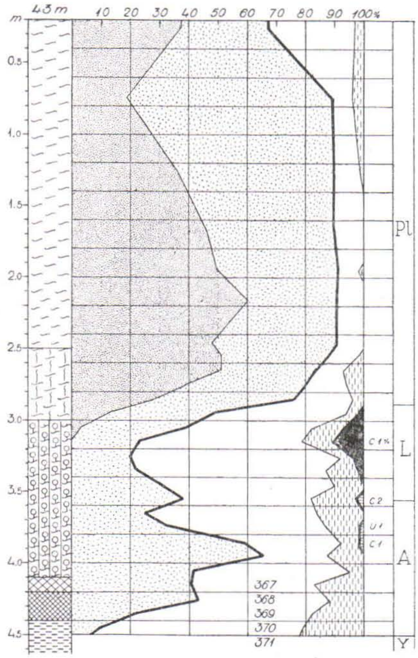

Fig. 21.

Fig. 20. Profile of the Vävarsbacka bog. Analyst E. Hyyppä.

Fig. 21. Profile of the 43 metre bog. Analyst E. Hyyppä.

Fig. 22. Profile of the 58 metre bog. Analyst E. Hyyppä.

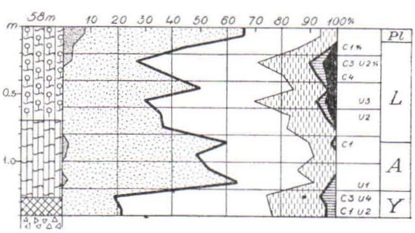

Fig. 22.

On the basis of the Vävarsbacka bog, however, it can be established that the development proceeded there in the same manner as in the Helsinki neighbourhood. This is intelligible, for the areas are close to each other and on almost the same isobases, as was shown already by Ramsay's studies (1920, 1926).

G. Rudeberg (1925 a) established an ancient beach about 2 km. S. of Vävarsbacka, which is 56.7 m. above sea-level. According to Rudeberg this is the maximum limit of the Ancylus transgression. This date is based solely on the altitude of the shore. I have two bogs in this investigation area that provide some stratigraphical evidence, too, of the age of this beach.

Table VII.

Anal. K. Salminen	Vävars-																
	278	279	280	281	282	283	284	285	286	287	288	289	290	292	293	294	295
Achnanthes brevipes var. intermedia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Clevei var. rostrata* ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *exiqua*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Kolbei?*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amphora commutata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—
» *ovalis var. libyca*	1	1	—	1	1	1	—	1	—	—	—	—	—	—	—	—	—
Bacillaria paradoxa	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Caloneis silicula	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
» » *var. gibberula* ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Campylodiscus clypeus	1	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—
» » *var. bicostata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *echeneis*	2	—	—	1	1	1	2	2	1	3	2	2	2	1	2	2	2
» *noricus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. hibernica*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chaetoceros sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cocconeis diminuta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pediculus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *placentula*	—	—	—	1	1	—	—	1	1	—	1	—	—	1	—	—	1
» » *var. euglypta*	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—
» *scutellum*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Coscinodiscus lacustris var. septentrionalis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyclotella comta	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—
» *Meneghiniana*	—	1	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—
» *stelligera*	1	—	—	1	1	—	—	—	1	—	1	1	—	—	1	1	3
» *striata var. bipunctata* ..	—	—	3	2	4	3	—	3	2	—	3	2	1	5	4	4	5
Cymatopleura elliptica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. hibernica*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymbella aspera	2	—	—	—	—	1	2	—	—	1	—	—	—	1	1	—	1
» *cistula*	—	1	1	—	—	1	1	1	—	1	2	1	1	—	—	1	1
» *cuspidata*	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Ehrenbergii*	5	1	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—
» *lanceolata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *naviculiformis*	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—
» *prostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sp.*	1	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	1
» *tumida*	1	—	—	1	—	1	1	—	—	—	1	—	1	1	1	—	1
» *turgida*	2	3	3	4	3	5	4	4	3	4	3	4	3	1	2	1	2
Diatoma sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Diploneis didyma	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *domblittensis*	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—
» *finnica*	5	1	1	1	1	1	1	—	—	2	1	1	—	1	1	1	1
» *incurvata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *marginestriata?*	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
» *ovalis*	—	2	—	—	1	—	—	—	—	—	—	—	—	—	1	2	1
» » *var. oblongella* ...	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—
» *puella?*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Smithii*	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
» » *var. rhombica* ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Epithemia argus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Hyndmanni*	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» *intermedia*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

backa I																							V-backa II				
296	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	317	320	321	322	367	368	369	370	371
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	1	1	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	2	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	1	—	—
—	1	1	1	—	1	1	1	—	1	1	1	1	1	1	—	—	—	—	—	1	—	1	—	1	2	—	—
—	—	—	—	—	—	—	—	1	1	1	—	2	1	1	—	—	—	1	2	—	—	—	—	—	—	—	—
—	1	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	2	1	4	4	2	3	4	2	—	—	—	—	—
1	2	3	2	3	1	3	2	2	2	1	3	1	3	3	3	5	5	5	5	3	5	4	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—
1	—	2	1	2	2	2	3	—	2	2	2	3	3	1	2	—	—	2	2	1	1	1	—	2	—	1	—
—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	—	—	5	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—
1	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	1	2	5	—	1	—	3	5	5	5	5	5	5	5	1	3	3	—	1	1	—	—	—	—	—
2	3	2	1	—	2	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	5	5	—	—	—	—	1	—	—	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
1	—	1	1	—	—	1	1	1	—	—	—	1	—	—	—	—	1	—	1	—	—	—	—	2	1	1	1
1	1	2	1	—	—	1	—	2	—	1	—	—	1	—	—	—	—	—	—	1	—	—	—	—	1	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
1	2	1	—	—	—	—	—	—	—	1	1	1	1	1	1	1	—	1	—	—	1	1	—	—	2	—	—
1	1	2	1	1	1	3	1	—	1	1	1	—	1	—	—	—	—	—	—	—	—	1	—	—	1	—	—
2	3	4	2	3	1	1	1	1	2	—	1	—	—	—	—	—	—	—	—	—	—	1	2	4	4	—	2
1	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	2	2	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
1	—	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	1	2	1	5	1	—	2	—	—	1	—	2	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	1	1	—	—	5	3	5	5	5	5	3	2	1	4	3	1	—	3	1	—	—	1	—	—	—	—	—
—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	—	2	1	4	2	1	1	1	—	1	1	—	1	1	1	—	—	1	1	1	—	—	—	—	—
—	—	1	—	1	1	1	1	2	1	2	1	—	1	1	3	2	3	2	1	3	3	2	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—

	Vävars-																
	278	279	280	281	282	283	284	285	286	287	288	289	290	292	293	294	295
Epithemia Muelleri	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sorex*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *turgida*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» » *var. granulata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. Westermanni*	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
» *zebra*	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
» » *var. porcellus*	1	1	—	—	—	1	1	1	1	2	1	1	1	1	1	3	2
Eunotia spp.	5	5	3	5	5	5	5	5	5	4	5	5	4	3	4	5	4
Fragilaria spp.	2	1	1	1	1	1	1	—	1	—	2	2	—	—	1	2	1
Frustulia spp.	—	1	1	1	1	1	—	1	—	—	1	1	1	1	1	1	2
Gomphonema acuminatum	1	—	—	1	1	1	1	1	—	1	1	—	1	—	—	—	1
» » *var. Brebissonii*	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—
» » *var. coronata*	—	1	1	1	2	3	1	1	2	1	2	1	2	1	1	2	—
» *augur. var. Gautieri*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
» *constrictum*	1	1	1	1	1	1	—	1	1	—	—	—	2	1	1	1	1
» *sp.*	—	1	—	1	1	—	—	—	—	—	1	—	1	—	—	1	1
Grammatophora oceanica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gyrosigma acuminatum	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—
» *attenuatum*	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
» *balticum frag.?*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *distortum var. Parkeri*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hantzschia amphioxys	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
» » *var. capitata*	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
» *elongata*	1	—	—	1	—	1	1	—	—	—	—	—	—	—	—	—	—
Mastogloia Braunii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elliptica*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Grevillei*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Smithii*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. amphicephala*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. lacustris*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Melosira ambigua	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—	—
» *arenaria*	—	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	—
» *distans*	5	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—
» *granulata*	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
» » *var. angustissima*	—	—	—	—	—	1	—	1	2	—	5	3	2	5	3	3	5
» » *var. muzzanensis*	—	2	—	3	—	4	—	4	1	—	3	2	1	2	5	—	—
» *islandica subspec. helvetica*	1	1	—	—	—	—	2	—	1	1	1	1	1	—	—	1	—
» *italica*	5	5	5	5	5	5	1	5	5	5	5	5	5	5	5	5	5
» » *var. valida*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Juergensi*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *moniliformis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Meridion circulare	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. constricta*	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—
Navicula americana	—	1	1	1	1	2	1	1	2	3	4	4	1	—	1	1	1
» *anglica*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *bacillum var. Gregoryana*	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—
» *crucicula var. obtusata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *gastrum*	—	1	2	1	1	1	—	—	—	—	—	—	—	2	1	1	1
» *hungarica*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

backa I																							V-backa II				
296	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	317	320	321	322	367	368	369	370	371
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	1	—	—	—	—	—
—	—	—	—	—	—	—	1	2	1	1	1	1	2	1	3	1	3	3	4	5	2	—	—	—	—	—	—
1	—	1	1	—	—	1	1	—	—	—	—	—	—	—	—	—	2	1	1	2	3	1	—	1	2	5	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	3	1	—	—	—	5	—
—	—	—	1	—	1	2	—	1	1	—	1	1	1	1	1	1	2	1	2	3	2	1	—	—	2	2	—
1	1	3	3	5	2	1	2	2	3	2	3	2	2	2	4	3	—	3	3	4	5	4	5	5	5	5	5
4	5	5	4	2	3	1	2	3	3	3	4	4	2	3	1	—	—	—	1	—	3	—	—	5	5	—	5
4	1	—	1	—	—	—	—	1	1	1	—	1	1	1	1	2	—	1	1	—	—	—	—	—	5	—	—
2	1	1	1	—	1	—	—	—	—	1	—	1	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—
1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	2	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	3	2	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	2	1	1	1	—	—	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	1	—	1	2	—	1
2	2	—	1	1	1	—	1	2	1	—	1	1	—	1	—	—	—	—	—	—	—	—	4	4	2	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	2	1	1	—	1	—	1	—	1	1	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	1	4	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	3	2	—	1	5	5	4	1	1	1	—	1	—	—	1	—	—	—	—	—	—	—	—	—
1	—	1	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
1	—	—	—	—	—	—	1	1	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	1	1	1	2	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	1	1	1	2	2	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	1	1	—	—	—	—	—	—	—	—
—	—	—	5	—	—	—	—	—	—	—	—	—	—	—	—	5	—	1	3	—	—	—	—	—	—	—	—
—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	1	—	1	—	—	—	2	—	—	1	1	5	1
5	5	5	4	2	3	1	1	2	1	1	1	—	1	—	—	1	1	—	3	—	1	5	—	—	—	—	—
5	5	5	5	3	1	—	5	1	3	5	1	5	4	1	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	2	—	—	1	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	1	1
5	5	5	1	3	5	5	5	5	5	5	—	1	2	3	1	2	—	1	3	1	—	5	5	3	5	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—
—	—	—	1	1	—	3	2	3	2	2	3	3	3	3	3	4	3	2	2	2	2	1	—	—	—	—	—
—	—	—	—	—	—	1	—	—	—	—	—	1	1	—	1	1	4	1	1	3	2	1	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	2	—	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	1	2	1	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	4	4	—	2
—	—	—	—	—	—	—	—	—	—	1	1	3	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	1	1	—	1	2	1	—	2	1	—	1	—	—	—	—	—	—	—	—	—
1	2	2	1	1	1	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	1	1	2	1	2	1	—	—	1	—	—	—	—	—	—	—	—	—

	Vävars-																
	278	279	280	281	282	283	284	285	286	287	288	289	290	292	293	294	295
Navicula Jentzschii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *laterostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *libellus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *peregrina*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. kefvingensis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *punctulata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. cluthensis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pupula var. capitata*	—	1	—	1	—	—	—	—	1	—	1	—	—	—	—	—	—
» » *var. rectangularis*	—	—	2	1	—	1	—	—	—	—	2	2	1	1	—	1	—
» *pusilla*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *radiosa*	—	1	1	2	1	1	1	1	2	—	3	3	2	2	1	1	1
» *rhynchocephala*	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1
» *scutelloides*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *tuscula*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neidium affine var. amphirhynchus	—	1	1	—	1	1	—	1	1	—	1	—	—	1	1	—	—
» *iridis*	1	1	1	1	1	1	—	—	—	—	—	—	1	—	—	—	1
» » *var. ampliata*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nitzschia acuminata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *amphibia*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *circumsuta*	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—
» *hungarica*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Lorenziana*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *navicularis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *obtusa*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. scapelliformis*	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *palea*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *punctata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
» *scalaris*	5	2	1	1	2	2	4	1	2	3	—	1	1	1	·1	2	1
» *sigma*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sigmoidea*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *tryblionella*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. debilis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. levidensis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. litoralis*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. subsalina*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. victoriae*	—	1	—	—	—	—	—	—	—	—	2	—	1	1	4	5	3
Opephora Martyi	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Pinnularia sp.	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pleurosigma sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhoicosphenia curvata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhopalodia gibba	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
» » *var. ventricosa*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *musculus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stauroneis alabamae var. angulata	1	1	—	—	1	1	1	1	—	—	—	—	—	—	—	—	—
» *anceps f. gracilis*	—	1	—	1	—	1	—	—	1	—	2	1	1	—	—	—	—
» » *f. linearis*	—	—	—	1	—	—	—	—	1	—	1	—	—	1	—	—	—
» *phoenicenteron*	2	1	—	1	1	1	2	—	—	—	1	—	—	—	—	—	1
» *Smithii*	—	1	—	1	1	—	—	—	—	—	1	—	—	1	1	1	1
Stephanodiscus astraea	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—
dubius	—	1	—	—	1	—	—	—	—	—	2	1	—	2	2	5	5
Surirella Capronii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

backa I																							V-backa II				
296	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	317	320	321	322	367	368	369	370	371
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	1	—	1	3	4	5	5	5	4	2	4	4	3	2	3	2	3	2	2	3	4	3	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	2	2	2	3	2	—	—	2	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	1	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—
2	2	2	1	2	1	—	2	1	—	—	1	1	1	1	—	1	—	1	1	—	—	—	—	—	1	—	—
1	1	1	1	—	1	—	1	1	1	3	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	2	1	1	1	1	1	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	2	1	2	3	3	3	3	1	—	—	1	2	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	1	3	1	—	—	—	—	—
1	—	1	1	1	—	2	1	1	—	—	1	1	1	1	1	—	1	—	—	—	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	1	—	—	—	1	—	—	—	1	1	—	—	—	—	—	1	—	1	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	3	5	5	4	5	3	1	—	2	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	2	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	3	1	—	1	1	—	1	1	—	2	—	2	1	1	1	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
3	4	5	5	5	5	5	—	5	4	5	5	5	5	4	3	1	3	3	1	1	3	4	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—
5	5	5	4	4	4	5	4	2	3	2	2	—	1	1	1	—	1	1	1	—	—	4	1	5	3	2	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	1	1	1	1	1	3	—	1	2	3	1	1	2	—	—	—	—	—
—	—	—	1	—	1	1	1	1	1	1	2	1	1	1	1	1	3	2	2	3	3	1	—	—	2	—	1
—	—	—	—	—	—	—	—	1	—	1	—	—	2	—	1	—	1	3	2	2	2	1	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	1	—	2	1	1	1	1	1	1	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1
—	1	1	1	—	2	—	1	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—
5	3	4	—	—	5	—	2	4	4	5	5	2	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	Vävars-																
	278	279	280	281	282	283	284	285	286	287	288	289	290	292	293	294	295
Surirella elegans	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
» *gracilis*	—	—	—	—	—	—	—	—	—	—	—	—	2	1	1	1	1
» *linearis*	—	—	—	—	—	—	—	—	—	—	—	—	—	2	4	—	1
» » *var. constricta*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—
» *ovalis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. pinnata*	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
» *robusta*	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
» » *var. splendida*	1	—	—	—	—	—	2	1	—	1	.	—	—	1	—	—	—
» *striatula*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *tenera var. nervosa*	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Synedra affinis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *var. obtusa*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pulchella*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sp.*	—	—	—	1	2	—	1	1	1	—	1	1	2	2	—	3	2
Tabellaria spp.	1	5	5	5	5	5	1	5	5	2	5	5	5	5	5	5	5
Terpsinoe americana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tetracyclus lacustris	4	1	—	1	1	1	1	—	—	—	—	1	1	1	1	—	1
» » *var. rhombica*	1	1	—	1	—	—	1	—	—	1	—	—	—	1	—	1	—
Thalassiosira baltica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The 43 Metre Bog.

Fig. 21, page 67, illustrates the profile of a bog situated about 2 km. N.E. of Vävarsbacka (investigation area No. 30). The bog is a *Pinus-Sphagnum* »Highmoor» and is situated about 43 m. above sea-level. The altitude is obtained in this case, as in the previous one, from the topographical map. The threshold of the bog, according to the map, is about 40 m. above sea-level. On the bottom of the bog there is clay, possibly varved, which is almost sterile. There were pollen grains only in the upper part of the clay bed (4.4—4.5 m.) and there are also very scarce diatoms in it. According to the diatoms (Table VII, Vävarsbacka II, 367—371) the clay, from the bottom up to 4.5 m., is late-Glacial. Sample 371 appears to belong to the Yoldia, as it contains *Grammatophora oceanica* and *Thalassiosira baltica*, though in very small quantities.

The next sample above (370), in which there is a typical big-lake flora, belongs either to the end of the Yoldia period or to the beginning of the Ancylus Lake. The basin is isolated soon after from the Ancylus Lake at a level of about 40 m. The Ancylus period, to judge by the pollen flora, still lasts for a long time after the separation.

backa I																							V-backa II				
296	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	317	320	321	322	367	368	369	370	371
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—
2	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	—	2	1	1	2	2	1	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	—	—	—	1	—	—	1	—	2	—	2	1	1	1	3	1	—	1	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	2	1	—	1	2	1	—	—	2	2	—	3	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	1	2	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	—	—	1	1	1	2	1	—	—	—	—	—
1	1	3	2	1	3	1	1	2	2	1	3	1	1	—	—	—	—	2	—	1	—	—	1	—	1	—	—
5	5	5	5	3	5	2	5	5	5	5	5	5	5	5	2	2	—	2	1	—	—	2	5	1	5	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
1	—	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	1

In the pollen diagram under discussion there is a distinct *Pinus* maximum in the terrestrial peat (3.9—4.0 m.). This *Pinus* peak of the Ancylus period corresponds in some cases to the time of the highest extent of the Ancylus transgression. In this case, however, it probably belongs to a time later than this maximum. The *Pinus* peak of the Ancylus period does not always correspond to the transgression maximum, though it should be considered certain that as a rule it belongs to the Ancylus transgression phase.

In this diagram, however, the point of the transgression peak referred to cannot be determined at all with absolute certainty. If sample 370 belongs already to the Ancylus period, it represents the highest level of the Ancylus Lake at this place. Also this sample is, however, so poor in diatoms that it does not suffice for thoroughly reliable dating. On the basis of the stratigraphy of the bog in question, however, it seems certain that the Ancylus maximum extended here at least to the level of the pass-sill of the bog or 40 m. above sea-level.

The 58 Metre Bog.

Rudeberg's »Ancylus maximum» mentioned in the former chapter is 56.7 m. above sea-level and thus represents a considerably higher level than the 40 m. referred to above. We can check the age of Rudeberg's shore-line by means of a third peat bog investigated by me in this area. This bog is situated about 1 km. S. of the former one (investigation area No. 30). Its surface, according to a topographical fixed point on the bog, is in round figures 58 m. above sea-level, so that the bog is approximately at the level of Rudeberg's beach. Fig. 22, page 67, illustrates the stratigraphy of the bog. The formation of peat began on a substratum of till, the local small pond being at first silted up. The pollen diagram exhibits a flora of a very distinct type which seems fairly reliable for fixing the date, although diatoms are not available in this case to help us in the pollen chronology. In the coarse detritus ooze on the bottom of the bog, deposited in the tarn, only small lake fresh-water diatom species occur, as: *Anomoeoneis follis* 3, *A. serians* 5, *Cocconeis diminuta* v. *euglypta* 4, *Epithemia zebra* v. *porcellus* 4, *Eunotia* spp. 5, *Navicula pupula* v. *rectangularis* 2, *N. radiosa* 1, *Pinnularia* spp. 5, *Tabellaria* spp. 1. This flora lived in quite a small lake or tarn and proves unquestionably, that the bog basin was already shut off from the Baltic at the time when the coarse detritus ooze lowest in the sequence was deposited.

From the age division of the pollen diagram it will be seen that the accumulation of the coarse detritus ooze began at this place already in the Yoldia period (field Y). The peat started to grow at the beginning of the Ancylus period at the latest. Yoldia pollen is in this bog represented by an assemblage dominated by deciduous trees situated below the *Pinus* maximum of the Ancylus period, in which there is also a slight quantity of rarer foliferous trees. Such a composition of the pollen spectrum is typical in South Finland particularly of the latter half of the Yoldia period.

The level of Rudeberg's »Ancylus beach» (56.7 m. above sea-level) corresponds approximately to the level of the bottom of this bog. As the bog basin, according to the evidence brought forward above, separated from the Baltic already at the end of the Yoldia period, this ancient shore also belongs to the Yoldia period and is not the maximum limit of the Ancylus transgression, as Rudeberg assumed. The Ancylus transgression maximum in this area is below Rudeberg's beach or below the level of 56.7 m. According to the evidence of the stratigraphy of the previous bog, the Ancylus transgression peak is at least 40 m. above sea-level, so that its exact position is between these levels.

PERNAJA.

Of this area I have so far no stratigraphical material whatever. The local Littorina Sea maximum limit, according to Ramsay (1926), is 28 m. above sea-level at Fantsnäs, S. of the town of Lovisa. G. Rudeberg (1925 a) likewise identified a shore escarpment on the eastern slope of the esker S. of Lovisa (Köpback) at 27 m. above sea-level and on the western slope at 28.1 m. above sea-level, and a raised beach 4 km. N.E. of Forsby at 29.4—30.2 m. above sea-level. According to Rudeberg these beaches represent the maximum limit of the Littorina Sea. But neither for these nor for Ramsay's dating has any stratigraphical evidence been produced. Taking into consideration the direction of the isobases of the Littorina Sea, which is already known in its main features in the South Finnish coastal area on the basis of Ramsay's researches, it seems certain that the maximum limit of the Littorina Sea is actually on an average 28 m. above sea-level in the Pernaja area.

My assistant, Mr. A. Valanne, determined a wave-cut cliff at Segerby in Pernaja (investigation area No. 31) E. of the road to Strömfors, the foot of which is 36 m. above sea-level. This shore-line is above the Littorina maximum referred to and belongs to the Ancylus period. It apparently corresponds to the ancient beach N. of Tikkurila determined by Rudeberg (1925 a) which is 37.3 m. above sea-level and which I, too, identified in the same area (page 60). This shore appears to be later than the actual Ancylus transgression, but nevertheless it belongs, as I have already mentioned, to the Ancylus period and, judging by its altitude, to the final phase of that period. In this connection it is impossible to say whether this shore-line represents a transgression or a delay that occurred in the retreat of the shore-line.

PYHTÄÄ, SILTAKYLÄ.

RAISED SHORES.

The following ancient shore-lines have been determined in this area:

Investigation area No. 32, Huutjärvi esker:

Wave-cut cliff winding round the highest top of the esker	25.9	m.	above	sea-level
Abrasion cliff on the western slope of the esker	16.9	»	»	»
Boulder shore south of the esker	8.5	»	»	»

Investigation area No. 33, esker E. of Munasuo bog:

Abrasion cliff winding round the slopes of the esker, Fig. 23	26.0	m.	above	sea-level

Investigation area No. 34, Aaltoila hill:

Boulder rampart on the slope of the hill	21.5	m.	above	sea-level
» » » » » » » »	27.0	»	»	»

Investigation areas Nos. 35 and 36, near the cemetery:

Wave-cut cliff S. of cemetery	26.8	m.	above	sea-level
» » N. » » within the same esker complex	26.8	»	»	»
Abrasion cliff slightly N. of the former	26.1	»	»	»
» » close to a shed by the side of the road leading to the Skogträsk bog ..	20.4	»	»	»
Abrasion cliff W. of the road, slightly N. of the former	26.0	»	»	»

All these shores were determined by my assistant, Mr. A. Valanne. They are grouped at the following levels: 8.5 m., 16.9 m., 20.4—21.5 m., and 26—27 m. above sea-level. The last of these shorelines is the best developed and it was also to be recognised at the largest number of observation points. On the basis of its altitude it would seem to represent the local maximum limit of the Littorina Sea which, *e. g.*, in the neighbouring area of Pernaja averaged 28 m. above sea-level. Below we will examine the age relations of these beaches in the light of the stratigraphy of the bogs.

STRATIGRAPHY OF THE PEAT BOGS.

Skogträsk Bog.

Fig. 24, page 85, illustrates the stratigraphy of the Skogsträsk bog. In type it is a *Pinus-Sphagnum* »Highmoor» and surrounds the small Skogträsk pond, investigation area No. 37. The surface of the bog at the point of boring is 27 m. and its pass-sill about 25 m. above sea-level. The latter was determined according to the topographical map and the figure is therefore not quite exact. The threshold is in any case slightly below the 27 m. level.

The 26—27 m. shore mentioned above appears in the esker landscape S.W. of the bog and there are boulder shores of this beach on the very edge of the bog. We will see whether the stratigraphy of the bog supports the opinion that this 27 m. shore-line represents the Littorina maximum of this district.

On the bottom of the bog there is fine detritus ooze which contains a diatom flora typical of the Littorina Sea and proving shallow water (diatom table VIII, Skogträsk bog). The Littorina maximum falls within the lower part of the ooze (samples 230 and 231), or consequently within the very beginning of the Littorina period, for there is good reason to assume that this ooze began to be deposited at the very

Photo A. Valanne.

Fig. 23. Abrasion cliff (L I) winding round the slopes of the esker E. of Munasuo bog, 26 m. above sea-level.

beginning of the Littorina period. This view is supported by the pollen flora which is dominated by pine in the fine detritus ooze at the bottom of the profile, as is the rule at the beginning of the Littorina period. The pass-sill of the Skogträsk bog is only about 2 m. and the bottom of the boring point only 3.8 m. lower than the 27 m. beach. The water body represented by the fine detritus ooze at the bottom of the bog should thus most probably reach the 27 m. level on the basis of these figures, as there is no other beach in the district that corresponds better to the littoral conditions under which the fine detritus ooze referred to came into being. This view gains strong support from the diatom assemblage which proves shallow water during the deposition of the fine detritus ooze. It also seems

Table VIII.

Anal. K. Salminen	Munasuo Bog						Eastern Munasuo Bog							Skogträsk Bog			
	173	174	175	176	177	179	197	198	199	200	201	202	203	227	228	230	231
Achnanthes brevipes v. intermedia	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
» *calcar*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *Clevei*	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—
» » *v. rostrata*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *lanceolata v. elliptica*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
» *Östrupi*	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—
Amphora arenicola v. major	—	—	1	1	—	—	1	4	—	—	—	—	—	1	1	1	2
» *baltica*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» *capitata*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» *commutata*	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	—	—
» *Normani*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *ovalis*	1	1	—	1	1	—	—	1	1	1	1	1	2	—	—	—	—
» » *v. libyca*	1	1	1	—	3	—	—	—	1	1	1	1	1	—	1	—	—
» » *v. pediculus*	—	—	—	—	—	—	—	—	3	1	2	2	—	—	—	—	—
Anomoeoneis sphaerophora	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
» » *v. polygramma*	—	—	—	—	—	—	4	1	—	—	1	—	—	1	—	—	—
» » *v. sculpta*	—	—	1	—	1	—	3	2	—	—	—	—	—	1	1	1	1
Caloneis formosa v. holmiensis	—	—	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—
» *latiuscula*	—	—	—	—	—	—	—	—	1	1	1	1	1	—	—	—	—
» *permagna*	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
» *Schumanniana v. biconstricta*	—	—	—	—	—	—	—	—	2	1	1	1	1	—	—	—	—
» *silicula*	1	2	2	1	1	—	—	—	—	1	1	—	—	—	—	—	—
» » *v. truncatula*	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
» *Zachariasi*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Campylodiscus clypeus	—	1	1	2	3	—	5	5	—	—	1	—	3	5	4	5	5
» » *v. bicostata*	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	1	—
» *echeneis*	5	5	5	5	5	2	5	5	1	1	1	—	2	3	2	5	5
» *noricus*	—	—	—	—	—	—	—	—	—	1	1	1	1	—	—	—	—
» » *v. hibernica*	—	—	—	—	—	—	—	—	1	1	1	1	1	—	—	—	—
Chaetoceros sp. (itiö)	—	—	—	—	—	—	2	5	—	—	—	—	—	—	—	—	—
Cocconeis diminuta	—	—	—	—	—	—	—	—	1	2	2	1	1	—	—	—	—
» *disculus*	—	—	—	—	—	—	—	—	3	1	1	2	—	—	—	—	—
» *pediculus*	—	—	—	—	—	—	—	—	1	1	1	1	1	—	—	—	—
» *placentula*	—	1	—	—	—	—	—	—	—	2	1	2	—	—	—	1	—
» » *v. euglypta*	2	1	1	1	1	—	—	1	1	2	2	2	—	—	—	—	—
» » *v. klinoraphis*	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
» » *v. lineata*	—	—	—	—	—	—	—	—	1	1	1	2	—	—	—	—	—
» *scutellum*	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
» » *v. parva*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Cyclotella comta	2	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
» » *v. paucipunctata*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Cymatopleura elliptica	1	—	—	—	—	—	1	—	1	1	1	1	1	—	—	—	—
» » *v. constricta*	—	—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—
» » *v. hibernica*	—	1	1	1	—	—	—	—	1	1	1	1	1	—	—	—	—
» » *v. nobilis*	—	—	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—
» *solea*	—	1	—	—	—	—	—	—	1	1	1	1	—	—	—	—	—
Cymbella aspera	2	1	2	2	2	—	—	—	1	2	1	1	1	—	—	—	—
» *cistula*	—	1	1	—	1	—	—	—	1	—	1	—	—	—	—	—	—
» *cuspidata*	1	—	1	—	—	—	—	—	—	1	1	—	—	—	—	—	—
» *cymbiformis*	—	—	—	—	—	—	—	—	1	1	1	1	—	—	—	—	—
» *Ehrenbergii*	—	1	—	—	—	—	—	—	1	1	1	1	1	—	—	—	—
» *lanceolata*	1	1	1	—	—	—	—	—	—	1	1	2	1	—	—	—	—
» *lata*	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—

	Munasuo Bog						Eastern Munasuo Bog							Skogträsk Bog			
	173	174	175	176	177	179	197	198	199	200	201	202	203	227	228	230	231
Cymbella leptoceros	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
» *prostrata*	—	—	—	—	—	—	—	—	1	1	1	1	—	—	—	—	—
» *spp.*	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—
» *tumida*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *turgida*	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Diploneis didyma	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
» *domblittensis*	—	—	—	—	—	—	—	—	1	1	1	2	1	—	—	1	—
» » *v. subconstricta*	—	—	—	—	—	—	—	—	1	1	1	1	1	—	—	—	—
» *elliptica*	—	—	—	—	—	—	—	—	1	1	1	1	—	—	—	—	—
» *finnica*	2	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *incurvata*	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—
» *interrupta*	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	1	—	—	—	—	—	1	—	1	—	—	—	—	—	—
» » *v. oblongella*	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» *pseudovalis*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *Smithii*	1	1	1	—	3	—	—	—	—	—	—	—	—	1	—	3	1
» » *v. rhombica*	—	1	2	3	3	—	1	2	—	—	1	—	—	—	—	1	—
Epithemia argus	—	1	—	1	1	—	2	3	2	1	1	1	—	1	1	1	—
» » *v. longicornis*	—	—	—	—	—	—	1	1	1	1	—	—	—	—	—	—	—
» *Hyndmanni*	—	—	—	—	—	—	1	1	3	2	4	5	4	—	—	1	—
» *intermedia*	—	1	1	4	3	—	—	—	1	1	2	2	—	—	—	—	—
» *Muelleri*	—	—	—	—	3	—	2	2	1	1	2	1	1	1	—	1	—
» *sorex*	1	—	1	3	1	—	—	1	1	1	1	1	—	—	—	1	—
» *turgida*	1	4	3	5	5	—	4	2	4	2	4	5	5	1	1	3	2
» » *v. granulata*	—	—	—	—	—	—	1	1	1	1	1	1	1	—	—	—	—
» » *v. Westermanni*	1	2	2	5	5	—	2	1	5	5	5	5	5	1	—	1	1
» *zebra*	2	3	2	5	5	1	—	2	5	5	3	3	1	1	—	1	—
» » *v. porcellus*	5	5	5	5	5	—	1	1	3	4	5	5	5	—	1	—	—
» » *v. saxonica*	—	—	—	—	—	—	—	—	—	—	2	1	3	—	—	—	—
Eunotia Clevei	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—
» *spp.*	5	1	2	—	2	—	—	1	—	—	—	—	—	1	—	—	—
Fragilaria spp.	5	—	1	—	—	—	1	1	2	2	3	3	2	3	3	—	—
Gomphonema acuminatum	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—
» » *v. Brebissoni*	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. coronata*	2	1	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—
» *constrictum*	1	1	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—
» *geminatum*	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
» *longiceps v. gracilis*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» » *v. subclavata*	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
Gyrosigma acuminatum	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» *attenuatum*	—	—	—	—	—	—	—	1	3	3	1	5	3	—	—	—	1
» *Spencerii v. nodifera*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Mastogloia Braunii	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—
» *elliptica*	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—
» » *v. dansei*	—	1	1	—	1	—	—	—	—	—	1	1	—	—	—	—	—
» *Grevillei*	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—
» *Smithii*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
» » *v. amphicephala*	1	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—
» » *v. lacustris*	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
Melosira ambigua	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
» *arenaria*	1	1	1	1	2	—	1	1	5	1	1	3	5	1	1	—	1
» *distans*	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—

	Munasuo Bog						Eastern Munasuo Bog							Skogträsk Bog			
	173	174	175	176	177	179	197	198	199	200	201	202	203	227	228	230	231
Melosira granulata	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *islandica subspec. helvetica*	3	1	1	—	1	1	—	—	3	5	5	5	4	1	—	—	—
» *italica*	—	—	—	—	—	—	—	—	2	1	—	1	—	—	—	—	—
» » *subspec. subarctica*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Juergensi*	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *moniliformis*	—	—	—	2	—	—	—	—	—	1	—	—	—	—	—	—	—
» *Westii f. parva*	—	—	—	—	5	—	1	5	—	—	1	—	—				
Navicula americana	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *anglica*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *bacillum*	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
» *crucicula*	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. obtusata*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *cuspidata*	—	1	—	—	—	—	—	—	1	1	—	1	—	—	—	—	—
» *elegans*	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *gastrum*	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
» *graciloides*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *humerosa*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» *Jentzschii*	—	—	—	—	—	—	—	—	1	1	1	3	1	—	—	—	—
» *lacustris*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *libellus*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *oblonga*	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—
» *peregrina*	3	5	5	1	4	1	2	3	1	1	1	1	—	1	1	2	1
» *placentula*	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
» » *f. jenisseyensis*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
» » *f. lanceolata*	—	—	—	—	—	—	1	—	1	1	—	1	—	—	—	—	—
» » *f. latiuscula*	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
» » *f. rostrata*	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—
» *platystoma*	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
» *punctulata*	1	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—
» *pusilla*	—	—	1	—	—	—	—	1	—	—	—	—	—	—	1	—	—
» *radiosa*	2	—	1	—	—	—	—	—	—	—	1	1	—	—	—	—	—
» *rhynchocephala*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Schönfeldii?*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *scutelloides*	—	—	—	—	—	—	—	—	2	1	1	1	—	—	—	—	—
» *tuscula*	—	—	—	—	—	—	—	—	1	1	1	3	—	—	—	—	—
Neidium iridis	2	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» » *f. vernalis*	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» » *v. ampiata*	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
» *productum*	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» *spp.*	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
Nitzschia acuta?	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» *angustata*	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» *circumsuta*	3	5	5	5	5	1	1	4	—	—	—	—	—	—	—	4	5
» *navicularis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
» *punctata*	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	1	—
» *scalaris*	5	5	5	5	5	1	5	5	—	—	—	—	1	4	1	5	3
» *sigmoidea*	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
» *spectabilis*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» *tryblionella*	1	2	2	2	2	—	—	1	—	—	—	—	—	—	1	—	1
» » *v. litoralis*	4	4	4	2	4	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. victoriae*	1	1	1	—	2	—	—	—	—	—	—	—	—	—	—	1	—
Pinnularia dactylus	2	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *macilenta*	3	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *maior*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *f. hyalina*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *nobilis*	4	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	Munasuo Bog						Eastern Munasuo Bog							Skogträsk Bog			
	173	174	175	176	177	179	197	198	199	200	201	202	203	227	228	230	231
Pinnularia spp.	5	3	3	4	5	1	—	1	1	1	1	1	1	1	—	1	—
» *viridis*	1	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhoicosphenia curvata	—	—	—	—	—	—	—	—	1	2	2	—	—	—	—	—	—
Rhopalodia gibba	3	—	1	2	1	—	—	—	1	2	2	1	1	—	—	—	—
» » *v. ventricosa*	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» *musculus*	—	—	—	—	1	—	1	1	—	—	—	—	—	1	—	—	—
Stauroneis acuta	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
» *anceps f. linearis*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *phoenicenteron*	3	1	2	—	—	—	1	1	1	1	1	—	—	—	—	—	—
Stephanodiscus astraea	1	—	—	—	—	—	—	—	1	2	3	5	—	—	—	—	—
Stephanopyxis turris?	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Surirella biseriata	1	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—
» » *v. bifrons*	—	1	1	—	—	—	—	—	1	1	1	1	—	—	—	—	—
» » *v. constricta*	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
» *Capronii*	2	1	2	1	1	—	—	—	1	—	—	—	—	—	—	—	—
» *elegans*	3	4	4	2	3	—	—	—	1	—	1	—	—	—	—	—	—
» *linearis*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
» *ovata v. crumena*	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
» *robusta*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. splendida*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *striatula*	—	1	1	2	1	—	2	1	—	—	—	—	—	1	—	3	4
» *tenera*	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Synedra sp.	1	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
» *ulna*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	4
» » *v. biceps*	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—
» » *v. spathulifera*	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
Tabellaria spp.	5	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—
Terpsinoe americana	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—
Tetracyclus lacustris	5	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. rhombica*	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

certain that the fine detritus ooze of the profile belongs entirely to the phase of the 27 m. shore-line and represents L I.

Even on the basis of this profile it cannot be established that any considerable transgression occurred during the formation of the uppermost Littorina shore. Judging by the altitude of the threshold of the bog, the possible transgression is about 2 m. at its highest. The weight of the evidence of the Skogträsk bog is, however, reduced to some extent by the circumstance that pre-Littorina sediments are absent, so that the important contact between Ancylus and Littorina cannot be examined in this case.

Eastern Munasuo Bog.

The bog is situated about 5 km. due N. of Siltakylä (investigation area No. 38). It is an *Eriophorum-Sphagnum* »Lowmoor» in type. Fig. 25, page 85, illustrates the profile bored on the bog and the pollen diagram. Lowest in the stratigraphical sequence, from the bottom up to 4 m., there is clay which is an Ancylus Lake sediment. The diatoms of the clay (table VIII, Eastern Munasuo bog) exhibit a typical big-lake flora having a composition precisely of the kind that appears as a rule in the Ancylus clays of South Finland. The pollen diagram also shows a *Pinus* maximum that is typical of the Ancylus time. The lower part of the clay certainly belongs to the time of the Ancylus transgression peak. According to the evidence of the diatoms this maximum should be placed in the very lowest part of the sequence or in the horizon of sample 203, *i. e.* at a slightly earlier time than the absolute *Pinus* maximum, just as in the Vävarsbacka diagram, Fig. 21, page 67. Mixed oak forests were still absent at that time and *Alnus*, too, appears sparsely as is generally the case in sediments of the Ancylus transgression period.

In the profile above the clay fine detritus ooze begins, the lower part of which represents the Ancylus regression time, while the upper part represents the Littorina transgression period. The contact of Ancylus and Littorina sediments is between samples 199 and 198. Samples 200 and 199 represent an Ancylus regression and there is typical small-lake flora in them. In sample 199 there is, besides, a fair quantity of *Eunotia Clevei*, which is a reliable index fossil of the final phase of the Ancylus Lake in South Finland. From the list of diatoms it is seen further that in the Ancylus clay and in the fine detritus ooze laid down during the regression period there are small quantities of some typical Littorina species. These, however, are entirely foreign in these associations. It is certain that they are impurities coming with the borer from the Littorina ooze above. No more attention can therefore be given to them in this connection.

Sample 198 contains very pure Littorina flora, an association of *Campylodiscus clypeus*, *C. echeneis*, *Diploneis Smithii* v. *rhombica*, *Mastogloia* spp., *Melosira Westii* f. *parva*, *Navicula peregrina*, *Nitzschia circumsuta*, *N. scalaris*. At the same time this sample represents the local Littorina Sea maximum. In the displacement of the shoreline this maximum, judging by the diatoms, does not signify any considerable advance of the shore towards the land.

No visible change occurs in the composition of the sediment at the contact between Ancylus and Littorina. The accumulation of the fine detritus ooze continued at the beginning of the Littorina period in precisely the same manner as it occured during the Ancylus regression. It also seems certain that there is no hiatus in the succession of strata in this important zone of contact. This view is

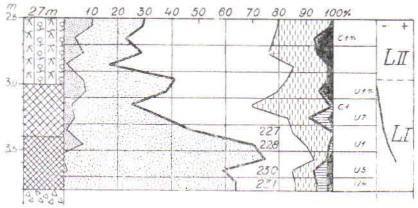

Fig. 24.

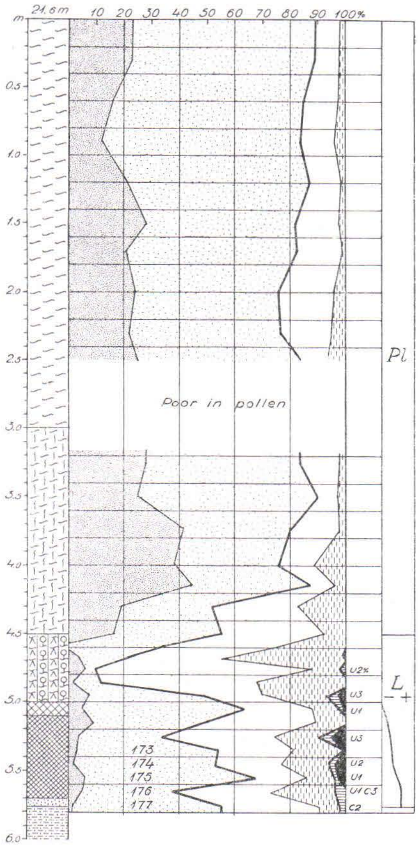

Fig. 26.

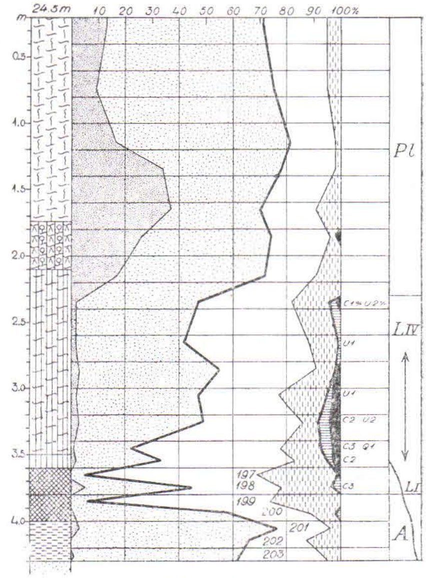

Fig. 25.

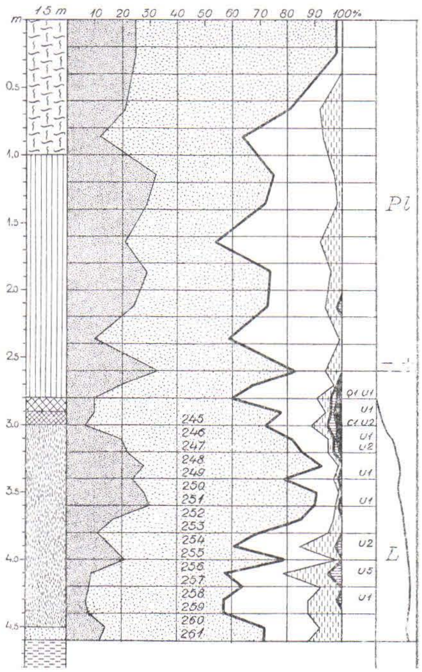

Fig. 27.

Fig. 24. Profile of the Skogträsk bog. Analyst E. Hyyppä.

Fig. 25. Profile of the Eastern Munasuo bog. Analyst E. Hyyppä.

Fig. 26. Profile of the Munasuo bog. Analyst E. Hyyppä.

Fig. 27. Profile of the 15 metre bog. Analyst E. Hyyppä.

supported by the development of the diatoms, the lithology of the sediment and also by the pollen flora. The pollen diagram is very normal in type and proves that the deposition occurred evenly without disturbance in one direction or another.

The *Pinus* maximum typical of the Ancylus period declines towards the end of the Ancylus regression, but rises again at the very beginning of the Littorina period to a slight culmination (sample 198), while at the same time the continuous field of mixed oak forests, which is typical of the Littorina period, begins. Such features of the pollen diagram as a rule characterise the beginning of the Littorina period in South Finland. On the whole we have here a pollen diagram that is very typical of the development of post-Glacial forests in South Finland which can be dated with complete certainty.

The stratigraphy of this profile further proves conclusively that at this place, too, the Littorina Sea maximum is to be placed in time at the very beginning of the Littorina period. The Skogträsk bog discussed above already led to this view, so that it should be considered certain that the Pyhtää district fully corresponds in this respect to the investigation areas dealt with above. This bog also proves that the negative change of the shore-line had proceeded rather far already at the beginning of the Littorina period, for the lower limit of the peat is only 20.9 m. above sea-level in the profile. When the water body at the place disappeared, this limit was, of course, a little higher, as the deposit has naturally compressed slightly in the course of time. Thus, when the paludification began, the shore was already below the 21 m. level. We see from the pollen diagram that the formation of peat began in the first half of the Littorina period. The level of about 21 m. therefore still belongs at this place to the first half of the Littorina period and to an earlier period than the peak of mixed oak forests.

From the list of ancient beaches it will be seen that at Siltakylä in Pyhtää there are also two shore-lines below the Littorina maximum: 20.4 m. and 21.5 m. above sea-level. Both these shores may possibly belong to the same phase of delay in the lowering of the water-level, although in this connection it cannot be said which of them corresponds more closely to the average level at that time. In regard to its altitude this shore-line should correspond to L III of the Helsinki neighbourhood. According to the pollen diagram it certainly belongs to the first half of the Littorina period.

Munasuo Bog.

On the W. of the previous bog there is another of the same type (investigation area No. 39), the stratigraphy of which is illustrated by fig. 26, page 85. On the bottom of the bog there is sandy clay at first, which is devoid of pollen and diatoms and evidently belongs to the late-Glacial time. This is followed by a thin layer of sand, sample 177, which is a Littorina Sea sediment and contains diatoms typical of this phase of the sea (table VIII, Munasuo bog). The flora in samples 176 and 177 is mostly of the same type as the diatoms of the sediment in the previous bog that represents the Littorina maximum. In this sequence, however, there is an obvious gap in the transition from late-Glacial clay to Littorina ooze, for Ancylus Lake sediments are lacking and possibly the beginning of the Littorina period is also not fully represented in the succession of strata. It seems certain, however, that samples 177 and 176 belong to the first half of the Littorina period, when the shore-level was still more than 20 m. above the sea.

The pass-sill of this bog is situated, according to the map, 15—20 m. above sea-level. The separation contact is 16.6 m. above sea-level. According to the pollen diagram it is to be placed about the L IV phase. The level corresponding to L IV is therefore about 16—17 m. above sea-level in this area.

The 15 Metre Bog.

The bog is a small *Pinus-Sphagnum* »Highmoor» about 0.5 km. S.W. of Vesterby, investigation a ea No. 40. Fig. 27, page 85, illustrates its stratigraphy. At the bottom of the bog there is clay, very poor in pollen and diatoms, similar to the previous bog. The precise age of the clay cannot be determined exactly owing to the absence of fossils. I consider that it belongs, like the previous one, to the late-Glacial time, just because of its lack of fossils. The Ancylus Lake and Littorina Sea sediment is, as a rule, comparatively rich in diatoms and pollen in South Finland. The upward succession of strata is of exactly the same types as in the previous bog: a stratum of sand, clay ooze, detritus ooze, all of which are Littorina Sea deposits. The Litotrina sediment in this case, however, is chiefly clay ooze, which is due to the bog being at a lower level than the previous one, so that at this place the water was deeper. The pollen flora contained in the sand bed and clay ooze is correspondingly more marine than in the previous bogs of this area (table IX, the 15 metre bog).

The Littorina Sea maximum falls, according to the diatoms, within the lower part of the clay ooze and the sand bed which scarcely represents a regression in this case any more than a distinct trans-

Table IX.

Anal K. Salminen	The 15 metre Bog															
	245	246	247	248	249	250	251	252	253	254	255	256	258	259	260	261
Achnanthes brevipes	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
» » *v. intermedia*	—	1	—	—	—	—	1	1	—	—	—	—	—	—	—	—
» *Clevei*	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» » *v. rostrata*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
» *delicatula*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *longipes*	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—
Amphora arenicola v. major	1	2	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» *baltica*	—	—	—	—	—	—	—	—	—	—	—	—	2	—	1	—
» *capitata*	2	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
» *commutata*	1	1	3	3	1	2	1	1	1	2	2	1	1	1	—	—
» *holsatica*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	2	—	2	1	2	3	1	2	2	1	3	2	2	1	—	3
» » *v. libyca*	—	2	4	3	4	2	4	1	1	3	1	1	2	—	—	1
» » *v. pediculus*	—	1	1	—	—	—	—	1	—	1	—	1	—	—	—	—
Anomoeoneis follis	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» *sphaerophora v. polygr.* ..	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. sculpta* ..	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Caloneis amphisbaena	—	1	1	1	1	1	2	1	—	1	1	1	—	—	—	—
» » *v. subsalina?* ..	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *bacillum*	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—
» *formosa*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Schumanniana*	—	—	1	—	—	—	—	—	—	1	—	1	—	—	—	—
» *silicula*	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Campylodiscus clypeus	3	3	—	—	—	—	1	1	1	—	—	—	—	—	—	—
» » *v. bicostata* ...	—	—	1	—	—	1	1	—	—	1	1	—	—	1	—	—
» *echeneis*	—	1	1	1	—	1	1	1	2	1	1	1	2	1	1	2
Chaetoceros sp. (itiö)	1	1	1	—	1	—	1	1	1	1	1	—	—	—	—	—
Cocconeis pediculus	1	—	3	2	2	2	2	2	1	1	1	1	1	1	1	1
» *placentula*	1	—	—	—	—	—	—	—	1	1	—	—	—	—	1	—
» » *v. euglypta*	3	1	1	1	1	1	1	1	—	—	—	1	—	—	—	—
» *scutellum*	1	2	1	1	1	1	1	2	—	1	1	1	—	—	—	—
Coscinodiscus asteromphalus?	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Granii*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
» » *v. aralensis*	—	—	—	1	1	—	1	1	1	1	1	1	—	—	—	—
» *lacustris v. septentrionalis*	—	1	1	1	2	1	3	3	2	1	1	2	3	1	4	3
» *Rothii v. Normani?*	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Cyclotella bodanica v. lemanensis	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—
» *comta*	—	—	—	—	—	—	1	—	—	—	1	1	1	—	—	—
» *Meneghiniana*	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Cymbella cistula	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—
» *prostrata*	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1
Diploneis didyma	1	—	1	1	—	—	1	1	—	1	1	1	1	—	—	1
» *elliptica*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
» *incurvata*	—	—	1	—	—	—	1	1	1	1	1	1	—	—	1	—
» *interrupta*	1	—	1	—	—	1	—	—	—	—	1	—	—	—	—	—
» *pseudovalis*	—	—	—	—	—	—	—	1	1	1	1	—	1	—	1	—
» *Smithii*	1	1	4	5	5	4	4	4	4	5	4	4	5	5	4	4
» » *v. rhombica*	—	—	1	3	1	2	4	1	1	2	3	2	1	1	1	2
Epithemia argus	1	—	—	—	—	—	1	—	1	—	—	1	1	—	—	—
» » *v. longicornis*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Hyndmanni*	—	—	—	—	—	—	1	1	1	1	—	1	—	1	—	—
» *intermedia*	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—

	The 15 metre Bog															
	245	246	247	248	249	250	251	252	253	254	255	256	258	259	260	261
Epithemia Muelleri	—	—	—	—	1	—	—	1	1	1	—	1	1	—	1	1
» *sorex*	5	1	1	—	2	2	1	1	2	2	1	2	2	3	3	3
» *turgida*	—	4	3	2	2	3	2	2	4	4	3	5	5	5	3	5
» » *v. Westermanni*	—	1	4	4	3	3	2	3	3	3	3	3	4	4	3	4
» *zebra*	—	—	1	1	—	1	—	—	—	—	1	1	—	—	—	—
» *v. porcellus*	3	4	1	2	1	1	1	—	1	1	1	1	1	1	1	—
» » *v. saxonica*	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eunotia spp.	1	1	1	1	—	1	1	1	1	—	—	1	—	—	—	1
Fragilaria spp.	5	5	1	—	—	—	1	—	—	—	—	—	—	—	—	—
Gomphonema acuminatum v. coronata	1	1	—	—	—	1	1	—	—	—	—	—	—	—	—	—
Grammatophora oceanica	—	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1
Gyrosigma attenuatum	—	1	—	—	—	1	1	1	—	1	2	2	—	—	—	—
» *balticum*	—	—	5	3	3	3	2	1	1	2	1	1	—	—	—	—
» *distortum v. Parkeri*	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Mastogloia Braunii	4	1	1	—	—	—	—	—	—	1	—	—	1	—	1	—
» *elliptica*	—	—	1	1	—	1	—	1	—	1	—	1	—	—	—	—
» » *v. dansei*	—	—	—	—	—	—	—	—	1	1	1	—	—	1	1	—
» *pumila*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *Smithii*	3	1	—	—	—	—	—	—	—	—	—	1	—	1	—	—
» » *v. amphicephala*	5	1	1	—	1	1	1	1	1	1	1	1	—	1	1	—
» » *v. lacustris*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Melosira arenaria	—	1	—	—	—	—	—	—	1	—	—	1	1	1	1	1
» *distans*	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
» *islandica subspec. helvetica*	—	—	—	—	—	—	—	—	1	—	—	1	1	1	2	1
» *italica*	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—
» » *subspec. subarctica*	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
» *Juergensi*	—	1	—	—	1	1	1	1	1	1	1	2	1	1	3	—
» *moniliformis*	—	—	—	—	1	—	—	1	1	—	1	2	2	3	3	2
» *Westii f. parva*	—	5	5	5	5	5	5	4	1	2	1	—	2	1	—	1
Navicula anglica v. subsalsa	—	—	1	1	—	—	1	1	—	—	—	—	—	—	—	—
» *crucicula*	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—
» » *v. obtusata*	—	—	4	1	1	1	2	1	—	—	—	—	—	1	—	—
» *digitoradiata*	—	1	3	1	1	2	3	3	3	3	3	2	2	2	1	1
» *elegans*	—	—	1	—	—	1	1	1	—	1	2	2	1	1	1	1
» *glacialis?*	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
» *halophila*	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—
» *humerosa*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *libellus*	—	—	1	1	1	2	2	2	1	3	4	2	1	2	1	1
» *palperalis v. angulosa?*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
» *peregrina*	4	5	5	5	5	5	5	5	5	5	5	5	5	5	2	3
» *protracta*	—	—	1	1	1	1	1	1	—	—	—	—	—	—	—	—
» *punctulata*	—	—	1	1	1	1	—	—	—	1	—	1	—	—	—	—
» » *v. cluthensis*	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
» *pusilla*	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pygmaea*	—	—	1	1	1	1	1	1	—	1	1	—	—	—	—	—
» *rhynchocephala*	—	—	3	2	4	4	5	4	1	3	4	3	2	1	4	—
Nitzschia acuminata	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
» *apiculata*	—	—	1	1	1	1	1	1	—	1	—	1	—	—	—	—
» *circumsuta*	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
» *hungarica*	—	—	4	2	2	2	5	4	1	3	4	3	3	2	1	2
» *obtusa*	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *punctata*	—	1	3	3	2	1	1	1	2	1	1	1	1	1	—	1
» *scalaris*	5	5	—	—	—	1	1	—	—	—	—	—	—	—	—	—
» *sigma*	—	—	1	2	3	3	5	5	2	2	5	5	3	2	5	—
» *sigmoidea*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3

	The 15 metre Bog															
	245	246	247	248	249	250	251	252	253	254	255	256	258	259	260	261
Nitzschia tryblionella	—	—	3	5	4	4	3	2	1	2	3	3	2	1	3	2
» » *v. subsalina*	—	—	2	—	—	2	2	1	—	1	1	1	—	—	—	—
» » *v. victoriae*	—	1	2	—	2	1	1	1	1	—	1	1	—	1	—	2
Pinnularia spp.	1	2	—	1	—	1	2	1	—	1	1	1	—	—	—	1
Pleurosigma elongatum	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhoicosphenia curvata	—	—	1	1	—	—	1	1	1	—	1	1	1	1	1	—
Rhopalodia gibba	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
» » *v. ventricosa*	—	—	1	—	1	1	1	1	1	1	—	1	1	1	1	1
» *musculus*	—	1	1	—	1	1	—	—	—	—	—	1	—	—	—	1
Scoliopleura peisonius	—	—	—	—	1	1	—	1	—	1	—	—	—	—	—	—
» *tumida*	—	—	—	—	—	1	1	1	—	1	1	2	—	—	—	—
Stauroneis Gregorii?	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
» *phoenicenteron*	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Stephanodiscus astraea	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
Surirella ovalis	—	—	1	1	—	1	1	1	—	1	—	—	1	—	—	—
» *ovata*	—	—	1	—	—	—	1	1	—	—	1	1	—	—	—	—
» *striatula*	—	2	2	1	3	4	1	1	—	1	1	1	—	—	—	1
Synedra affinis	—	1	2	1	1	2	1	1	2	2	2	2	2	1	1	2
» *pulchella*	1	1	1	—	1	—	1	1	—	1	—	—	—	—	—	—
» *sp.*	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Tabellaria spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Thalassiosira baltica	—	1	2	—	2	1	1	1	1	1	1	1	1	1	2	1

gression. In my opinion it is only a distal beach sand in the sense explained by Halden (B. Halden 1917). The curve for the changes of shore-line based on the pollen analysis declines fairly evenly towards the later part of the Littorina period and provides no evidence of the shore having shifted to any great extent at one time landwards, at another seawards during the Littorina period. The diatoms, rather, lead to the conclusion that some intermissions may have occurred in the fall of the sea-level.

The basin of the bog was isolated from the sea, when the shore-level was about 15 m. above the present level of the sea, for the threshold of the bog is about 15 m. above sea-level as shown by the map. According to the pollen diagram the separation phase is situated close to the end of the Littorina period or in L IV or else at a time immediately after it. According to this L IV should be slightly above the 15 m. level. On the basis of the previous bog I estimated L IV to be about 16—17 m. above sea-level in this area. The stratigraphy of this bog therefore yields the same result. In this district an ancient beach was also determined which is 16.9 m. above sea-level (see list, page 77). This shore-line, on the basis of the stratigraphical evidence discussed above, represents L IV.

This diagram is also interesting in the respect that it contains a fairly abundant quantity of *Picea* from the beginning of the Littorina period. This is not regular, but is evidently due to the mechanical concentration of *Picea* in the littoral deposits. We had a similar case already in the aqueous beds of the Pottmossen bog. In this case, of course, the *Picea* curve has no practical chronological value as regards the Littorina period. The abundant Littorina period appearance of *Picea* is also connected in this profile with the simultaneous exceptionally high frequency of pine, the reason for which, of course, is the same as for the former. The Littorina pollen flora in this diagram is dominated excessively by conifers, whereas in normal diagrams deciduous trees predominate in the Littorina period. Mixed oak forests, however, are in this case a certain and always infallible sign of the Littorina period, which the evidence of the diatoms unquestionably confirms.

THE CHANGES OF THE LITTORINA PERIOD SHORE-LINE IN THE PYHTÄÄ DISTRICT.

The stratigraphy of the bogs leads to the following conclusions concerning the changes of the shore-line during the Littorina period in the Pyhtää district. The raised beach, which is 26—27 m. above sea-level here, represents the greatest extent of the Littorina Sea. This Littorina Sea maximum is situated here, as in the previous investigation areas, at the very beginning of the Littorina period, so that from a practical point of view the *Clypeus* limit is the same as L I. At the time of this maximum limit the sea did not encroach appreciably upon the land. After the Littorina maximum other delays of the shore-line occurred: at the levels of 20—21 m. and 17 m. above sea-level. The former of these corresponds as regards its height most closely to L III and the latter to L IV. It seems certain that the regression of the shore-line during the Littorina period occurred in the Pyhtää area in exactly the same manner as in the previous investigation areas, although beaches corresponding to L II have so far not been recognised here.

THE STRATIGRAPHY OF THE PEAT BOGS IN THE JUURIKORPI DISTRICT.

Munasuo Bog.

The bog is a convex »Highmoor» in type and is situated about 20 km. N.E. of Siltakylä in Pyhtää and about 4 km. S.W. of the Juurikorpi railway halt, No. 41 on the map.

Fig. 28, page 94, illustrates the profile bored on Munasuo and its pollen diagram. At the bottom of the sequence there is a thick layer of varved late-Glacial clay which is almost devoid of fossils. There are slightly more pollen grains in its upper part (4.4 m.—4.6 m.), so that it was possible to make a quantitative analysis. According to this the pollen contained in the upper part of the varved clay (4.5 m.—4.6 m.) is of the late-Glacial type, chiefly owing to the comparatively large quantity of *Picea*. The uppermost layer of clay (4.4 m.—4.5 m.) may, however, already belong to the time of the Ancylus transgression maximum. The pollen analysis cannot, however, afford complete certainty on this point. Nor do the diatoms suffice in this case for exact dating, as only the following species appear very sparsely in the varved clay: *Melosira arenaria*, *M. distans*, *Epithemia turgida*.

The varved clay is succeeded in the profile by a thin layer of sand mixed with clay, 4.3 m.—4.4 m., belonging, on the basis of its pollen, to the Ancylus transgression time. The sandy bed is followed by fine detritus ooze, the lower part of which belongs to the Ancylus regression phase and the upper part to the beginning of the Littorina period.

The boundary between the Ancylus and Littorina periods is not quite sharply defined, as in this case it cannot be determined as the limit between fresh-water and salt-water diatoms, for the fine detritus ooze, like the sediment below it, only contains fresh-water diatoms.

In the fine detritus ooze, too, there are few diatoms. They are more abundant in its lower part (4.2 m.—4.3 m.). Of the diatoms of this stratum some of the more important should be mentioned, such as: *Amphora ovalis* 2, *Caloneis Schumanniana* v. *biconstricta* 2, *Campylodiscus noricus* 2, *Diploneis domblittensis* 3, *Epithemia turgida* v. *Westermanni* 5, *Gyrosigma attenuatum* 5, *Mastogloia Grevillei* 2. *Melosira arenaria* 1, *M. islandica* subspec. *helvetica* 4. Besides these fresh water species *Navicula peregrina* was found very rarely, which would indicate a weak marine influence, as also, perhaps, *Epithemia turgida* v. *Westermanni* which appears abundantly in this horizon. But if we consider that the diatom association of this sediment is clearly of the Ancylus type, we will find it unwarranted to conclude solely on the basis of these two species that the basin was directly connected with the Littorina Sea.

The pass-sill of the bog basin is approximately 29 m. above sea-level. The Littorina maximum is therefore below this level here, as the site, judging by the diatoms, was not directly connected with the sea. Probably the Littorina maximum is almost the same here as in the Siltakylä area in Pyhtää or 26—27 m. above sea-level, for these areas are situated close to each other and are almost on the same isobase according to Ramsay. In this connection I should like to mention that Ramsay's (1920, 1926) Littorina isobases are almost correct for South Finland as regards their direction. This view is also supported by the general direction of M. Sauramo's isobases concerning South Finland (M. Sauramo 1934, 1937).

The bog separates from the Ancylus Lake at the time, when the upper part of the fine detritus ooze (4.1 m.—4.2 m.) is deposited. This occurs at the beginning of the Littorina period. Large-lake forms disappear entirely from the diatoms and instead a poor small-lake flora appears, the principal representatives of which are: *Epithemia turgida* 5, *E. zebra* v. *porcellus* 4, *Stauroneis acuta* 1. The lake is soon filled up and the accumulation of peat begins. Above the detritus ooze there is a layer of deciduous tree peat (3.6 m.—4.1 m.), at the time of which the sea was still close to the bog. The *Alnus* maximum of the pollen diagram proves this. The shore retreats already, however, in the first half of the Littorina period from the vicinity of the bog and the growth of deciduous tree peat ceases. The further growth of the bog then continues by forming *Sphagnum* peat up to the present time.

In examining the pollen diagram it is interesting that the pollen of conifers increases appreciably as soon as the shore zone has retreated from the immediate neighbourhood of the bog. Here we again have clear proof of the extent, to which the shore zone influences the local composition of the pollen, as we saw above.

Kajasuo Bog.

The bog is situated about 5 km. N. of Juurikorpi station and the same distance S.E. of Inkeroinen station (investigation area No. 42). In type it is a convex »Highmoor» (Hochmoor), like the previous one. Fig. 29, page 94, illustrates the profile bored of the bog and its pollen diagram. The sequence of strata and the pollen of the bog are of precisely the same type as in the previous case. This is comprehensible, as the bogs are close to each other and at almost the same altitude. On the bottom of this bog, too, there is a thick layer of late-Glacial clay in which, however, a distinct lamination could not be detected on the basis of the boring samples. The clay is almost devoid of diatoms and pollen, except in the uppermost bed mixed with sand which contains a fair quantity of *Melosira arenaria* and less *Diploneis domblittensis*, *D. domblittensis* v. *subconstricta*, besides some other fresh-water species. These ap-

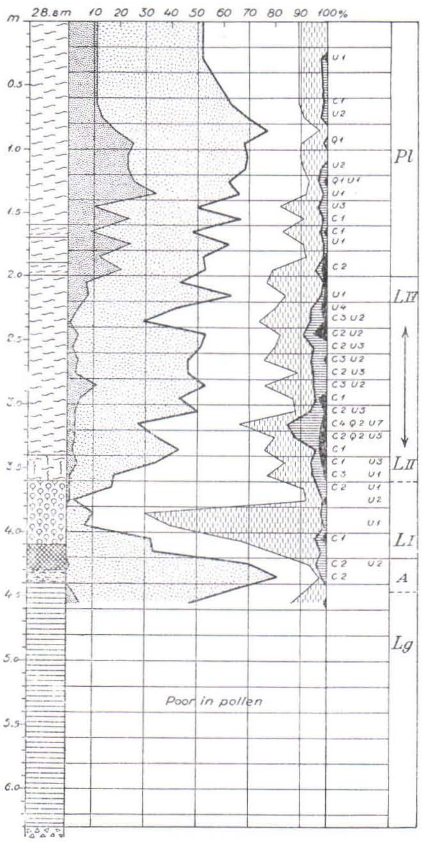

Fig. 28.

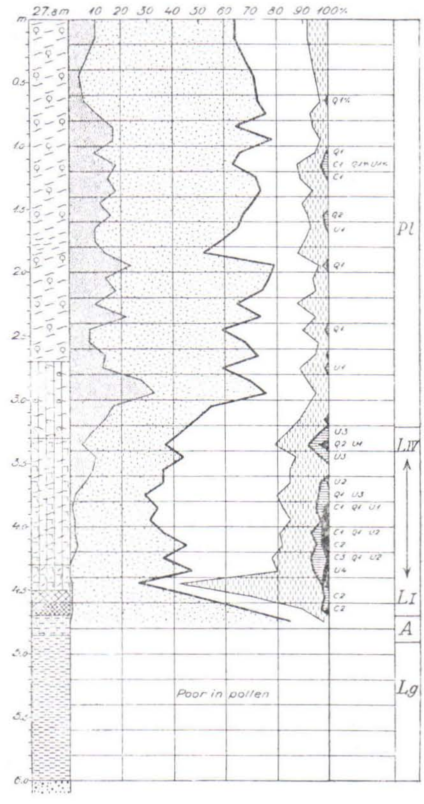

Fig. 29.

Fig. 28. Profile of the Munasuo bog. Juurikorpi. Analyst K. Salminen.
Fig. 29. Profile of the Kajasuo bog. Analyst K. Salminen.

pearances of diatoms lead to the view that the sandy clay (4.7 m.—4.9 m.) belongs to the Ancylus transgression time. This is also proved by the pollen content analysed from the upper part of the sandy clay bed which is clearly of the Ancylus type.

The site separated from the Ancylus Lake to become an independent small lake at the beginning of the Littorina period. The pass-sill of the basin of the bog is 28 m. above sea-level. The maximum limit of the Littorina Sea is therefore below this level. On the basis of the stratigraphy of the previous bog the Littorina limit of this area is below the 29 m. level. The stratigraphical evidence of both bogs regarding the Littorina maximum is therefore in agreement.

On the basis of the stratigraphy of Kajasuo bog it is certain that the absolute height of the Littorina maximum in this area was not greater than at Siltakylä in Pyhtää (26—27 m. above sea-level). It seems to be still more certain that the Littorina maximum is almost 27 m. above sea-level in the Juurikorpi area, as we can conclude already on the basis of the direction of the isobases. This result is given further confirmation by a couple of peat bogs situated farther east which are, indeed, on a slightly lower isobase, but on the basis of which the lower limit of the Littorina maximum is more than 25 m. above sea-level. In the area bounded by these bogs and the Juurikorpi bog the highest limit of the Littorina Sea is between the 25 and 28 m. levels.

Before passing on to deal with the stratigraphy of these bogs it is worth mentioning that W. Ramsay (1926) measured an abrasion cliff at Inkeroinen, the altitude of which he stated to be 32 m. above sea-level. Ramsay considers this to be the maximum limit of the Littorina Sea. This beach is about 5 km. N.W. of Kajasuo. In the Kajasuo area the Littorina maximum is less than 28 m. above sea-level, probably about 27 m. above sea-level, as is evident from the above. The figure obtained by Ramsay, 32 m. above the sea, seems too high, because his observation place is only about 5 km. N.W. of Kajasuo, although, indeed, towards higher isobases. Judging by Kajasuo, the Littorina maximum at Inkeroinen should be at most 28—29 m. above sea-level.

It is possible, however, that the shore-line determined by Ramsay belongs to L I, but was formed on a site, on which the abrasion and the effect of the winter ice were able to make the shore marks much above the average water-level. Further on we will see that farther east, on the Karelian Isthmus, the limit of the Littorina maximum, on the basis of the stratigraphy of the bogs, is in some cases considerably lower than the corresponding shore marks indicate.

THE STRATIGRAPHY OF THE PEAT BOGS IN THE REITKALLI DISTRICT.

Sikovuori Bog.

The bog is situated 3 km. N.E. of the Reitkalli railway halt, investig. a. No. 43. It is a *Sphagnum-Eriophorum* »Lowmoor» in type. Fig. 30, page 104, illustrates the profile bored on the bog and its pollen diagram. The sequence of strata begins at the bottom with clay mixed with sand which is an Ancylus Lake sediment. This is proved, in addition to the pollen, particularly by the diatoms of the sediment which are a very distinct type of Ancylus flora (diatom table X, Sikovuori bog). The sediment passes over upwards at 6.6 m. into pure clay which, on the basis of its diatoms, seems to represent the Ancylus transgression maximun. The transgression peak should best be placed at the level of samples 330 and 331, as the curve for the changes of the shore-line in connection with the diagram shows. The diatoms are, however, fairly homogeneous throughout the whole Ancylus sediment, so that the point of the transgression maximum cannot be determined precisely.

The Ancylus and Littorina contact is in the limit of samples 325 and 326. Sample 326, indeed, already contains some Littorina species, but they came with the borer from the upper strata, as there is a distinct floristic limit only between the diatom associations of samples 325 and 326. There is still typical Ancylus flora in sample 326: *Campylodiscus noricus* v. *hibernica* 1, *Cymbella prostata* 3, *Cymatopleura elliptica* v. *hibernica* 3, *Diploneis domblittensis* 2, *Gyrosigma attenuatum* 5, and so on. This flora disappears almost entirely, when sample 325 is deposited, this having been due to the ecological conditions being suddenly disturbed and converted into marine conditions, when the salt water penetrated into the Baltic. The bathymetric diatom curve in the diagram declines for this reason rather abruptly in sample 325, though rising again immediately in the next sample (324). The fall of the curve is evidently due to this ecological reason and cannot in this case either be taken with certainty as a gauge for the fluctuation of the water depth (cf. page 33).

The rise of the diatom curve in sample 324 is due to the ecological conditions having again become stabilised and an intermission having occurred in the retreat of the shore-line. The marine influence is, however, felt very slightly round the basin of the bog, as the Littorina sediment of the profile (4.5 m.—5.9 m.) contains a comparatively large quantity of the same large-lake species that characterised the Ancylus Lake deposit below it. This leads to the view that the Littorina Sea did not reach very much higher than the pass-sill of the bog even at the time of its maximum. The threshold of the bog is 25 m. above sea-level. The Littorina maximum is therefore slightly above the 25 m. level in this area.

At Juurikorpi, on the basis of the stratigraphy of the local bogs, the Littorina maximum was below the 28 m. level, probably about 27 m. above sea-level, as at Pyhtää, with which Juurikorpi is almost on the same isobase. Reitkalli is on a slightly lower isobase than Juurikorpi, so that the Littorina maximum is probably a little below the 27 m. level there. On the basis of the bog we are dealing with it is slightly above the 25 m. level. It seems certain that at Reitkalli the Littorina maximum is about 26 m. above the sea. Thus the maximum limit of the Littorina Sea is roughly the same at Reitkalli, Juurikorpi and Pyhtää or 26—27 m. above sea-level on the basis of the raised beaches and the stratigraphy of the bogs.

The Littorina sediment of the Sikovuori bog belongs entirely to the L I time, as it involves a water-level above 25 metres, as we have seen. In the Helsinki district L II is 24.5 m. above sea-level in those places in which L I is 30 m. above sea-level. There is no reason to suppose that the relative height of these shore-lines is different at Reitkalli.

During the L I time comparatively thick deposit was laid down in the basin of the Sikovuori bog. The diatom curve shows that two small rises of water-level occurred during the deposition of there strata: a and b. These cannot signify any great oscillation of the shore, as the basin of the bog did not even separate from the sea in the interval between these culmination points. The possible fluctuation of the shore-level is thus within a limit of 1 metre: the altitude of the local Littorina maximum, about 26 m. subtracted by the altitude of the pass-sill of the bog, 25 m.

As regards the Littorina transgression itself the profile of the Sikovuori bog proves unquestionably, as many of the previous bogs, that when the highest Littorina limit was formed, the shore-line did not shift considerably towards the land. Even if we were to take the maximum figure for the Littorina limit here as 27 m. above sea-level, which is already 1 metre more than I have estimated on the basis of the stratigraphy of the Sikovuori bog, the possible rise of the water-level would nevertheless be within a space of 2 metres: 27 m. — the height of the threshold 25 m. above sea-level, for the bog was not isolated from the Baltic before the Littorina maximum, as the diatoms of the succession prove.

The Sikovuori bog basin is shut off from the Littorina Sea at the end of L I or in the initial phase of the Littorina period. We see, how greatly the quantity of *Picea* in this diagram, too, rises as soon as the separation occurs, which signifies that the shore zone is moving away from the immediate vicinity of the bog. In regard to the pollen method this diagram is also instructive in other respects. If this diagram is divided into time-fields exclusively on the basis of the pollen analysis, the limit between the Ancylus and Littorina periods would be in the horizon of sample 316, for the mass-appearance of mixed oak forests and of deciduous trees in general that is typical of the Littorina

Table X.

	Siko-						
Anal. K. Salminen	312	313	314	315	316	317	318
Achnanthes calcar	—	—	—	—	—	—	—
» *lanceolata v. elliptica*	—	—	—	—	—	—	—
Amphora commutata	1	1	1	—	—	1	1
» *arenicola v. major*	—	—	—	—	—	—	—
» *ovalis*	—	1	1	—	1	1	1
» » *v. libyca*	—	1	2	1	—	1	—
» » *v. pediculus*	—	—	—	—	—	1	—
Anomoeoneis sphaerophora	1	1	1	—	—	—	—
» » *v. polygramma*	1	—	1	—	—	—	1
» » *v. sculpta*	1	—	1	1	1	1	1
Auliscus sp. (116.4—17.3)	—	—	—	—	—	—	1
Caloneis latiuscula v. subholstei	—	—	—	—	—	—	—
» *Schumanniana v. biconstricta*	—	—	—	—	—	—	—
» *silicula*	—	1	1	1	1	—	—
» *sp.*	—	—	—	—	—	—	—
Campylodiscus clypeus	5	5	5	1	1	1	3
» *echeneis*	2	2	3	1	—	1	1
» *noricus*	—	—	1	1	2	2	1
» » *v. hibernica*	1	1	1	1	—	—	1
Chaetoceros sp.	1	1	1	1	—	—	—
Cocconeis disculus	—	—	—	1	1	—	1
» *pediculus*	1	2	1	2	1	1	—
» *placentula*	1	3	3	5	—	1	1
» » *v. euglypta*	—	—	—	—	1	—	—
» *sp.*	—	—	—	—	—	—	—
Cyclotella bodanica	—	—	—	2	1	1	—
» *comta*	—	1	—	1	—	—	—
» *Kützingiana*	—	1	—	—	—	—	—
» » *v. radiosa*	—	—	—	—	—	—	—
Cymbella aspera	—	—	—	—	—	—	—
» *cistula*	—	—	1	—	—	—	—
» *cuspidata*	—	—	—	—	—	—	—
» *Ehrenbergii*	1	1	—	1	—	1	1
» *lacustris*	—	—	—	—	—	—	—
» *lanceolata*	—	—	—	—	—	—	—
» *prostata*	—	—	—	1	1	1	1
» *sp.*	1	2	2	2	—	1	1
Cymatopleura elliptica	1	1	1	1	1	—	1
» » *v. hibernica*	—	—	—	—	—	—	—
» *solea*	—	1	—	1	—	—	1
Didymosphenia geminata	—	—	—	—	—	—	—
Diploneis didyma	1	1	—	—	—	—	—
» *domblittensis*	—	—	—	1	3	5	3
» » *subconstricta*	—	—	—	—	—	1	1
» *elliptica*	1	—	—	1	1	2	1
» » *v. ladogensis*	—	—	—	—	—	1	—
» » *v. subconstricta*	—	—	—	—	—	—	—
» *incurvata*	—	—	—	—	—	—	—
» *interrupta*	4	5	4	1	1	1	1
» *Mauleri*	—	—	1	1	1	5	2
» *ovalis*	—	1	1	—	—	—	—
» » *v. oblongella*	—	1	—	—	—	—	—

vuori Bog

319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	1	—	—	1	2	2	1	2	2	1	—	2	2	2	2
1	—	—	—	—	—	—	—	1	2	1	3	1	1	1	1	3	2	4
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
1	—	—	—	—	—	—	—	1	1	1	1	1	1	1	1	2	2	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
3	5	4	3	5	4	1	2	—	—	—	—	2	—	1	—	—	—	1
1	1	1	1	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—
1	1	1	2	2	1	—	1	—	—	—	—	2	—	—	—	—	—	—
1	2	1	—	1	—	—	1	2	1	1	1	2	1	—	—	1	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	1	2	1	2	1	2	3	5	2	1	—
2	—	1	—	1	—	1	—	1	—	—	1	—	1	1	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	5
—	—	—	—	—	—	—	—	1	1	2	1	2	4	4	5	2	1	—
1	—	1	2	—	—	—	3	3	3	3	5	3	3	2	3	5	5	3
—	—	1	1	—	—	—	1	1	1	1	2	1	1	1	2	3	3	1
1	1	1	1	—	—	—	1	1	2	1	—	1	1	1	1	2	2	1
—	1	2	—	1	1	—	3	3	2	2	—	1	—	—	1	1	—	—
—	—	1	—	—	—	—	—	1	1	1	1	—	1	1	1	—	—	—
—	—	—	—	—	—	—	1	1	1	1	1	1	3	3	4	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	3	2	4	2	1	—	2	4	5	5	4	4	—	4	4	3	1	1
1	1	2	—	—	—	—	1	1	—	1	—	2	1	1	1	—	—	—
2	1	2	1	2	—	—	1	—	1	1	2	1	1	—	—	2	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
1	1	1	2	1	2	—	1	—	—	—	—	—	—	—	—	—	1	1
4	1	1	1	2	—	—	1	—	—	1	—	2	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	Siko-						
	312	313	314	315	316	317	318
Diploneis Smithii	—	—	1	—	—	—	—
» » *v. rhombica*	1	—	—	—	—	—	—
Epithemia argus	2	3	4	1	1	1	1
» » *v. longicornis*	—	1	—	—	—	—	—
» *Hyndmannii*	1	1	1	1	—	1	1
» *intermedia*	—	1	1	1	1	—	1
» *Muelleri*	1	2	3	—	—	—	1
» *sorex*	1	2	2	2	2	1	1
» *turgida*	2	5	4	3	3	2	3
» » *v. granulata*	—	—	1	—	—	—	—
» » *v. porcellus*	—	—	—	—	—	—	—
» » *v. Westermannii*	3	3	4	3	2	2	4
» *zebra*	3	2	3	1	2	3	2
» » *v. porcellus*	5	5	5	5	3	3	5
» » *v. saxonica*	—	—	—	—	1	—	—
Eunotia spp.	—	2	5	1	1	—	—
Fragilaria spp.	1	—	1	—	—	—	—
Gomphonema acuminatum v. coronata	1	1	2	2	1	1	—
» *constrictum*	1	—	—	1	—	1	—
» *sp.*	—	—	—	1	—	—	—
Gyrosigma attenuatum	—	1	—	2	4	2	1
» *sp.*	—	—	—	—	—	—	—
Mastogloia Braunii	1	1	2	—	1	1	1
» *elliptica*	1	—	—	—	—	—	—
» » *v. dansei*	1	1	2	—	—	1	1
» *Grevillei*	1	1	—	—	—	1	1
» *Smithii v. amphicephala*	1	—	1	—	1	—	1
» » *v. lacustris*	—	—	—	—	—	—	—
Melosira arenaria	2	2	2	2	2	1	3
» *islandica subspec. helvetica*	3	3	5	4	5	3	5
Meridion circulare v. constricta	—	—	1	—	—	—	—
Hantzschia amphioxys	—	—	—	—	—	—	—
» » *f. capitata*	1	1	2	—	1	1	—
Navicula amphibola	—	—	—	—	—	—	—
» *anglica v. subsalsa*	—	—	—	—	—	—	—
» *bacillum*	—	—	—	—	—	—	—
» *elegans*	—	—	—	—	—	—	—
» *gastrum*	—	—	1	—	—	—	—
» *oblonga*	—	2	2	4	—	1	1
» *peregrina*	—	—	—	—	—	—	—
» » *v. kefvingensis*	—	—	1	1	—	—	—
» *placentula*	—	—	1	1	1	—	1
» » *f. jenisseyensis*	—	—	—	—	—	1	—
» » *f. rostrata*	—	—	—	—	—	1	—
» *platystoma*	—	—	—	—	—	—	—
» *protracta*	—	—	—	—	—	—	—
» *pupula v. rectangularis*	—	—	—	1	—	—	—
» *pusilla*	2	3	4	1	1	2	1
» *radiosa*	—	—	—	1	—	—	—
» *scutelloides*	—	—	1	—	1	—	—
» *tuscula*	—	1	1	1	—	1	1
Neidium sp.	1	—	1	1	—	—	—

vuori Bog

319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	3	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	2	2
2	2	—	1	2	1	1	1	—	1	—	—	1	—	—	—	2	3	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	2	3	1	1	1	1	1	1	1	1	—	1	—	—	—	—	—	—
2	1	—	1	2	1	1	—	—	—	—	—	1	—	—	—	—	—	—
1	1	1	1	1	1	—	—	—	—	—	—	1	—	—	—	1	1	—
1	1	1	1	—	—	—	—	—	1	1	1	2	—	—	1	1	1	—
1	4	2	2	2	3	1	3	3	2	4	2	2	1	—	—	—	1	—
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
3	3	4	3	2	3	—	4	5	4	4	2	3	1	1	—	3	2	—
2	2	1	1	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—
5	4	3	4	5	4	2	2	2	2	1	—	3	1	1	—	2	2	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	1	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—
1	—	—	1	—	—	—	—	—	1	—	1	—	1	2	2	1	—	—
2	4	2	3	1	1	—	5	4	4	5	5	5	4	2	3	5	1	—
—	—	—	—	—	—	—	—	—	—	—	2	—	1	1	1	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—
1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	1	2
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
3	5	5	2	4	2	1	3	3	2	1	—	2	—	—	—	—	—	—
5	5	5	5	2	5	2	5	5	5	5	5	5	5	5	5	4	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	1	—	1	1	1	—	—	—	—	1
1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	3
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	1	—	—	—	—	—	—	—	—	—	1	—	1	1	—	—
—	—	—	—	—	—	—	1	1	—	—	1	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	1	1	—	—	1	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	1	—	1	—	1	—	—	—	1	1
—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	—	—	—

	Siko-						
	312	313	314	315	316	317	318
Nitzschia angustata v. acuta	—	1	—	—	—	—	—
» *circumsuta*	—	—	—	—	—	—	1
» *navicularis*	—	—	—	—	—	—	—
» *obtusa*	—	—	—	—	—	—	—
» *punctata*	—	—	—	—	—	—	—
» *scalaris*	2	4	3	1	—	2	2
» *Sigmoidea*	—	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—
» *tryblionella*	—	—	—	—	—	—	—
» » *v. victoriae*	—	—	—	—	—	—	—
Opephora Martyi	—	—	—	—	1	1	1
Pinnularia spp.	5	5	5	1	1	2	1
Rhopalodia gibba	—	1	—	1	1	—	—
» *musculus*	1	—	1	—	—	—	—
Rhoicosphenia curvata	—	—	—	1	—	—	—
Stauroneis anceps f. gracilis	1	1	4	—	—	—	—
» *phoenicenteron*	3	4	4	2	—	1	1
» *sp.*	—	—	—	—	—	—	—
Stephanodiscus astraea	2	2	2	5	2	3	2
Surirella biseriata v. bifrons	—	—	—	1	—	—	—
» *striatula*	1	1	2	1	—	—	1
Synedra sp.	—	—	1	1	—	1	—
Tabellaria spp.	—	—	1	1	1	1	—

period only begins above this. Below this sample, on the other hand, there is pollen assemblage dominated by *Pinus*, in which precious foliferous trees are very scarce, an association typical of the Ancylus period. On the basis of the diatoms, however, the limit between Littorina and Ancylus can be placed with complete certainty between samples 325 and 326. In this horizon the pollen composition does not present such a great change in type as to enable us to draw the limit on the basis of it. A division into zones, based solely on the pollen statistics, cannot be employed in this case, as it would lead to an erroneous result regarding this important limit.

The inapplicability of the pollen diagram referred to for exact dating is in this case, too, due to this being a case of aqueous sediment and of selective enrichment of pollen that occurred in the shore zone, in consequence of which the pollen assemblage dominated by *Pinus*, typical of the Ancylus period, continues exceptionally far into the Littorina period. I will return to this question in connection with the next bog.

vuori Bog

319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	3	1	1	2	1	—	—	—	1	—	—	—	1	4	4	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	1	—	—	2	1	—	—	—	—	1	—	—	—	—	—	1
2	3	2	2	3	1	1	1	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	1	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
—	—	1	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
3	1	1	2	3	1	1	1	1	—	1	—	1	1	—	—	1	1	—
1	1	—	—	—	1	—	1	—	1	1	1	1	1	—	1	1	3	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	2	—	—	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
2	1	1	1	1	—	—	1	1	3	3	5	4	5	4	5	1	1	—
—	—	—	—	—	—	—	—	1	1	1	1	1	2	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—

Reitkalli Bog.

The bog, a *Sphagnum-Pinus* »Highmoor», is situated about 1 km. N.E. of the Reitkalli railway halt (investigation area No. 44). Fig. 31, page 104, illustrates its stratigraphy. On the bottom of the bog there is clay, 3 m. in thickness, which is mixed with sand in its lower part. This sediment contains few pollen grains and diatoms only in fragments. On the basis of the pollen the clay is for the greater part late-Glacial. Its upper part may possibly be Ancylus Lake sediment. The clay cannot, however, be divided into horizons corresponding to the development of the Baltic with much certainty. I have, indeed, marked limits of periods in the diagram, but they cannot be considered exact, for the pollen content of this clay is fairly uniform from top to bottom, so that an exact chronological division cannot be made on the basis of it, especially as diatoms are lacking.

Special attention is attracted by the comparatively large quantity of *Picea* in the clay. This large quantity of *Picea* proves that this

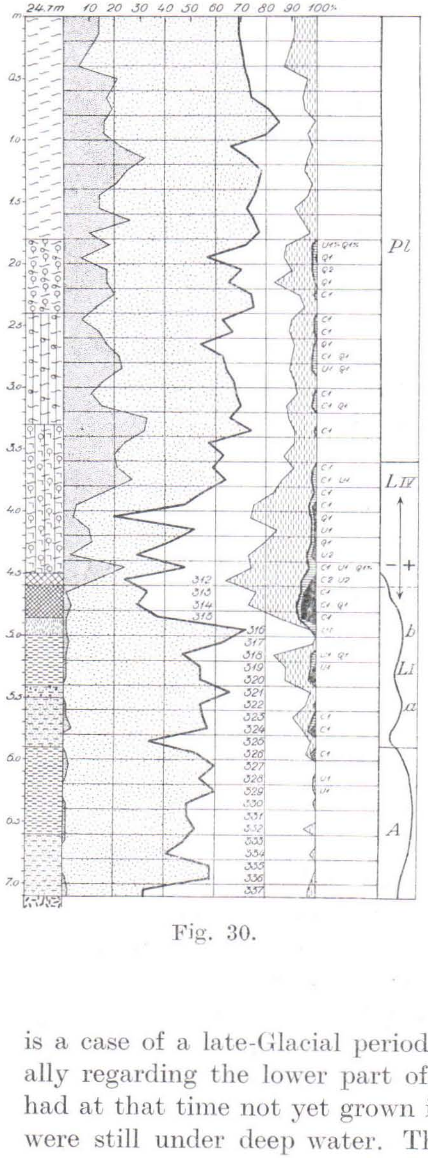

Fig. 30.

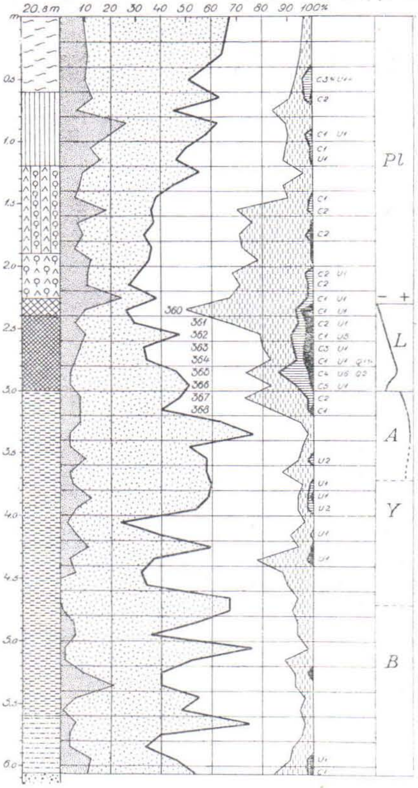

Fig. 31.

Fig. 30. Profile of the Sikovuori bog. Analyst K. Salminen.

Fig. 31. Profile of the Reitkalli bog. Analyst K. Salminen.

is a case of a late-Glacial period. This appears to be certain especially regarding the lower part of the clay deposit. *Picea*, it is true, had at that time not yet grown in the surroundings of the bog which were still under deep water. The *Picea* pollen must in this case be regarded as having been carried from a distance from such late-Glacial forests as already certainly existed on the eastern border of Finland and in Russia (cf. E. Hyyppä 1933 and 1936).

In the 3 metre horizon of the profile the clay passes rapidly over into fine detritus ooze, the latter being a Littorina Sea sediment. This is proved both by the pollen of the deposit and the dia toms (diatom table XI, Reitkalli bog). Sample 366 contains brackish-water species in small quantities, but already the next sample above, No. 365 shows that the salinity had increased and that the surface of the sea had, possibly, risen. In the curve for the changes of the sea-level in the diagram there is a distinct culmination at this point, after which the shore-line seems gradually to retreat past the site. The separation from the sea, occurs, according to the pollen analysis, at the end of the Littorina period. The beach was then about 15 m. above sea-level, a level that corresponds to the altitude of the pass-sill of the bog. L IV is situated in this period, so that at Reitkalli it is about 15 m. above sea-level or approximately at the same level as in the Pyhtää district. This is intelligible, because the maximum limit of the Littorina Sea (L I) in both areas is also almost at the same level (26—27 m. above sea-level), as I have shown above.

In the contact, at 3 metres, of the clay and detritus ooze in the profile there is an evident break in the sequence of strata. This view is supported by the diatoms of the sediments referred to. The pass-sill of the Reitkalli bog is 10 m. lower than the threshold of the Sikovuori bog. At the beginning of the Littorina period, therefore, the Reitkalli bog was much more freely connected with the sea than the Sikovuori bog which was only slightly embodied with the salt water at the time of the Littorina Sea maximum. Besides, the water above the Reitkalli bog at the beginning of the Littorina period was considerably deeper than in the area of the Sikovuori bog. It should consequently be expected that the lower part of the Littorina sediment in the Reitkalli bog would indicate, in its petrographical composition and its diatoms, deeper and more saliferous water than the Littorina deposits of the Sikovuori bog. However, the Littorina sediment of the Reitkalli bog rather indicates, both lithologically and by its diatoms, shallower water than the Littorina deposit of the Sikovuori bog. It therefore seems certain that, besides the sequence of the Ancylus regression period, the Reitkalli bog also lacks the beds corresponding to the beginning of the Littorina period (L I) which appear in the Sikovuori bog as an unusually thick deposit.

In connection with the stratigraphy of the Sikovuori bog it was already evident that the mutual connection between the pollen diagrams of these bogs did not provide quite a correct chronological result. On the basis of the pollen the 3.3 m.—4.1 m. zone of the Reitkalli bog should corrrespond to the 4.9 m.—5.9 m. zone of the Sikovuori bog. The pollen content of these zones is very similar in both cases. On the basis of the diatoms, however, we know that these horizons are of different date.

Table XI.

Anal. K. Salminen	Reitkalli Bog								
	360	361	362	363	364	365	366	367	368
Amphora ovalis	—	—	—	1	—	1	—	—	—
» » *v. libyca*	—	—	—	—	1	1	—	—	—
Anomoeoneis sphaerophora v. sculpta	—	—	1	—	1	—	—	—	—
Caloneis amphisbaena	—	—	—	1	—	—	—	—	—
» *formosa v. holmiensis*	—	—	—	—	—	2	1	—	—
» *silicula*	—	—	1	—	1	1	—	—	—
Campylodiscus clypeus	—	—	2	2	2	1	—	fr.	—
» *echeneis*	—	—	1	2	4	5	1	—	—
» *noricus v. hibernica*	—	—	—	—	—	1	—	—	—
Coscinodiscus sp.	—	—	—	—	—	—	—	—	fr.
Cymbella cuspidata	—	—	—	—	—	1	—	—	—
Diploneis didyma	—	—	—	—	—	1	—	—	—
» *Smithii*	—	—	—	—	1	4	—	—	—
» » *v. rhombica*	—	—	—	—	—	2	—	—	—
Epithemia Hyndmanni	—	—	—	—	—	1	—	—	—
» *Muelleri*	—	—	—	—	—	1	—	—	—
» *turgida*	—	—	—	1	—	2	1	—	—
» » *v. Westermanni*	—	—	—	1	2	2	—	—	—
» *zebra*	—	—	—	2	1	1	—	—	—
» » *v. porcellus*	—	—	4	3	4	1	1	—	—
Eunotia Clevei	—	—	—	—	—	1	—	—	—
» *spp.*	2	5	2	1	1	—	—	1	—
Fragilaria spp.	—	—	1	—	—	—	—	—	—
Gomphonema spp.	—	—	—	1	—	—	—	—	—
Gyrosigma attenuatum	—	—	—	—	—	1	—	—	—
Melosira arenaria	1	—	1	—	1	2	—	—	—
» *islandica subspec. helvetica*	—	—	—	—	1	—	—	—	—
» *italica*	—	—	—	—	1	—	—	—	1
» *Westii f. parva*	—	—	—	—	—	1	—	—	—
Navicula cuspidata	—	—	—	—	—	—	1	—	—
» *peregrina*	—	—	1	2	1	3	1	—	—
» *punctulata v. cluthensis*	—	—	—	1	—	4	1	—	—
» *pusilla*	1	1	—	—	—	—	—	—	—
Nitzschia circumsuta	—	—	—	1	1	4	—	—	—
» *scalaris*	—	1	5	5	5	3	3	1	—
» *tryblionella v. litoralis*	—	—	1	2	1	2	—	—	—
Pinnularia spp.	5	5	4	2	3	1	2	—	1
Rhopalodia gibba	—	—	1	—	—	—	—	—	—
» *musculus*	—	—	—	—	1	—	—	—	—
Stauroneis phoenicenteron	4	5	—	—	—	—	—	—	—
Stephanodiscus astraea	—	—	—	—	—	1	—	—	—
Surirella striatula	—	—	1	2	1	2	1	—	—

The error is in this case partly due to the fact that the diagram of the Reitkalli bog, as we saw above, is not complete. The erroneous dating is, however, caused chiefly by there being exceptionally much *Pinus* in the Littorina sediment, 4.9 m.—5.9 m., of the Sikovuori bog, so that its pollen composition is misleadingly similar to that of the Ancylus period. In this case *Pinus* has been enriched disproportionately in the shore sediment of the Littorina Sea. This is intelligible, if we take the topographical conditions of the district into consideration, for the shore of that time stood here on slopes of steep rocky hills, having a free exposition only to the south, towards the open sea. Such an exposed position of the shore-line is often favourable to the accumulation of conifers in littoral sediments, especially as the deciduous trees of the shore-zone are not able to gain so much habitat on rocky ground as to affect the composition of the pollen flora locally to any marked extent.

It was only when the Sikovuori bog separated from the sea that an actual shore stand containing plenty of *Alnus* was able to grow luxuriantly in the vicinity of the bog. At that time the shore-line had also already retreated from the slope of the rocks further towards the sea and dry ground better suited to the deciduous tree zone was provided. The depression of the Sikovuori bog was at that time also no longer so freely exposed towards the sea, which in turn contributed to the appearance of pollen flora corresponding to the local conditions.

RAISED SHORES IN THE HAMINA DISTRICT.

My assistant, Mr. A. Valanne, established the following ancient beaches in this area:

Munavuori Hill, at the N. end of the peninsula of Vilniemi (investigation area No. 45):

shore rampart W. of Munavuori			17.9	m.	above	sea-level
foot of wave-cut cliff	W. of	Munavuori	23.6	»	»	»
» » »	»	»	23.5	»	»	»
» » »	»	»	23.9	»	»	»
» » »	S.W.	»	26.7	»	»	»
» » »	S.	»	27.0	»	»	»
» » »	N.	»	16.8	»	»	»
shore bar	N.	»	22.8	»	»	»
foot of abrasion cliff	N.	»	26.2	»	»	»
» » »	S.	»	23.3	»	»	»

Eastern shore of the point of Hietaniemi, N. of Munavuori:

stony foot of wave-cut cliff	7.0 m. above sea-level
» » » »	8.5 » » »
sandy » » »	12.4 » » »
stony » » »	13.3 » » »
» » » »	16.6 » » »

Kettuvuori Hill, at the S.W. end of Vilniemi, investigation area No. 46:

foot of abrasion cliff S. of Kettuvuori	24.3 m. above sea-level

Rakila hill, at the S.E. end of Vilniemi (investigation area No. 47):

foot of wave-cut cliff E. of Rakila hill	11.8 m. above sea-level
» » » » » »	17.6 » » »
» » » » » »	23.5 » » »
» » » » » »	27.9 » » »

Summa esker on Summa peninsula, W. of Hamina (investigation area N:o 48):

abrasion cliff on E. slope of Summa esker	8.4 m. above sea-level
» » » » »	12.5 » » »
» » » » »	13.3 » » »
» » » » »	15.9 » » »
» » W. » »	12.5 » » »
» » » » »	16.2 » » »

The above shore-lines are distinctly grouped at the following levels: 8.5 m., 12.5—13.0 m., 16—17 m., 23.5 m., and 27 m. above sea-level. Of these the 23.5 m. shore is very well developed, while on the other hand the 27 m. beach is the most uncertain of all. It was only indentified at two places and is situated at the very top of the elevations in question. It is therefore possible that it only represents shoals capped with boulders just raised up to the surface of the sea, without there being any question of a delay having occurred in the land upheaval.

The date of these shore-lines in the Hamina area cannot be determined in this connection by means of the stratigraphy of peat bogs, as I have no materials for this purpose. If, however, we take into account the Littorina limit of the previous areas and the general direction of the isobases, it seems certain on the basis of these that the 23.5 m. level in the Hamina district is the Littorina Sea maximum. This is also strongly supported by the fact that the ancient beaches representing this level are fairly pronounced like the corresponding shores in the previous investigation areas.

The other shore-lines determined in the Hamina district belong either to the Littorina Sea period or to the period after it. I will return to the question of their date in connection with the relation diagram.

THE STRATIGRAPHY OF THE PEAT BOGS IN THE SALPAUSSELKÄ AREA.

This area extends along the first Salpausselkä ridge from the Viittamäki railway halt in the W. to Taavetti station in the east. In this area I investigated several bogs in order to ascertain the altitude of the pre-Littorina shore-levels. The stratigraphy of these bogs also throws additional light on the composition of late-Glacial pollen flora.

Haukkasuo Bog.

The bog, which is a large *Eriophorum-Sphagnum* »Lowmoor», is situated immediately to the S.W. of Utti station (investigation area No. 49). Fig. 32, page 111, illustrates its stratigraphy. In this case the bottom strata of the bog interest us particularly. They are varved clay, above which there is a little clay ooze and fine detritus ooze. This sequence of strata is devoid of pollen grains, but it contains diatoms, on the basis of which I established it to be a Yoldia Sea sediment. I cannot, however, consider this dating absolutely certain, as we must exercise caution in dating our late-Glacial diatom-bearing deposits, for quite recently isolated clay occurrences have been discovered in East Finland which are marine, but older than the time succeeding the last Glacial period (G. Brander 1937 a and b, E. Hyyppä 1937 c). These clays contain marine diatoms, partly the same species as have been found in late-Glacial Yoldia Sea sediments. Here the possibility must, of course, be taken into account that the late-Glacial saliferous diatoms may derive, at any rate partly, from these old marine deposits.

The former distribution of these (interstadial or interglacial) clays has, however, not yet been more closely examined, so that for this reason, too, it is difficult to estimate their potential share in the diatom flora contained in the late-Glacial clays. The composition of the diatom flora, of course, provides a basis in accounting for the origin in each individual case. In this case I am inclined to consider this diatom flora as primary.

The diatom table XII, Haukkasuo bog 159–169, illustrates the small number of species of diatoms determined in the aqueous deposits

Table XII.

Anal. K. Salminen	Haukkasuo Bog										
	159	160	161	162	163	164	165	166	167	168	169
Campylodiscus echeneis	1	1	—	—	—	—	—	1	—	—	—
Cymatopleura elliptica	—	—	—	1	—	—	—	—	1	—	1
» » *var. hibernica*	—	—	—	—	2	—	—	1	—	—	—
Cymbella prostrata	—	—	—	—	—	—	—	—	—	—	1
» *sp.*	2	—	—	—	—	—	—	—	—	—	—
Diploneis Smithii	—	2	—	—	—	—	1	1	—	—	—
Epithemia zebra v. porcellus	—	—	—	—	1	—	—	—	—	—	—
Eunotia sp.	5	—	—	—	—	—	1	—	1	—	—
Fragilaria sp.	—	—	1	—	—	—	—	—	—	—	—
Gyrosigma attenuatum	—	—	—	1	1	—	1	—	—	1	—
Hantzschia amphioxys	2	—	—	—	—	—	1	—	—	—	—
» » *v. maior*	5	—	—	—	—	—	—	1	—	—	—
Melosira islandica subspec. helvetica	—	—	—	2	—	2	5	2	—	1	5
Navicula placentula	1	—	—	—	—	—	—	—	—	—	—
» *pusilla*	5	—	—	—	—	—	—	—	—	—	1
Nitzschia navicularis	—	5	—	1	1	—	3	3	2	1	—
» *punctata*	—	2	—	—	—	—	1	—	—	—	—
Pinnularia sp.	5	1	—	—	1	—	1	1	—	—	—
Stauroneis acuta	1	—	—	—	—	—	—	—	—	—	—
» *obtusa*	3	—	—	—	—	—	—	—	—	—	—
Stephanodiscus astraea	—	—	—	1	—	—	—	—	—	—	—

of this bog. There are a few brackish-water species in the sediment in addition to fresh-water species almost from the bottom of the sequence of strata. Such a mixed flora is generally typical of the Yoldia Sea sediments that have so far been investigated in South Finland. The brackish-water species: *Campylodiscus echeneis*, *Diploneis Smithii*, *Nitzschia navicularis* and *N. punctata*, that appear in this sediment, too, belong to those very characteristic species that have hitherto been discovered in the Yoldia Sea deposits of South Finland. Up to the present it seems, on the basis of the material investigated, that these brackish-water species appear most abundantly in South Finland in the latter half of the late-Glacial period. Such an appearance during a particular period indicates that the diatom flora referred to is primary and developed at the very time, when the salinity of the Yoldia Sea was most clearly felt within the Baltic basin.

The aqueous deposit of the Haukkasuo bog appears, for the reasons given above, to be a Yoldia Sea sediment, excepting the very lowest strata which may belong to the period of the Baltic Ice Lake. The Yoldia Sea thus reached above the level of the pass-sill of the bog. The latter is in round figures 55 m. above sea-level. According to Sauramo (1934) Yoldia I is about 80 m. above sea-level here.

In Sauramo's relation diagram the Ancylus transgression maximum is about 55 m. above sea-level in this area. According to the pollen

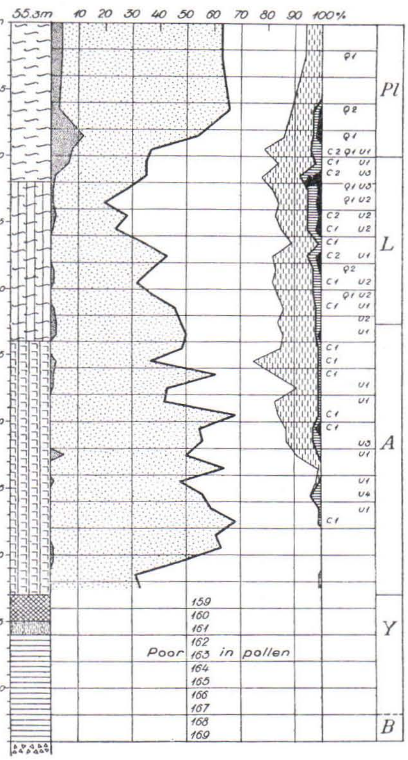

Fig. 32.

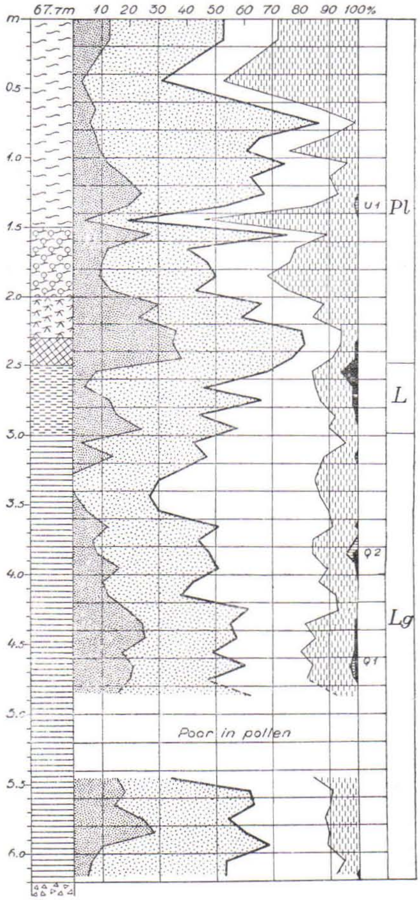

Fig. 33.

Fig. 32. Profile of the Haukkasuo bog. Analyst K. Salminen.

Fig. 33. Profile of the Suursuo bog, Viittamäki. Analyst H. Lavanni.

diagram the formation of peat began on Haukkasuo at the very beginning of the Ancylus period. According to this the local Ancylus maximum should be situated at any rate somewhat below the threshold of the bog or below the level of about 55 metres. Sauramo's relation diagram and the stratigraphy of Haukkasuo therefore are not in close agreement as regards the Ancylus maximum. This need not necessarily signify any essential contradiction, as a correlation between Sauramo's material and mine cannot be made with sufficient certainty, for Sauramo had no ancient beach representing the Ancylus transgression maximum in the vicinity of the bog at his disposal, nor any stratigraphical evidence for the determination of the local Ancylus-limit.

Suursuo Bog.

The bog which is a domed »Highmoor» (Hochmoor) in type, is situated S. of Viittamäki station on the southern slope of the first Salpausselkä ridge (investigation area No. 50). Fig. 33, page 111, illustrates its stratigraphy. At the bottom of the peat deposit there is a layer of late-Glacial varved clay, over 3 m. in thickness, in which there are only a few fresh-water diatoms and a little pollen. Nevertheless, it was possible to make a quantitative pollen analysis of almost the whole layer. In order to obtain the necessary quantity of pollen a larger amount of material than usual had to be treated. The pollen flora of the varved clay is of late-Glacial type. It contains an exceptional quantity of *Picea* as well as a slight quantity of pollen grains deriving from mixed oak forests. The large amount of *Picea* does not in this case signify that spruce forests grew abundantly in the neighbourhood. During the late-Glacial period the district was still almost entirely submerged, so that the pollen of this clay was mainly carried from a distance. In this case, however, these pollen contents reflect, at any rate roughly, the composition of the late-Glacial forests situated far from this area, although the *Picea* pollen seems to be enriched disproportionately in this sediment.

This varved clay is evidently mostly a Baltic Ice Lake deposit. The different levels of the Baltic Ice Lake exceed the altitude of this bog considerably (M. Sauramo 1934, 1937). The highest shoreline of the Yoldia Sea, according to Sauramo's relation diagram (M. Sauramo 1934), is about 80 m. above sea-level in this area, as in the previous one. The pass-sill of the Viittamäki bog is approximately 68 m. above sea-level. According to this the Yoldia Sea maximum extended appreciably above the level of the bog, so that there might also be sediment of the initial phase of the Yoldia Sea in the sequence of strata in the bog. The late-Glacial sediment at the bottom of the bog does not, however, contain a single salt-water diatom and is in general almost devoid of diatoms. Nor does the pollen flora of the deposit enable us to determine a precise date. In regard to the level of the Yoldia Sea the Viittamäki bog provides no evidence. It seems probable that there are no Yoldia Sea deposits at all in this succession of strata.

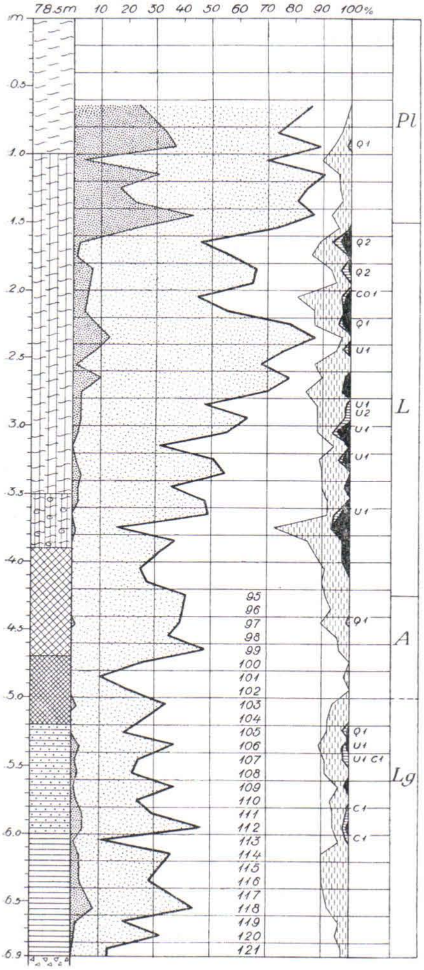

Fig. 34.

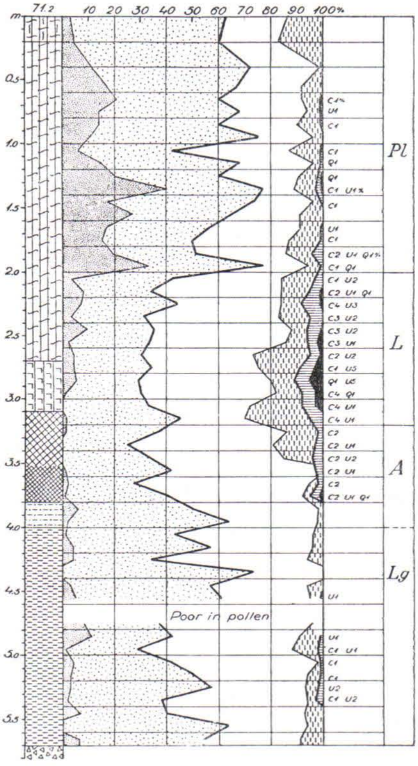

Fig. 35.

Fig. 34. Profile of the Mustalampi bog. Analyst S. Itkonen.

Fig. 35. Profile of the Likolampi bog. Analyst M. Salmi.

It is quite certain that Ancylus Lake sediments are lacking in this profile. The late-Glacial sediment is overlaid by the deposit of the Littorina period, which is represented by the clay and the coarse detritus ooze deposited in a local small lake. In this sediment there is typical small-lake diatom flora.

Mustalampi Bog.

The bog is a *Sphagnum-Calluna* »Highmoor» in type and is situated due N.E. of the previous bog, on the northern side of the first

Table XIII.

Anal. K. Salminen	Musta-					
	95	96	97	98	99	100
Achnanthes exigua	—	—	—	—	1	—
Amphora ovalis v. libyca	1	—	—	—	—	—
Anomoeoneis follis	3	4	5	5	2	—
Caloneis silicula	1	—	—	—	—	—
Campylodiscus noricus	—	—	—	—	—	—
Cocconeis placentula var. euglypta	—	—	—	—	—	—
Cyclotella antiqua	—	—	—	—	—	—
» *comta*	1	—	1	—	1	1
» » *v. obligatis*	—	—	—	1	4	—
Cymatopleura solea	—	—	—	—	—	—
Cymbella aspera	—	—	—	—	—	—
» *cuspidata*	2	1	2	1	1	—
» *Ehrenbergii*	1	—	—	1	1	—
» *naviculiformis*	5	4	4	2	2	—
» *sp.*	5	2	3	2	2	3
» *tumida*	—	—	—	—	—	—
» *turgida*	1	1	1	1	—	1
Diploneis elliptica	—	—	—	—	—	—
» *finnica*	1	—	—	—	—	—
Diatoma sp.	—	—	—	—	—	—
Epithemia sorex	—	—	—	—	—	—
» *zebra v. porcellus*	—	—	—	—	—	—
Eucocconeis flexella	1	—	1	2	2	4
» » *v. alpestris*	—	2	5	1	2	1
Eunotia sp.	5	3	3	3	2	2
Fragilaria sp.	5	2	2	1	1	1
Frustulia sp.	3	1	2	1	1	1
Gomphonema acuminatum constrictum	—	—	—	—	1	—
» » *v. coronata*	3	1	2	1	1	2
» *sp.*	1	1	1	—	1	—
Gyrosigma acuminatum	1	—	—	—	—	—
Hantzschia amphioxys	—	—	—	—	—	—
Melosira italica	—	5	—	2	1	—
» » *subspec. subarctica*	5	—	2	2	1	—
Navicula americana	1	1	1	—	—	—
» *bacillum v. Gregoryana*	1	2	2	2	1	—
» *crucicula v. obtusata*	—	—	1	1	1	—
» *cuspidata*	—	—	—	—	—	—
» *gastrum*	1	—	—	—	—	—
» *pupula*	—	1	—	1	—	—
» » *v. capitata*	—	—	1	—	—	—
» » *v. rectangularis*	4	3	5	5	5	5
» *radiosa*	3	1	4	4	5	5
» *tuscula*	—	—	—	—	—	—
Neidium iridis	1	4	4	2	2	3
» » *f. vernalis*	2	2	2	1	—	—
» *sp.*	5	3	2	1	1	—

lampi Bog

101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	1	—	—	1	1	1	—	2	1	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	2	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	1	—	—	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	—	—	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	1	1	1	2	—	1	1	—	—	—	—	—	—	—	—	—
4	5	5	4	1	2	4	2	3	—	2	1	—	—	1	1	—	—	1	—	—
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	4	2	1	1	1	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—
—	1	1	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
3	2	1	1	1	—	1	1	2	—	2	1	—	—	—	—	—	—	—	—	—
2	—	1	1	1	—	1	—	1	—	2	1	1	—	—	—	—	—	—	—	—
—	1	1	3	1	1	1	1	2	—	2	1	—	1	—	—	—	—	—	—	—
1	2	—	—	1	1	—	1	1	—	1	1	—	—	—	—	—	—	—	—	—
—	1	2	1	1	—	1	1	2	—	2	1	2	—	—	1	—	—	—	—	—
1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	1	1	—	1	—	1	—	—	1	—	—	—	—	—	—	—	—	—
2	1	1	1	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	1	—	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	2	1	2	1	1	2	1	3	—	5	—	—	—	—	—	—	—	—	—	—
5	5	2	4	2	2	3	3	4	—	5	1	1	1	—	1	—	—	2	—	—
1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	1	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	2	1	1	—	1	1	1	2	—	1	1	1	—	—	—	—	—	—	—	—

	Musta-					
	95	96	97	98	99	100
Nitzschia angustata	—	—	—	—	—	1
» » *var. acuta*	—	—	—	1	1	—
» *denticula*	—	—	—	—	—	—
Pinnularia sp.	5	5	5	5	5	4
Rhopalodia gibba	—	—	—	—	—	1
» » *v. ventricosa*	—	—	—	—	—	—
Stauroneis anceps f. gracilis	1	1	—	—	—	—
» *phoenicenteron*	1	1	3	1	2	5
» *Smithii*	1	—	—	—	—	—
» *sp.*	5	5	4	3	4	3
Synedra sp.	—	—	—	—	—	—
Tabellaria sp.	5	3	3	3	3	5
Tetracyclus lacustris	4	1	1	1	2	1
» » *v. elongata*	1	—	—	—	—	—
» » *v. rhombica*	1	—	—	—	—	—

Salpausselkä ridge (investigation area No. 51). Fig. 34, page 113, illustrates the stratigraphy of the bog. In regard to late-Glacial shore-levels this bog leads to exactly the same result as the previous one. I consider the varved clay at the bottom of the bog to be a Baltic Ice Lake sediment. This view is supported by the fresh-water diatoms contained in the upper part of the clay (diatom table XIII, Mustalampi bog 95—121). The lower part of the varved clay is, however, almost devoid of diatoms like the oldest deposits in South Finland of the Baltic Ice Lake.

In the upper, sandy part of the clay there is small-lake diatom flora which proves shallow water. Possibly the locality may already have been isolated from the Baltic at that time. The pass-sill of the bog is in round figures 80 m. above sea-level. Sauramo's Yoldia I, as already stated, is at about the same altitude here. No signs of salt water are visible in the sequence of the bog. It is therefore probable that the Yoldia Sea did not reach above the threshold of the bog or above the 80 m. level here.

The evidence of the diatoms, however, is not quite unimpeachable in this case. As a rule brackish- and salt-water diatoms are very scarce in Yoldia deposits in South Finland. Besides, even in the event of the Yoldia Sea having extended above the threshold of the bog, it must have appeared as quite a shallow littoral zone round the bog in which lampi Bog

101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121
1	2	—	1	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	2	1	1	—	1	1	—	1	—	—	—	—	—	—	—	—	—	1	—	—
2	5	3	5	2	2	4	1	5	—	3	2	1	1	—	—	—	—	1	—	—
2	3	2	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	1	1	1	—	1	2	1	1	—	1	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	3	2	2	1	—	1	—	1	—	2	—	1	1	—	1	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	3	3	2	1	1	3	1	3	—	3	1	—	1	—	—	—	—	2	—	—
—	—	1	1	—	1	1	—	2	—	1	—	—	·1	—	—	—	—	1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

the salinity was slight. In addition, the continental ice-sheet with its melting water was then still comparatively close to this site. The absence of salt-water diatoms in the late-Glacial aqueous sediment of the bog does not in this case preclude with absolute certainty the Yoldia Sea having reached above the pass-sill of the bog.

In any case this bog, too, separated from the Baltic at the latest in the Yoldia period. There was a small lake in the depression of the bog up to the beginning of the Littorina period, when the formation of peat first began.

The pollen flora of this bog is largely of the same type as in the previous case. It is worth noting the appearance of late-Glacial spruce and of mixed oak forests in a certain zone as in the previous bog. This pollen flora does not allow of a precise division into periods. Its late-Glacial type, however, is clear.

Likolampi Bog.

The bog, a *Calluna-Sphagnum* »Highmoor», is situated about 3 km. S.E. of Taavetti station (investigation area No. 52). Fig. 35, page 113, illustrates the stratigraphy of the bog which is of exactly the same type as the two previous bogs. In this case, too, there is a thick layer of late-Glacial clay at the bottom of the sequence which is unconformably overlaid by the post-Glacial sediment. The late-Glacial clay is devoid of diatoms with the exception of some fresh-water species that can be detected in the clay very sparsely. There is no sign of salt-water Yoldia Sea species which points to Yoldia Sea sediment being entirely lacking, too, in this succession of strata.

The threshold of the bog is about 72 m. above sea-level and Yoldia I is about 80 m. above sea-level in the neighbourhood of the bog, for this place is on the same isobase in Sauramo's system as the previous bogs in the Salpausselkä area. According to Sauramo's system, therefore, the Yoldia Sea flooded the basin of the bog here, too, but there is no sign of this in the stratigraphy. The late-Glacial clay of the profile, indeed, shows a pollen flora of a late-Glacial type, but detailed dating cannot be done on the basis of it alone, especially as in this case the pollen composition is also more or less of the same type throughout the whole layer of clay. This pollen assemblage, besides, was deposited in water and derived from distant forests, so that its use for precise dating is all the more doubtful.

In the composition of this late-Glacial pollen flora it is worth noting the uninterrupted, though scarce, appearance of mixed oak forests, 4.8—5.4 m. This is likewise striking in the two previous bogs, where in the late-Glacial sediment pollen grains of precious deciduous trees appear, also limited to a definite part of the profile. I have already dealt with the appearance of this late-Glacial mixed oak forest pollen flora in my previous papers (E. Hyyppä 1933, 1936). In the diagram of the Kämärä bog (E. Hyyppä 1936) there is an unusual abundance of such pollen element, falling partly in the Baltic Ice Lake and partly in the Yoldia Sea period. In the Kämärä diagram I made a detailed age division which is based on the diatoms. This division can, however, no longer be considered quite reliable in its details, for, as I mentioned, marine clay older than the late-Glacial period was discovered recently on the Isthmus. It is therefore possible that the Kämärä late-Glacial sediment is also contaminated with secondary diatoms from this ancient marine clay, although it seems certain that the diatoms of this bog are, nevertheless, principally primary. In any case, as already mentioned, the data available of the Kämärä bog only allow a rough dating on the basis of diatoms. The chronological position of the mixed oak forests in question is then also unsettled in its details. I will return to this question more thoroughly in connection with the Kämärä bog.

VIROLAHTI, VIROJOKI.

RAISED SHORES.

In this area I determined the following ancient beaches:

Pajulahti, SW. slope of the hill of 44.4 m., investigation area N.o 53.

Steep escarpment in rock,	its foot	7.8	m.	above	sea-level
» » »	»	15.0	»	»	»
» » »	»	18.2	»	»	»
Distinct ice-pushed rampart	»	19.0	»	»	»
Small wave-cut cliff	»	21.0	»	»	»
Boulder rampart	»	22.3	»	»	»
» »	»	22.6	»	»	»
» »	»	23.6	»	»	»
Wave-cut cliff in rock	»	24.3	»	»	»
» » »	»	36.3	»	»	»
Small wave-cut cliff in rock	»	40.2	»	»	»

Hill of 44.8 m., W. of the road to Kotola, investigation area No. 54.

Foot of high shore escarpment, according to levelling based on a fixed point of the topographical map	37.0	m.	above	sea-level

N. of Koivuniemi vicarage, investigation area No. 55.

Foot of strong abrasion cliff on the W. edge of the road	10.2	m.	above	sea-level

W. of the road near the main road, investigation area No 56.

Small abrasion cliff on E. edge of the bog, its foot	15.2	m.	above	sea-level
Large wave-cut cliff about 200 m. S. of the main road, its foot	20.5	»	»	»

These shore-lines are fairly clear, though in some cases rather rude, which is due to the locality in question having been open and exposed to strong wave-action which has caused rough forms in rocky ground. These beaches are grouped at the following levels: 8.7—10.2 m., 15.0 m., 18.2—19.0 m., 20.5—22.6 m., 24.3 m., 36—37 m. and 40.2 m. above sea-level. Below we will try to establish the age of the shore-lines by means of the stratigraphy of bogs.

STRATIGRAPHY OF THE PEAT BOGS.

The 14.7 Metre Bog.

The bog is situated on the W. of the highroad leading to the village of Virolahti, about 1 km. from the main road (investigation area No. 56). The bog is a level *Sphagnum-Eriophorum* moor, the stratigraphy of which is illustrated in Fig. 36, page 121. On the bottom of the bog there is a thin Littorina Sea deposit. This sediment contains typical *Clypeus* flora, as the diatom table shows (diatom table XIV, Virojoki 107). The Littorina Sea therefore reached here above the level of the pass-sill of the bog. The threshold is 15 m. above sea-level. Of the ancient beaches identified here only the 7.8 m. and 10.2 m. shore-lines are obviously below the pass-sill of the bog. Judging by the pollen diagram, the basin of the bog appears to have separated from the sea considerably before the end of the Littorina period. This result cannot, however, be considered absolutely reliable, as it is possible that the bottom strata of the sequence already belong to a fairly late Littorina period. This is indicated by the large quantity of *Picea* in the basal strata of the bog, which is not typical of the beginning of the Littorina period. Nevertheless, it is possible that *Picea* and *Pinus* have been enriched largely in this case, as we have already established in the case of the littoral sediments of several bogs. The difficulty of a more exact dating of the diagram is increased by the fact that pre-Littorina sediments are entirely lacking in it.

Although I do not see my way to make a detailed dating on the basis of the stratigraphy of this profile, it nevertheless proves with certainty that the Littorina maximum is clearly above the 15 metre level here. It is equally certain that the 15 m. shore-line established here which appears on the edge of this bog, still belongs to the Littorina period. The changes of the shore-line in the Littorina period seem in other respects to have occurred in the same manner as in the former investigation areas.

The 24.1 Metre Bog.

The bog which is of the same type as the previous one, is situated about 1 km. N. of the main road, N.E. of the path to Suursuo (investigation area No. 57). Fig. 37, page 121, illustrates its stratigraphy. The sequence of strata begins with detritus ooze which, on the basis of its pollen, is of the Littorina period. Diatom analyses of this sediment prove (diatom table XIV, Virojoki 15 and 16) that it is a case of small-lake flora, in which there is no sign of marine influence. The maximum limit of the Littorina Sea is therefore below the threshold of the bog at this place. The pass-sill of the bog is about 24 m. above sea-level. Of the ancient shores ascertained here the 24.3 metre shore-line is thus already certainly above the Littorina maximum. The precise determination of the latter is rendered

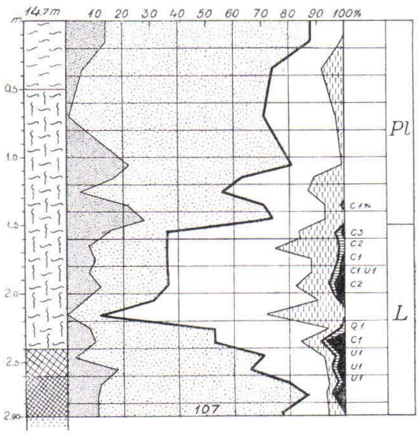

Fig. 36.

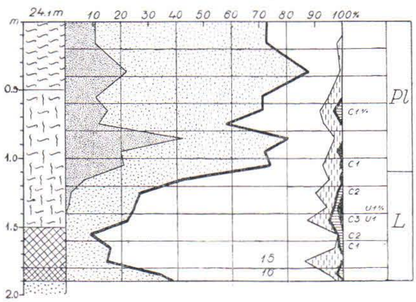

Fig. 37.

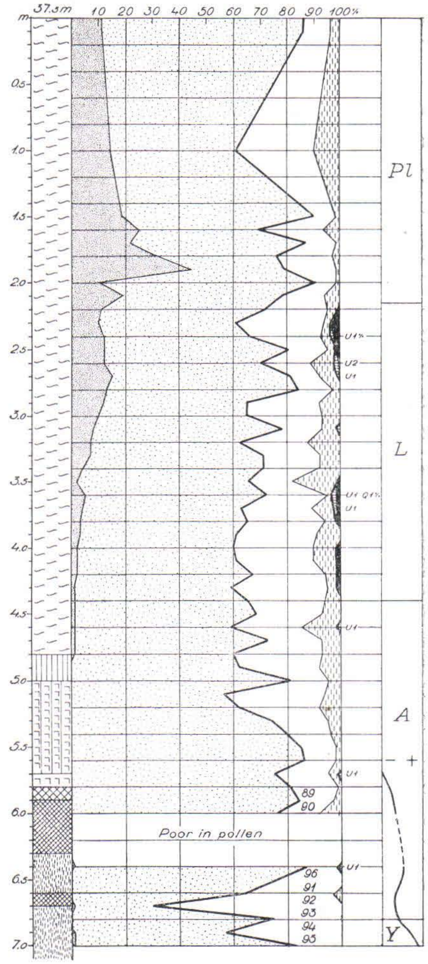

Fig. 38.

Fig. 36. Profile of the 14.7 metre bog. Analyst E. Hyyppä.

Fig. 37. Profile of the 24.1 metre bog. Analyst E. Hyyppä.

Fig. 38. Profile of the Suursuo bog, Virolahti. Analyst E. Hyyppä.

difficult by the fact that theres are several raised shores in the area that are not at exactly the same level, but evidently correspond approximately to the local Littorina maximum. These beaches are on an average 20—23 m. above sea-level, as seen from the list of shore-lines. On the basis of the morphology and occurence of these shores it seems that the 20 m. shore-line represents a definite phase of its own in the retreat of the shore-line and that the beach representing the maximum limit of the Littorina Sea is 22—23 m. above sea-level.

Thus Virojoki has in the maximum zone of the Littorina Sea at any rate two separate shore-levels with a small difference in altitude between them. The date of these shore-lines cannot be fixed precisely morphologically, but it is probable that the 22—23 m. level represents L I and the 20 m. level L II. On the basis of the stratigraphy of the 14.7 m. bog it seems certain in any case that L I is higher here than L II.

The Littorina maximum at Virojoki is appreciably lower than in the previous areas investigated with the exception of the Hamina district. The difference in level between L I and L II is thus already fairly small here, as these shore-levels approach each other as they reach lower isobases. In the Helsinki district, too, the difference in level between these shore-surfaces is only 5.5 m. It is therefore intelligible that at Virojoki, where the Littorina maximum is also already at least 7 m. lower than at Helsinki, these beaches are already close to their point of intersection.

Suursuo Bog.

In this area I investigated a third bog (Suursuo), situated about 2 km. N.W. of the previous one (investigation area No. 58). In type it is a *Sphagnum-Pinus* »Highmoor». Fig. 38, page 121, illustrates the stratigraphy of the Suursuo bog. The sequence of strata of the bog is over 7 m. in thickness, so that its bottom was not reached owing to the shortness of the borer. Nevertheless, the profile, even though incomplete, is very important as regards the displacement of shore-line during the Ancylus and Yoldia periods.

In the lower part of the profile there is clay ooze which, on the basis of its diatoms, belongs to the Yoldia period. Samples 94 and 95 contain the following brackish-water species in addition to fresh-water species: *Diploneis interrupta*, *D. Smithii*, *Grammatophora oceanica*, *Nitzschia navicularis*, *N. punctata* and *N. tryblionella* v. *victoriae* (diatom table XIV, Virojoki 89—96). With the exception of *Campylodiscus echeneis* the same brackish-water species appear here as in the Yoldia sediment of Haukkasuo already dealt with. Besides there are some species that are lacking in the flora of Haukkasuo that is also poorer in other respects. In any case it should be noted that the Yoldia of both these bogs is clearly of the same type particularly as regards the brackish-water species. The diatom flora of both is, besides, a typical mixed one, in which fresh-water species are in the majority.

The brackish-water species disappear in sample 93 and at the same time the surface of the water sinks. This change in the conditions marks the beginning of the Ancylus Lake, when, judging by the diatoms, a regression appears to have occurred: samples 92, 93. In the quality of the sediment itself a corresponding change also occurs. Sample 92 is fine detritus ooze which evidently was laid down in shallower water than the sediment below and above it. It is probable that the basin of the bog had then been separated from the Baltic, but was again embodied with it at the time of the Ancylus transgression maximum: samples 91 and 96. After this comes a non-fossiliferous zone which may belong principally to the Ancylus regression period, as the sediment passes over already 10 cm. above sample 96 into fine detritus ooze, which proves the water-level to have fallen. The formation of peat begins already early in the Ancylus period, so that the basin of the bog was only in connection with the Ancylus Lake during the peak of its transgression.

The pass-sill of the bog is 35 m. above sea-level. In this area there is a distinct raised shore which is 36—37 m. above sea-level. By its altitude this beach seems to represent the Ancylus transgression maximum. According to the stratigraphy of Suursuo and the absolute height of the threshold the Ancylus transgression peak actually exceeded here the 35 m. level, so that this shore should be considered the maximum limit of the Ancylus transgression. This seems to be all the more certain, seeing that the stratigraphy of Suursuo proves that the Ancylus transgression was only felt for a comparatively short time inside its basin and the water was only shallow there.

During the Yoldia period the shore-line stood considerably above the level of the bog. In this profile, however, we are not able to examine this period in detail, as only the final phase of the Yoldia Sea is represented in the succession of strata. Close to Suursuo I measured a slight wave-cut notch which is 42 m. above sea-level and a shore rampart built up of cobblestones the highest point of which is 44.6 m. above sea-level. These may be Yoldia Sea beaches like the 40 m. shore-line that I etablished at Pajulahti. I should like to remark in this connection that, when I speak of the Yoldia period, I refer under this name to the whole period that includes Sauramo's Yoldia, Rho and Rha phases.

Before passing on to discuss the next investigation area it is best to recall some important results referring to the changes of the shoreline in the Littorina Sea period. By means of the elevated shores and the stratigraphy of bogs we have been able to determine the maximum

Table XIV.

Anal. K. Salminen.	Virojoki										
	15	16	89	90	91	92	93	94	95	96	107
Achnanthes brevipes v. intermedia	—	—	—	—	—	—	—	—	—	—	1
Amphora ovalis	—	1	—	—	—	—	2	5	2	—	—
» » *v. effusa*	1	—	—	—	—	1	—	—	—	—	—
» » *v. libyca*	—	1	—	—	—	—	2	2	5	—	—
» » *v. pediculus*	—	1	—	—	1	—	—	5	5	—	—
» *commutata*	—	—	—	—	—	—	—	—	—	—	1
» *mexicana v. major*	—	—	—	—	—	1	—	—	—	—	—
Anomoeoneis serians	—	—	—	—	1	—	—	—	—	—	—
» *sphaerophora*	2	—	—	—	—	—	—	—	—	—	—
» » *v. Güntherii*	—	—	—	—	—	—	—	—	—	—	1
» » *v. sculpta*	—	—	—	—	—	—	—	—	—	—	3
Caloneis latiuscula	—	—	1	—	—	—	—	—	—	—	—
» *Schumanniana v. biconstricta*	—	—	—	—	—	—	—	1	—	—	—
» *silicula*	—	1	—	—	—	—	—	—	—	—	—
» » *v. truncatula*	—	—	—	—	—	—	1	—	—	—	—
Campylodiscus clyp us	—	—	—	—	1	—	—	—	—	—	5
» *echeneis*	—	—	—	—	—	—	—	—	—	—	3
» *noricus v. hibernica*	—	1	—	1	1	5	3	3	2	1	—
» »	—	—	—	—	—	—	1	3	2	—	—
Cocconeis disculus	—	—	—	—	1	—	3	2	—	—	—
» *pediculus*	—	—	—	—	—	—	—	—	—	—	1
» *placentula*	—	1	—	—	—	—	1	—	—	—	—
» » *v. lineata*	—	—	—	—	—	—	2	—	—	—	—
Cyclotella comta	—	—	—	—	—	—	1	—	—	—	—
» *Meneghiniana*	—	—	—	—	—	—	1	—	—	—	—
Cymatopleura Brunii	—	—	—	—	—	—	—	2	2	—	—
» *elliptica*	—	1	—	—	—	2	—	—	1	—	—
» » *v. constricta*	—	—	1	—	—	—	—	—	—	—	—
» » *v. hibernica*	—	—	—	—	—	—	5	1	—	—	—
Cymbella aspera	—	—	1	—	—	2	5	1	1	—	—
» *cistula*	—	—	—	—	—	—	1	—	—	—	—
» *cuspidata*	—	1	—	—	—	—	—	—	—	—	—
» *Ehrenbergii*	—	2	4	—	—	2	1	—	—	—	—
» *lanceolata*	—	1	—	—	—	—	5	—	—	—	—
» *prostrata*	—	—	—	—	1	1	1	1	—	—	—
» *spp.*	—	2	—	—	—	—	1	—	—	1	—
» *ventricosa*	—	—	—	—	—	—	1	1	—	—	—
Diploneis didyma	—	—	—	—	—	—	—	—	—	—	1
» *domblittensis*	—	—	—	—	—	—	1	2	1	1	—
» » *v. subconstricta*	—	—	—	—	—	—	—	—	1	—	—
» *elliptica v. ladogensis*	—	—	—	—	—	—	1	2	1	—	—
» *incurvata*	—	—	—	—	—	—	—	—	—	—	1
» *interrupta*	—	—	—	—	—	—	—	1	1	—	1
» *ovalis*	—	—	—	—	—	—	1	1	—	—	—
» *Smithii*	—	—	—	—	—	—	—	2	1	—	1
Epithemia argus	—	1	3	—	—	—	3	1	1	—	—
» » *v. longicornis*	1	1	—	—	—	—	1	—	—	—	—
» *Hyndmanni*	1	1	4	1	—	1	2	—	—	—	—
» *Muelleri*	—	—	1	—	—	—	—	1	—	—	—
» *sorex*	—	—	—	—	—	—	2	1	—	—	2
» » *v. gracilis*	—	—	—	—	—	—	1	—	—	—	—
» » *v. saxonica*	—	—	—	—	—	—	1	—	—	—	—

	Virojoki										
	15	16	89	90	91	92	93	94	95	96	107
Epithemia turgida	—	1	—	—	—	—	2	1	1	—	1
» » *v. granulata*	—	—	—	—	—	1	4	—	—	—	—
» » *v. Westermanni*	—	—	—	—	—	—	5	1	2	1	3
» *zebra*	—	1	—	—	—	—	—	—	—	—	—
» » *v. porcellus*	—	2	—	—	—	—	5	—	—	—	3
Eunotia spp.	—	—	—	—	2	1	1	—	—	1	—
Fragilaria spp.	5	5	—	—	2	—	—	—	—	—	5
Grammatophora oceanica	—	—	—	—	—	—	—	1	1	—	—
Gyrosigma acuminatum	—	—	—	—	—	—	1	1	—	—	—
» *attenuatum*	5	1	1	2	5	5	5	5	5	4	—
Hantzschia amphioxys f. capitata	—	—	—	—	—	—	1	—	—	—	—
» » *v. vivax*	—	—	—	—	—	—	—	—	—	—	1
Mastogloia elliptica	—	—	—	—	—	—	—	—	—	—	1
» *Grevillei*	—	—	—	—	—	—	2	2	—	—	—
» *Smithii v. amphicephala*	—	—	—	—	—	—	—	2	1	—	—
» *lacustris*	—	—	—	—	—	—	—	2	—	—	—
Melosira arenaria	1	1	2	2	3	1	—	—	—	5	—
» *granulata*	—	—	—	—	—	—	—	1	—	—	—
» *islandica subsp. helvetica*	1	4	2	2	5	—	2	1	—	3	—
» *italica*	5	—	—	—	1	—	1	2	—	—	—
» *Westii f. parva (Br.)*	—	—	—	—	—	—	—	—	—	—	2
Navicula cuspidata	—	1	—	—	—	—	1	—	—	—	—
» *lacustris*	—	—	—	—	—	—	1	1	—	—	—
» *peregrina*	—	—	—	—	—	—	—	—	—	—	1
» *placentula*	—	1	—	—	—	—	—	—	—	—	—
» » *f. jenisseyensis*	—	—	—	—	—	—	—	—	1	—	—
» » *f. latiuscula*	—	—	—	—	—	—	—	1	—	—	—
» » *f. rostrata*	—	—	—	—	—	—	1	—	—	—	—
» *radiosa*	—	—	—	—	—	—	1	—	—	—	—
» *scutiformis*	—	—	—	—	—	—	—	1	—	—	—
» *semen*	2	—	—	—	—	—	—	—	—	—	—
» *tuscula*	1	—	—	—	—	—	1	—	—	—	—
Neidium spp.	—	—	—	—	—	—	—	2	2	—	—
Nitzschia denticula	—	1	—	—	—	—	—	—	—	—	—
» *navicularis*	—	—	—	—	—	—	—	2	—	—	—
» *punctata*	—	—	—	—	—	—	—	1	1	—	—
» *scalaris*	—	—	—	—	—	—	—	—	—	—	3
» *spectabilis*	—	—	—	—	—	—	1	—	—	—	—
» *tryblionella var. victoriae*	—	—	—	—	—	—	—	1	—	—	—
Opephora Martyi	—	1	—	—	—	—	—	—	—	1	—
Pinnularia microstauron f. Brebissonii	—	—	—	—	—	—	—	1	—	—	—
» *spp.*	—	1	2	—	—	1	5	—	—	1	—
Stauroneis phoenicenteron	2	1	2	—	—	2	5	—	1	—	—
Surirella linearis v. helv.	—	—	—	—	—	—	2	1	—	—	—
» *spiralis*	—	—	—	—	—	—	—	2	1	—	—
» *striatula*	—	—	—	—	—	—	—	—	—	—	1
Synedra sp.	—	1	—	—	—	—	—	—	—	—	—
» *affinis*	—	—	—	—	—	—	—	—	—	—	1
Rhopalodia gibba	—	1	—	—	—	—	2	—	—	—	—
» » *v. ventricosa*	—	—	—	—	—	—	1	—	—	—	—
» *musculus*	—	—	—	—	—	—	—	—	—	—	1
Tabellaria spp.	—	1	—	—	—	—	—	—	—	—	—

limit of the Littorina Sea with fair certainty in all the investigation areas discussed so far. According to the stratigraphical evidence it seems certain, that, when the highest Littorina limit (L I) was formed, no considerable advance of the sea towards the land occurred in these areas any more than during the later delays of the Littorina Sea shore-line. The displacement of the shore-line in the Littorina period therefore occurred in all these areas in the same manner, and the maximum limit of the Littorina Sea is synchronous throughout the whole area or from Helsinki to Virojoki. It also seems certain that the Ancylus regression limit is, at any rate roughly, the same as L I, the latter thus also representing the so-called *Clypeus* limit (cf. W. Ramsay 1926). At Virojoki L II seems already to approach fairly close to L I, so that the point of intersection of these two shore-levels may be situated on a slightly lower isobase than that of Virojoki. In the next investigation area, Säkkijärvi, which is on a still lower isobase than Virojoki, it is to be expected that these shore-levels will intersect each other.

SÄKKIJÄRVI.

At Säkkijärvi I had already made investigations previously into the displacement of the shore-line (E. Hyyppä 1932). According to these studies the highest limit of the Littorina Sea in this area is 19.5—20 m. above sea-level and the maximum limit of the Ancylus transgression 33.5—34 m. above sea-level. I do not require to make any essential modifications in these results in the present investigation. Instead there is reason to establish the age of the highest Littorina Sea beach and the shifts of the shore at that time precisely by means of the stratigraphy of the peat bogs.

THE STRATIGRAPHY OF THE PEAT BOGS.

Suursuo Bog.

The peat bog, which is a level *Eriophorum-Sphagnum* »Lowmoor» in type, is situated about 1 km. E. of Säkkijärvi church (investigation area No. 59). Fig. 39, page 130, illustrates the stratigraphy of the bog. The borer did not reach the bottom of the succession of layers, though it reached the Ancylus Lake deposit which is represented by the clay ooze at the bottom of the profile. The clay ooze contains a large-lake diatom flora typical of the Ancylus Lake, as the diatom table shows (diatom table XV, Suursuo bog 148—167). In the

Table XV.

Anal. K. Salminen.	Säkkijärvi, Suursuo Bog																			
	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167
Achnanthes calcar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—
» *Clevei*	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	2	1	—	1
» » *v. rostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—
» *flexella*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
» *lanceolata v. elliptica*	—	—	1	—	—	—	—	—	—	—	—	1	—	—	1	—	1	2	1	3
» » *v. rostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *Östrupii*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Amphora arenicola v. major	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *commutata*	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	1	—	—	—	—	—	1	—	—	2	1	1	1	1	—	1
» » *v. libyca*	1	1	—	2	2	1	—	1	1	—	1	2	1	1	2	1	1	1	1	1
» » *v. pediculus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	1	2	2	1	1
Anomoeoneis sphaerophora	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» » *v. polygramma*	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. sculpta*	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Caloneis latiuscula	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» *silicula*	—	—	—	—	—	1	—	—	—	—	—	—	—	1	1	—	—	—	—	—
Campylodiscus clypeus	5	2	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	fr.	—	1
» *echeneis*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *noricus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1
» » *v. hibernica*	—	1	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	1	—
Cocconeis diminuta	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	1	2	5	2
» *disculus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
» *pediculus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	1	1	—	—
» *placentula*	2	—	1	2	2	2	2	2	1	3	2	2	2	2	1	4	3	2	1	1
» » *var. euglypta*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
Cyclotella comta	—	—	1	—	—	1	—	—	1	—	—	—	—	—	1	1	1	1	1	—
» *Kützingiana*	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	1	—	—
» *stelligera*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Cymatopleura elliptica	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	1	1	—
» *solea*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» *spp.*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Cymbella aspera	—	1	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	—	—
» *cuspidata*	—	—	1	—	1	1	—	—	1	—	1	—	—	1	—	—	—	—	—	—
» *Ehrenbergii*	—	1	—	1	1	—	—	—	—	—	1	—	—	1	1	—	—	—	—	—
» *lanceolata*	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	—	1	—	—
» *prostata*	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	1	—	—
» *spp.*	—	1	—	1	1	2	—	—	1	1	1	1	1	1	1	2	3	3	1	1
» *tumida*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—
Diploneis domblittensis	—	1	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	2	2	3
» » *v. subconstricta*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	—
» *finnica*	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *marginestriata*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—
» *Mauleri*	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	1	2	4	3
» *ovalis*	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	—	—
» *Smithii*	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elliptica*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—
Epithemia argus	—	1	—	—	—	—	—	—	—	—	—	—	1	—	1	1	1	1	1	—
» *Hyndmanni*	—	—	—	—	—	—	—	1	—	—	—	—	—	2	1	1	—	1	1	1
» *intermedia*	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—
» *Muelleri*	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sorex*	—	1	—	—	—	1	—	—	—	—	—	1	—	1	1	2	1	2	1	—
» *turgida*	1	1	—	1	—	—	1	—	—	1	1	—	1	1	2	1	—	1	—	—

	Säkkijärvi, Suursuo Bog																			
	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167
Epithemia turgida v. Westermanni	1	1	—	1	—	—	—	—	1	—	2	—	1	1	1	3	1	2	1	—
» *zebra*	1	1	1	1	—	—	—	—	—	—	1	—	1	1	2	2	2	1	1	1
» » *v. porcellus* ...	—	5	—	3	3	3	2	1	1	1	1	1	2	2	1	2	1	2	—	—
Eunotia spp.	—	—	1	4	4	5	5	5	5	3	1	1	—	—	1	—	1	—	—	1
Fragilaria spp.	2	5	5	5	5	5	5	5	5	1	5	5	5	5	4	1	2	1	1	1
Frustulia sp.	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Gomphonema acuminatum v. coronata	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	1	—	—
» *augur v. Gautieri*	—	—	—	—	—	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—
» *constrictum*	—	—	—	1	—	—	1	1	—	1	—	—	—	—	—	—	1	—	—	1
» *spp.*	—	—	—	—	1	1	—	1	—	1	1	1	—	—	1	1	1	1	—	1
Gyrosigma acuminatum	—	—	1	—	—	—	—	—	—	—	1	2	3	5	5	1	3	2	1	—
» *attenuatum*	1	—	1	—	1	—	1	—	1	1	1	1	1	4	4	2	1	2	2	—
Hantzschia spp.	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—
Mastogloia Grevillei	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *Smithii v. lacustris*	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—
Melosira arenaria	1	—	—	—	1	1	—	—	—	1	—	—	—	1	3	2	1	1	1	2
» *granulata*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	1	1	1	—	—
» *islandica subspec. helvetica*	1	1	1	1	1	2	1	2	1	1	1	1	1	1	3	3	4	5	2	2
» *italica*	—	—	—	—	1	—	1	1	—	—	—	—	—	—	1	1	1	—	1	—
» » *v. valida*	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Navicula americana	—	—	1	1	—	1	1	1	1	1	1	—	1	1	1	—	—	—	—	—
» *bacillum*	—	—	—	—	—	1	—	—	—	1	—	1	—	—	—	—	—	—	—	—
» *cocconeiformis*	—	—	—	1	—	—	—	—	1	—	—	1	1	—	1	—	—	1	2	2
» *cuspidata*	—	—	1	—	—	—	—	—	—	—	1	1	—	2	1	1	—	—	—	—
» *gastrum*	—	—	1	1	—	1	—	—	—	—	1	1	1	—	1	—	1	—	—	—
» *graciloides*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	2	—
» *Jentzschii*	—	—	—	—	1	—	—	—	—	1	—	1	1	1	1	1	—	—	—	3
» *libellus*	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *mutica v. Cohnii*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	1	1	2	3
» *peregrina*	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *placentula*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—
» » *f. latiuscula*	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—
» » *f. rostrata* .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
» *pseudocutiformis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
» *pupula*	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. rectangularis*	—	—	1	1	1	2	2	2	3	1	—	1	1	1	—	—	—	—	—	—
» *protracta*	—	—	2	1	1	1	1	1	—	1	4	3	1	2	1	—	—	—	—	—
» *radiosa*	—	—	—	—	1	1	1	2	1	1	1	1	1	2	2	1	1	—	—	1
» *Reinhardtii*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» *scutelloides*	—	—	1	—	1	1	—	—	—	1	1	1	1	1	1	1	—	2	2	2
» *tuscula*	—	1	1	1	—	1	—	—	—	—	—	—	—	—	1	1	2	—	1	1
Neidium spp.	—	—	1	—	—	1	1	1	1	1	1	—	1	1	1	—	1	1	—	—
Nitzschia scalaris	5	5	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Opephora Martyi	—	1	—	1	—	—	—	—	—	—	—	1	—	—	1	—	1	2	2	3
Pinnularia spp.	—	1	—	2	3	2	2	2	2	2	1	1	1	2	1	1	1	—	—	—
Rhoicosphenia curvata	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	2	1	—	—
Rhopalodia gibba	—	—	—	—	1	1	1	1	1	1	—	1	1	1	1	1	1	1	—	—
» » *v. ventricosa* ..	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—

	Säkkijärvi, Suursuo Bog																			
	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167
Stauroneis acuta	—	—	—	—	—	—	—	—	—	1	—	—	—	1	1	—	—	—	—	—
» *alabamae v. angulata*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
» *phoenicenteron*	—	—	1	1	1	1	1	1	1	1	—	—	2	1	—	—	—	—	—	—
» *Smithii*	—	—	—	—	1	—	—	1	1	1	1	1	—	1	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	1	1	—	—	—	1	—	—	1	1	—	—
Stephanodiscus astraea	—	—	1	1	1	1	1	1	1	1	—	1	1	1	2	2	2	3	1	—
Surirella elegans	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—
» *striatula*	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Synedra sp.	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	1	1	1	—	—
Tabellaria spp.	—	—	1	1	2	3	3	2	2	1	—	1	1	1	2	2	3	5	1	1
Tetracyclus lacustris	—	—	—	1	1	1	1	2	1	1	—	—	—	—	—	—	—	—	—	—

Ancylus flora there are several salt-water species that came as impurities from the Littorina sediments above.

The limit drawn in the diagram between Ancylus and Littorina is based in this instance solely on the evidence of the pollen, so that it cannot be considered quite exact. At the beginning of the Littorina period (L I) the Suursuo basin was isolated and became an independent small lake. This is proved by the dying out of the Ancylus diatoms and the growth of new flora. Such typical Ancylus species as *Diploneis domblittensis*, *D. Mauleri*, *Cymbella prostrata* disappear entirely and their place is taken by many small-water species of the genera *Eunotia*, *Fragilaria* and *Tabellaria*. The water-level was therefore below the threshold of the bog here in the initial phase of L I. The pass-sill of the bog is about 18-19 m. above sea-level, so that the level of the sea at Säkkijärvi during the L I period lay, at any rate in its initial stage, below the level of about 19 m.

In the fine detritus ooze of Suursuo, however, we begin to observe marine features already in sample 153, in which there is a little *Campylodiscus clypeus* and *Nitzschia scalaris*. These might still be impurities coming from above, as abundant *Campylodiscus clypeus* — *Nitzschia scalaris* flora only begins in sample 150, in which these species occur very abundantly, as well as other brackish-water diatoms that are typical of the Littorina. On the basis of these it seems certain that in a certain phase posterior to L I the Littorina Sea rose above the level of the threshold of the bog or above 19 m. The level of the sea, however, did not extend much above the pass-sill of the basin of the bog, as according to the diatoms the connection with the sea was very slight. The local Littorina maximum lies therefore a little higher than 19 m. above sea-level on the basis of the stratigraphy of the bog, which is fully in accord with my previous result, for the shores corresponding to the Littorina maximum are 19.5—20 m. above sea-level here.

Judging by the pollen diagram of Suursuo bog this Littorina transgression maximum would seem to be situated in time at the end of the Littorina period or at the time, to which L IV is referred. This result provided by the pollen diagram cannot, however, be considered correct. Either there must be a gap in the profile or there is the same source of error here that led to entirely erroneous results regarding the date of the Littorina transgression peak, when based solely on the pollen analysis, in the case of some of the other peat bogs in the Helsinki district (*e. g.* Pottmossen, page 38). To explain this source of error I refer to what I have written about this question in connection with the Helsinki peat bogs.

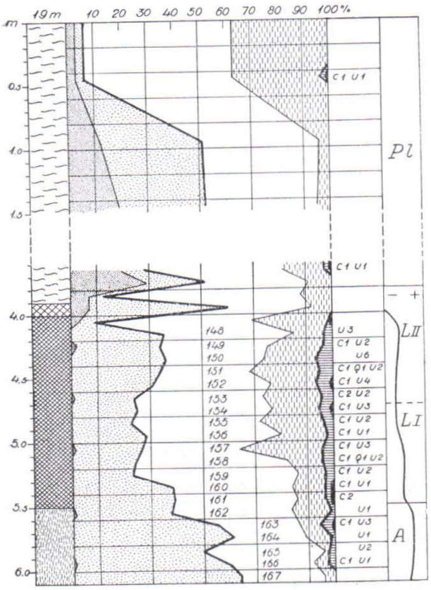

Fig. 39. Profile of the Suursuo bog, Säkkijärvi. Analyst K. Salminen.

Although the pollen diagram of Suursuo is unsuitable for an exact dating [1], it nevertheless proves quite certainly that the Littorina transgression maximum is clearly later here than in the preceding investigation areas, for the *Campylodiscus clypeus — Nitzschia scalaris* flora in the sequence of Suursuo is in no case situated in time in the beginning of the Littorina period or in the L I period. Then, of course, according to the chronological succession the following or L II period should be considered. The pollen diagram is, indeed, insufficient to prove that it is precisely the L II period that is in question, but this suggestion is turned into certainty by the evidence of the Stone Age finds made at Säkkijärvi.

According to A. Äyräpää (1923, 1926, and verbal statement) the lower limit of the earlier style of the typical comb-ceramic culture at the Meijermäki dwelling places in Säkkijärvi (church village) is

[1]) The upper part of the diagram has been shortened for want of space, as this does not upset the dating.

18.36 m. above sea-level. The lower limit of the later style of the same type of culture is 17.35—17 m. above sea-level at Suurpäälä (about 4 km. S. of church village). Äyräpää identified the foot of a wave-cut cliff on the same site that is 17 m. above sea-level and thus corresponds to the culture referred to. No dwelling places whatever representing the early comb-ceramic culture have been discovered at Säkkijärvi, although according to Äyräpää the Meijermäki dwelling place also contains implements approaching this type of culture. It is evident, however, that the level corresponding to the earlier style of the early comb-ceramic culture (I: 1) is slightly higher than the later Meijermäki dwelling place, the latter being 18.36 m. above sea-level. We can assume with good reason that the initial stage of the early comb-ceramic culture (I : 1) is situated here about 20 m. above sea-level or at the level of the local Littorina maximum — in no case below it.

According to the results I obtained in the Helsinki district the early comb-ceramic culture is situated on the beach of the L II period, to which it also corresponds chronologically. On an archaeological basis, too, we therefore arrive at the result that the maximum limit of the Littorina Sea at Säkkijärvi is L II. To supplement this line of argument I will mention further that the L II of the Helsinki district corresponds to the later style of the early comb-ceramic culture (I: 2, Storskogen dwelling place), the lower limit of which at Säkkijärvi would correspond to the level of the Meijermäki dwelling place or 18.36 m. above sea-level. The Säkkijärvi L II, on the other hand, corresponds, as I have already shown, to the earlier style of the early comb-ceramic culture (I: 1). There is thus a small difference in date between the Helsinki and Säkkijärvi L II which should be borne in mind in constructing the shore-levels of the relation diagram.

On the other hand the Suurpäälä 17 m. shore-line at Säkkijärvi, with which the typical comb-ceramic culture is connected, represents L III, as I can conclude on the basis of a correlation made between the beaches of the Helsinki district and the Stone Age cultures of Espoo.

In this connection it is worth while reverting to the pollen diagram of Suursuo. On the basis of the Stone Age coastal dwelling places dealt with above L III is here 17 m. above sea-level. Suursuo was therefore separated from the Littorina Sea already before L III (the threshold of the bog is about 19 m. above sea-level), and not as late as during L IV, as might be erroneously inferred on the basis of the pollen diagram alone.

As we have arrived at the result on the basis of the above that L II forms the maximum limit of the Littorina Sea at Säkkijärvi, the L I and L II shore levels intersected each other in passing from Virojoki to Säkkijärvi. It will be remembered that these shore-levels were already very close to each other at Virojoki: L II 20 m. and L I 22—23 m. above sea-level (see page 122). It is now necessary to ascertain, at what level this important point of intersection is situated and in what way the displacement of the shore-line occurred here in detail. In settling this delicate problem I must base myself on my earlier material concerning the Säkkijärvi area besides the facts already stated.

As regards my old material (E. Hyyppä 1932, page 167) I will first briefly mention its results. At Vilajoki on Säkkijärvi, situated 8 km. due E. of the church village, I previously established the maximum limit of the Littorina Sea by means of raised shores and the stratigraphy of the peat bogs. According to them the Littorina maximum, as I have already stated, is 19.5—20 m. above sea-level or the same as in the church village. Formerly I considered this limit as the L I limit, and the L II would, according to the view I held at that time, be the shore-line (17 m. above sea-level) that is associated with the typical comb-ceramic culture and represents L III according to my present opinion. The L III of that time was entirely hypothetical as regards Säkkijärvi, but is situated in time, where I now place L IV.

After this explanatory information it is worth while to submit to examination in its main points one of the Vilajoki peat bogs (Ratasuo bog), the stratigraphy of which I described in my former investigation (E. Hyyppä 1932, page 168, Ratasuo). The succession of layers of this bog begins with Ancylus Lake clay ooze which passes over, as we proceed upwards, into coarse detritus ooze. The latter contains an abundance of wood remains and fragments of vegetable tissues accumulated in shallow water. This bed corresponds to the lower limit of the Ancylus regression. In my former paper I assumed that this regression limit was about 15—16 m. above sea-level. Now, however, I have been obliged to raise it to about 17—18 m. above sea-level, for the threshold of the bog is at least 17 m. above sea-level and the basin of the bog was not separated from the sea during the Ancylus regression and Littorina transgression phase. This is proved by the diatoms of this deposit, for I have since made an examination of the diatoms of these samples and have observed that the Littorina Sea (L I) diatoms are present already in that part of the sediment which represents the shallowest water of all or the time at which the possible isolation should have occurred.

At the beginning of the Littorina period or L I the surface of the sea was about 17—18 m. above sea-level at Vilajoki according to the above. Later the sea encroached upon the land as the diatoms prove. On the basis of Suursuo at Säkkijärvi we know that this transgression attained its peak at a period subsequent to L I, and the Stone Age coastal dwelling places at Säkkijärvi prove irrefutably that the transgression maximum falls within the L II period, but it cannot be established in all details on the basis of the available material, how the shifting of the shore-line occurred from the limit of the Ancylus regression to L II.

The Littorina transgression was in its entirety fairly small here, too, at most 2—3 m., but the time corresponding to this small rise of the sea-level, on the contrary, is comparatively long or = L I + L II.

According to the stratigraphical evidence adduced above L I and L II intersect each other at Säkkijärvi at 18—19 m. above sea-level. According to the stratigraphy of Ratasuo bog at Vilajoki this point of intersection would be slightly above the 18 m. level, while according to the evidence of Suursuo it is below the 19 m. level. It is impossible to obtain an arithmetically exact figure in regard to this point of intersection on the basis of the stratigraphy of the peat bogs, as the threshold points of the basins of the bogs have not been determined quite exactly and as in such cases strict limits can never be fixed stratigraphically. The diatoms, *e. g.*, with which I have operated here chiefly, have by no means always appeared precisely up to the limit, to which the corresponding water body extended.

However, if we take into consideration that the threshold points of the bogs are defined with a precision of at least 1 metre, we may consider that the point of intersection, as arrived at by the stratigraphical method, is about 19 m. above sea-level. In my opinion this result cannot contain any essential error. On the basis of the raised beaches this point of intersection is at least 19.5 m. above sea-level, as we shall see later in connection with the relation diagram, too. This figure, of course, becomes of more practical importance, as the heights of the different levels are calculated, as a rule, on the basis of the shores. The dating of the shore-lines, again, is based above all on the stratigraphy of the sediments.

In this connection it would be tempting to compare the figure obtained for the point of intersection of L I and L II (19.5 m. above sea-level) with the results arrived at elsewhere in the region of the Baltic, but I will only proceed to do so, when I have finished dealing with my own materials and constructed a system of shore-levels on the basis of them.

Starting with Säkkijärvi and proceeding to lower isobases, L II forms the maximum limit of the Littorina Sea. Later we will see, how far L II retains this position towards the periphery of the area of post-Glacial uplift in Fennoscandia.

THE VIIPURI AREA.

My paper in 1932 referred principally to the post-Glacial changes of the shore-line of the Karelian Isthmus. The Viipuri area already belongs to this territory. It was only the Säkkijärvi area that represented the vast Fennoscandian shield of crystalline rocks N.W. of the Isthmus. In my investigation of that time I devoted special attention to the displacement of the shore-line during the Littorina period, in establishing which the stratigraphy of the sediments was employed for the first time in the region of the Isthmus in determining the age of the ancient shores. The field work on the Isthmus proved rather difficult, as the shore-lines even from the Yoldia are vertically close to each other there. The shore-levels of the Littorina Sea later than L I, especially, almost coincide. In such circumstances it is, of course, almost equally difficult to distinguish different levels and fix their age by means of the stratigraphy of the sediments.

There were also some defects and even actual errors in my former investigation in regard to determining the age, although as regards many of the principal points of the problem it provided a solution in the right direction. For instance, the Yoldia and Ancylus limits were transferred to lower levels than the ones at which they had formerly been placed. W. Ramsay (1928) already held this opinion, though he did not produce any direct observations in support of it. It was also evident from my investigation that the changes of the shore-line of the Littorina Sea period had occurred on the Karelian Isthmus in a much more complicated way than had been realised until then. I also proved conclusively that the Littorina Sea was transgressive in regard to the land on the Karelian Isthmus.

My former paper therefore affords a good and necessary basis for the final establishment of the changes of the shore on the Karelian Isthmus. I will briefly describe the new observations that I made on the Karelian Isthmus and check my former results on their basis.

RAISED SHORES AND STONE AGE SETTLEMENT.

So far I had not established any ancient shore-lines before in the neighbourhood of the town of Viipuri. The highest limit of the Littorina Sea had not in general been identified before with certainty in this area. The oldest communication appears in G. De Geer's paper in 1894. According to it a Littorina beach was supposed to have been recognised from the topographical map at Kähärilä (10 km. E. of Viipuri) at about 32 m. above sea-level. This figure stood for a long time until Ramsay (1920) reduced it to about 25 m. and later (1926) on the basis of the levelling carried out by Schjerfbeck to 21.5 m. However, no stratigraphical evidence was produced for the dating of this shore-line. I. Leiviskä (1934) places the Littorina limit there still lower. According to him the Littorina Sea beach at Käärmekallio, N. of Viipuri, is 19.4—19.7 m. above sea-level and in the Havi bay and at Vitsataipaleenniemi, S. of Viipuri, 18 m. above sea-level.

Leiviskä did not supply any kind of stratigraphical evidence either in support of these determinations. Nor has he published a more exact opinion anywhere of the displacement of the shore-line on the Karelian Isthmus. Leiviskä's figures cannot therefore be considered, as regards the maximum limit of the Littorina Sea under discussion, as better founded than the former determinations of the Littorina limit made in the Viipuri area. Nevertheless, Leiviskä's shore-lines correspond approximately in altitude to the ancient shores which I established at Häyrynmäki (5 km. N.E. of the town of Viipuri) and which, in my opinion, represent the local maximum limit of the Littorina Sea. Before proceeding to prove the correctness of this opinion, I will give a list of the ancient shores established by me in the Viipuri district.

Häyrynmäki esker mound near Viipuri, investigation area No. 60.

S.W. slope S. of the railway, next to a gravel pit. The same site on which the Stone Age coastal dwelling places of Häyrynmäki are situated. Distinct boulder rim worked by ice	17.5 m. above sea-level
Foot of wave-cut cliff on the other side of the esker	17.8 » » »

Häyrynmäki, investigation area No. 61.

1 km. S.E. of the former place, sand plain (ancient littoral bench) the proximal edge of which is 25 m. and the distal part 24 m. above sea-level	
S.W. slope of the esker N. of the highroad to Heinjoki. Foot of shore boulders piled up by ice	25.0 m. above sea-level
Flat top of the esker at the same point	28.7 » » »

Horizontal sand plain at the cross-roads, about 300 m. towards Viipuri from the former	20.5 m. above sea-level
Foot of shore-boulders piled up by ice at the same point S. of the highroad	20.5 » » »

Häyrynmäki, investigation area No. 62.

Foot of strong wave-cut cliff on the S.W. slope of the esker	17.5 m. above sea-level
Foot of large wave-cut cliff rimmed by boulders close to the former	19.8 » » »

These shore marks are fairly distinct, though some of them are rough. The exposition was good for the wave-action and the ice piled up many large boulders on to the shore-line and even above it. The raised shores in the above list are grouped at the following levels: 28.7 m., 25 m., 20.5—19.8 m. and 17.5 m. above sea-level.

On the basis of the levels of these shore-lines it seems that the 17.5 m. beach represents the local Littorina transgression maximum which would be L II here, too, in accordance with Säkkijärvi. Before seeking support for this view in the stratigraphy of the peat bogs, it is important to compare this level with the altitudes of the Stone Age coastal dwelling places of the district. They are close at hand, as some have been found here at the very places where I measured the 17.5 and 17.8 m. shores.

According to Äyräpää (A. Äyräpää 1926, 1935, and verbal statement) the Stone Age coastal dwelling places discovered on the Häyry esker (Häyrynmäki and Selänkangas) are situated at the following levels: early comb-ceramic culture (I: 1—2) 20—17 m. above sea-level, typical comb-ceramic style (II: 1—2) about 15 m. above sea-level, and debased comb-ceramic style (III) about 14.5 m. above sea-level. Finds representing the hammer-axe culture have been made at 12—20 m. above sea-level.

The early comb-ceramic style, corresponding to L II, is here connected on the basis of its altitude with the 17.5 m. shore-line. This beach therefore represents L II according to the archaeological evidence, as I had already assumed on the basis of the altitude of the shore. I also assumed that this level was here the peak of the Littorina transgression. Stratigraphical proof must, however, be produced in support of this view.

THE STRATIGRAPHY OF THE PEAT BOGS.

The peat bogs at the Häyry Esker.

I investigated several peat bogs in the neighbourhood of the Häyry esker in order to establish the level, to which the Littorina Sea reached here. One of these investigated bogs is 18 m. above sea-level and its threshold is in round figures at the same level. The bog is situated E. of the esker immediately N. of the Heinjoki highroad. In the clay and fine detritus ooze at the bottom of this bog there were no salt-water diatoms whatever, but instead there was an abundant lacustrine flora of large- and small-lake diatoms typical of the Ancylus Lake. On the basis of this the Littorina Sea did not extend to the level of 18 m.

This is comprehensible, for the shore-line referred to is on an average only 17.5 m. above sea-level. In addition to this bog I investigated three other bogs in the same area situated S. of the Heinjoki highroad. These bogs lie approximately at the 17 m. level and the heights of their thresholds are not higher, so that I expected to find clear indications of the Littorina Sea in the bottom sediments of the bogs. However, in the deepest beds of two of the bogs that I investigated there were only diatoms of small fresh water, but the third yielded positive results:

This peat bog is situated just below the 17.5 m. shore (investigation area No. 62) and is thus as regards its position, too, very suitable for determining the age of this shore-line. Fig. 40, page 138, illustrates the stratigraphy of the bog. At the bottom of the peat there are 10 cm. of coarse detritus ooze and above an organic shore accumulation mixed with sand. After this the formation of peat began on the site and proceeded undisturbed up to the present time. The succession of strata is similar in broad features in the other parts of the bog too. We see from the pollen diagram that the shallow-water sediment at the bottom of the bog, like a large part of the peat deposit above it, belongs to the Littorina period. The shallow-water sediment mentioned above contains, besides, so many typical Littorina Sea diatoms that it can be inferred with certainty that it was deposited in the Littorina Sea under littoral conditions. Samples 496—498, as well as the bottom samples from two other points bored in this bog, contained the following diatoms that are typical of the Littorina Sea: *Amphora arenicola* v. *major*, *A. commutata*, *Anomoeoneis sphaerophora* v. *polygramma*, *A. sph.* v. *sculpta*, *Campylodiscus clypeus*, *C. echeneis*, *Diploneis interrupta*, *D. Smithii*, *Mastogloia Braunii*, *Navicula elegans*, *N. humerosa*, *N. libellus*, *N. peregrina*, *Nitzschia scalaris.* In addition to this flora which indicates slightly saliferous and shallow water, there were a number of forms living in small fresh-water bodies.

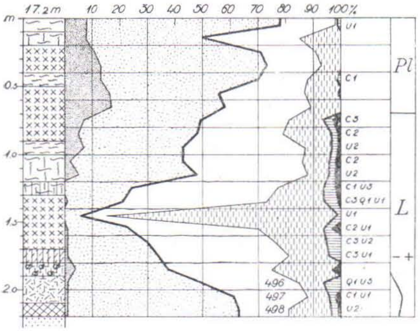

Fig. 40 Profile of the Häyry bog. Analyst K. Salminen.

The threshold of the basin of the bog is 15.6 m. above sea-level according to my levelling. On the basis of the evidence ot the diatoms it is certain that the Littorina transgression exceeded this level slightly. The distinct ancient beach on the edge of the bog, 17.5 m. above sea-level, indicates the highwater stand during the maximum of this transgression. According to the pollen diagram the marine sediment of the bog belongs to the beginning of the Littorina period or to the time, in which L I and L II are situated. Both L I and L II are likely to have extended above the pass-sill of the bog. After the transgression peak the shore still remained close to the bog for a comparatively long time. This proximity of the shore-line is proved by the *Alnus* maximum of the Littorina period in the pollen diagram.

The ancient beaches of the Häyry area, the Stone Age settlement and the stratigraphy of the bogs combined thus prove quite conclusively that the maximum limit of the Littorina Sea is 17.5 m. above sea-level in the vicinity of Viipuri and that this limit is L II. It should be mentioned that H. Lindberg (1916) already expressed the view that the Littorina limit was at a low level in the Viipuri district. He came to this conclusion in establishing that there are very few Littorina Sea diatoms also at lower levels in the sediments of the Viipuri district. Lindberg, however, did not concern himself with determining the Littorina limit more exactly in this area.

In view of the low level of the Littorina maximum in the Viipuri district it seems certain that the Littorina Sea could never have extended its marine influence inside the Laatokka basin. According to the levelling made by Mr. T. Huuskonen (communicated verbally) the important pass-sill of Vetokallio (the lowest valley across the divide between the Gulf of Finland and Lake Laatokka) at Heinjoki is 15.4 m. above sea-level. Vetokallio is already on a lower isobase than Viipuri, so that the Littorina maximum rose even at highwater stand only inappreciably above the present threshold of Vetokallio.

As the threshold was evidently at a higher level during the Littorina maximum than at present, it is all the more probable that the Littorina transgression did not extend even at its maximum phase above the level of the Vetokallio threshold of that time. This accounts for the fact that within the Laatokka basin no distinct Littorina Sea indications have been discovered in the diatoms (J. Ailio 1915, E. Hyyppä 1932, K. K. Markov and W. S. Poretzky 1934, 1935).

I have also some new material regarding peat bogs from the country drained into Laatokka and especially from the proximity of the Vetokallio threshold. I investigated bogs on either side of the Vetokallio pass-sill, in descending order from the level of the threshold, but did not find any sure marine features in the Littorina deposits of these bogs. The narrow waterway from the Vetokallio threshold to the Viipuri bay of that time, naturally, partly reduced the influence of the sea on Laatokka, just as the fresh water of Laatokka coming from the opposite side. I believe, however, that, if the Littorina transgression had clearly reached above the Vetokallio threshold of that time, there would have been signs of it in the immediate neighbourhood of the threshold. I will not go more closely into the history of the development of Laatokka in this connection, as I propose to publish an investigation of it later.

In connection with the Viipuri area some measurements of ancient shores are worth mentioning that Mr. T. Huuskonen (communicated verbally) made at Karisalmi, situated a little less than 20 km. N.E. of Viipuri. Huuskonen established a wave-cut cliff on the S. shore of Lake Määttälänjärvi, the foot of which is 15.5—15.9 m. above sea-level, and the following ancient shore-lines on the shore of Lake Pisponjärvi: 1) the foot of a slight wave-cut cliff 14.3 m. above sea-level, 2) the foot of a wave-cut cliff 17.2 m. above sea-level, and 3) the lower edge of a boulder rampart 20.2 m. above sea-level. For the two latter shore-lines there is an exact counterpart on the basis of their level in the raised shores of the Häyry esker, so that the 17.2 m. beach at Karisalmi represents the Littorina transgression maximum (L II) and the 20.2 m. shore-line belongs to the Ancylus period. The raised beaches at 14.3—15.9 m. belong mainly to the L I and L III levels. It seems certain that Häyry and Karisalmi are on the same isobase.

Pitkäsuo Bog.

The peat bog is situated E. of the Palosilta pond, about 10 km. N.W. of Viipuri (investigation area No. 63). Fig. 41, page 140, illustrates the stratigraphy of the bog. At its bottom there is late-Glacial clay, the lower part of which is devoid of pollen grains, though it contains diatoms (diatom table XVI, Pitkäsuo bog 678—695). From sample 691 upwards the sediment contains pollen in addition to diatoms. The pollen flora as well as the diatoms are of late-Glacial type up to sample 685. In this sample there are still signs of marine influence (*Diploneis interrupta, Hyalodiscus subtilis)*, but above it a typical Ancylus Lake flora begins, as will be seen in the diatom table.

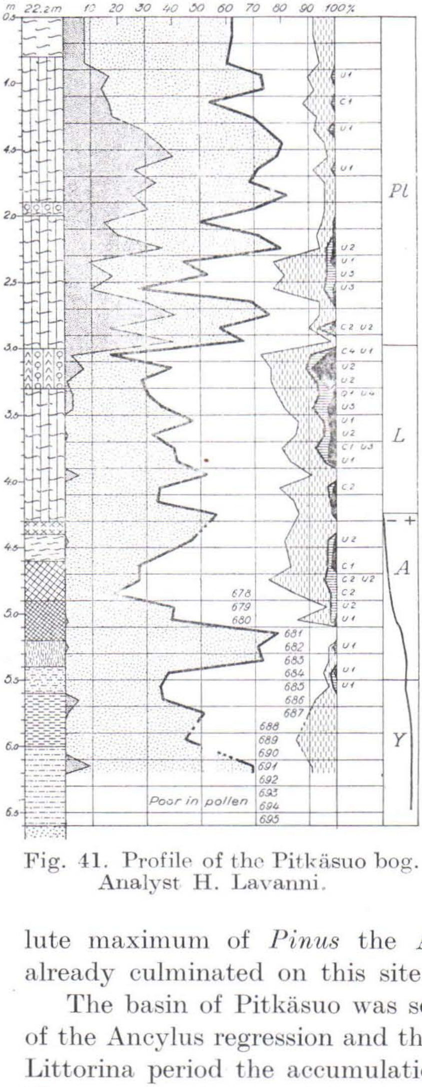

Fig. 41. Profile of the Pitkäsuo bog. Analyst H. Lavanni.

I have dated the late-Glacial clay of the profile, at any rate its upper part, as being of the Yoldia period. In its lower part it may be even older than this. This chronological position is supported by the diatoms of the sediment, in which there are small quantities of brackish-water species: *Campylodiscus echeneis, Cocconeis scutellum, Coscinodiscus* sp. *Diploneis interrupta, Grammatophora oceanica, Hyalodiscus subtilis*. Here there is again the same mixed flora, indicative of slight marine influence, that we encountered in the Yoldia deposits of some former peat bogs.

The Ancylus transgression rose above the level of the bog on this site or above 22.2 m. According to the evidence of the diatoms the transgression peak falls at the very beginning of the Ancylus period. At the time of the absolute maximum of *Pinus* the Ancylus transgression maximum had already culminated on this site.

The basin of Pitkäsuo was separated from the Baltic at the time of the Ancylus regression and the bog had started to develop. In the Littorina period the accumulation of peat was already far advanced. The maximum limit of the Littorina Sea is situated below the level of the bog.

Table XVI.

Anal. K. Salminen	Pitkäsuo Bog																	
	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695
Achnanthes Clevei	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *lanceolata v. elliptica*	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—
Anomoeoneis sphaerophora	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Amphora ovalis	—	1	—	1	1	2	1	1	1	—	—	—	1	—	—	—	—	—
» » *v. libyca*	—	—	—	—	—	—	2	1	1	—	—	—	—	—	—	1	—	—
» » *v. pediculus* ..	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—
Caloneis latiuscula	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Schumanniana v. biconstricta*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *silicula*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Campylodiscus echeneis	—	—	—	—	—	—	—	—	fr.	—	—	—	—	—	—	1	—	—
» *noricus v. hibernica*	1	1	—	1	1	1	—	1	—	—	—	—	—	—	—	1	—	—
Cocconeis diminuta	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—
» *disculus*	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
» *pediculus*	—	—	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—
» *placentula*	—	1	—	—	—	—	1	1	—	—	—	—	—	—	—	1	—	—
» *scutellum*	—	—	—	—	—	—	—	—	—	—	1	fr.	—	—	—	—	—	—
Coscinodiscus sp.	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	—	—
Cyclotella bodanica	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Kützingiana*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Cymatopleura elliptica	—	1	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. nobilis*	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *solea*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymbella aspera	—	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» *cuspidata*	1	1	—	1	—	—	—	—	1	—	—	—	—	1	—	—	—	—
» *Ehrenbergii*	—	1	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—
» *lanceolata*	—	1	—	1	1	1	—	—	1	—	—	—	—	—	—	1	—	—
» *prostrata*	—	—	—	1	1	1	1	1	—	—	—	—	—	—	—	1	—	—
» *spp.*	4	1	—	1	—	—	1	1	—	—	1	—	1	—	1	1	—	—
Didymosphenia geminata	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Diploneis Clevei	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—
» *domblittensis*	—	1	—	1	1	—	4	2	1	—	—	—	—	—	—	1	—	—
» » *v. subconstricta*....	—	—	—	1	—	4	1	1	—	—	—	—	—	—	—	—	—	—
» *elliptica*	—	—	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—
» » *v. ladogensis*	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
» *finnica*	1	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *interrupta*	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
» *Mauleri*	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	1	—	—
Epithemia argus	—	—	—	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—
» *Hyndmanni*	1	2	1	3	5	3	1	1	1	—	—	—	—	—	—	1	—	—
» *intermedia*	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—	—
» *sorex*	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	1	—	—
» *turgida*	—	1	—	4	2	3	2	—	—	—	—	—	—	1	—	1	—	—
» » *v. granulata*	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. Westermanni*	—	1	—	2	1	2	3	1	1	—	—	—	—	—	—	1	—	—
» *zebra*	—	1	1	3	1	4	2	1	—	—	—	—	—	—	—	1	—	—
» » *v. porcellus* ...	—	3	—	1	1	2	—	1	—	—	—	—	—	—	—	—	—	—
Eunotia spp.	4	1	3	1	—	—	—	1	1	1	1	—	1	—	1	—	—	1
Fragilaria spp.	5	1	5	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—
Gomphonema acuminatum v. coronata	2	1	2	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—

	Pitkäsuo Bog																	
	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695
Gomphonema augur v. Gautieri	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *spp.*	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Grammatophora oceanica	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	1	—	—
Gyrosigma acuminatum	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» *attenuatum*	—	1	—	3	3	5	5	2	2	1	1	—	—	—	—	1	—	—
Hantzschia sp.	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hyalodiscus subtilis	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Melosira ambigua	3	1	1	—	1	—	—	1	—	—	—	—	—	1	1	1	—	—
» *arenaria*	1	4	1	4	4	3	2	1	1	—	—	—	1	1	—	1	—	—
» *distans*	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—
» *granulata*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *islandica subspec. helvetica*	—	—	—	2	3	5	2	2	1	—	—	—	1	—	—	1	1	—
» *italica*	3	1	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—
» » *v. valida*	3	1	4	—	—	—	—	1	1	—	—	—	—	—	—	1	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Navicula americana	1	2	3	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—
» *bacillum*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» *cocconeiformis*	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
» *cuspidata*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—
» *gastrum*	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Jentzschii*	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—
» *mutica v. Cohnii*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» *placentula*	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
» *protracta*	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» *pupula v. radiosa*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» » *v. rectangularis*	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—
» *radiosa*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—
» *scutelloides*	—	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
» *tuscula*	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—
Neidium spp.	1	—	1	1	1	—	1	1	—	—	—	—	—	—	—	1	—	—
Nitzschia sigmoidea	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Opephora Martyi	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—
Pinnularia spp.	5	5	5	2	2	—	1	1	1	1	1	—	1	1	—	1	1	1
Rhoicosphenia curvata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Rhopalodia gibba	—	—	—	1	1	—	—	1	—	—	—	—	—	—	—	1	1	—
Stauroneis acuta	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *alabamae v. angulata*	—	4	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
» *anceps*	2	—	1	—	—	—	—	1	—	—	1	—	—	—	—	1	—	—
» » *f. gracilis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
» *phoenicenteron*	3	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stephanodiscus astraea	—	—	—	1	1	1	—	—	—	—	—	—	1	—	—	1	—	—
Surirella biseriata	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. bifrons*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. constricta*	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Capronii*	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elegans*	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—	1	—	—
» *ovata*	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Synedra sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Tabellaria spp.	1	1	1	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—
Tetracyclus lacustris	2	—	1	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—
» » *v. rhombica*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Kämärä, Mustalampi Bog.

The bog is situated about 3 km. N.W. of Kämärä station (investigation area No. 64). It is a partly dried *Pinus-Calluna* »Highmoor». I have already described the stratigraphy of this bog on a previous occasion (E. Hyyppä 1936). Fig. 2, page 15, illustrates the stratigraphy of the bog. It is the same as in my paper of 1936, except that I have simplified the chronological division of the late-Glacial period. Formerly my dating was based in its details on the diatom assemblage, but the weight of the evidence of the diatoms as regards the late-Glacial period is limited, for clay deposits earlier than the last late-Glacial period have been discovered (see page 109) that also contain marine diatoms and partly the same species that have been found in our late-Glacial sediments. The appearance of secondary diatoms derived from the earlier clays should therefore be borne in mind.

The clay at the bottom of the Kämärä bog, 5.4—6.6 m., contains, in addition to abundant large-lake flora, slight quantities of brackish-water species (diatom table XVII, Kämärä, Mustalampi Bog 166—201). These species are as follows: *Coscinodiscus argus, C. lacustris* v. *septentrionalis, C.* sp., *Diploneis didyma, D. interrupta, D. Smithii, Grammatophora oceanica, Gyrosigma distortum* v. *Parkeri, Mastogloia elliptica, M. Smithii, Hyalodiscus scoticus, Navicula digitoradiata, N. elegans, N. peregrina, Nitzschia circumsuta, N. hungarica, N. tryblionella* v. *levidensis* and *victoriae, Rhabdonema arcuatum.* The greater part of these species also occurs in the stratigraphical sequence above the 5.4 m. limit and fairly abundantly. Those salt-water species that have only been found below this limit are as follows: *Coscinodiscus argus* (in sample 190), *C. lacustris* v. *septentrionalis* (192 and 201), *Diploneis didyma* (192), *Hyalodiscus scoticus* (201), *Nitzschia circumsuta* (193, 200), *Rhabdonema arcuatum* (193).

All the latter species occur very sparsely in their particular samples. Such a scattered and sparse occurrence may, of course, be due to these diatoms having been washed off from older sediments. I have, however, no convincing proof for this view.

Below the 5.4 m. limit of the profile, however, as already stated, there are several other salt-water species. These may be, at least in part, impurities coming from higher horizons, samples 189—178. As a whole the part concerned of the profile, 5.4—6.6 m., is so wanting in homogeneity as regards its salt-water diatoms that I do not find myself able to make such a detailed age division on the basis of this flora as I did before (1936).

Table XVII.

Anal. E. Hyyppä.	Kämärä,												
	166	167	168	169	170	171	173	174	175	176	177	178	179
Achnanthes Clevei	—	—	—	—	—	—	—	—	—	—	—	—	—
» *flexella*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *lanceolata v. elliptica*	—	—	—	—	—	—	—	—	—	—	1	—	—
Amphora capitata	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	—	—	1	—	—	—	—	1	2
» » *v. libyca*	—	—	—	—	—	—	—	—	—	—	1	1	—
» » *v. pediculus*	—	—	—	—	—	—	—	—	—	—	—	—	—
Anomoeoneis sphaerophora	—	—	—	—	—	—	—	—	—	—	—	—	—
Caloneis amphisbaena	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ladogensis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Schumanniana*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. biconstricta*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *silicula*	—	—	—	—	—	—	—	—	—	—	—	1	1
Campylodiscus echeneis	—	fr.	—	—	—	—	—	—	—	—	—	—	—
» *noricus*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. hibernica*	—	—	—	—	—	—	—	—	—	—	—	1	—
Chaetoceros sp.	—	—	—	—	—	—	—	—	—	—	—	—	—
Cocconeis pediculus	—	—	—	—	—	—	—	—	—	—	—	—	—
» *placentula*	—	—	—	—	—	—	1	—	—	—	1	4	2
» » *v. euglypta*	—	—	—	—	—	—	—	—	—	—	—	—	—
Coscinodiscus argus	—	—	—	—	—	—	—	—	—	—	—	—	—
» *asteromphalus*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *lacustris v. septentrionalis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	—	—	1
Cymatopleura elliptica	—	—	—	—	—	—	—	—	—	—	—	1	—
» » *v. hibernica*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. nobilis*	—	—	—	—	—	—	—	—	—	—	—	1	—
» *solea*	—	—	—	—	—	—	—	—	—	—	—	1	1
Cymbella aspera	—	—	—	—	1	1	—	1	—	1	2	—	1
» *cistula*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *cuspidata*	3	3	2	—	—	1	—	1	1	1	3	2	—
» *lanceolata*	—	—	—	—	—	—	—	—	—	—	1	—	—
» *prostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *spp.*	4	4	5	5	5	—	—	3	1	5	5	2	2
» *tumida*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ventricosa*	—	—	—	—	—	—	—	—	—	—	—	—	—
Didymosphenia geminata	—	—	—	—	—	—	—	—	—	—	—	—	—
Diploneis didyma	—	—	—	—	—	—	—	—	—	—	—	—	—
» *domblittensis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elliptica*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. ladogensis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *finnica*	4	3	3	4	—	—	1	1	1	3	—	—	—
» *incurvata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *interrupta*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	—	—	—	—	—	—	—	1	—
» » *v. oblongella*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pseudovalis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Smithii*	—	—	—	—	—	—	—	—	—	—	—	—	1
Epithemia argus	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sorex*	—	—	—	—	—	—	—	—	—	—	—	—	2
» *turgida*	—	—	—	—	—	—	1	1	—	1	—	2	4
» » *v. granulata*	—	—	—	—	—	—	—	—	—	—	2	3	1
» *zebra*	—	—	—	—	—	—	1	—	—	1	2	5	4

Mustalampi Bog

180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201
—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	2	1	1	2	3	2	1	—	1	1	5	5	4	5	—	—	5	1	1	1
—	2	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	1	1	—	3	1	1	1	—	—	1	1	—	—	—	—	—	—	1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	1	1	1	1	—	—	—	1	—	—
1	1	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	fr.	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—
1	1	—	1	—	1	—	—	1	—	—	—	1	—	5	1	—	—	2	1	—	1
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	1	1	—
1	—	1	1	1	1	1	—	—	—	1	5	5	1	—	—	—	—	—	1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
—	—	—	1	—	—	1	1	—	1	1	1	1	1	1	1	fr.	1	—	—	1	1
1	—	—	—	1	1	—	—	—	—	—	—	1	—	2	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	1	—	—	1	—	1	—
—	1	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—
5	1	1	—	—	—	1	1	—	1	1	5	5	—	—	—	—	—	1	—	2	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
1	2	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	—	1	—	—	—
1	2	—	—	1	1	1	1	—	—	—	1	5	2	—	—	—	—	1	—	2	1
—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	2	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—
—	—	—	—	1	—	—	1	—	—	1	—	1	2	1	2	—	—	1	1	1	—
—	—	—	—	—	—	—	—	—	—	—	1	2	2	—	2	—	—	1	2	1	—
—	1	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	—
1	1	4	5	2	4	5	4	2	5	—	—	—	1	—	—	—	—	—	1	1	1
—	—	—	—	1	—	—	—	—	1	1	1	—	—	1	1	—	—	—	—	1	—
5	1	—	1	1	1	—	—	—	1	—	1	—	2	—	—	—	—	—	—	—	1
—	3	—	—	—	—	—	—	—	—	1	—	1	—	—	1	—	—	—	1	1	1
—	2	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	2	—	1	—	—	—	1	1	—	1	2	1	—	—	—	—	—	—	1	—	1

													Kämärä,
	166	167	168	169	170	171	173	174	175	176	177	178	179
Epithemia zebra v. porcellus	—	—	—	—	—	—	2	2	1	1	2	4	3
» » *v. saxonica*	—	—	—	—	—	—	—	—	—	—	—	—	—
Eunotia spp.	4	3	3	2	4	2	3	3	3	1	3	—	1
Fragilaria spp.	—	—	—	1	—	—	5	1	5	5	5	—	1
Frustulia sp.	—	—	—	—	—	—	—	—	—	—	—	—	—
Gomphonema acuminatum v. coronata	1	1	1	1	1	1	1	1	—	—	2	2	2
» *augur*	—	—	—	—	—	—	—	1	—	—	—	—	—
» » *v. Gautieri* ...	—	—	—	—	—	—	—	—	—	—	1	—	—
» *constrictum*	—	1	1	1	—	1	1	1	—	1	1	1	1
» *spp.*	—	1	—	—	—	—	—	—	—	1	1	—	—
Grammatophora oceanica	—	—	—	—	—	—	—	—	—	—	—	—	1
Gyrosigma acuminatum	—	—	—	—	—	—	—	—	—	—	—	—	1
» *attenuatum*	—	—	—	—	—	—	—	1	—	—	—	1	1
» *balticum*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *distortum v. Parkeri* ...	—	—	—	—	—	—	—	—	—	—	—	—	—
» *scalproides v. eximia* ...	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Spencerii*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. nodifera*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Kützingii*	—	—	—	—	—	—	—	—	—	—	—	—	—
Hantzschia spp.	—	1	1	—	—	1	1	1	—	1	1	—	1
» *virgata v. capitellata* ..	—	—	—	—	—	—	—	—	—	—	—	—	—
Hyalodiscus scoticus	—	—	—	—	—	—	—	—	—	—	—	—	—
Mastogloia Smithii	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elliptica*	—	—	—	—	—	—	—	—	—	—	—	1	1
» » *v. dansei*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *exigua*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Grevillei*	—	—	—	—	—	—	—	—	—	—	—	—	1
» *Smithii v. amphicephala*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. lacustris*	—	—	—	—	—	—	—	—	—	—	—	—	—
Melosira ambigua	5	5	5	5	5	5	5	5	5	5	5	—	—
» *distans*	5	5	5	—	—	—	—	1	1	3	1	—	—
» *arenaria*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *islandica subspec. helvetica*	—	—	—	—	—	—	—	—	—		—	—	1
» *italica v. valida*	5	5	5	5	5	3	1	3	1	3	1	—	—
Navicula americana	—	—	1	—	1	2	1	1	—	1	2	—	—
» *amphibola*	—	—	—	—	—	—	—	—	—	—	—	1	—
» *bacillum*	—	—	—	—	—	—	—	—	—	1	1	—	—
» *crucicula*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *cuspidata*	—	—	—	—	—	—	—	—	—	—	1	1	2
» » *v. ambigua*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *dicephala*	—	—	—	—	—	—	—	—	—	3	1	—	—
» *digitoradiata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elegans*	—	—	—	—	—	—	—	—	—	—	—	—	1
» *hungarica v. capitata* ...	—	—	—	—	—	—	—	—	—	—	—	—	—
» *peregrina*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *placentula*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *f. lanceolata* ...	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *f. latiuscula* ...	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *f. rostrata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *pupula*	—	—	—	—	—	—	—	—	—	—	1	—	—
» » *v. rectangularis* ...	—	—	—	—	1	—	—	—	—	—	1	—	1
» *pusilla*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *protracta*	—	—	—	—	—	—	1	—	1	—	—	—	—

Mustalampi Bog

180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201
1	2	5	5	5	5	5	5	5	5	5	5	5	1	—	1	—	—	—	2	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	1	—	—	—	1	1	—	1	—	2	1	—	—	—	—	—	—	1	—	1	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	1	—	1	—	—	—	1	1	1	—	—	—	—	—	—	—	1	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	fr.	1	—	1	—	1	—	1	1	2
—	—	1	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
1	—	1	1	1	2	2	1	1	2	1	2	5	5	5	5	—	—	5	5	4	1
—	—	—	1	1	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	2	1	2	5	1	2	—	1	—	1	—	—	—	—	—	—	—	—
—	—	—	1	1	2	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	2	—	1	—	2	—	—	—	—	—	2	1	—
—	—	—	—	—	—	—	—	—	—	—	—	2	2	—	5	—	—	2	1	—	—
1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—
1	—	—	—	1	1	—	—	—	—	—	1	—	1	—	—	—	—	—	—	1	—
—	—	—	1	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—
1	1	1	—	1	3	2	2	1	5	1	1	—	1	—	—	—	—	—	1	1	1
—	—	2	2	2	1	3	2	2	5	—	1	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	1	1	—	1	1	—	—	—	—	—	—	—
—	—	—	—	1	2	1	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	1	1	—	1	—	2	1	—	—	—	—	—	—	—	—	1	—	—
1	1	—	—	—	4	—	1	—	—	1	1	—	1	—	—	—	—	—	1	—	2
—	2	—	—	—	4	—	2	1	—	1	—	—	—	—	—	—	—	1	1	1	—
—	—	—	—	—	—	1	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—
1	—	—	1	1	—	1	1	—	—	5	1	2	2	1	5	—	—	—	5	5	3
—	1	—	—	—	2	1	1	—	—	1	—	—	—	—	—	—	—	—	1	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	1	—	—	—	—	1	—	1	—	1	1	2	—	—	1	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	3	2	1	2	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	1	1	—	1	1	1	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	2	4	—	—	—	—	—	1	1	—	—	—	—	—	1	1	—
1	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
1	1	5	3	2	3	2	1	1	2	1	1	—	1	—	—	—	—	—	1	1	2
1	—	—	—	—	—	—	—	1	—	—	—	—	—	2	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	1	1	—	—	1	1	—	2	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	Kämärä,												
	166	167	168	169	170	171	173	174	175	176	177	178	179
Navicula radiosa	—	—	—	—	—	—	—	—	—	—	2	3	2
» *Reinhardtii*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *rhynchocephala*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *tuscula*	—	—	—	—	—	—	—	—	—	—	—	—	—
Neidium iridis	—	—	—	—	—	—	—	—	—	—	—	—	—
» *spp.*	1	—	—	1	1	1	1	1	—	2	1	1	1
Nitzschia angustata v. acuta	—	—	—	—	—	—	—	—	—	—	—	—	—
» *circumsuta*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *commutata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *denticula*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *hungarica*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *navicularis*	—	—	—	—	—	—	—	1	1	—	—	1	1
» *punctata*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *scalaris*	—	—	—	—	—	—	—	—	—	1	—	—	—
» *sigma*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sigmoidea*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *thermalis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *tryblionella*	—	—	—	—	—	—	—	—	—	1	—	1	2
» » *v. levidensis*..	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. victoriae* ..	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. debilis*	—	—	—	—	—	—	—	—	—	—	—	—	—
Opephora Martyi	—	—	—	—	—	—	1	—	—	—	1	1	3
Pinnularia spp.	3	3	3	4	5	5	1	3	3	5	5	5	3
Rhabdonema arcuatum	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhoicosphenia curvata	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhopalodia gibba	—	—	—	—	—	—	—	—	—	—	1	2	—
» » *v. ventricosa*	—	—	—	—	—	—	—	—	—	—	—	—	1
» *musculus*	—	—	—	—	—	—	—	—	—	—	—	—	—
Stauroneis acuta	—	—	—	—	—	—	—	—	—	—	—	1	1
» *anceps*	—	—	—	—	2	2	2	—	—	2	2	1	1
» *phoenicenteron*	—	—	—	—	1	1	1	3	1	4	4	4	2
» *salina*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *Smithii v. incisa*	—	—	—	—	—	—	—	—	—	—	—	—	—
Stephanodiscus astraea	—	—	—	—	—	—	—	—	—	—	—	—	—
Surirella biseriata	—	—	—	—	—	—	—	—	—	—	—	1	—
» *Capronii*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *elegans*	—	—	—	—	—	—	—	—	1	2	—	1	—
» *linearis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. constricta*	—	—	—	—	—	—	—	—	—	—	—	1	—
» » *v. helvetica*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	—	—	—	—	—	—	—	—	—
» *robusta*	—	1	—	—	—	—	—	—	—	—	—	—	—
» *turgida*	—	—	—	—	—	—	—	—	—	—	—	—	—
Synedra pulchella	—	—	—	—	—	—	—	—	—	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	—	1	—	—
Tabellaria sp.	1	1	1	2	5	3	5	—	1	1	4	—	1
Tetracyclus lacustris	4	4	3	1	—	—	1	1	1	—	—	—	—
» » *v. elongata* ...	1	—	—	—	—	—	—	—	—	—	—	—	—
» » *v. rhombica* ...	—	1	—	—	—	—	—	—	—	—	—	—	—

Mustalampi Bog

180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201
3	2	1	—	—	1	—	1	1	—	1	5	5	1	—	1	—	—	—	2	1	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	1	1	—	1	1	—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—
—	—	1	1	2	1	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	1
1	—	1	4	5	2	3	3	4	2	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	—	2	2	2	2	2	5	—	1	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	1	5	1	1	—	1	—	—	—	1	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	1	1	2	4	3	5	2	2	5	1	1	—	—	1	—	—	—	1	—	1	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	3	2	4	4	4	1	2	5	1	—	—	1	—	—	1	—	—	1	1	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	1	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
5	4	—	—	1	2	1	2	1	—	2	1	1	—	1	1	—	—	—	1	2	1
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	1	—	1	1	1	—	1	—	—	1	1	—	—	1	—	—	—	—	—	—
—	1	1	1	—	—	—	1	1	2	—	5	5	2	—	—	—	—	—	—	—	—
—	—	4	4	2	3	2	2	4	2	—	5	5	2	—	—	—	—	—	1	1	1
—	—	1	2	1	1	1	—	2	2	1	1	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	1	—	—
1	2	—	—	—	—	—	1	1	—	1	1	—	—	—	—	—	—	—	1	—	1
—	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	1	1	1	1	—	—	—	—	—	1	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
1	—	4	2	2	5	3	2	1	2	—	2	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—
1	—	—	—	1	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	1	—
1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	1	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Nor can I decide the question with certainty whether this part of the profile belongs to the time of the Yoldia Sea or of the Baltic Ice Lake. Judging by the diatoms the latter opinion seems more correct, as the sediment contains abundant large-lake forms, especially *Gyrosigma attenuatum*. It should be remembered, however, that the Yoldia sediments investigated in South Finland as a rule contain just such mixed flora, in which fresh-water species are in the majority. The dating as regards this part of the profile must remain undecided pending future investigations.

On the other hand I can refer samples 189—178 to the Yoldia period without any question, for from sample 189, perhaps even partly from sample 190, such an obvious change occurs in the diatom association that it is necessarily due to a factor of prime importance. Brackish-water species increase appreciably in this part of the profile both in the number of species and of individuals, as will be seen from the diatom table. The plentiful occurrence of the following salt-water species should be noted in particular: *Diploneis Smithii, Gyrosigma balticum, G. distortum* v. *Parkerii, Mastogloia elliptica, M. elliptica* v. *dansei, Mastogloia Smithii* v. *amphicephala* (the last three are poor indicators of salt water), *Navicula digito-radiata, N. peregrina, Nitzschia navicularis* (very common in several samples), *N. sigma, N. tryblionella* v. *levidensis, N. tryblionella* v. *victoriae, Rhopalodia musculus*. These species occur constantly and abundantly up to sample 182, from which their number decreases very much until salt-water species practically cease after sample 178. I have drawn the upper limit of the Yoldia Sea deposits at this point of the profile. Above this limit the Ancylus Lake period begins. According to the diatoms the basin of the bog seems to have become an independent small lake approximately at the beginning of the Ancylus period. The Ancylus transgression maximum may possibly have just surmounted the threshold of the bog or the level of about 26 m.

In the sequence of this bog we meet for the first time in South Finland with a diatom flora belonging to the late-Glacial period and containing abundant salt-water diatoms in such conditions that they must be considered as the product of primary sedimentation, for in this profile there is a part, especially samples 189—184, the diatom flora of which exhibits an indisputable, coherent ecological type which proves marine conditions. As these diatoms are limited, besides, to a definite part of the profile, it is difficult to imagine that this should be a question of secondary derivation from older sediments.

These diatoms that lived in the Yoldia Sea prove that the sea was at that time comparatively shallow in this place and only slightly salt. If the B-field below the Y-field of the profile actually also belonged to the Yoldia period, it would represent a considerably deeper, but less salt initial phase of this sea. It is more probable, however, that this part of the profile belongs, at least to a large extent, to the period of the Baltic Ice Lake. Absolute certainty cannot be established in this connection regarding the date of the lower part of the profile, as already mentioned.

Our attention is attracted in the late-Glacial pollen assemblage of the Mustalampi bog by its comparatively large quantity of rarer deciduous trees and *Picea*. Here the same pollen flora is repeated as in the late-Glacial sediments of some previous peat bogs. I have expounded the forest-historical and climatic significance of this pollen composition in my former paper. I will return to this question in the proper part of the present study.

I identified a number of ancient shores at Kämärä situated on either side of the railway in the esker landscape. These shore-lines are situated at the following levels: 25 m., 30 m., and 51—53 m. above sea-level. Of these the 30 m. beach appears on the edge of the Mustalampi bog and, judging by the stratigraphy of the bog, belongs rather to the end of the Yoldia period than to the Ancylus period. The 25 m. shore-line, on the contrary, certainly belongs to the Ancylus period. A more precise dating of these raised shores is obtained in connection with the relation diagram.

SOMME.

In Somme I had previously (E. Hyyppä 1932) only ascertained a shore-line (15 m. above sea-level) corresponding to the typical comb-ceramic culture and another shore belonging to the Iron Age which is 5—6 m. above sea-level. On the basis of the Somme railway cutting I was, besides, able to establish that the Littorina Sea was transgressive here in regard to the land. The Ancylus regression limit was 11—15 m. above sea-level. Formerly I considered the 15 m. shore-line mentioned above to be L II. Now I place it in time in L III, as this beach is connected with the typical comb-ceramic culture. L II is slightly above L III at Somme and forms the highest limit of the Littorina Sea here, too, as in Viipuri. I can therefore conclude on the basis of it that the typical comb-ceramic culture both at Viipuri and Somme occurs about 15 m. above sea-level.

Both sites are therefore approximately on the same isobase. The maximum limit of the Littorina Sea would, on the basis of it, be about 17 m. above sea-level at Somme. In order to check this limit I investigated a peat bog at Somme, the stratigraphy of which is illustrated in Fig. 42 below. The bog is situated 2 km. S.E. of the Somme railway station (investigation area No. 65).

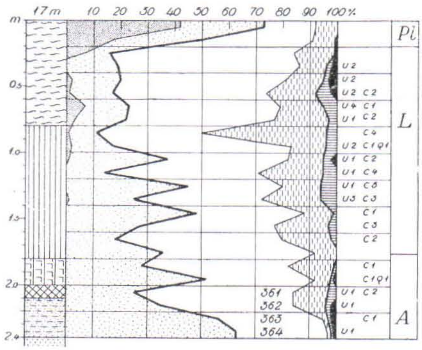

Fig. 42. Profile of the Somme bog. Analyst N. Massinen.

At the bottom of the bog there is a thin bed of clay mixed with sand, the lower part of which, samples 364 and 363, is Ancylus Lake sediment on the basis of the diatoms *(Diploneis domblittensis—Melosira arenaria* flora). The following samples, 362 and 361, represent the separation of the bog basin so as to form an independent small lake which occurred at the end of the Ancylus period. No signs of salt-water diatoms are visible in the sequence of this bog. The threshold of the bog is 17 m. above sea-level, so that the peak of the local Littorina transgression, determined stratigraphically, is here at any rate slightly below the 17 m. level.

JOHANNES.

According to my investigation in 1932 the post-Glacial shore-levels at Johannes are situated at the following altitudes: Yoldia 35 m., Ancylus 31 m., L I 26.6 m., L II 15 m., the shore-line representing the end of the Stone Age 11.8 m., and the shore situated in the Iron Age 5.7 m. above sea-level. According to my present views this result does not hold good precisely. The beaches referred to, indeed, clearly exist, but their dating is wrong. The error is worst in L I which was placed at the level of the Ancylus shore-line. Formerly I had not sufficient stratigraphical evidence regarding this area for determining the dates of the shores. Now I possess additional material of this area, too, so that I can correct my former results.

Revonsaari Bog.

The bog is situated on the island of Revonsaari, investigation area No. 66. In type it is a *Calluna-Pinus* »Highmoor». Fig. 43, below illustrates its stratigraphy. At the bottom of the bog there is a thin shallow-water deposit which contains a small-lake diatom flora, as the diatom table XVIII, Johannes 549—551, shows. The diatoms are of the Ancylus regression phase, when the basin of the bog had already been isolated and become an independent small lake. After this the formation of peat begins on the site and continues uninterruptedly to the present time. The maximum limit of the Littorina transgression is below the level of the bog or 19 m. This bog already proves that my former figure (26.6 m. above sea-level) is considerably too high for the Littorina limit. In the neighbouring area, at Somme, the Littorina limit, identified stratigraphically, was a little less than 17 m. above sea-level. At Johannes the Littorina maximum is at least slightly lower than at Somme. According to Leiviskä (I. Leiviskä 1934) the beach representing the Littorina Sea maximum at Kaislahti, situated close to Somme, is 19.2 m. above sea-level, and at Kirjola in the parish of Johannes 17 m. above sea-level. The latter locality is close to my own observation sites, so that this 17 m. shore might possibly represent the maximum limit of the Littorina Sea at the time of highwater. The Kaislahti beach, 19.5 m. above sea-level, on the other hand is at least 2.5 m. above the actual Littorina limit, as the stratigraphy of the Somme peat bog proves.

On the basis of the record of bogs presented in my former paper I place the Littorina maximum here, too, in the L II period. In my former investigation I placed the Ancylus regression limit at the 14—15 m. level. This figure, however, is too high, as according to the stratigraphy of the Rantasuo bog (E. Hyyppä 1932, page 144) the range of the Littorina transgression attained a larger extent than the limit of 14—15 m. for the Ancylus regression presumes, seeing that the Littorina maximum is only 16—17 m. above sea-level here. The stratigraphy of the Rantasuo bog

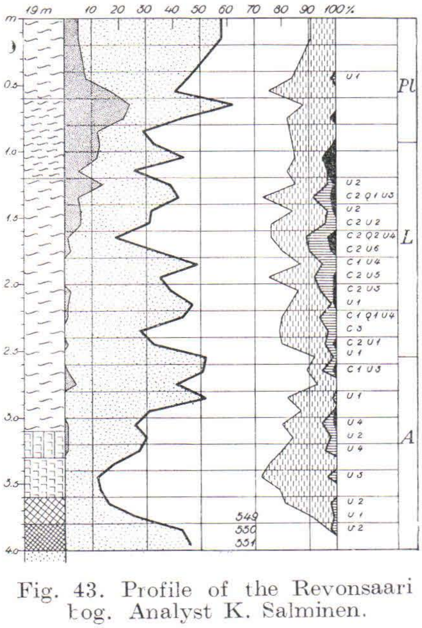

Fig. 43. Profile of the Revonsaari bog. Analyst K. Salminen.

necessitates the minimum limit of the Ancylus regression at about 11—12 m. above sea-level.

According to the excavation reports of the Finnish National Museum (KM. 9416: 8—10 and 9564: 21—25) the lower limit of the Myllykangas dwelling place at the village of Kaijala, parish of Johannes, is 12 m. above sea-level. This dwelling place represents the later part of the typical comb-ceramic culture (II: 2). On the adjacent site of discovery at Väntsi (KM. 9354: 1—4 and 9406: 1—256) the principal dwelling zone of the older type of the same comb-ceramic culture (II: 1) lies at 14.5—13.5 m. above sea-level. On the same site the style II: 2 remains below the 14 m. level and debased comb-ceramic dwelling places 13.5—13 m. above sea-level, the lower limit being 12.5 m. above sea-level. The lower limit of the cord-ceramic culture is 10.5 m. above sea-level.

It is particularly worth noting that the above comb-ceramic dwelling places partly overlap, according to archaeology, and that they are clustered at almost the same levels. The early comb-ceramic culture, which accompanies L II, has not been found here, but judging by the finds at Häyrynmäki near Viipuri it cannot be much above the typical comb-ceramic level (14.5 m. above sea-level). On the basis of the above we obtain the result that L II and L III are vertically close to each other here.

The upper limit of the typical comb-ceramic culture is 14.5 m. above sea-level at Johannes. S. of Rantasuo bog there is a boulder rampart piled up by the ice which is 14.5—15 m. above sea-level. The levels of the typical comb-ceramic culture and of this beach are so close to each other that they may possibly belong to the same shore-line or L III. E. of the road leading from Johannes railway station to the sea-shore I established a rampart of boulders piled up by the ice, the foot of which is 12.8 m. above sea-level. The foot of a slight wave-cut cliff at the E. edge of Rantasuo also lies 12.8 m. above the sea. On the basis of the stratigraphy of Rantasuo these latter shores belong to the Littorina period and are best placed in L IV.

Pienjärvi Bog.

The bog is situated about 3 km. E. of the village of Kaijala; it encircles a pond of the same name (investigation area No. 67). It is a *Carex-Equisetum* »Lowmoor» in type. Fig. 1, page 15, illustrates its stratigraphy. At the bottom of the bog there is sand and loamy sand which belong to the late-Glacial period. In this sediment a pollen composition is found that is typical of the late-Glacial period. The diatom analysis also disclosed a number of brackish-water diatoms in this sediment (diatom table XVIII, Johannes 583—606).

On the basis of the diatom analysis the whole Yoldia field of the diagram, samples 589—606, contains sparse brackish-water diatoms of those very species that we found in the Yoldia sediments of former bogs. These brackish-water species are as follows: *Campylodiscus clypeus* v. *bicostata*, *Campylodiscus echeneis* (very plentiful in sample 591), *Coscinodiscus* sp., *Diploneis interrupta*, *D. Smithii*, *Grammatophora oceanica*, *Navicula humerosa*, *Nitzschia navicularis* (abundant in sample 591), *N. punctata*, *N. scalaris*, *N. tryblionella* v. *victoriae*. The strongest indication of salinity is encountered in samples 591 and 592 or in the final phase of the Yoldia period, as in the case of the Kämärä bog. Further it seems certain according to the diatoms of the deposit that the water was deepest during the very phase, in which the highest salinity occurred. Here, therefore, we have a marine transgression situated in the latter half of the Yoldia period. If the whole Yoldia period is represented in this profile, this transgression peak also signifies the highest level of the Yoldia Sea on this site. The lower part of the profile contains so few salt-water diatoms that it cannot be concluded whether it belongs at all to the Yoldia Sea phase or possibly to a former period. It should be considered certain, on the other hand, that the upper part of the profile, at any rate from sample 594 upwards, is Yoldia Sea sediment.

The whole late-Glacial succession of the profile represents comparatively shallow water according to the diatoms. The threshold of the basin of the bog is 20—24 m. above sea-level. In any case, therefore, the Yoldia Sea reached above this level here.

The transgression that occurred at the end of the Yoldia period is succeeded by a slight regression which changes into the Ancylus transgression, samples 588—587. The diatoms prove this. A corresponding change occurs, too, in the lithology of the sediment; the fine detritus ooze at 4.1—3.9 m. grades over into clay mixed with sand at 3.9—3.7 m. The Ancylus transgression maximum is above the threshold of the bog or the 20—24 m. level in this area. The 26.6 m. shore-line also involves this, a beach which I formerly considered to be the maximum limit of the Littorina Sea, but which is older than it and certainly belongs to the shore-levels of the Ancylus Lake. The basin of the bog became an independent small lake, according to the diatoms, in the horizon of sample 584, possibly even slightly earlier, or comparatively soon after the Ancylus transgression maximum.

I do not possess adequate stratigraphical material for dating the other ancient shore-lines that I determined at Johannes (E. Hyyppä 1932) (31 m. and 35 m. above sea-level). Probably they belong to the Yoldia period.

Table XVIII.

Anal. K. Salminen.							Jo-
	549	550	551	583	584	585	586
Achnanthes flexella	—	—	1	—	—	—	—
» » *v. alpestris*	—	—	—	—	—	—	—
» *lanceolata v. elliptica*	—	—	—	1	1	1	—
Amphora ovalis	—	1	1	—	—	—	—
» » *v. libyca*	—	1	1	—	1	—	1
» » *v. pediculus*	—	1	—	—	—	—	—
Anomoeoneis follis	—	—	—	—	—	—	—
» *serians v. brachysira*	—	—	—	—	—	—	—
» *sphaerophora*	—	1	1	—	—	—	—
Caloneis latiuscula	—	—	—	—	—	—	—
» *Schumanniana v. biconstricta*	—	—	—	—	—	—	—
» *silicula*	—	1	2	—	1	—	—
Campylodiscus clypeus v. bicostata	—	—	—	—	—	—	—
» *echeneis*	—	—	—	—	1	—	—
» *noricus v. hibernica*	—	—	1	—	1	—	1
Cocconeis pediculus	—	1	—	—	—	—	—
» *placentula*	—	—	1	—	—	—	1
Coscinodiscus sp.	—	—	—	—	—	—	—
Cyclotella bodanica	—	—	—	—	—	—	—
» *comta*	—	—	—	—	—	—	1
» *Kützingiana*	—	—	1	—	—	—	—
» *stelligera*	—	—	—	—	—	—	—
Cymatopleura elliptica	—	1	1	—	—	—	1
» » *v. hibernica*	—	—	1	—	1	—	—
» » *v. nobilis*	—	—	—	—	—	—	—
» *solea*	—	1	—	—	—	—	—
Cymbella aspera	—	—	—	—	1	—	1
» *cuspidata*	—	2	2	1	—	—	2
» *Ehrenbergii*	—	1	3	—	—	—	1
» *lata*	—	—	—	—	—	—	—
» *prostrata*	—	1	1	—	—	—	—
» *spp.*	2	5	5	1	1	2	3
Diploneis domblittensis	—	1	1	—	1	—	—
» » *v. subconstricta*	—	1	—	—	—	—	—
» *finnica*	—	—	—	3	4	2	3
» *interrupta*	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	—	—	—
» *Smithii*	—	—	—	—	—	—	—
Didymosphenia geminata	—	—	1	—	—	—	—
Epithemia argus	—	2	1	—	—	—	1
» *Hyndmanni*	—	2	2	—	1	1	1
» *intermedia*	—	—	—	—	—	—	—
» *Muelleri*	—	1	1	—	—	—	—
» *sorex*	—	1	1	—	—	—	—
» *turgida*	1	1	1	—	1	—	—
» » *v. granulata*	—	—	—	1	1	—	—
» » *v. Westermanni*	—	2	1	—	—	—	—
» *zebra*	—	1	—	—	1	—	1
» » *v. porcellus*	1	1	1	1	2	1	1
Eunotia spp.	2	2	1	2	1	—	2
Fragilaria spp.	—	4	5	5	5	5	4
Frustulia sp.	—	—	—	—	—	—	—

hannes

587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	604	605	606
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	1	1	—	—	—	—	1
—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	1	—	—
1	1	—	1	4	1	1	1	—	1	—	—	1	—	—	—	1	1	—
1	1	1	—	—	—	1	1	1	1	1	1	1	—	1	1	—	2	1
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	1	—	1	1	1	—	1	1	1	1	1	1	1	2
—	—	—	—	—	—	1	—	1	—	—	3	1	1	—	—	—	—	1
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	1	—	—	—	—	—	—	1	—	1	—	—
—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	fr.	1	2	5	1	1	1	—	—	1	—	—	—	1	—	—	1	—
1	2	—	1	1	—	—	1	1	—	—	—	—	1	1	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	1	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	1	1	1	1	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—
—	1	—	1	1	—	—	1	—	—	1	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	—	1	1	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
—	—	1	1	—	—	—	1	—	1	1	1	1	2	—	1	1	3	1
2	1	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	1	1	1	—	—	1	—	—	—	—	—	—	—	—
2	—	—	3	1	1	1	3	2	3	2	4	4	1	3	3	1	3	3
2	1	—	—	—	—	1	—	—	1	—	—	1	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	2	1	1	—	1	1	—	3	2	1	3	2
—	1	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	1	1	—	—	—	1	1	—	1	—
—	—	—	1	3	1	1	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—
3	1	—	—	—	1	—	1	—	—	1	—	—	—	1	—	1	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—
1	1	1	—	1	—	—	1	1	—	—	1	1	—	—	—	—	1	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
2	1	—	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—
1	—	1	1	—	—	1	1	—	—	1	1	—	—	1	—	1	1	—
1	1	—	—	1	1	1	3	2	3	2	3	2	1	3	3	3	3	1
1	—	1	1	—	—	2	3	4	1	1	5	5	1	4	—	1	3	4
—	—	—	—	—	1	1	1	2	1	1	4	2	1	1	1	2	1	2

	Jo-						
	549	550	551	583	584	585	586
Gomphonema acuminatum v. coronata	2	—	—	1	1	1	1
» *constrictum*	—	1	1	—	—	—	—
» *spp.*	1	1	—	—	—	—	—
Grammatophora oceanica	—	—	—	—	—	—	—
Gyrosigma acuminatum	—	—	—	—	—	—	—
» *attenuatum*	—	1	—	1	1	—	1
Hantzschia elongata	—	—	—	—	—	—	1
» *sp.*	—	—	—	—	—	—	—
Mastogloia Smithii v. lacustris	—	1	1	—	—	—	—
Melosira ambigua	—	—	—	5	5	5	5
» *arenaria*	—	1	1	1	1	1	2
» *distans*	—	—	—	1	—	1	1
» *granulata*	—	—	1	5	5	5	5
» *islandica subspec. helvetica*	—	2	2	—	—	—	—
» *italica*	—	—	—	1	—	—	1
» » *v. valida*	—	—	—	5	4	—	4
Navicula americana	—	—	—	2	4	3	1
» *amphibola*	—	—	—	1	1	—	1
» *bacillum*	—	—	—	—	—	—	—
» *cocconeiformis*	—	—	—	—	—	—	—
» *cuspidata*	—	—	1	—	—	—	—
» *humerosa*	—	—	—	—	—	—	—
» *Jentzschii*	—	—	—	—	—	—	—
» *menisculus*	—	—	—	—	—	—	—
» *mutica v. Cohnii*	—	—	—	—	—	—	—
» *placentula*	—	—	—	—	—	—	—
» » *f. jenisseyensis*	—	—	—	—	—	—	—
» » *f. latiuscula*	—	—	—	—	—	—	—
» » *f. rostrata*	—	—	—	—	—	1	—
» *platystoma*	—	—	—	—	—	—	—
» *protracta*	—	—	—	1	2	1	3
» *pupula*	—	—	—	—	—	—	—
» » *v. rectangularis*	—	1	1	—	—	—	—
» *radiosa*	—	5	5	—	—	1	—
» *Reinhardtii*	—	—	—	—	—	—	—
» *rhynchocephala*	—	—	—	—	—	—	—
» *scutelloides*	—	—	—	—	—	—	—
» *tuscula*	—	1	2	—	—	—	—
Neidium spp.	—	2	1	1	—	1	1
Nitzschia angustata v. acuta	—	—	1	—	—	—	—
» *denticula*	—	2	2	—	—	—	—
» *navicularis*	—	—	—	—	—	—	—
» *punctata*	—	—	—	—	—	—	—
» *scalaris*	—	—	—	—	—	—	—
» *sigmoidea*	—	—	—	—	—	—	—
» *tryblionella v. victoriae*	—	—	—	—	—	—	—
Opephora Martyi	—	—	—	—	—	—	—
Pinnularia spp.	4	5	2	5	5	5	5
Rhopalodia gibba	—	1	1	—	—	1	1
Stauroneis acuta	—	—	—	—	1	—	1
» *alabamae v. angulata*	—	—	—	1	—	—	—

hannes

587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	604	605	606
—	—	1	1	—	—	—	1	—	—	1	1	1	—	1	1	1	1	1
—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—
—	—	—	—	1	—	—	1	—	—	1	—	1	1	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	1	—	—
5	5	—	—	—	2	1	2	—	1	1	1	—	1	1	—	1	1	1
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	1	1	1	1	—	1	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	5	5	2	5	2	5	3	4	5	3	4	2	5	3	4	5	3
2	2	1	—	—	1	—	1	—	—	1	—	—	—	—	1	1	—	—
1	1	—	1	3	3	—	5	1	2	5	3	1	1	1	2	2	5	3
—	—	—	—	—	3	2	4	—	1	1	1	2	1	3	2	3	3	2
5	2	—	—	—	2	2	1	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	1	1	1	1	1	1	2	1	1	1	5	2	1	5	4
—	—	—	1	—	2	—	—	—	1	2	1	—	1	4	2	1	4	—
—	—	1	—	—	1	1	3	1	—	1	—	1	—	1	1	1	1	1
1	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
—	—	—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	—	1
—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	—
—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	2	1	—	—	1	1	1	1	1	—	1	2	1	1	1	1	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	2	1	1	1	1	—	—	1	1	—	1
—	1	—	1	1	1	—	1	1	1	1	1	1	—	1	2	1	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	1	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	2	1	1	1	2	2	1	1	3	3	3	1	3	2	3	4
—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	4	1	—	1	—	—	—	—	—	—	1	—	—	—	—
—	—	—	—	1	2	—	1	—	—	1	1	—	—	—	—	—	—	—
—	—	1	—	—	1	—	—	—	—	1	1	—		1	1	1	1	1
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	1	1	—	—	1	1	1	1
1	2	4	3	2	3	1	4	4	4	4	5	4	4	5	5	4	5	5
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—
—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—

	Jo-						
	549	550	551	583	584	585	586
Stauroneis anceps	1	2	2	—	—	—	—
» » *f. gracilis*	—	—	—	—	—	—	—
» *phoenicenteron*	—	2	2	—	4	4	2
Stephanodiscus astraea	—	1	1	—	—	—	—
Surirella biseriata	—	—	—	—	1	—	—
» *Capronii*	—	—	—	5	3	—	1
» *elegans*	—	—	—	1	4	2	1
» *linearis v. constricta*	—	—	—	—	—	—	—
» *robusta*	—	—	—	—	1	—	—
» *tenera v. nervosa*	—	—	—	—	—	—	—
Synedra sp.	—	—	—	—	—	—	—
Tabellaria spp.	2	2	1	1	1	—	1
Tetracyclus lacustris	—	—	—	—	—	1	1
» » *v. rhombica*	—	—	—	—	—	—	—

KOIVISTO.

RAISED SHORES.

Since the publication of my paper in 1932 I have established the following ancient shore-lines in this area.

Investigation area No. 68, close to the cemetery:

Foot of large wave-cut cliff	30.5 m. above sea-level
Foot of wave-cut cliff below the former	26.1 » » »
The same about 100 m. W. of the former	26.0 » » »

Investigation area No. 69, close to the coast road:

Crest of a large gently-shaped shore bar	19.5 m. above sea-level
Foot of a bouldery wave-cut cliff	15.1 » » »

Investigation area No. 70, at the railway:

Highest point of a sandy shore bar	16.1 m. above sea-level

Koivisto island, Patala, investigation area No. 71:

Foot of wave-cut cliff	9.8 m. above sea-level
»	8.3 » » »
Foot of a very distinct wave-cut cliff	12.4 » » »
»	15.9 » » »
Foot of a wave-cut cliff	16.5 » » »
Mean height of a flat-topped plain	20.0 » » »

hannes

587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	604	605	606
—	—	—	—	1	1	—	1	1	1	—	1	1	—	1	—	1	—	1
—	—	—	—	—	—	1	—	1	1	—	1	2	1	—	1	1	—	1
—	1	3	3	1	1	1	3	1	1	2	1	1	1	2	2	1	3	1
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	1	—	1	1	—	—	—	—	—	—	—	—	—	1	—
1	1	1	1	—	—	—	1	—	—	—	—	—	—	1	—	—	1	—
—	1	5	5	1	1	1	1	1	—	1	1	1	—	1	1	—	5	1
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—
—	—	1	—	—	1	1	1	2	3	1	5	3	1	1	1	1	1	1
—	—	—	1	1	1	1	1	1	1	1	1	—	—	1	—	—	2	1
—	—	—	—	—	1	—	1	1	—	1	1	1	—	1	—	—	1	1

Almost all these ancient shores are fairly distinct. They are grouped at the following levels: 30.5 m., 26 m., 19.5—20 m., 15.9—16.5 m., 15.1 m., 12.4 m., and 8.3—9.8 m. above sea-level. From the altitude of the shore-lines it is already evident that this is a case of beaches that are almost on the same level as at Johannes. It therefore seems certain that the 16 m. level represents the Littorina transgression maximum (L II) and that the 26 m. shore-line belongs to the Ancylus. The 15.1 m. level represents L III and the 12.4 m. level L IV. The 8.3—9.8 m. level belongs to the post-Littorina period and the 30.5 m. level to the pre-Ancylus period. I have stratigraphical evidence, too, from this area which is important especially in regard to the displacement of the shore-line during the Littorina period.

THE RAILWAY CUTTING AND STRATIGRAPHY OF THE PEAT BOGS.

In the railway cutting (investigation area No. 70) a very interesting sequence of layers was exposed. At this point the railway cuts across a Littorina shore bar (an embankment thrown up by waves). The ridge is about 500 m. in length and extends from W. to E., damming up a bog on its landward or N. side. On the opposite side the ground descends evenly to the adjacent sea. In Fig. 44, page 162, we see the bar at the point of the railway cutting, looking seawards.

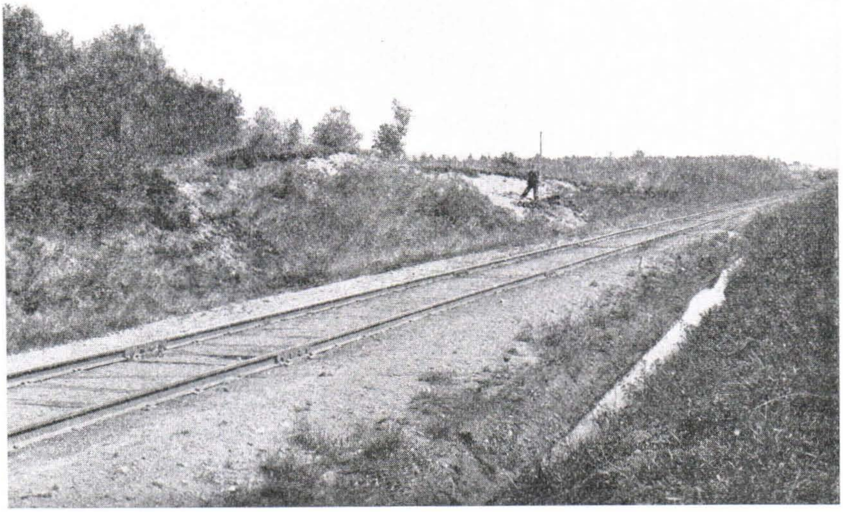

Photo. E. Hyyppä.

Fig. 44. Railway crossing a thrown-up shore bar of the Littorina Sea about 0.5 km. W. of Koivisto station. The rodman stands on the seaward slope of the ridge, at the level of the peat layer buried by sand.

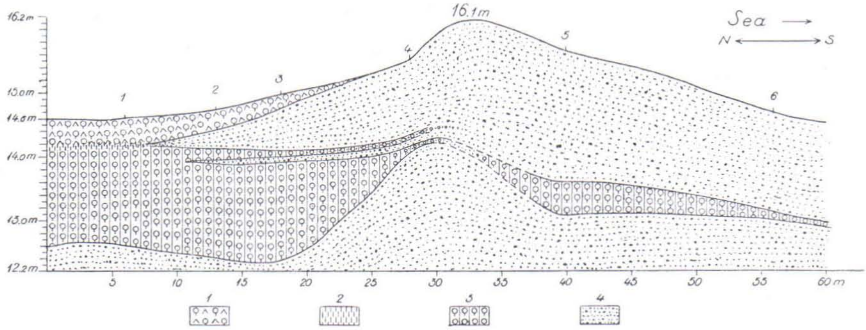

Fig. 45. Cross-section of the raised Littorina shore bar shown in the preceding figure. 1 = mixed forest peat, 2 = Phragmites peat, 3 = Carex-deciduous tree peat, 4 = shore sand and shingle.

When this railway was built in 1915, a thick layer of peat was disclosed underneath a sand bed in the earth cutting. A geologist, Mr. J. N. Soikero, visited the locality and took samples, but I have no knowledge of their subsequent fate. All the information concerning the results of the investigation are confined to a brief diary note

(J. N. Soikero 1915), in which it is assumed that this is a case of a bog submerged during the Littorina transgression. When I was studying the Koivisto area in the summer of 1935, I knew nothing of this earlier discovery, but found a peat layer beneath the shore ridge referred to, which is certainly the same that Soikero investigated. Fig. 45, page 162, illustrates a section of the bar which is based on six profiles dug with a shovel.

It will be seen from the drawing that the bog behind the bar has become partly overlaid by the shore sand and gravel. Fig. 46 and 47 were taken from excavation No. 3 and in them the quality of the material is visible at closer range. Fig. 48, page 165, shows the pollen analysis made of the same digging.

The pollen diagram reveals at a glance that the shore ridge was accumulated during the Littorina period. The mixed oak forest field of the diagram provides irrefutable evidence of this. The formation of peat began on this site at the time of the Ancylus regression and still continued undisturbed during the beginning of the Littorina period. The Littorina transgression, however, already raises the sea at the time of L I to the level of the bar. Proof of this is provided by the thin bed of shore sand and shingle which was deposited on top of the peat during L I. The material is clearly stratified and contains small quantities of *Grammatophora oceanica* and *Epithemia turgida* (sample 321). The occurence of *Grammatophora oceanica* in this layer proves marine conditions of origin. On the basis of the pollen analysis the date of the bed certainly falls within the early part of the Littorina period. I am unable to establish the beginning of the Littorina period quite exactly on the basis of the diagram, especially as the pollen has been deposited in the littoral zone.

This shore deposit extends, as will be seen from the figure 45, some distance on to the bog behind the embankment. Towards the middle part of the bar this shore deposit rises higher, while at the same time the peat layer of the Ancylus regression period below it becomes thinner. We see from Fig. 45 that at section No. 4 the shore deposit is 14—14.5 m. above sea-level. As this excavation is almost at the highest point of the shore ridge, the 14.5 m. level may be considered the maximum height of the shore deposit accumulated during the L I phase. The sea-level during L I did not rise above this level even at the time of highwater except, perhaps, occasionally during floods caused by heavy storms.

After L I a regression occurred, as is proved by the peat layer, 12—15 cm. in thickness, above the shore sand. The lower part of

Photo E. Hyyppä.

Fig. 46. Section in the Littorina shore ridge at Koivisto, point No. 3 in the former figure.

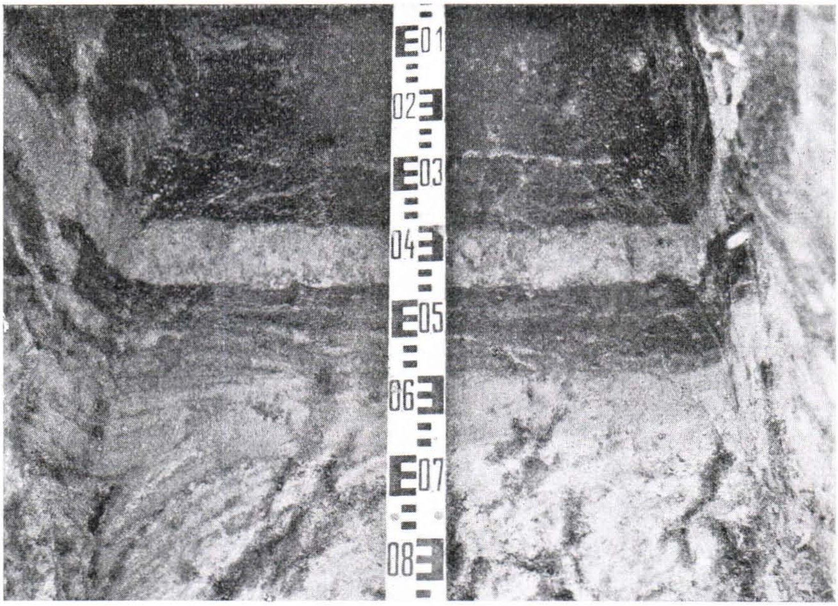

Photo E. Hyyppä.

Fig. 47. Wall of the section shown by the former figure at closer range.

the bed is pure deciduous tree peat. In the upper part of the peat layer, on the other hand, thin intercalations of sand are a sign of a new transgression. The sea soon rose again to the level of the shore bar and higher this time than during L I, for a layer of shore sand and shingle, 70 cm. thick, follows in the succession of strata, containing stones about 1 cm. in diameter. The material is clearly stratified and the beds dip landwards. There are wood pieces and other organic remains in the sand. It is in all respects a typical shore deposit. Its marine character is proved, in addition to the position of the ridge itself, by some diatoms. In the lower part of the shore deposit (samples 316 and 317, Fig. 48) *Cocconeis pediculus*, *C. scutellum* and *Grammatophora oceanica* occur sparsely.

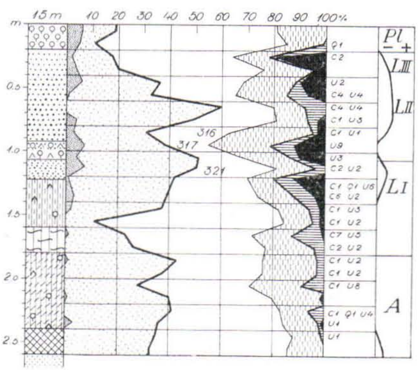

Fig. 48.

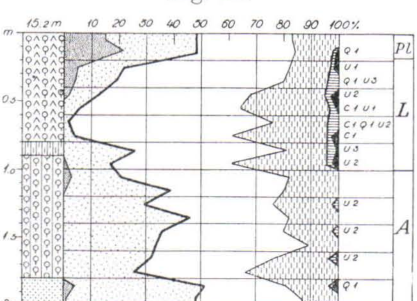

Fig. 49.

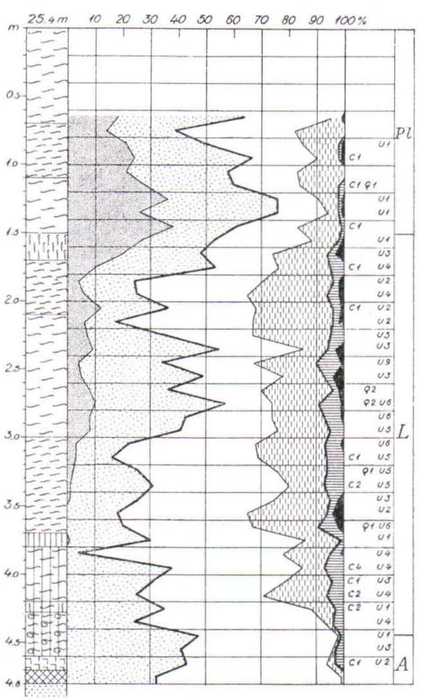

Fig. 50.

Fig. 48. Profile of the Littorina bar in Koivisto railway cutting. Analyst M. Salmi.

Fig. 49. Profile of the bog behind the Littorina bar at Koivisto. Analyst S. Itkonen.

Fig. 50. Profile of the Suurjärvi bog. Analyst N. Massinen.

According to the pollen diagram this transgression culmination, too, falls clearly within the Littorina period and at any rate its initial phase belongs to LII. At the top of the sequence of strata there is a layer of peat which is younger than Littorina. The bog was only able to spread on to the shore bar long after the shore-line had finally receded from this site.

The upper beach deposit of the shore bar which represents LII, at any rate mainly, lies at the highest point of the ridge 16.1 m. above sea-level. This level therefore represents the LII maximum at this place. From the list of raised shores we see that there are other ancient beaches corresponding to this level at Koivisto which consequently also belong to the LII shore-level.

In the sequence of layers of the bog behind the bar there are also faint indications of the proximity of the shore. Fig. 49, page 165, illustrates the stratigraphy of the bog behind the ridge. The profile was taken from a place near the digging No. 1 (see Fig. 45). We see from the pollen diagram that there is a bed of limnotelmatic *Carex-Phragmites* peat, 0.8— 0.9 m., between forest peat layers in the sequence. This peat layer is situated in time in the initial part of the Littorina period and represents LI or LII. During LII the surface of the sea was higher, so that this telmatic peat layer is more likely to have been formed by it. The influence of the Littorina Sea is, however, very faintly recognisable in the bog. This confirms the observation already often made that the average water height lay considerably below the level measured on the basis of the shore marks. As all the time, we were naturally in this case, too, dealing with levels determined by means of the shore features, whenever they were available.

On the seaward side of the bar L I and L II cannot be distinguished from each other, which is intelligible, as the abrasion during the transgression destroyed the peat layer that was formed during the regression between L I and L II. Only the peat grown during the Ancylus regression is left, as is proved by the pollen analysis of the peat layer that I made. At excavation No. 6 the upper part of the peat, *e. g.*, contains flora typical of the Ancylus regression period: *Pinus* 63 %, *Betula* 23 %, *Alnus* 12 %, *Corylus* 2 %. In the shore sand above the peat there is an abundant admixture of peat detritus on the seaward side which proves the marine erosion referred to.

The lower limit of the peat layer of the Ancylus regression time is 13 m. above sea-level at section No. 6, but it obviously extends still lower, though I was not able to determine its lowest limit. It is certain that the Ancylus regression limit is below the 13 m. level here. The lower limit of the regression between L I and L II can again not be estimated, as the abrasion has removed the peat layer that represents this regression entirely from the seaward side of the shore bar.

I am convinced, however, that at any rate a small regression occurred here during the time between L I and L II. It cannot be very large at Koivisto, as in the Johannes and Viipuri areas, for instance, I have so far not found any sure signs of it. Seeing the exposed situation of the Koivisto shore bar it might, naturally, be conceivable that the two transgression layers in the ridge are only signs of storm floods. There are such phenomena particularly in the region of the Karelian Isthmus, which naturally necessitates great caution in explaining formations of this kind. I have strong support, however, from elsewhere in the region of the Karelian Isthmus for the opinion that between L I and L II there is actually a distinct regression of some duration here. We will deal with these cases in the next investigation areas.

This conclusion also obtains strong support from elsewhere in the region of the Baltic. It is especially interesting to compare Koivisto with the Littorina shore bar at Snoder on Gotland. This comparison is all the more convenient, seeing that the Littorina maximum (L II) is at the same level in both places or roughly 16 m. above sea-level. It was already in 1927 that L. von Post obtained exactly the same result as regards L I and L II on the basis of the stratigraphy of the Snoder Littorina bar and the Mästarmyr bog behind it as I did at Koivisto. L. von Post described the Snoder bar already in 1903, but was inclined at that time to explain the double character of the ridge as being due to storm floods. In his paper of 1927, however, he proves quite conclusively by means of the stratigraphy of Mästarmyr that this is a case of two actual rises of the sea-level, in the time between which the shore-line receded. The earlier of these transgression peaks is L I which extended to about 15 m. above sea-level, and the later is L II which is 16 m. above the sea. L. von Post's and my L I and L II also correspond to each other as regards the pollen chronology, as according to v. Post L I and L II are situated in the first half of the Littorina period precisely as with me.

I have already mentioned that the 26 m. shore-line at Koivisto represents the Ancylus transgression maximum. This result, too, is in harmony with the one obtained on Gotland. According to H. Munthe (H. Munthe 1910, 1925) the 26 m. Ancylus isobase passes through Snoder. This locality again, as already stated, corresponds exactly to

Koivisto in regard to the displacement of the shore-line. I also possess stratigraphical support for the dating of this 26 m. shore. Fig. 50, page 165, represents the stratigraphy of the Suurjärvi peat bog investigated by me on the Koivisto island (investigation area No. 72). The threshold of the bog is about 25 m. above sea-level. The accumulation of peat could only have begun on this site at a time subsequent to the 26 m. level or after the Ancylus transgression peak. According to the pollen diagram the paludification began during the final phase of the Ancylus regression, so that the stratigraphy of the bog is in accordance with the view that the 26 m. level represents the local Ancylus transgression maximum.

I also identified an ancient shore-line in the Koivisto area at 19.5— 20 m. above sea-level, though it is rather inconspicuous. This beach is of pre-Littorina date, but later than the actual Ancylus transgression.

MAKSLAHTI.

N. of Koivisto at Makslahti (investigation area No. 73) I also identified some ancient shore-lines. Close to the harbour of Makslahti there is a wave-cut cliff, the foot of which is 16.3 m. above sea-level. This beach represents the Littorina Sea transgression maximum (L II). Above it there are two others: 25.8 m. and 30 m. above sea-level. The former is a distinct wave-cut cliff, the latter a doubtful sand plain. On the basis of its level the 25.8 m. shore-line is the Ancylus maximum and the 30 m. shore is Yoldia as at Koivisto.

According to I. Leiviskä (1934) the Littorina shore-line at Römpötti is 16.5 m. and south of Kukkola 17 m. above sea-level. These observations lead, as regards the Littorina maximum, to almost the same result as I obtained, so that in Leiviskä's case and mine it is the same shore-line. Leiviskä, however, did not make a stratigraphical investigation in order to establish the age of this beach nor did he put forward a more detailed opinion regarding the shifting of the shore-line during the Littorina period in this area.

KUOLEMAJÄRVI, KARJALAINEN.

According to my paper of 1932 L I is 22—22.5 m. above sea-level at Karjalainen and in the neighbouring area of Muurila, L II 14.7—14.9 m. above sea-level and the hypothetical L III approximately at the L I level. The Ancylus transgression maximum was

24—25 m. above sea-level. There are actually raised shores corresponding to these levels in this area, but only the dating of the 14.7—14.9 m. beach is correct. According to my present opinion the L I of that time should be the Ancylus transgression limit and the Ancylus (24—25 m. above sea-level) the Yoldia. The former erroneous dating was due to some doubtful signs of transgression that certainly belong to the Littorina period and are difficult to understand except as caused by the sea. I am now convinced, however, that these formations did not arise at any rate at any constant level of the sea. Evidently they are caused by very violent occasional storms.

The peat bogs that I investigated at Karjalainen are situated behind a large chain of shore bars and dunes. Already in the Littorina period these mighty accumulations severed the open connection of the bog basins with the sea, the influence of which was slight in the lagoons formed in this way.

A sequence of layers, however, discloses important details in the displacement of the shore-line. I refer to the profile that I took from the Ahvenjoki ravine which I published in my previous paper. I have now examined this succession of layers afresh in order to obtain more precise results than before regarding the changes of the shore in this area during the Littorina period.

THE AHVENJOKI CUTTING.

Ahvenjoki is a little stream flowing from the cultivated bog area on the west of the village of Karjalainen to the sea. The stream, which was subsequently deepened, flows across the system of shore bars and dunes that separates this bog area from the sea. In this cutting (investigation area No. 74) the succession of layers was exposed that is illustrated in Fig. 51, page 170. The more exact position on the map is shown in my paper of 1932.

At the bottom of the cutting there is coarse gravel, of which only the upper part could be examined owing to the underground water. Sample 409 is from this layer. It contains lacustrine diatom flora of small water (diatom table XIX, Ahvenjoki cutting), in which the genera *Eunotia* and *Pinnularia* predominate. Judging by this flora the site belonged to the shore zone of a small lake. The sea coast was situated at that time below the level of the layer (9.7 m. above sea-level). According to the pollen analysis this bed belongs to the transition zone from Ancylus to Littorina, either to the Ancylus regression or the very beginning of L I. In both cases the layer proves that the Ancylus regression limit is below the 9.7 m. level here.

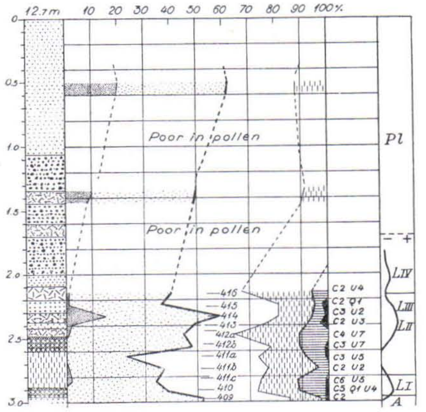

Fig. 51. Profile of the Ahvenjoki cutting. Analyst K. Salminen.

This is succeeded in the sequence by a stratum representing the L I transgression peak, sample 410. It consists of fine detritus ooze mixed with sand and contains typical Littorina diatoms that lived in shallow water. On the basis of its pollen content, too, this layer clearly belongs to the beginning of the Littorina period. L I is followed by a regression, to which a 30 cm. thick *Phragmites* peat layer bears witness, 2.6—2.88 m. The basal portion of this layer was laid down in shallow water close to the shore, as samples 411 c and 411 b contain diatoms. Sample 411 c also contains Littorina species, so that the sea shore was then at least at the level of the bed or in round figures 10 m. above sea-level. When sample 411 b was deposited the site was separated from the sea and sample 411 a already represents almost terrestrial conditions, when the average level of the sea was, perhaps, slightly below the 10 m. level.

The regression soon turns to a fresh transgression, the maximum of which falls within sample 413 on the basis of the diatoms. This transgressional maximum is L II and represents slightly deeper water than the L I culmination. Judging by the diatoms (see the diatom table), however, the height difference between both these culminations was not large. In any case it is certain that the marine influence is felt more strongly during L II than during L I and that L II is the peak of the Littorina transgression here, too.

The L II phase is succeeded in the sequence by L III, though it cannot be distinguished precisely from L II in this profile. Between these phases there does not appear to be any considerable regression, at any rate here. The L II—L III succession ends in a layer, sample 416, which, on the basis of its diatoms as well as of its lithology, proves very shallow water. This is followed in the sequence of strata by a sand bed that possibly indicates a fresh rise in the surface of the water. Above the sand layer there are shingle and pebbles between which there are two thin sand beds containing peat detritus.

Table XIX.

Anal. K. Salminen.	Ahvenjoki cutting										
	409	410	411a	411b	411c	412a	412b	413	414	415	416
Achnanthes brevipes v. intermedia	—	—	—	—	—	—	—	1	—	—	—
» *dispar*	—	—	—	—	—	—	—	1	—	—	—
Amphora arenicola v. major	—	—	—	—	—	—	—	—	—	—	1
» *commutata*	—	1	—	—	—	1	—	—	2	1	2
» *cruciata*	—	1	—	—	—	—	—	—	—	—	—
» *ovalis*	—	1	—	—	1	1	1	1	2	—	1
» » *v. libyca*	—	1	—	—	—	1	1	1	—	—	—
» » *v. pediculus*	—	1	—	—	1	—	1	—	—	—	—
Anomoeoneis sphaerophora	—	1	—	—	—	1	1	—	1	—	—
» » *v. polygramma*	—	1	—	—	—	1	1	—	1	—	—
» » *v. sculpta*	—	2	—	—	1	1	1	2	4	4	5
Caloneis amphisbaena	—	—	—	—	—	1	—	1	—	—	—
» *obtusa*	—	1	—	—	—	1	—	—	—	—	—
» *permagna*	—	—	—	—	—	—	—	1	—	—	—
» *Schumanniana v. bicontsricta*	—	1	—	—	—	—	1	—	—	—	—
» *silicula*	—	—	—	—	—	1	1	—	—	1	—
Campylodiscus clypeus	—	1	—	—	1	1	—	1	2	—	1
» » *v. bicostata*	—	1	—	—	—	1	—	—	1	—	—
» *echeneis*	—	—	—	—	1	—	1	1	—	—	—
Chaetoceros sp.	—	1	—	—	—	1	—	1	1	—	1
Cocconeis disculus	—	1	—	—	—	1	—	1	—	—	—
» *pediculus*	—	3	1	—	1	4	5	3	3	2	1
» *placentula*	—	1	—	—	—	—	—	1	—	—	1
» *scutellum*	—	—	—	—	—	—	—	—	—	2	—
Cymatopleura elliptica	—	1	—	—	1	1	1	1	1	1	—
» *solea*	—	—	—	—	—	—	—	—	1	—	—
Cymbella aspera	—	—	—	—	—	1	—	—	—	1	—
» *lanceolata*	—	1	—	—	—	1	1	—	1	—	—
» *spp.*	—	2	—	—	1	1	1	2	3	1	3
» *tumida*	—	1	—	—	—	—	—	1	—	—	—
Diploneis domblittensis	—	1	—	—	—	1	1	1	1	—	—
» *didyma*	—	—	—	—	—	—	—	1	—	—	—
» *incurvata*	—	2	—	—	1	1	1	1	1	—	—
» *interrupta*	—	1	—	—	—	—	1	1	1	1	1
» *Smithii*	—	1	—	—	—	2	1	2	2	1	1
» » *v. rhombica*	—	3	—	—	2	3	3	3	5	2	1
Epithemia argus	—	3	—	—	1	4	5	2	5	1	—
» *Hyndmanni*	—	—	—	—	—	—	1	1	—	—	—
» *intermedia*	—	1	—	—	—	—	—	—	—	—	—
» *Muelleri*	—	2	1	1	1	1	3	3	3	1	1
» *sorex*	—	5	—	—	1	5	3	2	2	—	—
» *turgida*	—	2	1	—	2	5	4	1	3	3	—
» » *v. granulata*	—	—	—	—	—	—	—	—	1	1	—
» » *v. Westermanni*	—	3	—	—	—	4	4	3	5	3	2
» *zebra*	—	2	—	—	1	3	1	5	5	1	—
» » *v. porcellus*	—	2	—	—	1	4	3	3	2	1	2
Eunotia spp.	4	1	1	—	—	1	1	1	—	1	4
Fragilaria spp.	—	—	—	—	—	—	—	—	—	—	1
Gomphonema acuminatum	—	—	—	—	—	1	—	—	—	—	—
» » *v. coronata*	—	—	—	—	—	1	—	—	—	—	1
» *augur v. Gautieri*	—	—	—	—	—	1	—	—	—	—	—
» *constrictum*	—	1	—	—	—	—	—	—	—	—	1
» *sp.*	—	1	—	—	—	1	—	—	—	—	—

	Ahvenjoki cutting										
	409	410	411a	411b	411c	412a	412b	413	414	415	416
Gyrosigma attenuatum	—	—	—	—	—	1	—	—	—	—	—
» *balticum*	—	—	—	—	—	—	—	—	1	—	—
Hantzschia sp.	—	—	—	—	—	—	—	1	—	1	1
Mastogloia Braunii	—	—	—	—	—	—	—	—	1	—	—
» *elliptica*	—	1	—	—	—	—	1	1	—	—	1
» » *v. dansei*	—	1	—	—	—	—	—	2	—	—	—
» *Smithii*	—	1	—	—	—	—	—	—	1	—	—
» » *v. amphicephala*	—	1	—	—	—	—	—	—	—	1	—
» » *v. lacustris*	—	4	—	—	—	2	1	2	1	1	—
Melosira arenaria	1	1	—	2	1	1	1	1	1	1	—
» *granulata*	—	—	—	—	—	1	—	—	—	—	—
» *islandica subspec. helvetica*	—	—	—	—	—	—	1	1	—	—	—
» *italica*	—	—	—	—	—	2	—	1	—	—	—
» » *v. valida*	—	—	—	—	—	—	—	—	—	—	2
» *Juergensi*	—	1	—	—	—	2	1	1	—	—	—
» *moniliformis*	—	1	—	—	—	1	—	1	1	1	—
» *spp.*	—	1	—	—	—	—	1	—	—	—	—
Navicula americana	—	—	—	—	—	—	—	—	—	—	1
» *crucicula*	—	—	—	—	—	—	—	1	—	—	—
» *cuspidata*	—	1	—	—	—	—	—	—	1	—	1
» *elegans*	—	1	—	—	—	—	—	2	2	1	1
» *humerosa*	—	1	—	—	1	1	1	1	2	—	—
» *libellus*	—	1	—	—	—	1	—	1	1	1	1
» *peregrina*	—	1	—	—	1	2	—	4	2	2	3
» *placentula*	—	—	—	—	—	—	1	1	—	—	—
» *platystoma*	—	1	—	—	—	—	1	1	—	—	—
» *pupula v. rectangularis*	—	—	—	—	—	—	—	1	—	—	—
» *pusilla*	—	—	—	—	—	—	—	—	—	1	1
» *pygmaea*	—	1	—	—	—	—	—	—	—	—	—
» *rhynchocephala*	—	1	—	—	—	—	1	2	—	—	—
» *tuscula*	—	2	—	—	1	1	1	2	1	—	—
Nitzschia obtusa	—	—	—	—	—	—	—	1	—	—	—
» *scalaris*	—	4	—	1	1	4	3	3	5	5	5
» *tryblionella*	—	—	—	—	—	—	—	1	—	—	—
Pinnularia spp.	5	1	—	1	1	2	3	4	5	2	3
Rhoicosphenia curvata	—	1	—	—	—	—	—	1	—	—	—
Rhopalodia gibba	—	1	—	—	1	2	2	2	2	—	—
» *musculus*	—	1	—	—	—	—	1	1	—	1	—
Stauroneis phoenicenteron	1	1	—	—	—	—	—	1	1	1	—
Surirella ovalis	—	1	—	—	—	1	—	1	—	—	—
» *ovata*	—	—	—	—	—	—	—	1	1	—	—
» » *v. crumena*	—	—	—	—	—	—	—	—	1	—	—
» *peisonius*	—	—	—	—	—	1	—	1	1	1	—
» *striatula*	—	—	—	—	—	—	—	1	1	1	—
Synedra affinis	—	—	—	—	—	—	—	1	—	—	—
» *pulchella*	—	1	—	—	—	1	—	1	—	1	—
» *sp.*	—	1	—	—	—	2	—	—	—	1	—
Tabellaria spp.	—	1	—	—	—	1	—	1	—	1	1
Tropidoneis sp.	—	—	—	—	—	1	—	1	1	1	—

These layers prove that at that time the shore-line lay approximately at the level of this part of the profile or about 11—12.7 m. above sea-level. I also have raised beaches in this area that are 11 m. and 12.3—12.7 m. above sea-level. On the basis of their level these shores might very well represent the L IV phase, but I do not possess sufficient stratigraphical material in support of this view.

The profile of Ahvenjoki leads to exactly the same result in regard to the displacement of the shore-line during the Littorina period as the profile of the Koivisto railway cutting. The Ahvenjoki profile proves quite conclusively that there was a regression here between L I and L II that lasted for a comparatively long time. The lower limit of this regression preceding L II is, perhaps, slightly below the 10 m. level.

Besides the foregoing I determined some new raised shores belonging to L II here that are 14.3 m. and 14.4 m. above sea-level. According to these and to my former measurements the average upper limit of L II is 14.5 m. above sea-level at Karjalainen. During L II, therefore, a transgression of at least 4.5—5 m. occurred here. It is difficult to estimate the minimum extent of the transgression during L I, as the upper limit of L I cannot be established precisely here.

INO.

In my former paper (1932) Ino was a crucial area, as it was clearer there than anywhere else that the Littorina Sea encroached upon the land on the Karelian Isthmus, for a whole bog was submerged during the Littorina transgression. In this transgression I distinguished three culminations, the last of which (the L III of that time) was higher than the others. I came to this conclusion on the basis of a deposit, in which there are sand beds above the peat up to 18 m. above sea-level. These accumulations are certainly of the Littorina period, but it is difficult to explain their origin quite satisfactorily. Probably they are best explained as having been piled up during severe storms from sand carried partly by the breakers, partly by the wind. The similar accumulations at Karjalainen are contemporaneous with the former, so that in both areas these deceptive »shore marks» are to be accounted for by common causes.

I measured the maximum limit of the Littorina Sea at Ino earlier on the basis of these features and obtained far too high a level. It was also misleading that there are true beaches at Ino at the level of these apparent transgressional formations. These ancient shores however, belong to the Ancylus and Yoldia according to my present opinion. The Littorina maximum is much lower at Ino, as can already be inferred on the basis of the previous investigation areas.

I have many elevated shore-lines, too, at lower levels. They are rather doubtful, however, and are situated at different levels, so that

Photo E. Hyyppä.

Fig. 52. Shore cliff of the Littorina Sea at Elinälä, W. of Ino. The formation of the cliff began already at the late-Glacial water-levels; its cutting was accomplished by the Littorina Sea. The foot of the cliff is now on an average 10 m. above sea-level at the L IV level.

Photo E. Hyyppä.

Fig. 53. Wave-cut cliff of a late-Glacial raised shore-line Lg IX at Ino, 17—19 m. above sea-level.

it is difficult to conclude on the basis of the morphological data, which of them possibly represents the maximum of the Littorina transgression. The following of these shore marks may be mentioned: 10—11 m., 12.5 m., 13—13.5 m. and 15—16.5 m. above sea-level. Above these lie the large wave-cut cliffs already referred to, the foot of which is on an average 17—19 m. above sea-level (see Fig. 53). These beaches are situated partly in front of the Ino fortifications and partly on the coastal slope east of it. With regard to a more detailed description of the shores I merely refer to my previous study (E. Hyyppä 1932).

These same shores appear in the levelling profiles published by I. Leiviskä (1934) and he considers the 12.6 m. level to be the Littorina Sea limit. He did not produce any stratigraphical evidence in support of this dating. Neither can I establish by means of the stratigraphy of the peat bogs at Ino, which of these shores is the maximum limit of the Littorina Sea. According to the results obtained in the previous area (Karjalainen) it might, indeed, be taken to be about 12—13 m. above the sea here. There are several raised shores at Ino within this vertical range, so that these evidently represent the maximum limit of the Littorina Sea broadly considered. In the neighbouring area of Vammelsuu I am able to base my identification of the maximum limit of the Littorina Sea also on the stratigraphy of the deposits. The result obtained at Vammelsuu is also applicable to Ino, as these places are on the same isobase. Before dealing with Vammelsuu, we will examine the stratigraphy of the Ino bog which throws some light upon the succession of the changes in the shore-line in this area.

Ino Bog.

Fig. 54, page 176, illustrates the profile bored of the Ino bog (investigation area No. 75). With regard to the detailed structure of the bog I refer to my former paper. I took the present profile later (1935) and by means of it I am able to obtain a more correct idea than before of the displacement of the shore in this area.

The bottom strata of the bog are very watery slimy clay of which no samples could be obtained. Nevertheless, they certainly belong to the late-Glacial period. From sample 288 upwards the sediment (clay ooze) may possibly already be an Ancylus Lake deposit. The next subjacent portion of the clay ooze is placed in Yoldia. I cannot, however, consider this dating absolutely certain, as the only signs of marine influence in the investigated samples are *Campylodiscus* *echeneis*, *Coscinodiscus* sp. and *Grammatophora oceanica* (diatom table XX, Ino bog) which occur very sparsely. In my paper of 1932 I mentioned that, among others, *Campylodiscus clypeus* and *Nitzschia circumsuta*, which are characteristic Littorina Sea species, occurred in this »Yoldia deposit». Now I found no trace of these species in this part of the profile, so that it is certain that these species were introduced into my earlier samples by the borer from the higher Littorina Sea deposits.

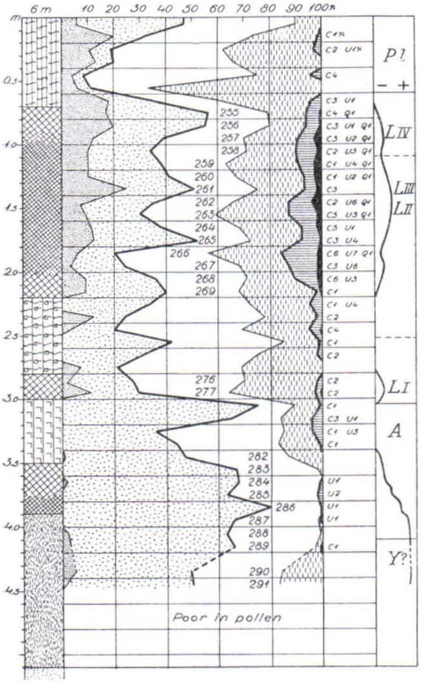

Fig. 54. Profile of the Ino bog. Analyst M. Salmi.

The Ancylus deposit of the profile contains the same type of flora in its lower part (samples 288, 287) as the »Yoldia» clay ooze below it. The only difference is that there are no marine species at all in samples 288 and 287. This, however, does not signify an essential difference, if the scarcity of marine species in the »Yoldia» horizon is borne in mind. The boundary between the Ancylus and late-Glacial periods is not clear in the profile. It is possible that the clay ooze belongs entirely to the late-Glacial period. It seems certain on the other hand that samples 286—282 are Ancylus Lake deposits, seeing that they contain typical Ancylus diatoms, as the diatom table shows. The Ancylus transgression maximum extended here considerably above the present level of the sea and, to judge by the diatoms, also higher than the Littorina maximum.

The Ancylus transgression is succeeded by the Ancylus regression, as is shown convincingly by the succession of strata in the bog: 1) fine detritus ooze, 2) coarse detritus ooze, and 3) terrestrial peat. Previously I had obtained the figure of 2 m. above sea-level as an approximate estimate of the Ancylus regression and I see no reason for altering it at present.

The terrestrial peat is followed by the L I peak of the Littorina transgression, represented by the coarse detritus ooze, 2.8—3.0 m. This deposit contains typical Littorina Sea diatoms (samples 277,

276) which prove that the water was shallow. The quality of the sediment proves the same, for it contains a lot of peat detritus and much humus. The transgression maximum during the L I period falls within the horizon of sample 277. The diatoms of the next sample (276) prove that the shore had again begun to retreat. The retreat continues and another layer of terrestrial peat is formed on the site. At that time the shore-line was at the most 3.2 m. above the sea, to judge by the contact between the ooze and the peat. This contact surface was, of course, formerly slightly higher, as the strata have become compressed in the course of time. It is probable, nevertheless, that the lowest limit of this regression is not above the 4 m. level.

According to the pollen diagram L I and the succeeding regression should be placed at the beginning of the Littorina period. The fresh transgression of L II that succeeded the regression and is visible in the succession of strata from sample 269 onwards, should also be referred to the first half of the Littorina period. In my former paper I placed the beginning of the Littorina period at this point of the profile which was due to no diatom analysis having been made of the coarse detritus ooze of L I, so that the marine character of this bed was not recognised. This layer, indeed, appears in my profiles made at that time. It cannot be established with equal clarity throughout the whole bog.

The L II transgression culmination reached a higher level at Ino, too, than L I. This is proved both by the quality of the deposit and its diatom flora. At the beginning of the L II transgression the deposit is coarse detritus ooze, but passes over into highly characteristic fine detritus ooze from sample 267 upwards. At the point of this sample there is a slight transgression culmination, as is seen by the curve for the change of the shore-level in the diagram. The transgression maximum, however, only occurs higher, in the part of the profile bounded by samples 264—261. When the upper part of the Littorina sediment was deposited, sample 257, it seems, judging by the diatoms, that a slight transgression occurred again before the sea finally receded from this place.

The upper portion of the Littorina Sea sequence of the Ino bog (samples 269—255) would thus contain three transgression peaks according to the evidence of the diatoms. I distinguished these already in my paper in 1932. The possible regressions between these culminations can, however, only be established very vaguely in the development of the diatoms. For this reason it is unwarranted to draw any very detailed conclusions regarding the displacement of

Table XX.

Anal. K. Salminen.	Ino Bog						
	255	256	257	258	259	260	261
Achnanthes brevipes v. intermedia	—	—	—	—	—	—	—
Actinocyclus Ehrenbergii v. crassa	—	1	1	—	—	—	—
» » *v. tenella*	—	—	—	1	—	—	—
Amphora arenicola v. major	1	—	1	1	1	2	1
» *commutata*	1	2	3	3	3	1	1
» *ovalis*	—	—	—	1	—	1	1
» » *v. libyca*	—	—	—	—	—	1	1
Anomoeoneis sphaerophora	—	—	—	—	—	—	—
» » *v. polygramma*	—	—	—	—	—	—	—
» » *v. sculpta*	3	2	2	1	1	1	—
Caloneis amphisbaena	1	3	1	1	1	—	—
» *formosa v. holmiensis*	—	—	—	—	—	—	—
» *silicula*	—	—	—	—	—	—	—
Campylodiscus echeneis	1	1	1	1	2	2	3
» *clypeus*	5	4	4	3	5	3	2
» » *v. bicostata*	—	1	—	—	1	1	2
» *noricus v. hibernica*	—	—	—	—	—	—	—
Chaetoceros sp.	—	1	—	1	1	1	1
Cocconeis pediculus	—	1	1	1	—	1	1
» *placentula*	—	1	1	1	—	—	—
» *scutellum*	1	1	1	1	1	1	1
Coscinodiscus lacustris v. septentrionalis	1	—	—	—	—	1	—
» *sp.*	1	1	1	—	—	—	1
Cyclotella Kützingiana	—	—	—	—	—	—	—
Cymatopleura elliptica	—	—	—	—	—	—	—
» » *v. hibernica*	—	—	—	—	—	—	—
» » *v. nobilis*	—	—	—	—	—	—	—
» *solea*	—	—	—	—	—	—	—
Cymbella aspera	—	—	—	—	—	—	—
» *cuspidata*	—	—	—	—	—	—	—
» *Ehrenbergii*	—	—	—	—	—	—	—
» *lanceolata*	—	—	—	—	—	—	—
» *prostrata*	—	—	—	—	—	—	—
» *spp.*	—	—	—	—	—	—	—
» *tumida*	—	—	—	—	—	—	—
Diploneis didyma	1	1	1	1	1	1	—
» *domblittensis*	—	—	—	—	—	—	—
» » *v. subconstricta*	—	—	—	—	—	—	—
» *elliptica*	1	—	—	—	—	—	—
» *incurvata*	1	—	—	1	1	1	—
» *interrupta*	—	—	1	1	—	1	1
» *ovalis*	—	—	—	—	—	—	—
» » *v. oblongella*	—	—	—	—	—	—	—
» *Smithii*	—	—	—	—	—	—	1
Epithemia argus	—	—	—	1	—	—	—
» *Hyndmanni*	—	—	—	—	—	—	—
» *intermedia*	—	—	—	—	—	—	—
» *Muelleri*	—	—	—	—	—	—	—
» *sorex*	1	—	1	1	—	—	—
» *turgida*	1	1	—	—	1	—	3
» » *v. Westermanni*	—	1	1	1	1	1	1
» *zebra*	—	—	—	—	—	—	—
» » *v. porcellus*	2	1	3	3	1	1	1
Eunotia spp.	—	1	1	1	—	1	1

Ino Bog																			
262	263	264	265	266	267	268	269	276	277	282	283	284	285	286	287	288	289	290	291
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	—	1	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—
—	2	2	1	1	2	1	1	1	1	—	—	—	—	—	—	—	—	—	—
1	—	—	1	—	1	—	—	—	—	—	1	1	1	1	—	1	1	—	—
—	1	1	1	—	1	—	—	—	—	1	2	1	—	—	—	—	—	1	—
—	—	1	—	1	1	1	1	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	1	2	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	1	1	—	2	1	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
2	2	3	3	1	2	1	2	2	2	—	—	—	—	—	—	—	—	—	1
1	3	3	4	5	5	5	5	4	4	1	—	—	—	—	—	—	—	—	—
1	1	1	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	—	—	—	—	—
1	—	2	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	—	1	1	—	1	—	—	—	—	—	1	1	—	—	—	—	—
—	—	—	—	1	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—
1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	1	—	1	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	1	1	—	1	—	1	—	1	—
—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	2	1	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
1	1	—	1	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	1	1	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—
1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
1	1	1	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	1	5	1	5	5	1	1	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	1	2	1	1	—	—	—	—	1	—	1	—	—	—	—	—	—
—	1	1	2	2	1	2	1	1	1	1	2	2	4	3	1	1	—	1	—
1	2	2	2	1	3	3	2	1	1	—	1	2	4	2	—	1	—	—	—
—	—	—	—	—	—	1	2	1	—	1	2	2	3	4	2	—	1	—	—
—	1	1	3	3	5	4	2	1	1	2	5	—	1	1	—	—	—	1	1
—	1	—	—	—	1	—	1	—	—	2	2	1	1	—	—	—	—	1	1

	Ino Bog						
	255	256	257	258	259	260	261
Fragilaria spp.	—	—	—	—	—	—	1
Frustulia sp.	—	—	—	—	1	—	—
Gomphonema acuminatum	—	—	—	—	—	—	—
» » *v. coronata*	—	—	—	—	—	—	—
» *augur v. Gautieri*	—	—	—	—	—	—	—
» *constrictum*	—	—	—	1	—	—	—
» *spp.*	—	—	—	—	—	—	—
Grammatophora oceanica	1	1	1	1	—	—	—
Gyrosigma acuminatum	—	—	—	—	—	—	—
» *attenuatum*	—	—	—	—	—	—	—
» *balticum*	—	—	—	—	1	1	1
Mastogloia elliptica	—	—	1	1	1	—	—
» » *v. dansei*	—	—	—	—	—	—	—
» *pumila*	—	—	—	—	—	—	—
» *Smithii*	—	—	—	1	—	—	—
» » *v. amphicephala*	—	—	—	—	—	—	—
» » *v. lacustris*	—	—	—	—	—	—	—
Melosira ambigua	—	—	—	—	—	—	—
» *arenaria*	—	—	—	—	1	—	—
» *granulata*	1	—	—	—	—	—	—
» *islandica subspec. helvetica*	—	1	—	—	—	1	—
» *Juergensi*	—	5	5	5	1	—	1
» *moniliformis*	1	—	—	—	—	5	5
» *Westii f. parva*	—	—	—	—	1	5	5
Navicula amphibola	—	—	—	—	—	—	—
» *cuspidata*	—	—	—	—	—	—	—
» *crucicula obtusata*	—	—	1	1	—	—	—
» *digitoradiata*	—	—	—	—	—	—	1
» *elegans*	1	1	1	—	1	—	—
» *hungarica*	—	1	—	—	—	—	—
» *humerosa*	—	—	—	—	—	1	—
» *Jentzschii*	—	—	—	—	—	—	—
» *libellus*	1	2	5	2	2	2	2
» *peregrina*	4	5	5	4	4	5	2
» *placentula*	—	—	—	—	—	—	—
» *punctulata v. cluthensis*	—	—	—	—	—	—	1
» *pusilla*	1	1	1	1	—	1	—
» *rhynchocephala*	—	—	—	—	—	—	—
» *scutelloides*	—	—	—	—	—	—	—
Neidium spp.	—	—	—	—	—	—	—
Nitzschia circumsuta	1	1	1	—	—	1	1
» *punctata*	—	—	—	—	1	—	1
» *scalaris*	2	2	1	1	1	—	1
» *sigma*	—	1	1	1	1	1	—
» *tryblionella*	3	2	2	—	2	1	1
» » *v. litoralis*	3	1	2	1	1	1	—
» » *v. victoriae*	—	—	1	1	1	1	1
Opephora Martyi	—	—	—	—	—	—	—
Pinnularia spp.	—	—	—	1	1	—	—
Rhoicosphenia curvata	—	—	1	—	—	—	—
Rhopalodia gibba	—	—	—	—	—	1	—
» » *v. ventricosa*	—	1	1	1	1	1	1
» *musculus*	1	1	2	5	4	1	—

Ino Bog																			
262	263	264	265	266	267	268	269	276	277	282	283	284	285	286	287	288	289	290	291
—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—
—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	1	1	—
—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	1	1	3	2	1	2	3	2	—	1
1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	1	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	3	1	5	1	1	1	—	1	1	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	1	—	1	—	—	—	—	—	1	4	4	3	4	5	3	2	1
1	2	2	1	1	—	2	2	1	1	—	—	—	—	—	—	—	—	—	—
5	5	5	5	2	3	2	4	—	—	—	—	—	—	—	—	—	—	—	—
5	5	5	5	—	—	4	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	1	—	2	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
1	1	1	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
2	4	2	3	1	5	2	2	1	2	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	2	1	3	—	—	—	—	—	—	—	—	—	—
1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	1	1	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—
1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	3	1	1	3	2	5	5	3	2	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	1	1	—	1	1	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—
1	2	1	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	1	—	1	—	1	1	3	1	2	4	3	1	1	1	—	—	—	1	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
—	1	—	1	—	1	—	—	—	1	—	1	—	—	—	—	—	—	—	—
—	1	1	2	1	2	1	1	1	1	—	—	—	—	—	—	—	—	—	1

	Ino Bog						
	255	256	257	258	259	260	261
Stauroneis acuta	—	—	—	—	—	—	—
» *alabamae v. angulata*	—	—	—	—	—	—	—
» *phoenicenteron*	—	1	—	—	1	—	—
Stephanodiscus astraea	—	—	—	—	—	—	—
Surirella Capronii	—	—	—	—	—	—	—
» *ovalis*	—	—	—	—	—	—	—
» *elegans*	1	—	—	—	—	—	—
» *ovata*	1	—	—	—	—	—	—
» *striatula*	1	2	1	1	1	2	2
Synedra affinis	—	1	3	1	1	1	2
» *pulchella*	1	1	2	1	1	—	1
» *sp.*	—	—	—	—	—	—	—
Tabellaria spp.	—	1	—	—	—	—	—
Thalassiosira baltica	—	—	1	—	—	—	1
Tropidoneis sp.	—	—	1	—	1	—	1

the shore-line on the basis of the diatoms. So much is certain, however, that the part of the sequence of strata bounded by samples 264—261 represents the absolute maximum of the Littorina transgression here. I am also convinced that this maximum falls within the L II period. It is possible, too, that L III is vertically so close to L II here that it is situated in the later part of the transgression zone referred to. L IV, again, I have placed at the end of the Littorina period as in the other profiles. The small transgression culmination should be referred to the same point according to the evidence of the diatoms, as already stated. This may signify a slight shifting of the shore-line landwards during the L IV period.

VAMMELSUU.

Here I identified several beaches. Quite close to the sea (investigation area No. 76) there is the foot of a small wave-cut cliff 4.7 m. above the sea. Some distance inland from this there is a shore bar, the foot of which is 10 m. and the top 11 m. above sea-level. About 500 m. from the coast there is another well-defined shore bar, the foot of which is 11 m. and the top 12.3 m. above the sea. Behind this ridge lies a bog, from the stratigraphy of which it was obvious that the bar represents the maximum limit of the Littorina transgression (L II).

Ino Bog																			
262	263	264	265	266	267	268	269	276	277	282	283	284	285	286	287	288	289	290	291
—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—
1	—	—	—	—	1	—	—	—	—	5	2	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	—	—	1	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	3	2	2	5	1	3	1	2	1	—	—	—	—	—	—	—	—	—
1	1	—	1	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—
—	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	1	—
—	1	1	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The 10.5 Metre Bog.

The bog is a small *Sphagnum-Pinus* »Highmoor», the stratigraphy of which is illustrated in Fig. 55, page 184. At the bottom of the peat there is a shallow-water deposit, samples 476—468, which was laid down in the Littorina Sea according to the evidence of the diatoms (diatom table XXI, Vammelsuu 468—476). The transgression maximum falls within the part of the profile represented by samples 476 and 475. At that time, too, the water was shallow and the influence of the sea was felt feebly in the basin of the bog, as the association of the diatoms proves. It is certain that the Littorina Sea did not extend above the level of the bar on the edge of the bog and that this shore bar represents the local Littorina Sea maximum. According to the pollen analysis the transgression peak is best placed in the L II period. According to the pollen diagram the basin of the bog was isolated from the Littorina Sea approximately about the middle of this period or during L III. Although this dating is not exact, it seems certain that the L III reached above the pass-sill of the bog basin or about the 10—11 m. level. L IV on the other hand is below this level, as during the final part of the Littorina period the growth of terrestrial peat had already got well under way on this bog. The shore-line, however, was situated in the vicinity of the bog during the L IV period, as the simultaneous *Alnus* maximum in the pollen diagram proves. The stratigraphy of the bog further leads to the view that L I did not reach above the pass-sill of the basin of the bog or above the 10—11 m. level.

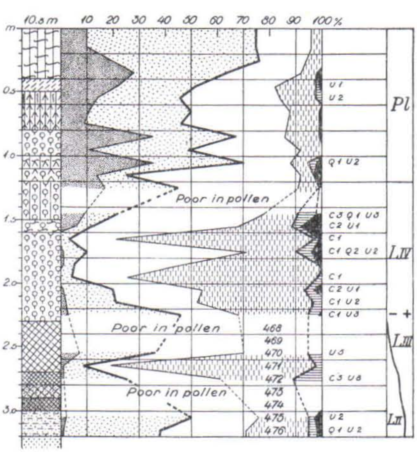

Fig. 55.

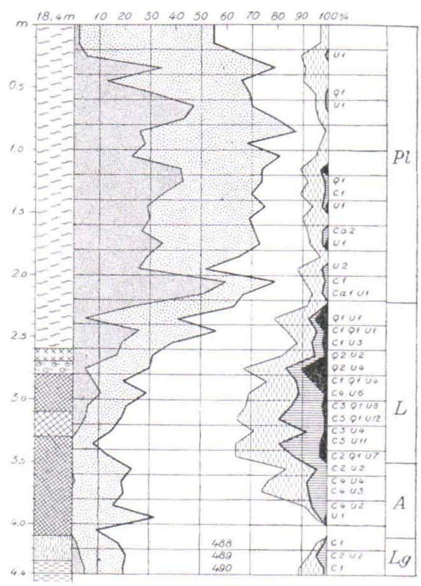

Fig. 56.

Fig. 55. Profile of the 10.5 metre bog. Analyst H. Lavanni.

Fig. 56. Profile of the 18,4 metre bog. Analyst K. Salminen.

The 18.4 Metre Bog.

The bog lies immediately to the N. of the railway about 500 m. S.W. of Vammeljoki River. It is a small »Highmoor» occupying a narrow depression. Fig. 56, above, illustrates its stratigraphy. At the bottom of the peat there is a late-Glacial deposit containing very sparsely *Campylodiscus echeneis* (mere fragments), *Coscinodiscus* sp. and *Grammatophora oceanica* (diatom table XXI, Vammeljoki 488—490). The pollen flora of the sediment is also of a late-Glacial type. It is impossible to decide with certainty on the basis of the stratigraphical data whether this sediment belongs to the period of the Baltic Ice Lake or of the Yoldia Sea. The sparse occurrence of brackish-water diatoms does not justify us in referring the sediment with any certainty to the Yoldia.

Instead it seems certain that the bog basin was already isolated during the Ancylus transgression. The fine detritus ooze that represents the Ancylus period in this profile, and partly too the Littorina, is deposited in a local small lake. In the fine detritus ooze there are very few diatoms and these are characteristic species of a small water body. The pass-sill of the bog basin is about 18 m. above the sea. The Ancylus transgression maximum is below this level here.

Table XXI.

Anal. K. Salminen.	Vammelsuu											
	468	469	470	471	472	473	474	475	476	488	489	490
Anomoeoneis sphaerophora	—	—	—	—	—	—	—	—	1	—	—	—
Amphora commutata	—	—	—	—	—	—	—	—	2	—	—	—
» *ovalis v. libyca*	—	—	—	1	—	1	1	—	—	—	—	—
Caloneis silicula	—	—	—	—	—	—	—	—	1	—	—	—
Campylodiscus echeneis	—	—	—	—	—	—	—	—	—	—	fr.	—
Cocconeis diminuta	—	—	—	—	—	—	—	—	1	—	—	—
» *pediculus*	—	—	—	—	—	—	—	1	1	—	—	—
» *placentula*	—	—	—	—	—	—	—	1	1	—	—	—
» *scutellum*	—	—	—	—	—	—	—	—	1	—	—	—
Coscinodiscus sp.	—	—	—	1	—	—	—	1	—	—	1	—
Cyclotella comta	—	—	—	—	—	—	—	—	1	—	—	—
» *Meneghiniana*	—	—	—	—	—	1	—	—	—	—	—	—
Cymbella aspera	—	—	—	1	—	1	—	1	—	—	—	—
» *spp.*	—	—	—	—	1	1	—	1	1	—	3	1
» *tumida*	—	—	—	—	—	—	—	—	1	—	—	—
Diploneis didyma	—	—	—	—	—	—	—	—	1	—	—	—
» *incurvata*	—	—	—	—	—	—	1	1	1	—	—	—
» *ovalis v. oblongella*	—	—	—	—	—	—	—	—	1	—	—	—
» *Smithii*	—	—	—	—	—	—	—	1	—	—	—	—
Epithemia sorex	—	—	—	—	—	—	—	—	1	—	—	—
» *turgida*	—	—	—	1	—	—	—	—	1	—	—	—
» » *v. Westermanni*	—	—	1	—	—	—	—	—	—	—	—	—
» *zebra*	—	1	1	1	—	5	—	—	—	—	—	1
» » *v. porcellus*	—	—	1	4	1	2	4	2	1	—	—	—
Eunotia spp.	1	1	4	3	1	3	1	2	1	—	1	—
Frustulia spp.	—	—	—	—	—	—	—	—	—	—	1	—
Gomphonema acuminatum	—	—	1	—	—	1	—	1	1	—	—	—
» » *v. coronata*	—	—	—	—	—	—	—	1	1	—	—	—
» *augur v. Gautieri*	—	—	—	1	—	—	—	—	—	—	—	—
» *constrictum*	—	—	—	—	—	1	—	1	—	—	—	—
» *spp.*	—	—	—	—	1	—	—	1	1	—	—	—
Grammatophora oceanica	—	—	—	—	—	—	—	—	—	1	1	1
Hantzschia spp.	—	—	—	—	—	—	—	1	1	—	1	—
Mastogloia exigua	—	—	—	—	—	—	—	—	1	—	—	—
» *Smithii*	—	—	—	—	—	1	—	—	—	—	—	—
» » *v. lacustris*	—	—	—	—	—	—	—	1	1	—	—	—
Melosira distans	—	—	—	—	—	—	—	—	—	—	1	—
» *islandica*	—	—	—	—	—	—	—	—	1	—	—	—
» *italica*	1	1	1	1	1	—	—	1	—	—	—	—
» *sp.*	—	—	—	—	—	—	—	—	—	1	—	—
Meridion circulare v. constricta	—	—	—	—	—	—	—	1	1	—	—	—
Navicula americana	—	—	1	1	5	1	2	—	—	—	—	—
» *amphibola*	—	—	—	—	—	—	—	1	—	—	—	—
» *cuspidata*	—	—	—	—	—	—	—	—	1	—	—	—
» *dicephala*	—	—	—	—	1	—	—	—	1	—	—	—
» *elegans*	—	—	—	—	—	—	1	—	1	—	—	—
» *hungarica v. capitata*	—	—	—	—	—	—	—	—	1	—	—	—
» *peregrina*	—	—	—	—	—	—	2	2	3	—	—	—
» *pupula*	—	—	—	—	—	—	—	1	—	—	—	—

	Vammelsuu											
	468	469	470	471	472	473	474	475	476	488	489	490
Navicula pupula v. rectangularis	—	—	—	—	3	1	—	1	—	—	—	—
» *pusilla*	—	—	—	—	1	—	1	—	1	—	—	—
» *radiosa*	—	—	—	—	1	1	—	1	—	—	—	—
Neidium spp.	—	—	—	—	1	—	—	—	—	—	—	—
Nitzschia scalaris	3	3	5	5	3	5	5	1	3	—	—	—
Opephora Martyi	—	—	—	—	—	—	—	1	—	—	—	—
Pinnularia spp.	1	1	2	4	4	5	5	1	3	1	2	—
Rhopalodia gibba	—	—	—	—	—	1	1	1	—	—	—	—
» » *v. ventricosa*	—	—	—	—	—	—	—	1	1	—	—	—
Stauroneis anceps	—	—	—	—	—	—	—	—	—	—	1	—
» *phoenicenteron*	—	—	—	1	—	1	—	—	1	—	1	—
Surirella ovata	—	—	—	—	—	—	—	—	1	—	—	—
Synedra affinis	—	—	—	—	—	—	—	—	1	—	—	—
» *pulchella*	—	—	—	—	—	—	—	—	1	—	—	—
» *spp.*	—	—	—	—	—	—	1	—	1	—	—	—
Tabellaria spp.	1	1	1	1	2	1	1	5	1	—	—	—
Tetracyclus lacustris	—	—	—	—	—	—	—	—	—	—	1	—

In the neighbourhood of this bog I levelled an abrasion cliff, the foot of which is 20.5 m. above sea-level. A flat-topped plain extends S. of the railway, which is 29—32.4 m. above the level of the sea. These beaches belong to the late-Glacial period. I am unable to determine their age with great eraccuracy by means of the stratigraphy of the bogs.

Vammelsuu and Ino are only 10 km. distant from each other and are, besides, on the same isobase. The general direction of the isobases is already known here, too, in broad features on the basis of previous investigations. The Littorina limit of Vammelsuu, 12.3 m. above the sea, should therefore also apply to Ino.

In this connection some raised shores that I identified at Terijoki should also be mentioned. In the village of Terijoki I levelled a slight abrasion notch at 6 m. above sea-level. Below the Russian church there is a distinct wave-cut cliff, the foot of which is 10.5 m. above the sea. In the W. part of the village there is a wave-cut cliff N. of the coast road, the foot of which is 15 m. above the sea. I made these measurements in the winter, so that they are not quite exact. I have no stratigraphical evidence for fixing the age of these shores. The 10.5 m. shore belongs to the Littorina period on the basis of its level and can scarcely be much below the Littorina maximum.

At Ollila, close to the Russian frontier, I established the maximum limit of the Littorina Sea at 12.7 m. above sea-level in my paper in 1932. I have now again examined my samples taken from this locality, the study of the diatoms of which was incomplete at that time owing to the force of circumstances. On the basis of the evidence of the diatoms the Littorina limit is not at the 12.7 m. level here, but slightly lower. I have also an ancient beach here that is 11.4 m. above the sea and one that is 9 m. above sea-level. On the other side of the frontier (at Sestrorjetsk) the Littorina maximum, according to Russian scientists is 10 m. above sea-level (K. K. Markov and W. S. Poretzky 1934, 1935). The 11.4 m. shore-line may be the Littorina maximum limit at Ollila, although even its level is, perhaps, too high. This shore was established on the edge of a bog, where the exact height of the foot of the cliff cannot be measured. If the 10 m. Littorina limit of the Russians at Sestrorjetsk is correct, it should also hold good as regards Ollila. On the basis of the stratigraphy of the Kiiselisuo bog (E. Hyyppä 1932) the Littorina transgression peak at Ollila, too, falls within the L II period.

GENERAL CONCLUSIONS.

THE RELATION DIAGRAM.

I have dealt above with the changes of the shore-line in South Finland within separate areas. By means of the raised shores and the stratigraphy of the sediments the levels representing the post-Glacial phases of the Baltic and the course of the displacement of the shore-line have been established in each area. Having done so, the results obtained are to be combined, so as to give a general idea about the whole succession of events relating to the post-Glacial shifts of the shore in South Finland. This is best done by means of the so-called relation diagram, as at the same time it affords an opportunity of fixing the date of the ancient beaches, for the dating of which I do not possess adequate stratigraphical data.

Appendix II shows the relation diagram that I have drawn up on the basis of the investigations dealt with in the present paper. I have included a good deal of the materials of other scientists, too, in the diagram in order to compare my own results with the sequence of events established within other parts of the Baltic region. I will revert to this comparison later.

In drawing the diagram I have employed as a guide level (index-level, level of reference) the maximum limit of the Littorina transgression which is the LI shore-level in Uusimaa and the LII shore on the Finnish side of the Karelian Isthmus. I have been able to determine the height of these shore-levels in the different areas with the necessary precision both stratigraphically and by means of the ancient shores. The same refers to their point of intersection at Säkkijärvi at 19—20 m. above the sea (page 133).

It should be noted, however, that the LII shore-level divides into two, the earlier, L IIa, corresponding to the older style of the early comb-ceramic culture, I : 1, and the later, LIIb, to the later style of the same culture, I : 2 (see page 131). The LIIa shore-level runs through the Säkkijärvi point of intersection (19—20 m. above sea-level). In Uusimaa it can be supported by the levels of the coastal dwelling places corresponding to the early comb-ceramic I : 1 culture and by the measured raised shore-levels, if LI is used as a guide level. The position of the L IIa surface in the diagram in relation to LI will thus be established, so that the former can in turn be used as a guide-level in that region, where it forms the maximum limit of the Littorina transgression.

The L IIb shore-level can be drawn in the diagram in its correct position in the same manner. This is accompanied with the later stage of the early comb-ceramic culture, I : 2, of Uusimaa, there being raised beaches representing it in Uusimaa, too (*e. g.*, in the Helsinki area at 24.5 m. above sea-level). The L IIa and L IIb surfaces intersect each other at 15 m. above the sea, from which level L IIb becomes the guide level for the periphery of the land upheaval and retains this position as far as the Russian side of the Karelian Isthmus. L IIa and L IIb intersect each other at a very acute angle, so that these shore-levels almost coincide on the Isthmus.

When the shore-levels that represent the Littorina transgression maximum (in my investigated area) have been placed in the correct altitude to each other in the diagram, it is easy to place the other shore observations in their proper places. The broken line representing the maximum limit of the Littorina transgression is now the index level of the diagram for the whole area. The altitude of the Littorina maximum of each investigation area being known, it is placed at the point corresponding to this height on the guide level. The other raised shores of the area are then placed along the vertical line passing through this point at places corresponding to their elevation.

If the construction of my relation diagram as described above is correct, the shore marks placed in the diagram must be arranged in such a way that straight lines, *i.e.* shore-levels, can be drawn through the observation points that belong to synchronous stages. This presumes, of course, that the land upheaval occurred proportionately throughout the whole region.

The shores that I have placed in the relation diagram do in reality group themselves in such a way that straight lines representing the shore-levels can be drawn through them. In this case, too, the shores that are synchronous on the basis of the stratigraphy of the sediments and of the archaeological finds, occupy positions at the same shore-level.

THE SHORE-LEVELS.

LITTORINA AND POST-LITTORINA SEA SHORE-LEVELS.

In examining the shore-levels it is best to start downwards and upwards from the guide level. I will deal first with the Littorina Sea and post-Littorina surfaces.

It has already been demonstrated, how the shore-levels corresponding to LI and LII (L IIa, b) were placed in the relation diagram. It has also been shown that these surfaces are associated with Stone Age cultures. A few words more concerning the latter should be said in this connection.

The Suomusjärvi culture corresponds most closely as regards its level to LI and perhaps to a slightly later period, but so few finds representing this culture have been made so far that a more exact co-ordination to the shore-surfaces is impossible.

The L IIa shore-level is connected with the older stage of the earlier comb-ceramic culture (I : 1). This is very convincingly clear from the Stone Age coastal dwelling places investigated in Uusimaa. Of these I have only placed those in the relation diagram, the altitude of which is known with sufficient precision and which are established definitely as dwelling places situated on the beach. This refers, *e. g.*, to the Espoo Stone Age dwelling places (A. Äyräpää 1922 and 1926). The older style of the early comb-ceramic culture (I : 1) occurs at 30.5—32.5 m. above sea-level at Espoo in the places in which LI is 35—36 m. above the sea. At Liljendal, according to Ramsay, LI lies 30.6 m. above the sea. According to A. Äyräpää (KM 9273: 1—398, 1930) the older style of the early comb-ceramic culture

(I : 1) is 27.4 m. above sea-level at the same place. The placing of the Häyrynmäki early comb-ceramic dwelling places at the L IIa shore-level has already been referred to (page 136). The dwelling places in Lappträsk representing the I : 1 stage of the early comb-ceramic culture also seem to be situated at the L IIa level. In measuring the height of the Lappträsk dwelling places, however, fixed points on the topographical map were used as starting points, in which there may be errors. As, besides, I do not know the level of the Littorina maximum limit at Lappträsk exactly, I have omitted these dwelling places from the relation diagram.

The dwelling places representing the later stage of the early comb-ceramic culture (I : 2) accompany the L IIb shore-level. Already in connection with the Helsinki district it proved obvious that the Storskogen dwelling place (page 64) belonged to LII. At that time I did not yet recognise the two shore-levels to be distinguished in the LII phase (L IIa and L IIb), as I did not discover an L IIa beach in the Helsinki district. We see from the relation diagram that the Storskogen dwelling place falls into the L IIb surface. Obviously shore marks representing it, too, are to be found in the Helsinki district. At Espoo the later stage of the early comb-ceramic culture (I : 2) is connected with the L IIb level.

Below LII the LIII shore-level appears in the diagram, accompanied by the typical comb-ceramic culture. In this culture, too, there are an earlier and a later stage (II : 1 and II : 2), but in Uusimaa as well they are situated vertically close to each other, and the shore-surface corresponding to them, LIII, does not divide into two parts like LII. The debased comb-ceramic culture (III) appears to be situated slightly below the LIII level. On the Karelian Isthmus LIII intersects L IIa at about 12 m. above sea-level and L IIb at about 9 m. above the sea. The angle of intersection is so acute that especially L IIb and LIII almost coincide there.

Below LIII the LIV or the last shore-level belonging to the Littorina period is shown in the diagram. It is connected in places with the cord-ceramic culture. The dwelling places that represent the cord-ceramic culture are, however, not certain coastal dwelling places, so that their correlation with any definite shore-level is not quite reliable. The dwelling places representing this culture are in some cases situated below LIV, but also at heights above it. From this it would seem that LIV corresponds chronologically to the beginning of the cord-ceramic culture.

On the Karelian Isthmus LIV is fairly close to the Littorina Sea shore-levels that are older than it. It intersects the LII levels at

7—8 m. above sea-level and LIII at about 5 m. above the sea. From this level towards lower isobases LIV forms the maximum limit of the Littorina transgression. LIII, however, is situated so close to LIV in this zone of isobases that it is not easy to distinguish these beaches from each other morphologically. The same is to be said of all the Littorina Sea surfaces as regards the eastern part of the Karelian Isthmus.

Below LIV three more distinct shore-surfaces appear in the relation diagram. On the basis of the stratigraphy of the peat bogs these shore-levels are of post-Littorina date. It seems on the basis of the Stone Age finds that the Pl I level occupies a position in time at the end of the Stone Age, as we have seen when dealing with the Helsinki district (page 64). Pl II and Pl III may belong to the transition phase from the Bronze Age to the Iron Age, Pl III probably already to the Iron Age.

All the shore-levels described above consist of shore features, the position of which in the relation diagram is determined by the altitude of the peak of the Littorina transgression in each area investigated. This altitude was established both stratigraphically and by means of raised shores. There are, however, a number of shores in the relation diagram, the emplacement of which in the diagram is not based on the elevation of the maximum limit of the Littorina Sea, determined stratigraphically.

I have such a series of observations, for instance, in the Hamina district. In explaining the ancient beaches of this area (page 107) I already came to the conclusion that the Littorina maximum was 23.5 m. above sea-level in the Hamina district. The shore representing this level is well developed and the general direction of the isobases also supports the view that the Littorina peak is at approximately this altitude at Hamina. Consequently, I have placed the shore observations of the Hamina area in the relation diagram taking the 23.5 m. level as the Littorina limit. This placing seems to be correct, as the other beaches of the Hamina area are then also situated at the shore-levels drawn in the diagram.

I have proceeded in the same manner in regard to the succession of ancient shores identified by me at Pohjan Kuru. There, too, the Littorina maximum can be estimated at about 40 m. above sea-level on the basis of studies carried out in neighbouring areas (I. Leiviskä 1920, W. Ramsay 1926, E. Aurola, verbal communication) and of the direction of the isobases. I have actually no shore established at Pohjan Kuru corresponding to this maximum, as the area I investigated (E. Hyyppä 1937a) scarcely attained as much as

40 m. above the sea. The beaches that I measured below this level fall almost exactly on the shore-levels of the relation diagram, if 40—41 m. above sea-level is taken as the local Littorina limit.

PRE-LITTORINA SEA SHORE-LEVELS.

Although the main object of my studies was the displacement of the shore during the Littorina and post-Littorina periods, my material offers an opportunity of examining the shifts of the shore-level during the pre-Littorina period, too. I have comparatively plentiful observations of raised shores from phases preceding the Littorina and stratigraphical evidence that supplies information regarding the age of these shore-levels, as has already been shown in dealing with the material.

Above the LI surface three shore-levels are formed at first, AV, AIV and AIII, in support of which there are only a few shore observations. It is therefore impossible to say whether AIII, AIV and AV represent delays of the shore retreat or are merely beaches that came into existence during the regression. It is certain, however, that they belong to the Ancylus period. This is proved by the stratigraphy of the peat bogs. It also seems certain that the AV shore-level is the same that represents the so-called »*Mastogloia* Sea» phase in the development of the Baltic according to B. Halden (1917), U. Sundelin (1919), Thomasson (1927) and L. Aario (1932, 1935).

Attempts have been made to refer this phase to the Littorina period, in which case it would mark the first slight salinity inside the Baltic. This opinion is, however, quite unfounded in regard to my area, as I showed in connection with the Helsinki district. In Uusimaa LI forms the Littorina maximum limit, on the Karelian Isthmus LII and partly LIII and LIV. Above this level there is no sign of the Littorina Sea. Above the Littorina limit, indeed, *Mastogloia* species do occur here and there in isolated cases and especially in late-Glacial sediments. The occurrence of these species is, however, so irregular and sparse that it is misleading, as regards South Finland, to speak of the *Mastogloia* Sea on the basis of them.

After these three indefinite shore-levels there are two others, AII and AI, in the diagram, the records of which are especially clear on the Karelian Isthmus. They certainly belong to the Ancylus period on the basis of the stratigraphy of the bogs. The position of the shore-levels in the relation diagram leads us to the same date, for they are the next older certain shore-surfaces prior to the Littorina. The AI surface would thus represent the maximum extent to which the Baltic encroached upon the land during the Ancylus transgression. This view is in complete accordance, as regards the eastern part of my area, with the results obtained elsewhere in the Baltic region. In the western part of my area, on the contrary, or on higher isobases this shore-level remains lower than the level at which the Ancylus transgression maximum has been placed on the basis of former studies. I will deal with this important question in greater detail further on.

Above the AI level the LgIX and LgVIII shore-levels stand out in the relation diagram and the indefinite LgVII. With regard to the construction of these surfaces I had only a few observations of my own. They seem, however, to be older than the Ancylus period, in which case they belong to the late-Glacial period. On a stratigraphical basis I place their date in the latter half of the Yoldia period. I have already brought forward evidence for this dating, when dealing with my material, and will return to the subject, when I compare my results with those for other parts of the Baltic.

Above the LgIX—VII shore-levels there are several others that I have designated: LgVI, LgV, LgIV, LgIII, LgII and LgI. The observations that serve as a basis for these surfaces are also scarce. I considered it worth while, however, to place these ancient shores, too, in the relation diagram, as shore-levels can be drawn through them. These surfaces are, of course, rather hypothetical. It is evident from my stratigraphical material, however, that the ancient beaches at these levels belong for the greater part to the time of the Baltic Ice Lake.

THE CHANGES OF THE SHORE-LINE.

In dealing with the individual areas it was already evident in its main features in what way the shore-line in each area shifted during the post-Glacial period. I can also draw some main conclusions on the basis of my material in regard to the late-Glacial or pre-Ancylus changes of the level. The relation diagram now affords an opportunity for examining the displacement of the shore-line for the whole area on the basis of the results obtained by me for the individual areas.

LATE-GLACIAL PERIOD.

As already stated, I refer the pre-Ancylus shore-surfaces to the late-Glacial period. On the basis of the material the boundary between the late-Glacial and post-Glacial periods should be drawn between the LgIX and AI shore-levels.

My material concerning the late-Glacial period is scarce. For this reason I can, of course, not draw precise conclusions as to the late-Glacial changes of the shore. M. Sauramo (1934, 1937) has given a detailed account of the development of the Baltic during the Baltic Ice Lake and Yoldia Sea periods, so that I need only refer the reader to those studies. In the next chapter I will parallelise Sauramo's system with my own in some points, but before doing so we must see, what main features are provided by my own observations of the late-Glacial displacement of the shore.

The shores belonging to the LgI—VI surfaces would seem to belong to the period of the Baltic Ice Lake on the basis of the stratigraphy of the sediments. In the late-Glacial deposits above the Lg VII shore-level I failed to discover even the smallest signs of the water having been saliferous at that time. The aqueous sediments at the level of the Lg I—VI shore surfaces consist as a rule of varved clay which contains a few fresh-water diatoms and pollen of a late-Glacial type, in which the pollen grains of *Picea*, *Alnus* and rarer foliferous trees occur in small quantities besides *Pinus* and *Betula*. The sediments belonging to the time of these shore-levels are in many cases entirely devoid of subfossils. The best idea of these late-Glacial deposits is obtained from the peat bogs of the Salpausselkä area (page 109).

The stratigraphy of these bogs provides no detailed information concerning the displacement of the shore-line. The varved sediments in them seem to have been deposited in comparatively deep water. As to their mutual angles, the Lg I—VI shore-levels differ very little from each other in direction which would indicate their close connection and a small difference in age between them.

The shore-levels Lg VII, Lg VIII and Lg IX, which I also refer to the late-Glacial period, clearly form a group of their own in relation to the former ones. This is also evident from the fact that the Lg I—VI surfaces are considerably inclined in respect of the Lg VII—IX group. Of these latter I refer at any rate Lg VIII—IX with certainty to the Yoldia period, when the Baltic was in connection with the ocean. It is not evident on the basis of my material, however, in what way the shore-line was brought from the Baltic Ice Lake level down to the ocean level. With regard to this question I refer the reader to Sauramo's (1934, 1937) studies.

I can, however, prove some features in the character of the changes of the late-Glacial shore-level stratigraphically. Late-Glacial salt-water and brackish-water diatoms do not occur in a single instance in my material above the level of the Lg VII—IX surfaces, but remain below them. It seems that the salt-water diatoms that I consider to be primary (cf. page 109, 143) and that occur most abundantly at the end of the late-Glacial epoch, belong in the first instance to the phase of the Baltic represented by Lg VIII—IX. It is possible, however, that Lg VII also belong to this period. Judging by the diatoms a small transgression appears to have occurred then. This is shown, *e. g.*, by the sequence of the Pienjärvi bog (page 154).

The pollen flora corresponding to these shore-levels is of late-Glacial type. In comparison with the previous period *Picea* has decreased, but it is nevertheless present in the sediments of the date in question. The pollen of mixed oak forests also occurs sparsely. Of these *Corylus* and *Ulmus* are the most important. *Alnus* pollen occurs in comparative abundance in the sediments of this time. *Betula* and *Pinus* still predominate and in most cases *Betula* is more plentiful than *Pinus*. In regard to its pollen flora this time corresponds best to L. von Post's Gotland zone IX.

THE POST-GLACIAL CHANGES OF THE SHORE-LEVELS.

Ancylus period.

The A I and A II shore-levels rest on a surer foundation than the former both stratigraphically and on the basis of the raised shores. This refers especially to Eastern Uusimaa and the Karelian Isthmus, of which I have the most plentiful materials. On the basis of the stratigraphical evidence these shore-levels represent the time of the Ancylus transgression maximum. On the basis of my material, however, the detailed succession of the displacement of the shore-line is not clear with complete certainty. In regard to the eastern parts of my area, however, the stratigraphy of the peat bogs leads to the conclusion that during the time of the Ancylus transgression the sea invaded landwards to some extent. This is seen, *e. g.*, by the stratigraphy of the Suursuo bog (page 122) and of the Pienjärvi bog (page 154). The ancient beaches belonging to these shore-levels are also well developed in the eastern parts of the area which would point to the landward advance of the shore. In the western parts of the area I have fewer morphological and stratigraphical observations connected with these shore-surfaces. It would seem, therefore, that the ancient beaches representing these levels had developed worse in the western parts of the area than in the eastern.

In dealing with the material referring to the Helsinki district I mentioned a number of beaches above the Littorina limit. Several of these fall within the A I and A II shore-level in the relation diagram. The peak of the Ancylus transgression cannot be determined with certainty on the basis of the stratigraphy of the bogs in the Helsinki district. These bogs rather lead to the conclusion, however, that the Ancylus transgression maximum did not rise above the A I shore-level in the Helsinki district. According to the stratigraphy of the Rusutjärvi swamp (page 57) the Ancylus Lake appears to have been transgressive towards the land in the Helsinki district, too. The boundary between the Ancylus Lake and Yoldia Sea deposits cannot, however, be established with certainty in the strata of the Rusutjärvi swamp. The evidence provided by the swamp regarding the Ancylus transgression is therefore also doubtful. The ancient beach above the bog, 64.8 m. above sea-level, which is the maximum limit of the Ancylus transgression according to G. Rudeberg, is situated in my relation diagram at the Lg IX level or in the shore-system of the Yoldia Sea. The aqueous sediment at the bottom of the Rusutjärvi swamp is also late-Glacial for the greater part, and the *Mastogloia* species in it may possibly indicate a weak marine influence.

The absolute maximum of the Ancylus transgression is represented in the relation diagram by the A I shore-level. The A II level lies slightly below it, the difference in height being only 3—4 m. in Uusimaa. On the Karelian Isthmus these shore-levels approach each other still more closely. Both these surfaces belong to the time of the Ancylus transgression and represent two delays or small positive shifts of the shore lying close to each other chronologically and as regards their level. In the pollen diagram this time of the Ancylus transgression, or of the A I—A II phases, corresponds to the absolute *Pinus* maximum or a slightly earlier time. All the pollen diagrams do not yield exactly the same result in this respect. It is certain, however, that the Ancylus transgression is situated in the time of forests dominated by pine, when precious deciduous trees and *Alnus* occur very sparsely and are often entirely absent. Besides pine, only the pollen of birch occurs fairly plentifully. The diatom and pollen flora lead to the further conclusion that the Ancylus transgression peak falls within the former half of the Ancylus period. The time between the end of the Yoldia period and the Ancylus transgression maximum is comparatively short, judging stratigraphically. The small difference in inclination between the Yoldia and Ancylus shore-levels in the relation diagram leads to the same conclusion.

From the A II level the actual Ancylus regression begins and continues until the level of the ocean rises to the level of the threshold in the Danish Straits of that time and the Ancylus Lake is converted into the Littorina Sea. Prior to this important event intermissions can be observed in the retreat of the shore. The shore-levels A III, A IV, and A V, subsequent to the Ancylus transgression maximum, are recorded in the relation diagram. These surfaces are based on shore marks that I observed only in some of the investigated areas. These raised shores, however, are fairly well developed. During their formation at any rate no considerable landward shifting of the shore seems to have occurred, but obviously, too, a longer or shorter delay in the regression.

From A V the shore retreats to the lower limit of the Ancylus regression which I have drawn in the diagram in such a manner that in intersects L I at 34—35 m. above the sea and the present level of the sea at the point, where the Littorina maximum is about 11 m. above sea-level. If drawn in this way, this boundary indicates the upper limit of the Ancylus regression, the fixed points of which are at the lowest level of the peat deposits and shallow-water sediments formed during the Ancylus regression. This level is about 2 m. above the sea at Ino (page 176), below the 9 m. level at Karjalainen (page 170) and about 17—18 m. above the sea at Säkkijärvi (page 132). The actual limit of the Ancylus regression is probably slightly lower still than the limit I have drawn in the relation diagram. This boundary plane also corresponds to the so-called »*Clypeus* limit» which, according to W. Ramsay (1926), for instance, marks the phase in the displacement of the shore, when the Baltic became connected with the ocean through the Danish Straits and the Littorina period began.

Littorina and the post-Littorina period.

According to the stratigraphy of the sediments L I is the maximum limit of the Littorina Sea in Uusimaa. Starting from Espoo or the isobases of the Littorina limit above 35—36 m., the »*Clypeus* limit» may possibly form the highest limit of the Littorina Sea. In Uusimaa it proved impossible to distinguish the L I and the »*Clypeus* limit» stratigraphically from each other. When the L I shore-level was formed, the shore-line did not shift noticeably landwards in those regions where the Littorina maximum limit lies higher than 19—20 m. above the sea. The possible transgression that may have occurred then does not exceed 2 m., *e. g.*, on the 30 m. LI isobase.

Proceeding to lower isobases from the 19—20 m. Littorina maximum limit, a notable encroachment of the sea upon the land occurred during the LI period. This is seen, *e. g.*, by means of the stratigraphy of the bogs at Koivisto, Karjalainen and Ino. At Ino, according to my relation diagram, the sea-level rose at least 5.5 m. in regard to the land during the LI period. At Karjalainen the corresponding figure is more than 3 m.

In several stratigraphical sequences that I investigated the shoreline would seem to have retreated, according to the diatom statistics, still during the first penetration of the salt water into the Baltic. I am inclined, however, to interpret this phenomenon as only signifying a great change in the ecological conditions of the diatoms at the time, when the Ancylus Lake was converted into the Littorina Sea. When the fresh water became brackish, the Ancylus flora declined and the Littorina flora only developed into full bloom, after the marine conditions had become stabilised. Statistically this floristic discontinuity looks like a regression, though it need not actually have occurred. This question, however, is still unexplained in detail.

The beginning of the Littorina period corresponds pollen-floristically to the beginning of the uninterrupted appearance of rare foliferous trees, especially *Tilia*. *Pinus* is decreasing just then from its maximum during the Ancylus period, but still occurs in fairly large proportions. In several pollen diagrams there is a distinct *Pinus* culmination at the beginning of the Littorina period, though it is less pronounced than the *Pinus* peak of the Ancylus transgression period. The boundary between the Ancylus and Littorina periods can only be established with absolute precision in the littoral sediments by means of the diatoms.

After L I a regression occurs throughout the whole area investigated by me. The retreat of the shore is already arrested, however, in the first half of the Littorina period and on the Karelian Isthmus the shore again begins to advance at that time. This can be proved stratigraphically in the investigation areas of Koivisto, Karjalainen and Ino. At Karjalainen the amount of the fresh transgression was at that time at least 5 m. In Uusimaa I was unable to prove this transgression stratigraphically. There merely an intermission in the retreat of the shore-line seems to have occurred simultaneously The shore cut during this time is LIIa in the relation diagram, which intersects L I at Säkkijärvi at 19—20 m. above sea-level. On the isobases above the point of intersection a regression thus succeeded the formation of the LI surface, having been stopped, when the LIIa shore-level was formed. On the isobases below the point of intersection the shore also retreated at first, but the regression changed again to a transgression that reached its peak, when the LIIa shore-level was registered.

After the formation of the LIIa shore-line the regression continued in Uusimaa, but only for a short time, as a delay occurs again in the displacement of the shore. This delay is represented in the relation diagram by the LIIb surface which almost coincides with the LIIa shore-level on the Karelian Isthmus. In the latter area, therefore, the shore-line practically remained stationary during the whole of the LII phase. LIIa and LIIb only intersect each other at 8—9 m. above the sea. On isobases below this level the shore shifted slightly landwards during the LIIb phase, too.

After the LIIb phase the shore-line in Uusimaa and on the Finnish side of the Karelian Isthmus retreated. This retreat is arrested for some time by two delays, when even a slight transgression may have occurred in the region of the Karelian Isthmus. These two intermissions are represented in the relation diagram by the LIII and LIV shore-levels. On the Russian side of the Karelian Isthmus the shore seems to have remained almost stationary since the LII phase.

The displacement of the shore during the Littorina period occurred in different ways on the Karelian Isthmus and in Uusimaa. In Uusimaa the shore-line retreated mostly. This retreat did not, however, occur quite continuously, but was interrupted by intermissions that occurred during the LI, LIIa, LIIb, LIII and LIV phases, when the shore may have shifted slightly landwards. Stratigraphically, however, I have not ascertained any distinct transgression in regard to the land on higher isobases than 19—20 m. for LI and therefrom downwards, towards the periphery of the land uplift.

In the latter area or in the region of the Karelian Isthmus the Littorina Sea was again transgressive in regard to the land at any rate during the LI and LII time. The regression between LI and LII can be clearly established on the Karelian Isthmus. The level of the sea appears to have risen here in the course of the whole Littorina period, so that the Littorina transgression only reached its maximum, when the LIV shore-level was formed. After this the rise in the level of the ocean would seem to have ceased or at least to have become much slower.

The Pl I—III shore-surfaces seem to represent delays of short duration in the post-Littorina period. I have no stratigraphical evidence from South Finland indicating a landward shifting of the shore during these phases.

We see from the relation diagram that the Pl I, Pl II, and Pl III shore-levels intersect each other and L IV at a level very close to the present sea-level. If these shore-levels continue as actual beaches down to the point of intersection, the sea-level did not sink during the time subsequent to L IV, assuming that the land has not subsided. However, this problem contains so many unknown factors hitherto that it cannot be solved except by means of substantial observations in future.

The present threshold between the basin of the Baltic and the ocean at Darsser (in the Danish Straits) is on the Littorina 0-isobase referred to. If the LI shore-level in my relation diagram is extended to the threshold, it is several metres below the present level of the pass-sill. The pass-sill is 18 m. below the level of the sea. If the threshold has grown higher during the post-Glacial time owing to sedimentation, my LI shore-level can be considered to be close to the original level of the pass-sill. This level which is more than 20 m. below the present sea-level, would indicate that since the formation of the LI surface the level of the Baltic has risen over 20 m. at least.

The actual rise of the ocean level would, naturally, be considerably greater. Also in the Baltic the water-level would have risen considerably more than 20 m., if we take the Ancylus regression limit as a starting point. According to my relation diagram this is 33 m. below sea-level at the Darsser threshold. Close to this depth (about 35 m. below sea-level) stumps have been encountered outside Kåsberga (S.E.-Scania) on the bottom of the sea that are obviously in a primary position and the age of which would seem to fall, on the basis of the pollen analysis, in the Ancylus regression period (cf. L. von Post 1928, page 70).

The Ancylus regression limit is so much below the Darsser pass-sill in the relation diagram that it would mean that the Baltic was an undrained lake during the time of the Ancylus regression. Before considering such a hypothesis it would be necessary to possess data on a much surer basis than at present concerning the post-Glacial development of the Danish Straits. The same applies, of course, to my Ancylus regression limit which is by no means in its final position in the relation diagram. Fig. 57 finally illustrates the displacement of the shore in Uusimaa and on the Karelian Isthmus.

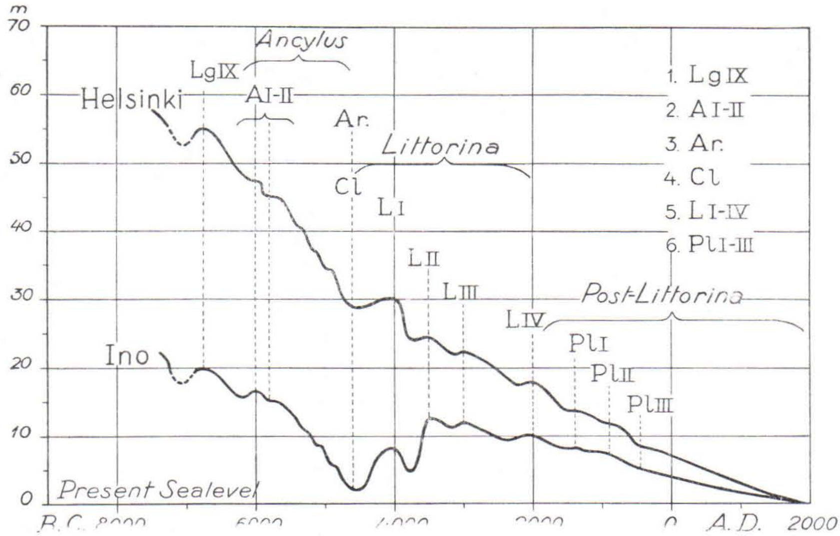

Fig. 57. Schematical curves showing the changes of the shore-line in the Helsinki district and at Ino during the post-Glacial epoch.

COMPARISONS WITH OTHER PARTS OF THE BALTIC REGION

I have dealt above with the late-Quaternary changes of the shore-line principally on the basis of my own material without comparing my results, excepting some individual cases, with other parts of the Baltic region. As my system of the displacement of the shore is now as complete as my material enables it to be at present, it seems worth while to correlate it with other parts of the Baltic. Within the limits of this paper I can only make such a comparison in broad lines. Besides, the analysis of the development of the entire Baltic is still so incomplete that it would not be justifiable to draw detailed parallels for the whole region.

THE NEIGHBOURHOOD OF LENINGRAD.

The papers published by K. K. Markov (1931) and by him and W. S. Poretzky (1935) provide data, based on the stratigraphy of peat bogs and on raised shores, concerning the changes of level in the neighbourhood of Leningrad. According to these writers only one culmination of the Littorina transgression and one beach of the Littorina Sea can be established on the Russian side of the Karelian Isthmus. Near the Finnish frontier the shore of the Littorina Sea is 10 m. above sea-level. The 5 m. isobase passes S.E. of Leningrad.

Between these places, *e. g.*, at Lachta, the Littorina maximum is 7 m. above sea-level. The Littorina transgression was preceded by a regression (Ancylus regression) that fell 2.4 m. below the present sea-level at Leningrad.

I have placed Lachta and Leningrad in their respective positions in my relation diagram. We then see that my Ancylus regression limit lies 13.5 m. below the present level of the sea at Leningrad. The difference in comparison with the results of the Russians is so great that it cannot be a case of the same regression limit. I am convinced that the Ancylus regression limit at Leningrad is lower than 2.4 m. below the present sea-level, as my Ancylus regression limit on the Karelian Isthmus can in no case be raised any higher. The inclination of this surface may be slightly different from what it is in my diagram, but it cannot be altered so much as to comply with the result of the Russians.

The pollen diagrams of the above authors show with certainty that the maximum limit of the Littorina Sea on the Russian side of the Karelian Isthmus is also later than LI. According to my relation diagram the maximum limit of the Littorina transgression forms a shore-level complex on the Russian side on the Karelian Isthmus, in which the different phases of the Littorina Sea from LII to LIV almost coincide vertically. LI is already below the present sea-level on the Russian side. The Russian geologists do not seem to have obtained this result. According to them the Littorina Sea only had one phase throughout the whole of the Baltic, but this cannot be proved on the basis of the conditions on the Russian side of the Karelian Isthmus.

The Russian students can in reality only establish one transgression stratigraphically and by means of beaches. The irrefutable oscillation of the beach between LI and LII is not visible on the Russian side of the Isthmus, because, as already stated, LI is below the present sea-level there. After that the level of the sea rose gradually and reached the transgression maximum in the western part of the area during LIIb, but in its eastern parts only during LIV.

My relation diagram leads to this result in regard to the Russian side of the Isthmus and the stratigraphical material of the Russians is fully in accordance with this view. If we study the diatom statistics and pollen diagrams of the Russians, it will be clear to us with complete certainty that LI is in no case the Littorina transgression peak on the Russian side of the Karelian Isthmus, for the transgression maximum indicated by the diatoms is situated in all their pollen diagrams in a period considerably later than L I, just as on the Finnish side of the Isthmus.

I have also placed two other ancient shores identified by the Russians in my relation diagram, using the Littorina maximum as a guide level. There are many such observations mentioned in the works of the geologists referred to and in S. A. Jakovleff's study (1926) dealing with the same area. Regarding the age of these beaches these writers supply no precise data. It is certain, however, that they belong to the late-Glacial period. The so-called sub-Arctic transgression, which the Russian students parallelised with W. Ramsay's and M. Sauramo's B III on a stratigraphical basis, is fairly prominent. This shore is situated approximately at the Lg I shore-level in my relation diagram. The other late-Glacial shore-line of the Russians is analogous to my Lg II shore-level, as the diagram shows.

WESTERN UUSIMAA.

In 1935 a paper was published by L. Aario dealing with this area, in which the post-Glacial changes of the shore-line were treated by means of the raised shores and of the stratigraphy of the peat bogs. Aario's study is confined mainly to the isobase passing through Espoo, in which the Littorina transgression maximum (L I = the »*Clypeus* limit») is 36 m. above the sea according to Aario. If I place Aario's other ancient shores that are on the same isobase in my relation diagram, they coincide, with the exception of the very lowest one, very well with my shore-levels. As to the Littorina period Aario's results and mine are identical, too, in regard to the age of the shores.

In the displacement of the shore-line there is this difference between Aario's opinion and mine that according to Aario the shore shifted considerably landwards during the different phases of the Littorina Sea. Thus, for instance, when the maximum limit of the Littorina transgression occurred, Aario considers the water-level to have risen 5.5 m. from the bottom of the preceding regression in Western Uusimaa. According to my observations the corresponding figure, *e. g.*, in the Helsinki district is within a range of 2 m. This difference in the results obtained by Aario and myself in adjacent areas is obviously inessential and easily explained, seeing that both of us have the same system of shore-levels of the Littorina period. The solution of the question would necessitate fresh investigations.

Above the Littorina limit Aario has a *Mastogloia* beach which, in his opinion, represents a separate marine *Mastogloia* transgression. This beach of Aario's coincides exactly with my A V shore-level which, in my opinion, belongs to the end of the Ancylus period and represents a fresh-water phase in the history of the Baltic. Nor was I able to establish that the shore had moved considerably landwards during this phase. It is certain that in this case Aario and I are dealing with the same shore, the character of which we interpret in a different manner. The contradiction is, however, perhaps only apparent, as Aario has no sign of salinity in the diatoms in this phase of the Baltic. He is also inclined at present to refer his »*Mastogloia* level» to the Ancylus period (verbal statement).

Above the »*Mastogloia* transgression» Aario has two other beaches, 49—51 m. and 63 m. above sea-level. The former should belong, according to him, to Sauramo's (1934) Rha phase and the latter were the peak of the Ancylus transgression. In my relation diagram these shores are placed differently. The 49—51 m. group of beaches falls within the A II shore-level and the 63 m. beach within the Lg IX level. Aario's Ancylus would thus belong to a marine phase and the marine Rha would be turned to Ancylus, if these beaches were dated according to my material. I consider it justifiable to do so, too, as Aario does not possess reliable stratigraphical evidence regarding the age of these raised shores.

GOTLAND.

Gotland has already been a classical area for a long time for the study of the displacement of the shore-line. Thanks to the researches of H. Munthe (1910, 1925) and L. von Post (1903, 1925, 1927) the history of the post-Glacial development of the Baltic in regard to Gotland is known fairly exactly. The information concerning the late-Glacial period, on the contary, is doubtful in regard to this area. It is difficult, too, to establish the late-Glacial changes of the shore on Gotland owing to the low height of the island,

In dealing with the Koivisto area (page 167) it was shown that the Littorina shore bar at Snoder in Gotland and the Littorina embankment at Koivisto were quite similar as regards their development. The isobase representing the Ancylus transgression maximum that passes through Snoder corresponds at the same time in height to the Ancylus transgression peak that I established at Koivisto. I have placed several other observation points on Gotland, too, in my relation diagram, from the southern end of the island to its northern end, using the Littorina maximum as a guide-level. As the relation diagram shows, the Littorina and Ancylus limits in Gotland accord very well with my corresponding shore-levels.

In my relation diagram the A I and A II shore-levels represent the Ancylus transgression period, the A I shore-level marking the maximum limit of the transgression. The A I and A II shore-levels are, however, only at an interval of 2—3 m. from each other vertically on the isobase corresponding to Gotland. This difference between the shore-levels is as large as the actual differences in height of the Ancylus shore bar on Gotland in the same investigation area (Munthe 1910).

This variation in the height of the Ancylus embankment caused Munthe some difficulty, when he was establishing the altitude of the maximum limit of the Ancylus transgression on Gotland. Munthe endeavoured to adjust his measurements in order to fix a »normal level» for the Ancylus limit in different areas. Owing to this correction some of Munthe's figures appear in the relation diagram between the A I and A II surfaces of mine. Such adjustment is unnecessary, however, as the Ancylus transgression is represented by a couple of beaches constituting two separate shore-levels. Towards lower isobases these shore-levels approach each other very closely. On Gotland it is difficult to distinguish these two levels from each other, as the Ancylus shore generally appears there in the form of a bar thrown up by waves.

Gotland corresponds in my relation diagram to the area that extends from the Seivästö district to near Porvoo. A correlation of the results obtained on Gotland with mine thus refers to an area in which the maximum limit of the Littorina transgression is not synchronous, but is formed by the L I and L II shore-levels. The Littorina and Ancylus limits on Gotland fit equally well in my relation diagram both in the L II and L I areas, which proves further that the L I and L II shore-levels are in the right position to each other in my relation diagram. After this comparison it should be considered quite certain that the Gotland Ancylus and my Ancylus are identical.

The shore bars at the highest point on Gotland, 82—83 m. above the sea, belong to the Baltic Ice Lake period. The position of these corresponds approximately in Central Gotland to the 21 m. Littorina isobase. If I place this 82—83 m. beach in my relation diagram at the point of the 21 m. Littorina limit, it falls within the Lg I shore-level. The beach that corresponds to B III in the neighbourhood of Leningrad according to Markov (the Baltic Ice Lake III in Ramsay's and Sauramo's system) was also situated on this surface.

According to L. von Post (1933) there are, too, a number of beaches on Gotland below the Littorina limit. I have placed these series of observations in my relation diagram, as will be seen by the place names. In this case I used L IIa, which corresponds to von Post's L II (»second top of the postglacial transgression») as a guide level. These beaches subsequent to the Gotland L I also coincide very well with my shore-levels subsequent to L I. Of L. von Post's shore-levels only one is missing from my system. It lies below my Pl III level, where I have no shore-surface on the basis of the present observations.

ÖLAND.

It has already been shown that the investigations carried out on Gotland lead to the same result in regard to the history of the development of the Baltic as I obtained in South Finland. It is therefore to be expected that the data concerning the changes of level on Öland should be in agreement with my results. The post-Glacial displacement of the shore on Öland was studied by G. Lundquist (1928) on the basis of stratigraphical evidence.

From Lundquist's investigations only the Ancylus transgression maximum and the position of the shore-level representing L II are clearly established. These correspond entirely to the results I obtained in South Finland. According to Lundquist the earlier and later Littorina shore (L I and LII) intersect each other at about 19 m. above sea-level. In my system this point of intersection is 19—20 m. above sea-level. Lundquist's L II intersects the maximum limit of the Ancylus transgression between the 10 and 11 m. isobases. According to me this point of intersection is 10 m. above the sea. The shore-level representing the Ancylus transgression peak in Lundquist's system is also at precisely the same inclination in regard to the Littorina limit as in mine. I have only placed one of Lundquist's series of observations (Vannborga) in my relation diagram. This is in the area, in which L II is the highest Littorina limit. The Ancylus beach of Vannborga coincides exactly with my A II shore-level which forms the lower limit of the couple of beaches that represent the Ancylus transgression maximum. This comparison is already sufficient to show that Lundquist's system of shore-surfaces is exactly the same as mine.

SCANIA.

In this area I have selected Limhamn as a point of comparison, as for a long time a good shore bar (Järavallen) has been known there which belongs to the Littorina Sea formations both on an archaeological and geological basis. It is evident already from K. Kjellmark's investigations (1903) that Järavallen is composed of at least two parts of different age. These are connected with Stone Age dwelling places, the latest of which is situated highest at the ridge. This leads to the conclusion that the Littorina Sea transgression lasted a long time there and attained its peak comparatively late.

O. Rydbeck (1928) examined the structure of the embankment and the Stone Age implements there more closely and obtained more accurate results in establishing the dates of the finds. According to Rydbeck there are three accumulations of different age on top of each other at Järavallen, each of which is associated with its own Stone Age culture. The lowest shore bar (No. 1) represents L I and the beginning of the Kökkenmödding period. Above this there is a L II shore ridge belonging to the transition from the earlier to the later Stone Age. At the top is the third shore bar which should be referred archaeologically with complete certainty to the latter half of the »Gånggrift» (passage tomb) period.

According Järavallen the transgression maximum reached a height of about 5 m. above sea-level at Limhamn. In my relation diagram the 5 m. Littorina limit lies at the point, where L III and L IV are at the same level and together form the maximum limit of the Littorina transgression. L IIa and L IIb are below the former on this isobase. L IIa is about 3 m. lower at this place than the Littorina maximum (L III—L IV). L I is already nearly 9 metres below the present level of the sea there. On the Järavallen isobase L IIa, L IIb and L III—L IV are vertically so close to each other and in such successive order that I consider these three phases (L III—L IV merge on this isobase into one phase in the displacement of the shore) to correspond to Rydbecks' three shore ridges and the cultures connected with them.

This parallelisation is also broadly in accordance with Rydbeck's results in regard to dating. The Littorina transgression maximum corresponds, according to him, to the latter part of the »Gånggrift» period which is synchronous with our hammer-axe culture (A. Äyräpää, verbal statement). The hammer-axe culture, again, corresponds with certainty to my L IV which, according to my relation diagram, is at the highest level of the Littorina Sea at Limhamn. The Littorina Sea maximum is thus L IV at Limhamn both according to Rydbeck and to me.

Shore bar No. 2 below this maximum limit (Rydbeck's L II) is connected archaeologically to the transition from the earlier to the later Stone Age or to the beginning of the later Stone Age. It should therefore best correspond to our early comb-ceramic culture which, according to me, is associated with L II. Rydbeck's L II should correspond, more exactly, to my L IIa. The lowest part of Järavallen, the date of which seems doubtful and the existence of which is questionable in other respects, should correspond to a period earlier than L II. Rydbeck coordinates this part of the embankment with L I, which cannot be considered correct dating, as L I is below the present sea-level on this isobase in my opinion. This controversy is, however, not essential with regard to the question of the transgression peak itself, especially as the structure of the lower part of the ridge and the archaeological dating seem to be unclear.

I am inclined to explain the structure of Järavallen by there being two main portions: 1) the lower, representing L II both archaeologically and geologically, and 2) the upper, connected on the same bases with the L III—L IV shore-level.

Rydbeck points out already that the development evidently occurred on the Danish coasts in the same manner as in Scania. The Danish scientists do not distinguish more than a single Littorina transgression. This is in apparent conflict with Rydbeck's results. In my opinion, however, there is no actual contradiction, as on the isobase corresponding to Limhamn only a single Littorina transgression can be established stratigraphically which attains its maximum during L IV. The Littorina transgression peak is therefore evidently L IV on the Danish coasts, too, on the isobase corresponding to Limhamn, in no case L I.

When the sea-level rose in this zone of isobases from L II to L IV, a slight fluctuation of the shore-line in regard to the land may, perhaps, have occurred, which may appear greater at Järavallen than the displacement of the shore-line was in actual fact. I have signs of such slight oscillations of the shore on the Karelian Isthmus, too. The stratigraphy of the peat bogs there does not, however, indicate any great fluctuation of the shore-line during this time. Roughly speaking, the sea-level rose continuously in respect to the land on the Limhamn isobase from L II to L IV, during the latter of wich the transgression only attained its maximum.

GUSUM—KOLMÅRDEN.

The comparisons I have made so far referred to the isobase zones, to which my own investigations have been principally confined and with regard to which my results, especially concerning the post-Glacial epoch, are most certain. On the basis of my relation diagram, however, it is interesting to examine whether the shore-surfaces identified in other parts of the Baltic region are in accordance with my system on higher isobases.

In Sweden, on the basis of H. Thomasson's researches (1927, 1932), there has already been a change of opinion as to the maximum limit of the Ancylus transgression in the area between the Kalmar Strait and Degerfors. According to L. von Post (1928, 1929) the shore-level, that forms the maximum limit of the Ancylus transgression on Gotland, Öland and at the Kalmar Strait, passes above the thresholds of Degerfors, so that the Ancylus Lake drained into the ocean by this waterway during the transgression maximum. Von Post reaches this conclusion on a pollen-chronological basis.

Thomasson's researches referred to above already provoke the question whether the Ancylus transgression maximum ever rose above the Degerfors pass-sill. It is the Gusum and Kolmården area, where Thomasson obtained a result entirely dissimilar to G. Assarson (1927) earlier in regard to the limit of the Ancylus transgression. According to Assarson the Ancylus limit at Gusum is 70 m. above the level of the sea. Thomasson, however, proved later (1932) that the 70 m. shore is not Ancylus, but an older one. According to Thomasson's terminology it is the *Echeneis* Sea limit and would thus represent a marine phase in the history of the Baltic. According to Thomasson the maximum limit of the Ancylus transgression at Gusum is below 65 m. above the sea.

In regard to Kolmården Thomasson came to a conclusion corresponding to Gusum. According to Thomasson's diagram (Fig. 2, page 172, H. Thomasson 1932) the Ancylus transgression peak (A II in Thomasson's terminology) at Gusum would be about 52 m. above sea-level and at Kolmården about 60 m. above sea-level. In the text Thomasson mentions later (page 185) the figures 52 for Gusum and 64 for Kolmården in speaking of the position of the A II level. These figures appear in the text, however, only as bare figures, the significance of which the reader must realise for himself.

In Gusum and Kolmården the maximum limit of the Littorina transgression has also been established, so that the pre-Littorina shores of these districts can be placed in my relation diagram by employing the Littorina limit as a guide-level. Let us first examine the Kolmården shores, as, besides the Littorina maximum (LI), also LII and later Stone Age coastal dwelling places are known there, the latter of which can be divided according to their pottery into different styles: Säter II, III and IV (T. Engström and H. Thomasson 1932).

Thomasson's LI, however, cannot be placed in my diagram quite exactly, as I do not know the mutual relation of the »*Clypeus* limit» and LI sufficiently well on this isobase. My LI shore-level can, however, be used as an index level. If a slight error occurs, it is of no significance in regard to the chronological result to be obtained from the comparison.

According to Thomasson LI lies 42—42.5 m. above the sea at Kolmården and LII is 30.5 m. above sea-level. In my relation diagram Thomasson's LII falls within the LII b shore-level, so that Thomasson's result and mine regarding the mutual levels of LI and LII are the same. The fact that Thomasson has no LIIa shore in Kolmården does not imply a discrepancy. It is further evident from the relation diagram in what way the Kolmården Stone Age coastal dwelling places correspond to my shore-levels. Hyttan is situated in a period between LI and LII. Åbacken corresponds to LII or our early comb-ceramic culture. Säter II and III accompany LIII and correspond to our typical comb-ceramic culture, Säter III sooner already to the debased comb-ceramic culture. Säter IV corresponds chronologically most closely to LIV or our cord-ceramic culture. Thomasson obtained the same results in broad lines in comparing the altitude of these dwelling places in Sweden and Finland with the elevation of the Littorina maximum in each place of observation.

On the strength of the comparison I have made and its positive result I am entitled to postulate that Kolmården is in its right place in my relation diagram. We can now see, how the shores at Kolmården that are older than LI are placed in my system. Thomasson's extrapolated Ancylus level, about 60 m. above sea-level, fully coincides with my AII level. Thus Thomasson's opinion and mine of the maximum limit of the Ancylus transgression are essentially the same as regards Kolmården. Thomasson's *Echeneis* Sea limit in Kolmården (EIII) falls in my diagram along the LgVII surface. This shore-level is very uncertain in my diagram, as it is only supported in Finland by Sauramo's beach on Suursaari (Sauramo 1936), the age of which has not been determined stratigraphically.

The Gusum 70 m. shore (Thomasson's EIII) lies slightly below the LgVIII shore-level in my relation diagram, if the Gusum Littorina limit is about 39 m. above the sea. If, on the other hand, the Gusum Littorina limit is taken according to the stratigraphical upper limit (H. Thomasson 1932), 36.5 m. above the sea, the 70 m. shore occupies a position slightly above the LgVIII shore-level.

These two alternatives are, however, inessential in regard to the result that the Gusum 70 m. shore is situated in my relation diagram in a shore-level system that is older than the Ancylus transgression maximum (AI—AII). My result is therefore fully in accordance with Thomasson's result in this respect. Thomasson's extrapolated Ancylus limit at Gusum (about 52 m. above sea-level) lies 3.5 m. below my AII surface. The pre-Littorina shore-levels are in a different position to each other in Thomasson's diagram than they are in mine. This, however, does not prevent my result and Thomasson's being the same in their main features as regards the peak of the Ancylus transgression on the Gusum and Kolmården isobase. In this connection I will not deal any further with Thomasson's system of late-Glacial shore surfaces. As far as I understand, it is by no means yet in its final form any more than my late-Glacial shore-levels.

Besides, there are so many data already concerning the maximum limit of the Ancylus transgression throughout the Baltic region that its proper establishment also on higher isobases could be expected in the immediate future. I shall have occasion to dwell on this important subject and to return to Finland in my comparison later, for we have here the first complete study on the development of the whole of the Baltic published by Sauramo in 1934. This fundamental work was supplemented by a paper published in 1937.

SUURSAARI—LOHJA.

It would be appropriate, of course, to correlate my shore-levels with Sauramo's relation diagram, but this is impossible, as the guide-level of Sauramo's relation diagram, although also the Littorina maximum, is not quite identical with my guide-level. At the time, when Sauramo worked up his relation diagram, the displacement of the level of the Littorina period was not known exactly in South Finland. For this reason Sauramo drew the Littorina transgression limit as being synchronous and as a straight line down to the 10 m. isobase. In my diagram, however, LI and LII intersect each other already at 19—20 m. above sea-level, as I have shown. Thus, in constructing the relation diagram, the same guide-level used by Sauramo and myself was different in form. In that case, naturally, the diagrams must differ in every respect.

I have made a comparison of Sauramo's results and my own by placing two of his observation series in my own diagram, in which it is possible to start from the Littorina maximum level. One of these is on Suursaari (M. Sauramo 1934, 1937 and verbal statement) lying on the same isobase as Virojoki. Sauramo's Suursaari beaches fully correspond to my Virojoki shores. The oldest distinct shore-line that I identified at Virojoki is Ancylus (36—37 m. above the sea). Sauramo's Ancylus on Suursaari is 34—37 m. above the sea. Above this Sauramo has 42 and 45 m. shores, of which the 42 m. shore corresponds to my LgIX and the 45 m. shore to LgVIII. According to Sauramo, too, the latter shores belong to the Yoldia period. The Suursaari shores above the 45 m. level are also situated on my late-Glacial shore-levels. Sauramo, however, has no certain data regarding the age of these shore-lines.

At Karjaa, a locality which is situated on the same isobase as Lohja and 30 km. S.W. of it, the Littorina limit is according to Leiviskä (1920) 38—38.5 m. above the sea. Consequently, the Littorina limit at Lohja, too, lies with fair certainty about 38—39 m. above sea-level. Lohja is therefore about on the Gusum isobase and is very suitable as a point of comparison. According to Sauramo the Ancylus limit at Lohja is 69—70 m., Yoldia I 96—101 m. and Zirphaea 112 m. above the sea. In my relation diagram Sauramo's Ancylus corresponds to the LgVIII shore-level, Yoldia I to the LgV—VI surface and Zirphaea to the LgIII level.

Sauramo's Ancylus at Lohja thus corresponds to Assarson's Gusum Ancylus. On lower isobases Sauramo's Ancylus shore-level coincides with my Ancylus (*e. g.* on the Virojoki—Suursaari isobase) and with the Gotland Ancylus. According to my diagram Sauramo's Ancylus is therefore composed of two shore-levels of different age. The case is the same with regard to v. Post's Ancylus in the sense of his explanation of the maximum limit of the Ancylus transgression in his papers of 1928 and 1929.

Sauramo has not yet been able to establish the age of the 70 m. shore at Lohja stratigraphically with complete certainty. Owing to this he too is inclined at present (verbal statement), on the basis of the materials at his disposal, to refer the 70 m. shore to the Rha phase, *i. e.* the end of the Yoldia period, to which it belongs according to my dating.

In this connection it is necessary to revert once more to some peat bog profiles, the stratigraphy of which proves in a convincing way that the LgVIII and LgIX shore-levels are older than the Ancylus period in Uusimaa and Gotland.

At Illby in the parish of Porvoo, as already stated (page 67), G. Rudeberg (1925 a) measured a wave-cut cliff, the foot of which is 56.7 m. above sea-level. This shore lies in my relation diagram on the LgVIII surface. Rudeberg's shore is therefore of the same age as the 70 m. beach at Gusum and Lohja. I have a bog in the vicinity of Rudeberg's shore, Fig. 22, page 67, the bottom of which is precisely at the level of Rudeberg's 56.7 m. beach. It is indisputably evident from the pollen diagram of this peat bog that the formation of peat began at this level already at the end of the Yoldia period or at the beginning of the Ancylus period at the latest. The stratigraphy of this bog proves that the Ancylus limit is below the 56.7 m. level at this place and in addition that the sea-level already fell at the end of the Yoldia period somewhat below the elevation of the bog or of the LgVIII shore-line. According to this the 70 m. shores at Gusum and Lohja are also older than Ancylus and belong to the Yoldia period, as they correspond in my relation diagram to the LgVIII shore-level.

The result provided by the above bog is confirmed by another bog that I investigated in the same area, Fig. 21, page 67. The threshold of this bog is about 43 m. above sea-level. According to my relation diagram the Ancylus limit is 45 m. above the sea at this place. The bog basin can therefore have been connected with the Ancylus Lake only for a short time and to a slight extent. The stratigraphy of the bog also leads to this conclusion. According to the pollen diagram of the bog it is even questionable, whether the Ancylus Lake ever rose to the level of the bog. The upper part of the clay ooze at the bottom of the bog, sample 370, may just as well belong to the end of the Yoldia period as to the beginning of the Ancylus. It may correspond most likely to the period that Thomasson calls AI and above which only the actual Ancylus transgression maximum period (Thomasson's AII) appears in the profile. During the latter phase this bog was already shut off or was in course of separation from the Baltic.

I have a third bog, too, the evidence of which in regard to the maximum limit of the Ancylus transgression is very convincing. This bog (Haukkasuo, Fig. 32, page 111) is situated in the relation diagram in the 30—33 m. isobase zone of the Littorina limit. In this zone my Ancylus limit is 45—50 m. above sea-level and the shore-levels representing the end of the Yoldia period, LgIX—VIII, 55—60 m. above the sea. The threshold of Haukkasuo bog is about 55 m. above sea-level. The final phase of the Yoldia period, which is clearly marine according to my diatom material, was thus able to make itself felt at the level of the bog. At the bottom of the sequence, in reality, there is a horizon that contains brackish-water diatoms and that I refer to the Yoldia period (page 110). The upper part of this stratum apparently represents the LgVIII—IX phase.

It is, however, more important in this connection to ascertain that the formation of peat began at this place already at the beginning of the Ancylus period. This appears beyond doubt from the pollen diagram of the bog and proves that the Ancylus transgression peak is below the 55 m. level or the LgVIII—IX shore-levels in this isobase zone.

The evidence I have quoted is so convincing, that on the basis of it my view of the Ancylus transgression maximum appears to be correct, all the more so as my result is in complete accordance with the Ancylus limit established on Gotland and Öland. As to the development of the Ancylus Lake this conclusion, however, affords some new points of view.

The supposed outflow of the Ancylus Lake at Degerfors then also becomes an object of attention on my part, for, if the Ancylus limit (AI) of my relation diagram is prolonged at the same inclination to Degerfors, it is probable that it does not rise there above the pass-sill of the supposed spillway of the Ancylus Lake. This result of the extrapolation is doubtful, however, as Degerfors can so far not be placed in my relation diagram with the necessary precision. It is possible, besides, that the shore-level representing the transgression peak of the Ancylus Lake is not quite synchronous throughout the Baltic. Neither can it be taken for granted that the land upheaval obeyed the same proportionate course between Gusum-Kolmården and Degerfors as in general. The synchronous shore-levels, *e. g.*, may have subsequently suffered such a deformation there that the placing of shore observations in the relation diagram in the ordinary way will lead to erroneous conclusions.

It is therefore premature, too, to assert that the Ancylus Lake did not drain into the sea at all through Degerfors. There is the more reason for saying so, as Thomasson's Ancylus limit and mine are likely to be slightly later than the initial phase of the Ancylus Lake. It is possible that, at any rate in its initial phase, the Ancylus Lake drained into the sea through Degerfors.

I cannot, of course, express any final opinion of the development of the Ancylus Lake in the present stage of investigation. On the basis of my materials, however, some facts have been established that should give rise to fresh studies of the development of the Ancylus Lake.

ANCIENT FLORA.

In this chapter I propose to give a short glance at the development of the pollen and diatom flora in the area I investigated during the phases of the Baltic that I have described and will also touch slightly on the question of post-Glacial climate on the basis of this material.

L a t e-G l a c i a l p e r i o d. The peat deposits of this period have a trifling distribution in the area investigated and all derive from the end of the late-Glacial period. The late-Glacial aqueous sediments, on the contrary, are abundant. These consist chiefly of varved clay, clay ooze and sand accumulations deposited for the greater part during the time of the Baltic Ice Lake.

These sediments contain both pollen grains and diatoms in many cases. The oldest strata, however, are as a rule devoid of subfossils. It has been impossible hitherto to divide the late-Glacial epoch into defined sub-periods on the basis of the pollen chronology, but it is obvious that its older half is characterised by the comparatively plentiful occurrence of *Picea* pollen. The late-Glacial maximum of spruce is older than the Yoldia period. In the sediments of that period pollen of *Alnus* and of rare deciduous trees: *Ulmus*, *Corylus* and *Tilia*, also occurs sparsely. Birch and pine form the predominant tree assemblage of this period.

In the very oldest late-Glacial sediments fresh-water diatoms are very scarce or else they do not occur at all. During the later phases of the Baltic Ice Lake, however, the diatom flora increases rapidly. It is large-lake flora, in which *Gyrosigma attenuatum* is the characteristic species. This flora is associated as a rule with salt-water species, among which the *Grammatophora oceanica* and *Coscinodiscus* species are the most usual. Possibly these sparse occurrences of marine diatoms derive from sediments older than the late-Glacial period, which have been discovered quite recently on the Karelian Isthmus (G. Brander 1937 and E. Hyyppä 1937 c).

The latter half of the late-Glacial epoch, the Yoldia period, is as a rule a time, in which *Betula* is preponderant. There is, however, much *Pinus* pollen in these sediments, too. Late-Glacial spruce has disappeared or its pollen grains occur rarely. At the end of the Yoldia period the quantity of pollen of precious deciduous trees increases again, consisting mostly of *Ulmus*. At the same time the diatom flora develops in the Baltic indicative of clearly marine influence which especially occurs rather prominently in the sediments of the Karelian Isthmus. This flora seems to be primary and proves that the salinity of the late-Glacial sea, at any rate in the region of the Karelian Isthmus, was greatest at that time. A list follows below of the principal brackish-water and salt-water species of this flora.

Campylodiscus clypeus v. *bicostata* 2, *C. echeneis* 1, *Chaetoceros* sp. 1, *Coscinodiscus argus?* 1, *C. asteromphalus* 1, *C. lacustris* v. *septentrionalis* 1, *Diploneis didyma* 1, *D. incurvata* 1, *D. interrupta* 1, *D. Smithii* 2, *Grammatophora oceanica* 1, *Gyrosigma balticum* 2, *Hyalodiscus scoticus* 1, *Mastogloia elliptica* 2, *M. Smithii* 1, *M. Smithii* v. *amphicephala* 1, *Navicula crucicula* 1, *N. digitoradiata* 1, *N. elegans* 1, *N. humerosa* 1, *N. peregrina* 2, *Nitzschia commutata* 1, *N. navicularis* 2, *N. punctata* 2, *N. scalaris* 1, *N. sigma* 2, *N. tryblionella* 2, *N. tryblionella* v. *debilis* 1, *N. tryblionella* v. *levidensis* 1, *N. tryblionella* v. *victoriae* 2, *Rhabdonema arcuatum* 1, *Rhopalodia musculus* 1, *Surirella ovalis* 2.

Besides these species this flora contains fairly plentiful lacustrine species. This flora may accompany principally the Lg VIII—IX phase which seems to correspond to Sauramo's Rha and Thomasson's Echeneis Sea. According to my material the sea was transgressive at that time. All these circumstances probably point to the fact that the climate ameliorated at the end of the Yoldia period. I had come to this conclusion already in an earlier study (E. Hyyppä 1936). In this connection it is worth mentioning that in Denmark the climate shows distinct signs of amelioration during the latter half of the late-Glacial period on the basis of the mollusc fauna (V. Nordman 1928).

I dealt in greater detail with the question of the late-Glacial climate in my paper in 1936. I then inferred that the later phases of the Baltic Ice Lake (especially the BIII period) were a time of comparatively favourable continental climate. In the earliest Yoldia period (Sauramo's Yoldia I) the climate again deteriorated, but became better at the end of the Yoldia period. No essential correction can be made at present in this conclusion. On the other hand, on the basis of my present material it is evident that the dating of the late-Glacial period based on the microflora is as yet on an insecure basis in its details. In that case, of course, a detailed chronological division of the late-Glacial climatic conditions is also an open question at present.

In the composition of the late-Glacial pollen flora in South Finland interest is centred chiefly on precious deciduous trees which occur fairly plentifully in several profiles, 1—5 per cent and more. In accounting for the origin of these pollen three possible sources are to considered: 1) they may derive from strata older than the late-Glacial time, 2) they may have been carried a long distance, and 3) they may be indigenous to forests that grew in South Finland. In view of the paleogeographical conditions in South Finland during the late-Glacial time it should be considered certain that forests could only grow at that time to any extent worth mentioning in the interior of the Karelian Isthmus and in Karelia N. of lake Laatokka. I am convinced that at any rate *Betula*, *Pinus*, *Picea* and *Alnus* grew at that time in the eastern parts of the Karelian Isthmus, though not at the very beginning of the late-Glacial time. The forests followed fairly closely the retreating ice margin, as I have shown on previous occasions (E. Hyyppä 1933, 1936).

The pollen grains of rarer deciduous trees that occur in the late-Glacial sediments in South Finland seem, however, to have been carried from a distance even to the Karelian Isthmus. This is indicated by the fact that these pollen only occur as a rule in the sediments of comparatively deep water. When they were deposited, most of South Finland was still submerged, so that pollen grains could be carried with great ease from far sources in the south and south-east.

On the other hand it should be mentioned that material deriving from older sediments is most likely to be incorporated in the deep-water deposits. I do not deny at all that pollen grains may be partly of this origin. On the basis of the available materials, however, this re-deposition of pollen would seem to have occurred only to a slight extent, for it is to be noted that in the sediments that are older than the late-Glacial epoch discovered hitherto in South-Eastern Finland, the flora is of a different type than in the late-Glacial deposits now in question. Another important argument against this source of late-Glacial pollen is their occurrence in such sediments, the quality of which strictly precludes such a secondary origin. Late-Glacial *Picea*, *e. g.*, occurs in peat, too, in East Finland.

Late-Glacial pollen flora and the question of climate will still require a great deal of research in South Finland, so that it is premature in this connection to go into this question further.

T h e A n c y l u s p e r i o d is conspicuous for the predominance of pine forests, *Betula* and *Alnus* being the principal trees next to *Pinus*. Pollen grains of rare deciduous trees have now disappeared entirely and only begin to re-appear in South Finland during the Ancylus regression. With the exception of the Karelian Isthmus, South Finland began to be afforested only during the Ancylus period, when the role of distant derivation decreases in the pollen statistics. It seems on the basis of the pollen flora that the climate in South Finland was more continental during the Ancylus period than in the preceding Yoldia period.

The diatom flora of the Ancylus Lake is decidedly of fresh-water type in South Finland. This flora cannot, however, be sharply distinguished from the later phases of the Baltic Ice Lake nor from the flora of the Yoldia Sea. During the final phase of the Yoldia period the diatom flora, at any rate in the region of the Karelian Isthmus, develops, indeed, clearly in a marine direction, but contains plenty of the same species at that time too, that subsequently live in the Ancylus Lake. On the other hand, diatoms indicating brackish water, as, *e. g.*, *Mastogloia* species, also occur in the sediments of the Ancylus Lake. The fact that the Ancylus Lake flora lived in shallower water than the late-Glacial one, partly exercises a notable control on the composition of the flora. *Eunotia Clevei*, as has already been established (H. Lindberg 1916), is a certain index fossil for the final phase of the Ancylus Lake in South Finland.

The Littorina period. This period is characterised by pollen assemblage dominated by deciduous trees, in which the peak of mixed oak forests forms the most important fixed point in post-Glacial pollen chronology. In South Finland the quantity of pollen of rare foliferous trees amounts in some cases to 20 per cent, but is 5—10 per cent on an average and often even less. According to the pollen flora the principal precious deciduous trees were *Tilia* and *Ulmus*, but *Corylus* also occurs abundantly in some places. *Quercus*, on the contrary, was rarer. The pollen curve for mixed oak forests begins to rise continuously already in the final phase of the Ancylus period, but as a rule the spread of these trees and especially the uninterrupted occurrence of *Tilia* only starts at the beginning of the Littorina period. In this respect, however, the pollen diagrams display a great variety, especially those parts which correspond to shore zone accumulations.

The absolute maximum of mixed oak forests is also of varying date in different profiles. In most cases it occurs approximately halfway through the Littorina period or earlier, which would correspond, too, to the optimal time of the climate. During the Littorina period *Picea* appears again among the forest trees. On the Karelian Isthmus the spread of spruce begins as a rule already at the beginning of the Littorina period, but in Uusimaa about the middle of this phase. However, there are many exceptions to this rule. Aqueous sediments in particular contain *Picea* pollen in very varying proportions which by no means always reflects the areal distribution of spruce, but the influence of local factors on the sedimentation of the pollen grains in shore zones. The climate was a marine one during the time of the Littorina Sea throughout the Baltic region and at its post-Glacial optimum, as has been recognised for a long time.

The Littorina Sea deposits in South Finland contain a distinctly marine, abundant diatom flora chiefly consisting of brackish-water species. By means of the diatoms a sharp limit can be drawn between the Ancylus and Littorina strata. The most characteristic species is *Campylodiscus clypeus* which often occurs in masses in the Littorina Sea ooze. The *Clypeus* flora reached South Finland at the very beginning of the Littorina period. It was not preceded in this area by any *Mastogloia* flora, as has been assumed (cf. page 61).

The post-Littorina period begins, where spruce is on the rise towards its post-Glacial maximum and the continuous occurrence of precious deciduous trees ceases. The post-Littorina period is actually a time of spruce forests in South Finland, when the composition of the forests gradually develops to its present state. The favourable climate of the Littorina period has grown worse. Blytt-Sermander's detailed theory concerning the changes of climate is familiar to all students of the post-Glacial climatic fluctuations. The stratigraphy of the peat bogs in South Finland does not furnish any conclusive evidence with regard to this theory, at any rate on the basis of an examination of its main features. I have abstained in the present study from going into this large question. Besides, in regard to the post-Littorina climate V. Auer recently published some new points of view, so that I will confine myself to referring to his researches (V. Auer 1933, 1935).

The post-Littorina pollen flora is still worth considering in one respect, for it contains *Carpinus* pollen grains which V. Auer discovered already in 1928 in the bogs of Ahvenanmaa (verbal statement). Occurrences of *Carpinus* are met with all the way from the Helsinki district to the Karelian Isthmus (cf., *e. g.*, the diagrams Fig. 7, page 23, Fig. 14, page 39, Fig. 56, page 184). In almost all cases there is only 1 per cent of *Carpinus*. It appears at the very beginning of the post-Littorina period and continues even past the absolute maximum of spruce. The occurrence of *Carpinus* in Sweden, too, is confined to this period (L. von Post 1924). It cannot yet be asserted with certainty on the basis of these slight appearances of *Carpinus* pollen that *Carpinus* grew in Finland during the post-Littorina period, but such a possibility is not precluded.

In this connection it should also be mentioned that the accumulation of peat proceeded very slowly in South Finland up to the Littorina period. The actual formation of bogs and of peat only started at the beginning of the Littorina period and has continued intensively up to the present. The rapidity of the growth of peat has varied during this long period being probably due, at any rate partly, to minor climatic fluctuations. I am not able to discuss these questions, interesting though they are, in the present paper. As to the »Highmoors» E. Granlund (1932) has dealt with them in a meritorious manner.

The inquiry into the development of the Baltic is thus intimately connected with the gradual unraveling of the history of the post-Glacial climate and forests. To the same extent as the study relating to the former progresses, our knowledge of the late-Quaternary climatic and forestrial conditions is also constantly increased.

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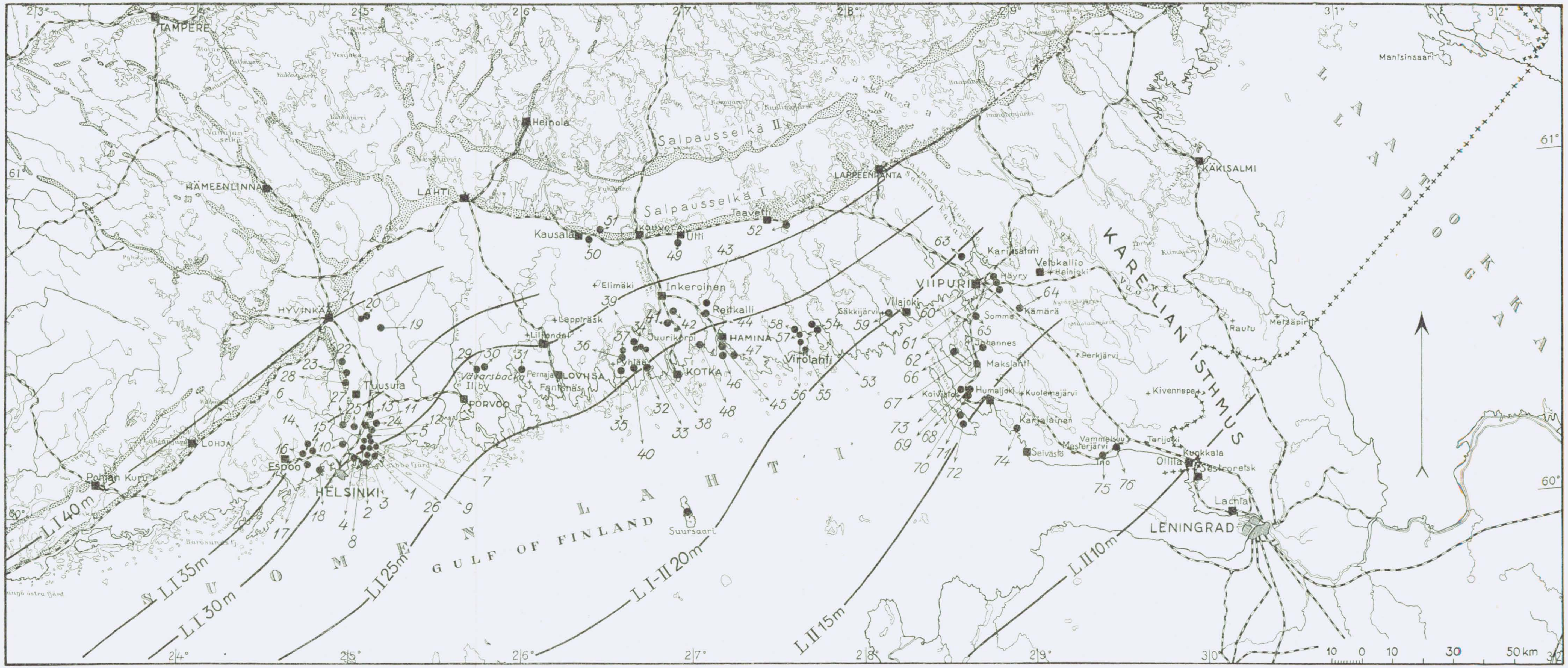
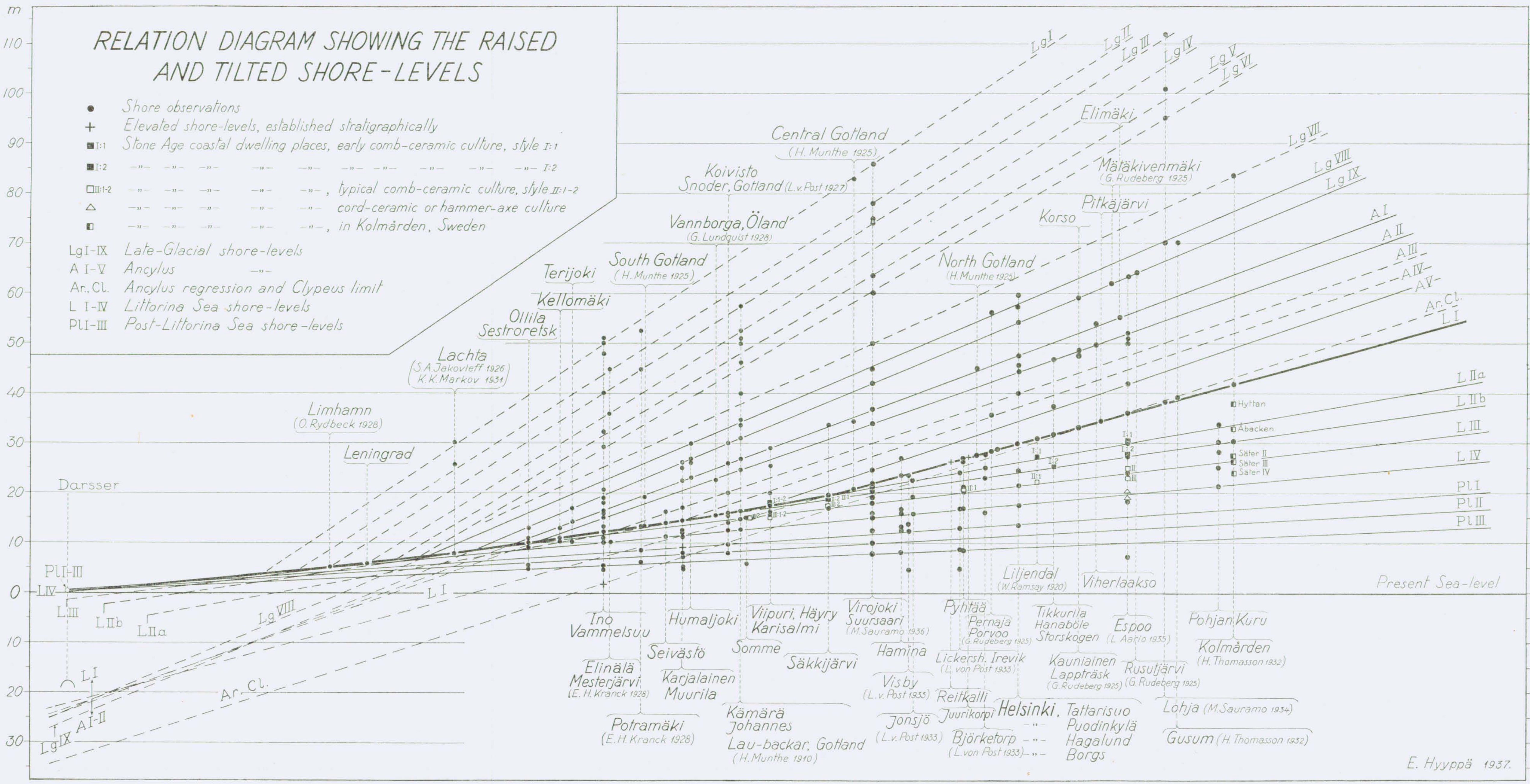


Investigation areas and the isobases showing the maximum extent of the Littorina Sea. On the Karelian Isthmus L II is the highest limit of the Littorina Sea, in Uusimaa it is L I. These shore-levels intersect each other at Säkkijärvi, 19—20 m. above the sea.

Esa Hyyppä: Post-Glacial Changes of Shore-Line in South Finland.



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