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ESTIMATING THE LENGTH OF A PERIOD BY MEANS OF ^{14}C-TESTS

This paper presents a method which aims to create a set of guide-lines for estimating the fit between two irregular probability distributions. One, the observed, is made up of the sum of the probabilities of any number of ^{14}C-tests describing the length of a period during which a certain context was formed. The other, the expected, is made up of the probabilities connected with a series of points on the calibration curve, e.g., the 11 BP-values (assigned the average standard deviation of the observed tests) that match the calendar years 105, 115, ... 205 AD. This series is considered to be a model of a period with a linear relationship between the course of time and the production of ^{14}C-test material. The discussion is centred around the construction and the interpretation of a conventional index. It draws upon one example each from the Mesolithic and Migration/Vendel Periods.

Introduction

When the opportunity for dating organic material by means of the radiocarbon method was first introduced, the technique was primarily considered as an independent means of dating archaeological material. Little attention was paid to the fact that in theory there is no difference between the occurrence, in a context, of a piece of charcoal or of an artefact; each has intricate and obscure ties with prehistory and time. Man's constant and supposedly unreflected need for organic material was on the whole thought to provide samples with a straight forward link back into prehistory, and expectations were high for the future of archaeology (e.g. Kjærum 1959:91), or at least there was a firm belief in the independence of the new method (Rausing 1958:93ff; Moberg 1959:11).

Some years later, the subject of archaeology serviced by the natural sciences had developed into a reader phenomenon (Brothwell & Higgs 1963), and ^{14}C-tests were considered as the standard independent means of solving chronological problems (Willis 1963); a method that would eventually save us from endless chronological discussions that were from the very beginning blocked by the incompatible opinions on cultural history held by the debating archaeologists (cf. e.g. Ekholm 1943; 1945; vs Norling-Christensen 1944 on the chronology of the Roman Iron Age in the Germanic periphery). Today, radiocarbon dating is one of a growing range of scientific dating methods, that have in themselves become disciplines in their own right (Göksu et al. 1991).

The average archaeologist finds it hard to consider himself as naïve as the forefront researcher some 40 years ago, but the *Deus ex machina* view of the ^{14}C-date is still common, and if it is not a stated principle, at least a hope is shared by many that the radiocarbon method will provide chronological first-aid. The cautious source-critical discussions from the 1950s (Kjærum 1959:87ff), or Rausing's or Moberg's insights from around 1970 (Moberg 1969:64ff; Rausing 1971:171ff), tend to fall into oblivion as ^{14}C-testing becomes a mass-phenomenon. The aim of this article is to lead us away from the *Deus ex machina* view, and to present a method for organizing ^{14}C-dates from archaeological contexts. In so doing, all test results that will be used are accepted as published, and no competition between chronological methods is intended.

With the present increase in numbers of tests, the need to handle the results as some form of description of more or less complicated contexts of specific temporal duration in time, becomes obvious (e.g. Ottaway 1973; Tauber & Malmros 1977; Kyhlberg 1982; or Hassan 1990). This means that the inherent value of these tests has swung away from that of independent dates related to the substance of a specific object, to that of one possible date among many connected with a specific context. Such imprecise and biased dates are familiar to archaeologists, since they are part and parcel of the chronological status of all artefacts and contexts. This altered status of the ^{14}C-test deprives us of the independent date, and calls for a discussion towards establishing a more formalized and context-dependant method of presenting the values.

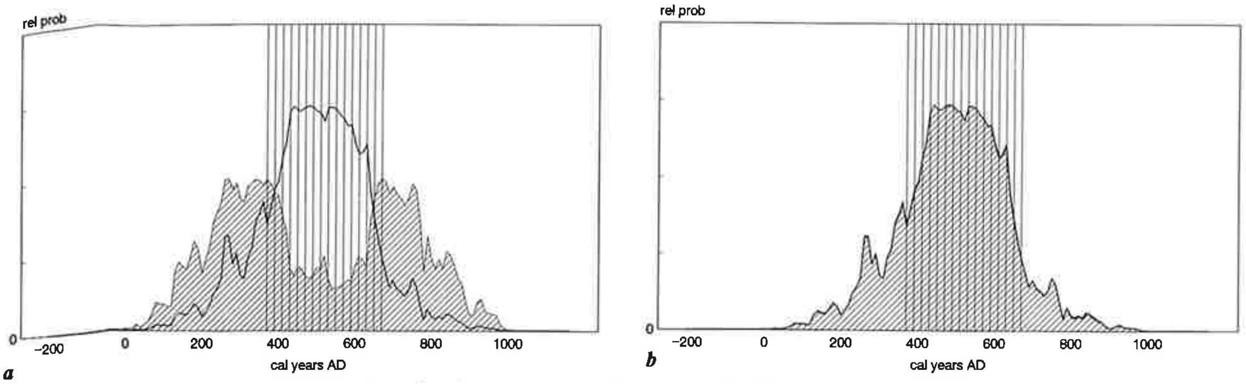

Fig. 1. The difference between two probability distributions covering the period 385–675 AD. Differences are the result of the number of tests used to define the period. Vertical lines mark out each period. a) the hatched area depicts the minimum definition, i.e. the sum of the probability distributions for the years 385 and 675 only. The curve signifies the sum of the probabilities for the years 385, 415, 445, 475 ... 675 AD. b) the hatched area is equal to the area below the curve of fig. 1a, and the curve reproduces the sum of the probabilities for the years 385, 395, 405, 415, 425, 435 ... 675 AD. The two distributions are almost equal, but some minor differences can be observed e.g. between 800 and 900 AD.

Method

The procedure outlined here is based on the calibration program from Washington University, Quaternary Isotope Lab. Radiocarbon Calibration Program, the 1987 revised 2.0 edition. The Appendix describes how the necessary computations can be carried out.

It is necessary to first calibrate the tests and to compile a database in which each record consists of two variables: the year covered by a calibrated test and the probability that this particular year is dated by the test. A database with these values is established by the calibration program itself, in ASCII-format, for each test individually, and collected in a file, here the default file *C14FIL.PRB*.

A single test covers several hundred years, and several tests overlap considerably. In order to be manageable, the probabilities connected with each year must be summed up and grouped into classes of a given span, e.g., of five or ten years. The probabilities that one of the years in these classes is dated by one or more of the tests is displayed in a diagram, e.g., a curve, in such a way that the area below the curve is equal to 100, whatever the number of tests used to construct the diagram. The curve describes the ^{14}C-date of the context as a probability distribution in calibrated calendar years.

This way of presenting probabilities is in essence the same as the procedure carried out by the subprogram DISPLAY in the Washington program, and is related to the presentations made by J. van der Plicht and W. G. Mook (1989:fig. 3), though their examples only cover single tests and not a series describing the duration of an archaeological context. To archaeologists, however, single tests are of limited interest if they cannot be used to describe the duration in time of a context, and few contexts are so short-lived and so closely linked to the moment, that a single test or date is sufficient to describe their period of compilation or use. This simple way of summing up the calibrated years of a ^{14}C-dated phenomenon, can sometimes in itself support an archaeological interpretation (Hjärthner-Holdar 1993:fig. 83; Pikirayi 1994:166; Chami 1994:fig. 70).

The next archaeological concern centres around the question of how well the tests in a sample describe the course of time during the period in which the material pattern, that we have chosen to call the context, was formed. That is to say, what is the likelihood that a given point in time belongs to, and can be described by, this context?

One might think of several models outlining the relation between time and the ^{14}C-sample, but the most natural model is that in which all points in time, which make up the period covered by the context, have an equal possibility of being dated by a ^{14}C-test. That model reminds us of the way we usually measure time and although it is a theoretical ideal that no empirical material will ever match, a comparison between the observed probability distribution and an ideal, reflecting the continuous formation of a ^{14}C-test material, is a natural analytical step. Most chronological discussions tend to depend upon an understanding of the context in focus rather than on methodological principles.

The estimation problem

The estimation of the length of a period is based on a comparison between a theoretically defined period using the fixed points of a calibration curve, in this case the ATM-files of the calibration program, and a ^{14}C-sample from a context. There are two types of fit that should be defined in connection with the estimation of the length of a period covered by a context.

Given the variations of ^{14}C-years in terms of calendar years, it is relevant to first ask how well the probability distribution that reflects the period, fits the limits of that period. One way of estimating this fit is to work out what percentage of the probability distribution lies outside the limits of the period. This measure is called *p1*. There are several phenomena regulating this fit (see below), but

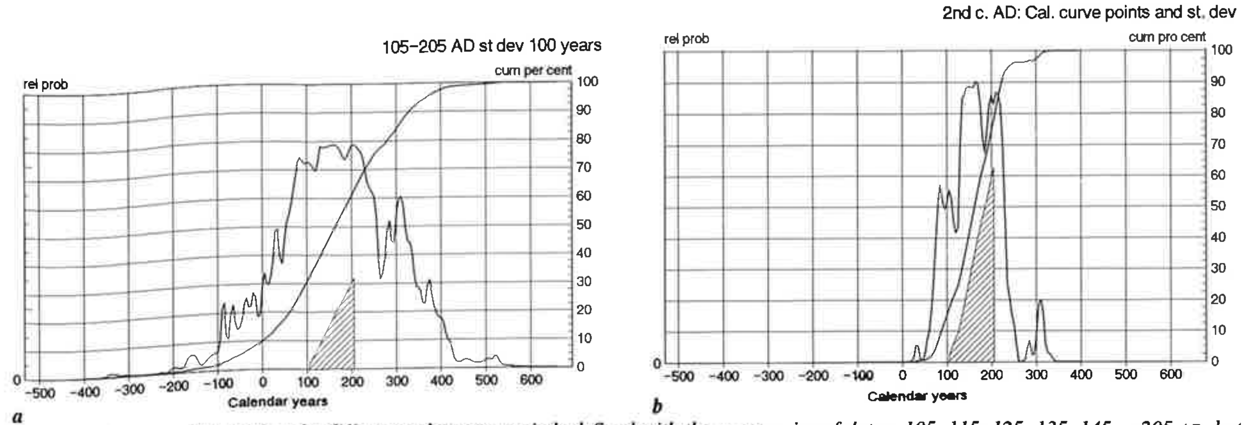

Fig. 2. Two diagrams illustrating the differences between periods defined with the same series of dates: 105, 115, 125, 135, 145 ... 205 AD, *but with two different sets of standard deviations. The hatched area signifies the percentage of probabilities within the limits of the period. a) standard deviation of 100 years for each date. b) standard deviations are those of the points in the calibration curve, see table 1.*

generally speaking, these relate to the number of points used to define the period, since the more tests involved, the more stable the definition.

The next problem concerns estimation of the fit between the theoretically defined period and the distribution of the sample probabilities. The ideal would be no difference at all, but when in practice differences do occur, these should be judged according to their position in the distribution. Differences that fall within the limits of a theoretically defined period are, generally speaking, the result of the fact that some points of time within the period are not as evenly stressed in the sample as they are in the model case in which all points of calendar time carry the same weight. These unevenly stressed points still fall, however, within the period, and have little effect on its limits. This measure is called *p2*.

Differences that fall outside the period are much more decisive, since they imply some fault in the definition of period length or with its position along the time scale. These can have two causes: on the one hand, the sample might contain points of time that fall outside the period, on the other hand, it might lack points of time in the border zones of the period. Both problems are crucial to the estimation of fit, and so this percentage, the *p3*-measure, should carry greater weight when estimating the fit, than p1 and p2.

This means that there are three percentages of probability to take into account namely: P1, the percentages outside the limits of the period in the expected ideal distribution; P2, the probability percentage between the expected and the observed (i.e. the sample) within the limits of the period; P3, the probability percentage between the expected and the observed which falls outside the limits of the period.

The construction of an ideal period is influenced by four factors:

1. The number of tree-ring years dated to within the period, i.e., the number of points by which the period is defined. This factor works in the following way. If a period is defined by the minimum number of points, i.e., two, then approximately 50% of the possibly dated years will fall outside the period when factors 2 and 3 are constant. Should, however, more dates be added symmetrically in-between these dates, then a greater number of years will fall within the limits of the period (fig. 1a). The drop in percentages outside the period limits is not proportional to the number of tests, since due to variations in the production of ^{14}C, even a period defined by many points will have some probabilities outside its limits (fig. 1b). Eventually the distribution will represent the true picture of the calibration curve during the period being examined. This picture, contrary to that which is based on just a few tests, is only marginally influenced by each of the tests involved. This means that the number p1 should be down-weighted by the number of tests used in the definition of the period.
2. The actual length of a period. This factor works in such a way that a very short period, such as "the year 1 AD", will have most of its dates falling outside the period while a very long period, such as "5000 years on either side of the birth of Christ", will harbour nearly all the inexactnesses of the ^{14}C-dating technique. Due to variations of the standard deviation, factors 1 and 2 are strongly linked to each other.
3. The standard deviation pertaining to the ^{14}C-dating of the tree-ring years of the period: the smaller the standard deviation, the better the definition of the period (fig. 2a–b).
4. The correspondence or parallelism between the calendar years and the ^{14}C-years in that part of the past which is covered by the period.

There are periods of the past where the correspondence factor makes it too difficult for the radiocarbon method to be useful (cf. e.g. Possnert et al. 1989). In these time-segments even the definition of a period suffers from lack of correspondence.

The following examples illustrate some of the above arguments, while taking for granted that the points used

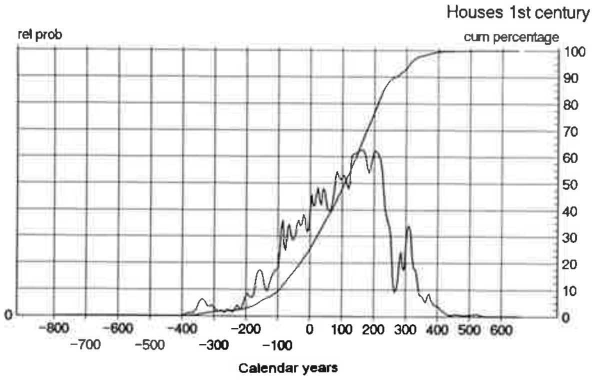

Fig. 3. The probability distribution of the ^{14}C-tests which date houses nos. 13, 18, 19 and 20, from Ulväng 1992.

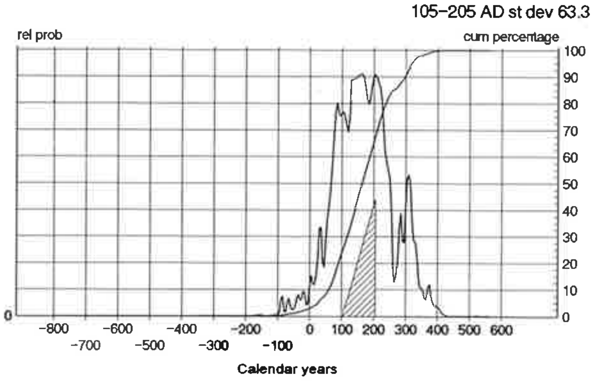

Fig. 4. The distribution of the probabilities for the dates 105, 115, 125, 135, 145 ... 205 AD, with the average standard deviation of the dates from Ulväng (1992) nos. 13, 18, 19 and 20.

to define the periods should be those on which the calibration curve is built. This means that, e.g. "the second century AD" or "the period 105–205 AD" would consist of the dates represented in table 1.

If these BC values are calibrated according to their standard deviation and if, this being done, all the compiled probabilities are summed-up in one probability distribution, then we have produced a picture of what the period 105–205 might reasonably look like, where all points in time have an equal chance to be represented and where the period is represented by only 11 points with the varying precision indicated by the standard deviations. The result of this compilation is seen in fig. 2b, and in accordance with the above discussion, the quality of the period definition is p1/n1=38.16/11=3.46.

It does not much matter if, instead of the actual standard deviation of each test, we use their average standard deviation, 22.63. In both cases the average contribution of one test, to the values outside the period, is c. 3.5%. If it were possible to produce a sample with an average standard deviation of 22.6 years, then the period defined above could be compared to this sample. In a normal case, however, the average standard deviation is much greater, nevertheless it is still a reasonable basis for the definition of a period.

Constructing a conventional index

By down-weighting the p1-measure (by the number of tests, n1) the value p3 has automatically come to carry a greater weight. This weight, however, is conventional, as there are no logical reasons for giving the measure any specific weight compared to p1.

Relatively speaking, even the measure p2 gets a greater weight, equal to that of p3, when p1 is down-weighted. This, however, is not reasonable, and therefore the p2-measure must be down-weighted. This too is a matter of a conventional, rather that mathematically motivated, down-weighting.

It can be argued, that if the number of points in the sample is increased, then there is also an increase among the points which liebetween those used to define the period. This will create a small difference of little importance, but if the p2-measure is at all needed, then it does not seem totally wrong to down-weight p2 in the same way as p1 was down-weighted, namely by the number of tests in the sample, n2. This will not lower the index decisively since the relation between p2 and p3 most often tends to let p3 increase if p2 increases.

It follows that the index is equal to I=p1/n1+p2/n2+p3, and that it consists of the average contribution of one test to the probabilities that fall outside the limits of the ideal period, the average contribution of one test to the differences between the expected and the observed *within* the limits of the period, and the differences between the expected and the observed *outside* the limits of the period.

To exemplify these principles, we may expand upon the above example from the second century AD and compare that period to a sample from a context, e.g. the house-type represented by houses 13, 18, 19 and 22 in Ulväng's (1992) analysis. The sum of the probabilities linked to these tests produces the curve represented in fig. 3, and the average standard deviation of the sample works out at 63.3 ^{14}C-years (table 2). The deviation defines the precision of the period, which is represented by the probability distribution in fig. 4. The quality of the period definition, i.e., p1/n1, is 44/11 or 4%.

Comparing the period and the sample (fig. 5), there are immediate differences to be seen, and if they are investigated, then the fit between period and sample is

Tree-ring year	Most plausible BP-year	St. dev
105.0	1884	26
115.0	1891	27
125.0	1897	13
135.0	1825	16
145.0	1825	26
155.0	1832	22
165.0	1838	27
175.0	1820	26
185.0	1799	22
195.0	1811	26
205.0	1846	18

Table 1. A subset of the calibration points in the curve ATM10.14C.

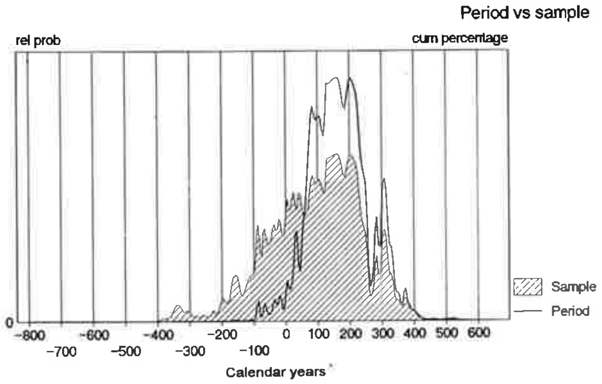

Fig. 5. A comparison between the sample in fig. 3 (bold line), and the period definition of fig. 4 (hatched area).

shown to lack 57% (fig. 6). Of this percentage only 13.8, the p2-measure, falls within the period. This percentage should be down-weighted according to the number of tests in the sample and therefore its value becomes 13.8/9=1.53. Thus the sum of the two weighted values becomes 4.0+1.53 or 5.13. The remaining measure, p3, is equal to 57–13.8=43.2%. This describes the lack of overlap between a short period and a small sample and it should be added to the weighted value, making the end product equal to 5.13+43.2=48.33.

It is obviously wrong to say that the period to which the context, i.e. the house type, could be dated, is equal to the second century AD. The fit is bad, the period is short and thus difficult to define precisely, and the sample is small and thus probably an unstable reflection of the context.

To sum up, the index covers three measures: p1/n1, which does not show on diagrams; p2/n2, which can be observed only as an unweighted difference; and p3, which is the difference that catches the eye. It is clear that employment of the method involves assessment of the theoretical qualities of the context, the source critical aspects of the sample, and the technical steps leading to the optimal period definition, before evaluating the index. In what follows, this assessment is made with regard to two case-studies, in order to clarify that the index should be used as an aid for tentative discussion in which it is pointless to figure out specific confidence levels as a basis for conclusion.

Test no.	BP- year	St. dev.
1	1850.0	50.0
2	1820.0	50.0
3	1840.0	50.0
4	1820.0	60.0
5	1960.0	50.0
6	2020.0	50.0
7	1970.0	60.0
8	1825.0	100.0
9	2025.0	100.0

Table 2. Nine test samples dating a house type.

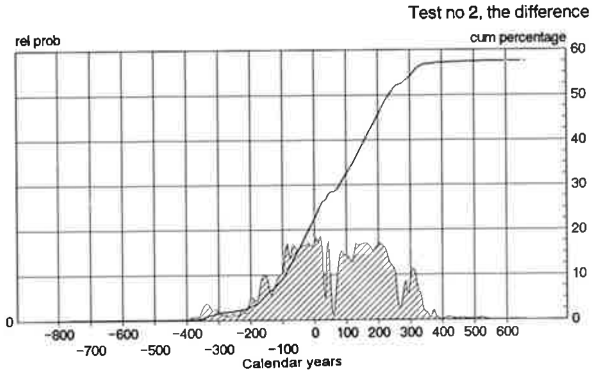

Fig. 6. The differences between the two distributions in fig. 5.

Friesack 4

At Friesack, some 60 kilometres northwest of Berlin in the county of Potsdam, waste from a Mesolithic settlement was during some periods continuously thrown into a lake from a low sandy rise on which the settlement

Test no.	BP-year	St. dev.	Layer	Phase
Bln-3036	7730.0	70.0	10a/Xe	1
Bln-3026	7720.0	60.0	10a/Xe	1
Bln-2756	7680.0	100.0	10a/Xe	1
Bln-2761	7610.0	100.0	10a/Xe	1
Bln-3001	7630.0	60.0	13a	1
Bln-3020	7690.0	60.0	9b	1
Bln-3019	7690.0	60.0	9a	1
Bln-2753	7540.0	100.0	9a	1
Bln-1914	7500.0	65.0	9a	1
Bln-2760	7470.0	100.0	8b/Xc	2
Bln-3025	7390.0	70.0	8b/Xc	2
Bln-3000	7270.0	60.0	8b/Xc	2
Bln-2752	7240.0	100.0	8b/Xc	2
Bln-3018	7450.0	70.0	8a	2
Bln-2751	7330.0	100.0	17	2
Bln-2758	7300.0	100.0	17	2
Bln-3009	7290.0	70.0	17	2
Bln-2750	7240.0	100.0	17	2
Bln-3024	7230.0	70.0	17	2
Bln-3035	6900.0	60.0	17	2
Bln-1913	7025.0	70.0	7	3
Bln-1913A	6900.0	70.0	7	3
Bln-3008	7090.0	70.0	6cA6	3
Bln-3027	7090.0	70.0	6cA6	3
Bln-3017	7060.0	70.0	6cA6	3
Bln-3014	7030.0	60.0	6cA6	3
Bln-2723	7030.0	100.0	6cA6	3
Bln-3016	7020.0	70.0	X8	3
Bln-3023	7090.0	60.0	6b	3
Bln-3013	7030.0	60.0	6b	3
Bln-3015	7190.0	60.0	X6	3
Bln-3022	7200.0	70.0	5b	3
Bln-3007	7030.0	60.0	5b	3
Bln-3012	7010.0	60.0	5b	3
Bln-3011	6890.0	60.0	6a/C17	3
Bln-2755	6680.0	100.0	6a/C17	3
Bln-3028	6990.0	60.0	5a	3
Bln-3010	6860.0	70.0	5a	3
Bln-3021	7060.0	70.0	16	3
Bln-3006	7050.0	70.0	32b	3
Bln-3003	6990.0	60.0	32b	3
Bln-3002	7080.0	60.0	33	3

Table 3. The Friesack 4 sample, after Gramsch 1987.

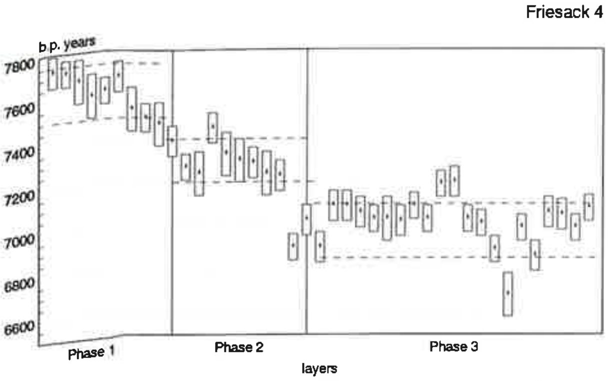

Fig. 7. Diagram showing the distribution of the uncalibrated ^{14}C-tests from Friesack 4. The height of the bars is defined by ±1 standard deviation in ^{14}C-years for each test. Tests are ordered along the horizontal axis in accordance with table 3.

proper was situated. As a result, charcoal, wood and bone have been preserved in stratified layers on the lake shore (Gramsch 1987).

The test material used by Gramsch to establish a ^{14}C-based site chronology, comprised charcoal from the waste layers connected with the occupation, i.e., firewood, a material for which there was constant demand during what seems to have been periods of regular visits to the site. Assessments of the quality of the context and source-critical aspects are, in other words, solved by adopting Gramsch's interpretation. Stratigraphical, palynological and archaeological evidence, in addition to radiocarbon dates, have helped to define the relative and absolute chronology of the sedimentation.

When the radiocarbon tests are in focus, it is natural to concentrate upon the tests that fall between Middle Preboreal and Early Boreal times. Here, tests are abundant and the different kinds of source material mutually support one another. This means that from the stratigraphical series of tests published by Gramsch, one should choose the 42 tests between layer 10a and layer 33 for analysis.

Based on table 3 and a graphical presentation of the tests (fig. 7), Gramsch combines stratigraphy with test results in such a way that three periods emerge:

Period 1: c. 7750–7500 BC
Period 2: c. 7400–7200 BC
Period 3: c. 7100–6850 BC

From a purely stratigraphical point of view, as well as from a palynological, not least synanthropical, angle, the same type of settlement process is in fact repeated twice on the site. At first, the finds become embedded in the mud, but the frequent visits to the low sandy hill lead to an increasingly sandy sedimentation in the lake. These initial sandy deposits terminate with layer 9a.

In his interpretation of the site-stratigraphy, Gramsch prefers to see the muddier layers above 9a, i.e. layers 8b to 17, as a period of their own and the sandy complex above these layers, i.e. layers 7 to 33, as yet another period. Palynologically, however, there is reason to draw a parallel between layers 10a to 9a and layers 8b to 33. Both groups seem to be the result of middle Preboreal and Boreal land-use as summarized by Kloss in his description of the synanthropic pollen in his second profile (Kloss 1987:115). Stratigraphically the transition from the sandy layer 9a to the mud in layer 8b indicates a hiatus in the Mesolithic use of this small sandy settlement site within the lake system. From a methodical point of view, what matters is the comparison between Gramsch's balanced discussion of period formation (using uncalibrated central ^{14}C-BC values in connection with their standard deviation) and the method suggested above.

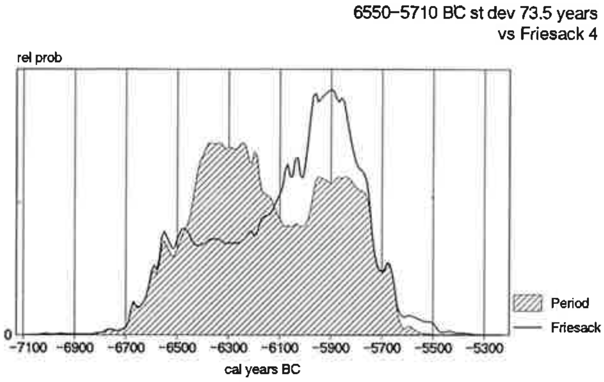

Fig. 8. A comparison between the period cal 6550–5710 BC, i.e., the points 6550, 6530, 6510 ... 5710 paired with the standard deviation of the Friesack sample (bold line), and the 42 tests in the Friesack sample (hatched area).

A glance at fig. 7 can suggest a rather continuous series of tests without the breaks indicated by site stratigraphy. If this hypothesis – i.e. that the sample covers regular visits to the site between 6550 and 5710 BC (the best fit) – is tested against the sample, then the graphs obviously do not show the correspondence we would demand in order to find support for our hypothesis (fig. 8). The index of the fit is 2.9, and the marked split between the two distributions shows that there is a lack of probabilities in the sample around 6300 BC and a surplus around 5900 BC. This is an indication of a hiatus in the use of the site at c. 6300 BC, and that 5900 BC constitutes the mid-point in a period of use. Due to the hiatus around 6300 BC, we might even expect that the values at 6500 BC, demarcate a probability maximum and the centre of

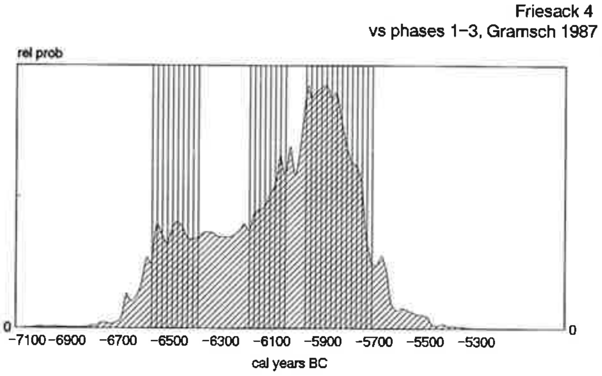

Fig. 9. A calibration of Gramsch's phases superimposed upon the probability distribution of the 42 tests in the Friesack sample, cf. fig. 8.

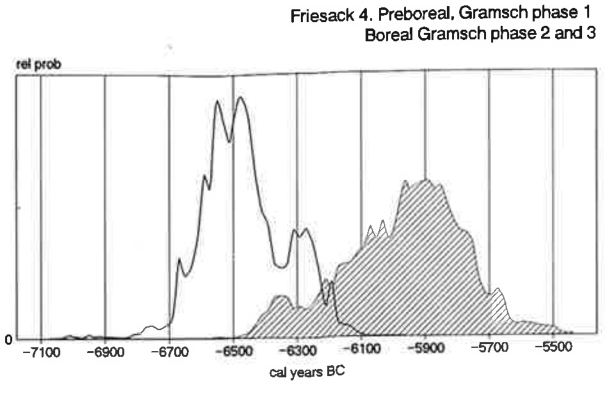

Fig. 10. The probability distribution of the Preboreal (bold line) and Boreal (hatched) phases at Friesack 4.

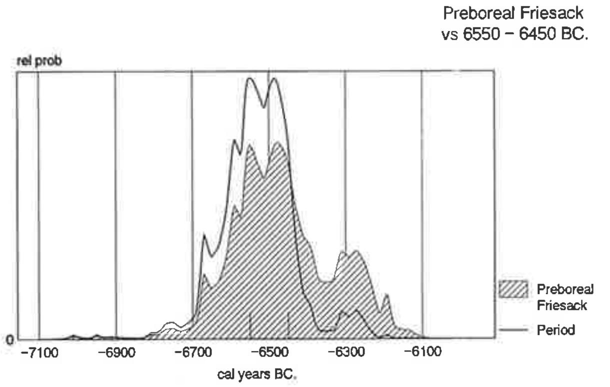

Fig. 11. A comparison between the probability distribution of the Preboreal layers in Friesack 4 (hatched), and the probability distribution for the period 6550–6450 BC (bold line).

an early period of use. The stratigraphical division of the site into two main periods of use, is initially supported by these analyses of the ^{14}C-tests, but in relation to the great length of the total period of Preboreal and Boreal use of the site, 840 years, the hiatus c. 6300 BC need not cover a wide gap.

We obtain the same results if the periods estimated by Gramsch are calibrated, i.e. if their boundaries are roughly estimated by means of the calibration curve, and are superimposed upon the diagram. This procedure clearly shows that there is no total correspondence between the periods and the probability distribution (fig. 9). The middle period, Gramsch's phase 2, layer 8b to 17, does not match any culmination of probabilities, indeed on the contrary, during those years the curve rises towards the main culmination at c. 5900 BC. As a rule of thumb, however, the central part of any period should be characterized by the years with the highest probability values. For this reason, bearing in mind the palynological evidence and the main structure of the stratigraphical record, one might pursue the hypothesis that there are two main or intensive occupation periods on the site – layers 10a to 9a, and layers 8b to 33 – rather than three.

If the ^{14}C-tests belonging to these two groups of layers are singled out (fig. 10), then they both form the peaked distributions that in theory signify periods: one c. 6500 BC, the other c. 5900 BC. The distributions are not quite symmetrical, which might mean that they do not fit a period with evenly distributed possibilities for dating a certain point in time, but the apparent skewness might also be due to variations in the production of ^{14}C.

If the possibilities are unevenly distributed, this might indicate that the context formation was contaminated by old wood or disturbed by a change in activity and by sedimentation of charcoal in a certain period. One might suppose that for a while two family groups, rather than one, paid regular visits to the site, leading archaeologists to extract more tests from an intensive short period than from the longer less intensive ones. The risk of making this type of mistake is probably negligible when studying Mesolithic society, which is characterized by its small, relatively constant population and abundance of easily accessable firewood. Both the Preboreal and the Boreal distribution may therefore be tested against the model of charcoal that is distributed evenly in time.

Let us suggest that c. 6500 BC is the centre of the first period and estimate its length as the 100-year span between 6550 and 6450 BC. The result is seen in fig. 11. The overall shapes of the two curves, Friesack 4 Preboreal and the 100-year span, resemble one another, indicating that the irregularities of both curves are the result of variations in the calibration curve rather than the

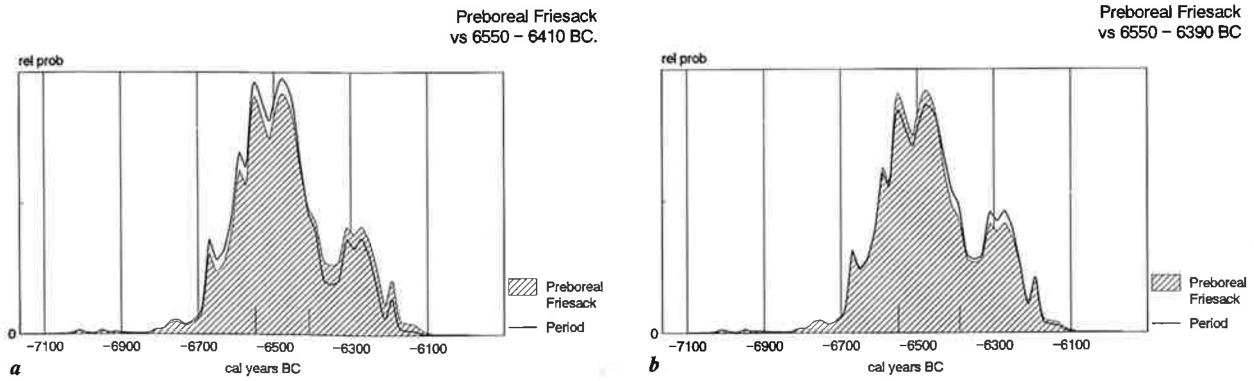

Fig. 12. a) Comparison between the probability distribution of the Preboreal layers in Friesack 4 (hatched), and the probability distribution for the period 6550–6410 BC (bold line). b) comparison between the probability distribution of the Preboreal layers in Friesack 4 (hatched), and the probability distribution for the period 6550–6390 BC (bold line).

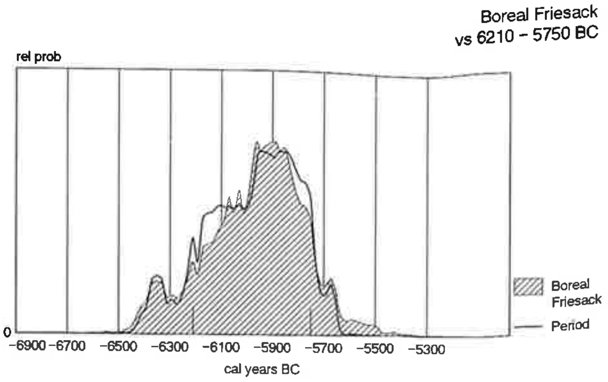

Fig. 13. Comparison between the probability distribution of the Boreal layers in Friesack 4 (hatched), and the probability distribution for the period 6210–5750 BC (bold line).

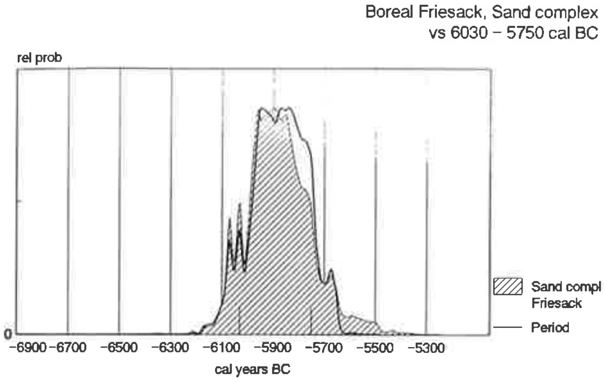

Fig. 14. Comparison between the probability distribution of Gramsch's phase 3, the upper, Boreal, Sand Complex in Friesack 4 (hatched), and the probability distribution for the period 6030–5750 BC (bold line).

result of major differences between the ideal and the sample. Although the two curves are similar there is no doubt that the younger part of the Friesack distribution does not match the younger part of the century curve. Therefore, in fig. 12a–b, the expected period has been extended to 140 and 160 years respectively, in order to minimize the accumulated differences between the curves.

There is little doubt that both curves match the Friesack Preboreal distribution well, and in fig. 12b the differences amount to c. 6.5% of the total, 200%, probability on which the two curves are based. But the more recent section of the distribution, and the peak, fit the period-curves differently, implying that the most reasonable length of the Friesack Preboreal settlement phase is c. 150 years from c. 6550 to c. 6400 BC. Since the method used here is based on the calibration curve *ATM20.14C* with its 20 year intervals between fixed points, there is, however, no room for that kind of interpolation. The analysis transposes the centre of the period, tentatively defined as c. 6500 BC, to c. 6480 or perhaps 6470 BC.

To sum up, the 160-year period 6550 to 6390 BC is made up of nine tests from the calibration curve *ATM20.14C*. Due to the average standard deviation of the tests in the sample, 51.93% of the distribution falls outside the period limits. Therefore the p1/n1-measure is 51.93/9=5.77%. The difference between sample and period in fig.12b amounts to 6.54%. The percentage within the period, the p2-measure, is 3.67%, a figure that should be down-weighted by the number of tests in the sample, n2, to 3.67/9=0.41. When the remaining 2.97%, p3, are added, the index equals 5.77+0.41+2.97 or 9.15.

In the Boreal phase (the hatched part of fig. 10) the probabilities are lower, which probably means that the period covered by these is considerably longer than c. 150 years, but theoretically it could also be a result of variations in the production of ^{14}C. Experimentation with different periods shows that the 460 years between 6210 and 5750 BC are the most suitable for matching the distribution (fig. 13). This is not as good a match as that which characterizes the Preboreal settlement, but the period is longer and the sample larger, producing a less decisive misfit for the period as a whole. There is, moreover, little evidence of a hiatus anywhere between 6060 and 5970 BC.

Instead of pointing to discontinuity within the Boreal occupation, we should perhaps emphasize the relatively regular way in which the ^{14}C-tests describe the course of time. The intensity with which a settlement site was used

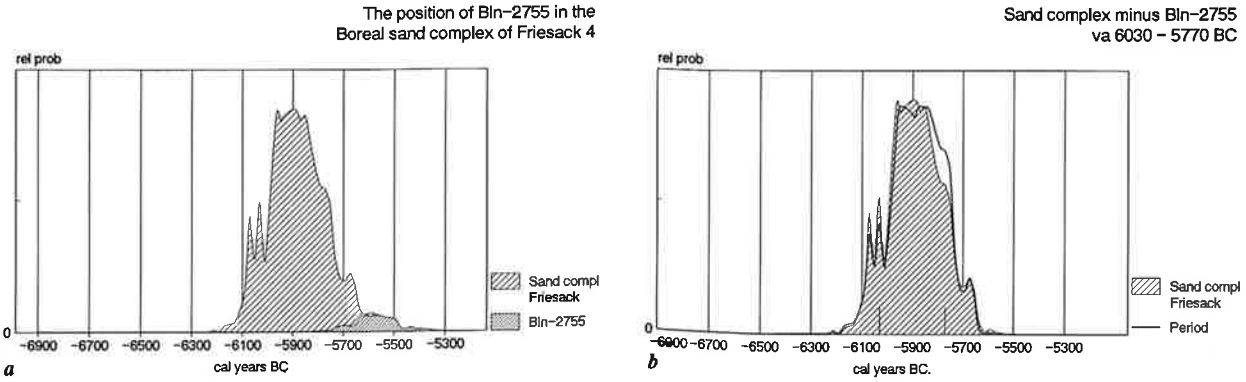

Fig. 15. a) The contribution to the probability distribution of Gramsch's phase 3, the upper, Boreal, Sand Complex in Friesack 4 (sparsely hatched), by the test Bln-2755 (densely hatched). b) a comparison between the probability distribution of Gramsch's phase 3, the upper, Boreal, Sand Complex in Friesack 4 without the test Bln-2755 (hatched), and the probability distribution of the period 6030-5770 BC (bold line).

during no less than 460 years, can be expected to vary more than in this case, and to vary in such a way that some phases of the period produced more charcoal than others, thus causing such intervals to have a greater chance of being dated by a ^{14}C-test. The difference between the ideal and the observed distribution, in other words, does not create any great problems for the interpretation of the curves.

To sum up, the 460-year period 6210 to 5750 BC is made up of 22 tests from the calibration curve *ATM20.14C*, where 17.95% of the distribution falls outside the period limits. Therefore the p1/n1-measure is 17.95/22=0.82%. The difference between sample and period in fig. 13, amounts to 13.99%, and there are 33 tests in the sample. As much as 8.35% fall within the period, thus adding 8.35/33=0.25 (p2/n2) to the index. When the remaining 5.65%, p3, are added, the index amounts to 0.82+0.25+5.65 or 6.72.

If finally we look at the Boreal sand complex, Gramsch's phase 3, (fig. 14), then once more we find only a passable affinity with a period of stable consumption of homogeneous firewood. The index is 8.89 and the misfit is obvious. Some very late year-classes in the distribution are not matched by the period, and conversely the century around 5850 BC in the Friesack sample is weakly represented in the distribution, but over-represented by the period. There is, in other words, a tendency among the ^{14}C-tests to include material that is separated from, and younger than, the bulk of the tests. This might be due to a situation whereby people tend to reduce their regular visits to a settlement during the final decades of its use. In my opinion, this explanation is as good as the source-critical suggestion that the late value of the test Bln-2755 is the result of a contamination from later Atlantic settlements. This may of course be the case, but it should be noted that even if we exclude Bln-2755 from the sample, skewness is still visible (fig. 15a–b). This fact supports an explanation in terms of human behaviour rather than source-critical scepticism. The index for the estimation in fig. 15b is 4.84.

These characteristics of the end of the Boreal phase (fig. 13, c. 5800 to 5400 BC) have their counterparts, if not equally obvious, in the beginning of the phase (fig. 13, c. 6500 to 6100 BC). This indicates that the period began and ended with relatively irregular visits to the site or at least irregular waste dumping. The limits of the period are thus not very sharp.

A comparison between the discussion by Gramsch (1987) and the method adopted here, shows that a cautious discussion based on ^{14}C-years and guided by stratigraphical evidence does not mislead. There were, however, some important differences in the two approaches.

The hiatus that Gramsch places between 7200 and 7100 BC, based on relatively weak stratigraphical evidence (Gramsch 1987:78), is reflected only in a lack of central uncalibrated BC-values. As a matter of fact, 11% of the probability for the whole occupation, and 14% of the Boreal occupation, fall within this ^{14}C-century with only one central value. These percentages should be compared to 9% and 10% between 7300 and 7200 BC, a ^{14}C-century with no less than five central values.

Test no.	BP-year	St. dev.	House
U 0541	1530	80	I
St1756	1370	75	I
St1970	1645	65	A
St1973	1475	70	II
St1974	1545	65	III
St1981	1460	65	IV
St1909	1635	100	L
St2358	1460	100	D
St2360	1615	100	C
St2362	1470	100	F
St2363	1400	100	E
St2364	1535	100	VI
St2365	1410	100	03
St2366	1270	100	B
St2367	1460	100	05
St2368	1595	100	C
St2369	1430	100	H
St2907	1460	100	St/sq.
St2911	1655	100	L
St2913	1420	100	M
St2914	1410	100	07
St2904	1575	100	St/sq.
St2906	1625	100	M
St2908	1475	100	M
St3013	1475	100	L
St3015	1475	100	S
St3491	1575	100	Ö
St3492	1595	100	Ö
St3496	1655	100	T
St3497	1535	100	Aa
St3507	1495	100	Ö
St3509	1625	100	W
St3510	1515	100	Ab

St/sq = Street or square in the Eketorp-II ring-fort.

Table 4. The Eketorp-II sample, cf. Näsman 1976a.

The feasablity of judging the length of periods (in this case the suggestion that layers 10a–9a, Gramsch's phase 1, covers the same number of years as the upper sand complex, layers 7–33, Gramsch's phase 3) seems to be limited when estimation is based on central BC-values and standard deviations in ^{14}C-years alone. If, on the other hand, estimation is based on the calibrated ^{14}C-values in the layers, then one reaches the conclusion that the Preboreal phase is considerably shorter than the Boreal sand complex, the latter in its turn being just the final phase of a longer period of visits to the site. Even the weight of a single, seemingly late, test that as a central value could tempt the archaeologist to repudiate primary judgements, takes on more reasonable proportions when the total possibility distribution is evaluated.

It is essential to point out that Gramsch's interpretations are not questioned by these ^{14}C-tests. However, the support given by the tests for his chronological discussion is not as obvious as one might at first have thought. There is, on the other hand, a possibility that interpretation of the site could benefit from some of the alternative chronological solutions preferred here.

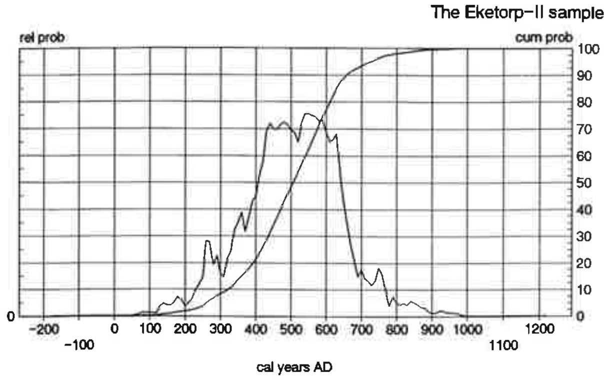

Fig. 16. The probability distribution of the Eketorp-II sample.

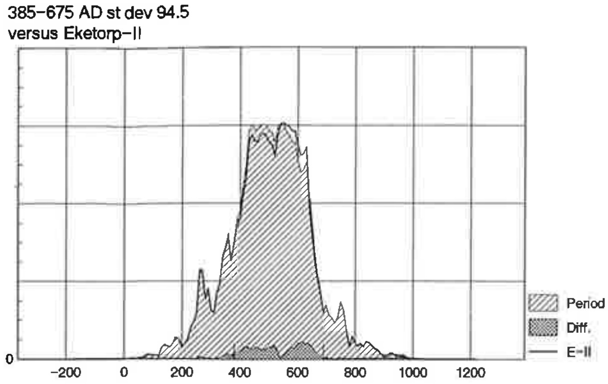

Fig. 17. A comparison between the probability distribution of the Eketorp-II sample (bold line) and the period 385–675 AD (sparsely hatched). The differences between the two curves are singled out (as the densely cross-hatched distribution). The scale of the latter is ten times that of the other two distributions.

Discussion

It is reasonable to assume that the Mesolithic way of life normally resulted in ideal samples of charcoal from firewood made up of young branches and brush wood. Moreover, the traditional hunting habits and nomadic life style of Mesolithic man, would have led to regular visits to the settlement site and a regular deposition of charcoal. In the case of Friesack, the importance of the find has also led to a great number of samples being collected, thereby minimizing the risk that a single sample might dominate the results.

Although the conditions for chronological analyses in the Friesack case are excellent, the analysis of the ^{14}C-tests seems to benefit from a more formalized approach, in as much as the intuitive approach partly fails to weight the calibrated probabilities correctly.

Estimation of the Preboreal period is hampered by the fact that the period-definition must be based on the 20-year points of the calibration curve. The p1/n1 measure is large, due to n1 being small, and it is obvious from the diagrams (fig. 12a–b) that the fit would have been best if it could have been calculated for the period 6550–6400 BC.

Estimation of the Boreal period is more a matter of assessing the differences in the diagram, with the conclusion that the period fit is not very good. However, if some irregularities in the beginning and the end of the period are allowed for, then a period of use might be represented, although this "use" is hardly characterized by a constant production of charcoal. It should be mentioned that the hiatus, which Gramsch (1987) finds in the Boreal phase, is perhaps to be understood as the result of irregular visits to the site in the beginning of its Boreal use.

Both estimations show weaknesses, but at the same time they contribute to the chronological discussion in an independent way. It seems moreover correct to say that with an index between 3 and 10, one can hardly say that the observed sample fits the expected ideal.

Migration Period Eketorp

From the Migration Period settlement phase in the ring-fort at Eketorp (Eketorp-II), 33 ^{14}C-tests from the house floors, mainly from the hearths have been used to date the phase. All are stratigraphically well-defined charcoal samples (table 4).

During excavation, some 3000 artefacts could be precisely related to the ^{14}C-dated floor layers, and the archaeological date of the settlement from the Migration Period to the first part of the Vendel Period, somewhere between 400 and 700 AD, is difficult to doubt (Näsman 1976a; Iversen & Näsman 1978). It is obvious, however, that among the artefacts, those dated to the Vendel Period dominate, although the reason for this is not straightforward.

First of all one should point to the pattern of the settlement development. In the beginning there is an initial settlement-phase probably attached to the building of the settlement. During this phase some houses produced floors with a very limited artefact content and a hearth placed approximately in the centre of the house. These floors do not seem to have served any specific type of dwelling and are perhaps linked to the temporary dwellings that characterize the first Eketorp ring-fort, Eketorp-I. Typically enough, these floors are found in the eastern, damp part of the ring-fort where drainage problems would have inspired the inhabitants to raise the floors when redoing them rather than to shovel out old floors before constructing new ones. The latter procedure would have been the rational procedure in the dry, eastern part of the ring-fort. No tests from these eastern initial floors are included in the sample.

Apart from the initial floors, the first true floors in Eketorp-II, the lower ones, belong to a planned ideal settlement consisting of dwelling houses, byres, barns and stores, as well as buildings with special functions such as smithies or grain-drying structures. Although these functions when mapped seem to balance each other in an orderly way (Edgren & Herschend 1989:9; Herschend 1988), the plan must conceal some development since it can be shown that all houses were not built at the one time. It evidently took some years for the ring-fort to fill up with houses, and thus some time before a site pattern

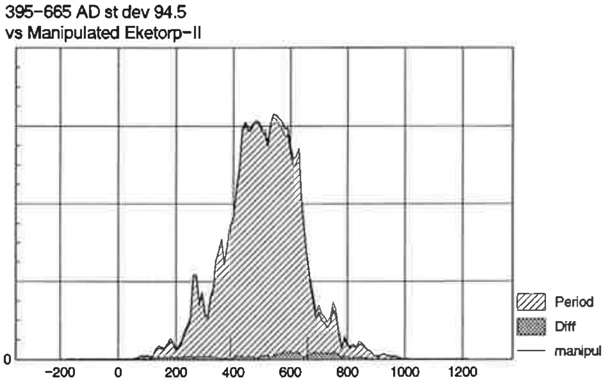

Fig. 18. A comparison between the probability distribution of the manupulated Eketorp-II sample (bold line) and the period 395–665 AD, (sparsely hatched). The differences between the two curves are singled out (as the densely cross-hatched distribution). The scale of the latter is ten times that of the other two distributions. The manipulation of the sample consists in five tests being added to the sample: two with the BP-value 1530, two with the value 1540 and one with the value 1545. The standard deviation of these manipulating tests is equal to the average of the original sample, i.e., 94.5 ^{14}C-years.

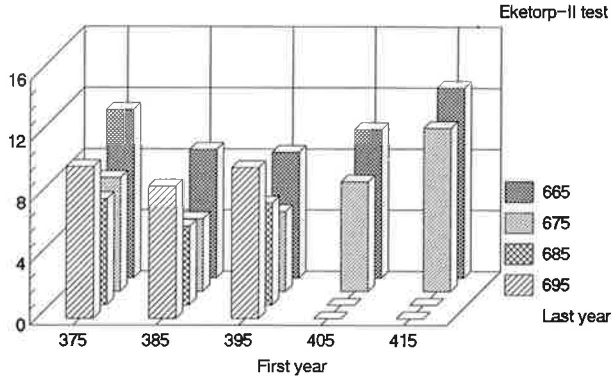

Fig. 19. A three-dimensional bar diagram showing the percentual difference between the probability distribution of the Eketorp-II sample and a series of periods.

was developed (Näsman 1976b).

Turning to the upper floors in Eketorp-II, a functionally differentiated picture can no longer be found, since nearly all houses had now been turned into dwellings. Whether this complete change took place gradually or abruptly cannot be established with certainty. There is, however, no sign that the settlement was abandoned at any stage. On the contrary, when a byre is being changed into a dwelling, the settlers start by moving into a cleaned byre in order to subsequently rebuild it as an ordinary dwelling house. This means that the byre was not allowed to fall into ruin before it was reused.

At some stage, the ordinary houses are abandoned, but the ring-fort continues to be used by a population living in the ruins of the intentionally demolished buildings. From these stratigraphically well-defined layers there are no ^{14}C-tests in the sample.

The development pattern of the settlement indicates an increase in the population of the ring-fort, a fact that may well explain the greater number of artefacts dating from the Vendel Period. On the other hand, it must also be kept in mind that general changes in material culture, not least jewellery trends, greatly facilitate detection of a Vendel rather than a Migration Period artefact. The artefact material does not seem to date the Eketorp-II settlement period evenly, so when the limits 400–700 AD are given, these limits are only approximate; the beginning and end of the period are not so well represented by artefacts.

The immediate countryside around Eketorp was only sparsely forested during the middle of the first millennium AD and brushwood probably constituted most of the firewood. This palynologically-based hypothesis is supported by an analysis of a charcoal sample from one of the house floors which implies that the age of the charred wood was low and so too the standard deviation of the average year. A constant need for firewood is taken for granted, but the fact that it is uncertain whether or not the floors represent a continuous development, does cast some doubt on whether this charcoal material was evenly distributed over time.

The probability distribution of the Eketorp-sample is represented by fig. 16 and it is clear that the centuries around the middle of the first millennium AD are well represented. Therefore it stands to reason that correspondence is relatively good between the archaeological artefact dates and the ^{14}C-dates of the charcoal samples, and it seems worthwhile to search for the best fit between a period and the sample.

When best fit was attempted in the case of Friesack, most attention was given to the *best* period. It may therefore be said that the Friesack case mainly illustrated three of the four quality-determining points mentioned in the introduction, namely the number of points defining the period, the length of the period and its standard deviation.

In the case of Eketorp, even the fourth point should be taken into consideration, namely the difference between the best fit, the next best, the third best and so on. This step is necessary in order to establish whether or not the characteristics of the calibration curve blur the concept of a best fit.

The best fit is illustrated in figs. 17 and 19. Although the period 385–675 AD fits the sample best, there are other periods with a fit nearly as good as the best. Generally speaking this would mean that the limits are not indisputable. The relative preciseness of the fit, 4.74%, is however strengthened when we calculate the index value, since the differences between period and sample are situated mainly within the limits of the period and down-weighted. Diagram fig. 20, where the index for period-estimation 385–675 AD is 1.74, therefore shows that one of the qualities of the best fit in this case is that the differences between the expected and the observed occur almost exclusively within the limits of the period. It must, however, be pointed out that as in the case of the archaeological dates, there is a tendency for the sample to emphasize the later years of the settlement period. This

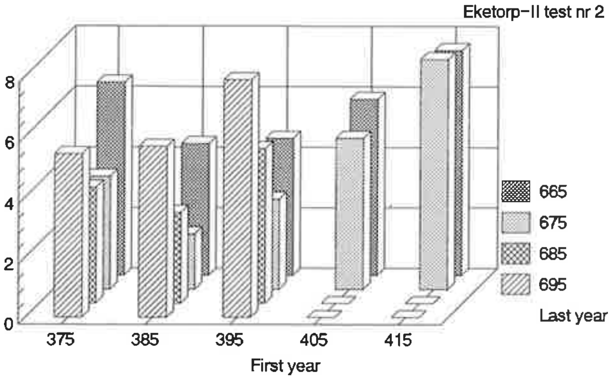

Fig. 20. A three-dimensional bar diagram showing the index of fit between a series of periods and the probability distribution of the Eketorp-II sample. The smallest index is equal to 1.74.

tendency falls out if the differences within the period in fig. 17 are studied more closely, in as much as the examination reveals that down to c. 550 AD the sample produces lower probabilities, while after that date the opposite is the case.

Given our imprecise knowledge of the development of this settlement, the differences between the model period and the sample, may well reflect a historical situation in which the later part of the Eketorp-II phase has supplied the bulk of the artefact material, while the charcoal from the hearths, although influenced by overall changes in the settlement structure, are more evenly distributed throughout the period.

To sum up, although the fit is very good between the sample and the period 385–675 AD, it is also relatively good between the sample and the periods 385–685 or 395–675 AD. These periods all agree relatively well with the archaeological date, but their beginning is nonetheless rather early. This is true even if the overall period is moved along the time-scale in order to adjust for the average (tree-ring) age of the firewood used during the Eketorp-II phase. Generally speaking, however, the ^{14}C-tests seem to reflect the duration of the settlement period reasonably well.

General discussion

The index has been tried out on a number of different distributions, and it has been emphasized that it was most often a *guide* to the interpretation of these distributions, and to the fit between the expected and the observed, rather than a *solution* to the problem whether or not the fit was so good that the sample should be accepted as the correct image of a certain period. As an example of this, the fit linked to fig. 8 (index 2.9) was considered a misfit, while the index linked to fig. 12a–b (9.15) although high was, however, not considered to cover a deviance as dramatic as a hiatus or break in the continuous occupation of the site. Obviously the hiatus was short compared to the 840 years of the total period, but in terms of interpretation it was cardinal.

Such results are due to the construction of the index. Two of its crudest components favour long periods and large samples, and down-weight differences within the period limits. That is why the index linked to fig. 8 becomes so small, and when it comes to judging the standard deviation, then large deviations are of course decisive, though even *their* negative effect can be balanced by large samples. The construction favours the definition of limits, but when a sample is considered equal to a period then the period is nonetheless not as stable as we might intuitively like to think. The Friesack Sand Complex illustrated some of this instability. As long as the test Bln 2755 was included, the period was c. 280 years long (fig. 14), but when the test was omitted, the period reduced to 260 years. This change could be explained by the way periods are constructed (a series of tests separated by 20-year periods), but still it is odd that one test, of a point in time, should be equal to 20 years of a period.

Turning to the Eketorp-II sample (fig. 17) for yet another example of period instability, we might imagine that there were by chance more tests in the sample with a central BP-value resulting in calibrated probabilities mainly in the fifth to seventh centuries. If we manipulate the distribution in this way – and that might easily have been done unintentionally when sampling for tests during the excavation – then the best fit will be attached to a narrower period (figs. 18). The fit is still very good, but the probabilities outside the limits of the period have grown, and for that reason the best index is linked to the slightly longer period 395–675 AD.

These two examples of instability make it clear that although the index is designed to make periods stable, their limits can still be changed by adding or subtracting tests at the centre or the periphery of the distribution. This creates a problem, since if our dates had been artefact dates, then we would have been reluctant to consider a number of redated artefacts from the middle of the settlement period good-enough reason for narrowing down the date of this period, i.e. for changing our chronological views about artefacts that we had already called early or late.

Due to the idea of the best fit, the definition of the period becomes so sensitive that, in order to understand the distributions we are forced, at an early stage in the discussion, to talk about model-disturbing phenomena such as, in the Friesack case, a hiatus and irregular visits to a site at the beginning or the end of its occupation. It is worth pointing out that this type of discussion is in principle not unknown to the artefact-dependant discussion on chronology, and Eketorp-II is an example of this. Here, from among so many artefacts, there are of course some that must be considered antiquities (Näsman 1984:40f), but there are even a few artefacts from the eighth and ninth centuries that must be understood as having been lost in the ruined ring-fort some decades and perhaps centuries after the termination of the Migration

Period settlement. Had there not been such an abundance of artefacts from c. 550–650 AD, providing find-combinations in the contents of sealed-floor layers and stratigraphical support for the interpreted site-chronology, then it would have been difficult to preclude these late stray-finds from the earlier occupation phase; someone was undoubtedly there to drop these items! Concepts such as contamination, change of function, abandonment, and occasional visits to ruins, are therefore necessary for understanding the formation of such a complex artefact context as at Eketorp-II.

One of the aims in estimating the length of a period as presented in this paper, is to call into question the model by which we date a context, namely by declaring that it starts at T1 and stops at T2. Such a model is considered insufficient for understanding the formation of the context over time. In the duration model, limits are nonetheless of great traditional importance, and therefore the index compensates for the floating period definition by giving decisive weight to the misfit between the expected and the observed outside the defined period. This, however, is of minor assistance and must not overshadow the fact that the method aims at reorientating chronological discussion away from the question of the duration of the context to the formation of it, without totally dropping the idea that a period has a limit.

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APPENDIX

A description of the procedure from test value to diagram

The aim of the linkage between the programs described in the chart fig. 1, is to facilitate proceeding from any number of ^{14}C tests in the form of a laboratory protocol with bp-values and standard deviations, to a diagram showing the probability distribution in calibrated form. The procedure is carried out with the ultimate aim of assigning a date or a period to an archaeological context.

All programs and applications require a PC with a hard disk, preferably with a 486 processor. The hard disk must contain the following four programs:

1. A word-processing program capable of importing and exporting ASCII-files, e.g., *Word5*, or *XYWrite*, but probably not *WordPerfect*, since its end-of-record sign is not automatically recognized by the calibration program. Therefore the end-of-record sign must be changed to the ASCII-sign no. 10 (cf. point H in the example below).
2. The calibration program from Washington University, Quaternary Isotope Lab. Radiocarbon Calibration Program, the 1987 revised 2.0 edition.
3. The database program *dBASE IV* or *dBASE III+*.
4. A program for creating diagrams (the program must be able to import ASCII-files), e.g., *Graph-in-the-box*.

The calibration program and the database program must be put in the subdirectories indicated in the chart, and if *Start 1* is used as an alternative, then care must be taken to ensure that the ASCII-file (created through the word-processing program) from which the calibration program takes its input, is saved to the root directory on a diskette in drive A.

In order to create the numbers used by the diagram program to produce the diagrams, a dBASE-application, the subprogram *ÖVERFÖR.PRG* is needed (this program is reproduced at the end of this Appendix). The program, *ÖVERFÖR.PRG*, takes its input from a temporary ASCII-file, *C:\C14\C14FIL.PRB*, created by the calibration program, and exports the basic values for the diagram program to another ASCII-file, *A:DIAGRAM.TXT*, on the diskette in drive A.

This text-file, in its turn, is imported by a diagram program, e.g., *Graph-in-the-box*, and the end product, a **.GIX*-file or a printer output, is created by means of layout and data manipulation.

The system requires knowledge of the word-processing program and of the diagram program. The calibration program is virtually self-instructing and so is the *dBASE-IV* application *ÖVERFÖR*. It is necessary, however, to be able to start a dBASE application, i.e., to use the dBASE command DO.

The difference between *Start 1* and *Start 2* is simple enough. With *Start 2*, the data file used by the calibration program is created interactively from the keyboard while running the program, but in the alternative, *Start 1*, this file must be prepared in advance. This latter procedure saves time and it provides a better documentation of the work process.

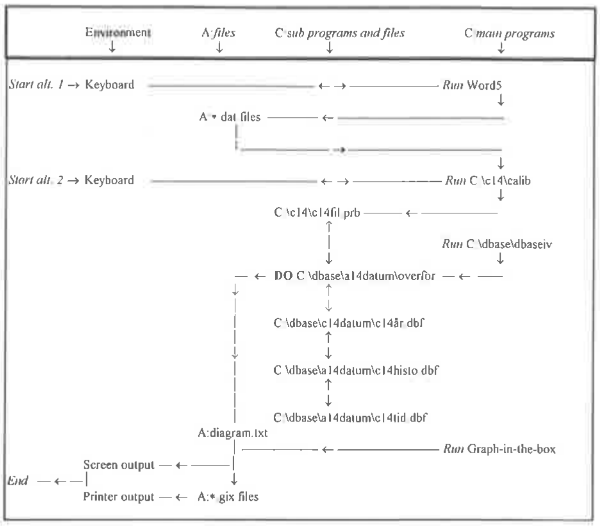

Chart summarizing the organization described in the Appendix.

The steps that lead from sample to diagram can be described in the following way:

A. Guided by a series of test values (BP-years and st. dev.) and helped by the word-processing program, a suitable ASCII-file with the extension *.DAT* is created and saved onto the diskette in drive A (in the program *Word5* this task is accomplished by using the option save text only). Guide-lines on how to structure the file are given in the example below.

B. The next step is to proceed to the calibration program and start it with the command CALIB. The program must be stored in the subdirectory *C:\C14*, which requires changing over to this directory before starting CALIB, or alternatively adding CALIB to a path command in the *AUTOEXEC.BAT*-file.

When the prompt asks whether or not the answers are to be printed out, type N and press enter.

Next the appropriate calibration curve must be chosen. *ATM10.14C* is to be preferred if it covers the relevant time span.

The program will now ask how the data is to be input. The answer should be, of course, from a file (alt. 2), giving the name of the file already prepared on the diskette in drive A, remembering to include the extension *.DAT*.

In the next two steps, the first alternative is chosen and *C14FIL.TXT* and *C14FIL.PLT* are accepted as temporary text and plot files.

Faced with the choice between one or two calibration methods, the second alternative must be chosen, which means that the program is desired to do both the methods.

The last question is concerned with the name of the file in which are to be stored all the probabilities calculated by method B. The first alternative, *C14FIL.PRB*, must be chosen, thus storing the probabilities on the file *C:\C14\C14FIL.PRB*.

The program now runs through the values in the *A:name.DAT* file that has been prepared. This takes some time.

C. When the calibration program is completed, the database program must be started. It is neccessary that the applicatiom *ÖVERFÖR.PRG* and the three database files that go together with it, are located to the subdirectory *C:\DBASE\C14DATUM* and that the database program itself is in *C:\DBASE*. Otherwise *ÖVERFÖR* will not find its way through the DOS-system.

When *ÖVERFÖR* is running, it asks four simple questions and indicates the nature of the tasks performed. Between the first question, which has the form of a request, and the second, and likewise between the third and the fourth, there is a time delay.

ÖVERFÖR ends when it has exported the information neccessary to make a diagram to the ASCII-file *A:DIAGRAM.TXT*. For this reason it is important to remember to have a diskette waiting in drive A.

D. When the program has come to an end the diagram program is started after first quitting *dBASE IV*, in order to import the file *A:DIAGRAM.TXT* and create a suitable analytical and aesthetical diagram. The diagram must be renamed before saving.

Diagram programs often have a calculus function in connection with their spreadsheet function. This function is necessary for analysing the raw data imported from the file *A:DIAGRAM.TXT*.

An example of an A:name.DAT *file*

```
1.00
1              1590.0   60.00   .0    .0     100.0   .0
xx
```

The structure of the first line is:

```
--1.00ì
```

i.e. two spaces, the number 1.00 (meaning that the lab error is not used) and the "end of record" sign, i.e., *enter*.

The structure of the last line is:

```
-xx----------------ì
```

i.e. one space followed by "xx" (the conventional name for ending the procedure), 16 spaces and the "end of record" sign, i.e., *enter* or the ASCII-sign no. 10.

The structure of one of the intermediate lines is:

```
-St1577--------------1590.0--100.00------.0-----.0--100.0-----.0ì
    A                   B       C         D    E   F        GH
```

i.e.:

A. A space followed by a test name.
B. The BP-value ending in position 27.
C. The standard deviation ending in position 36.
D-G. Four constant variables with position and values shown in the example.
H. The "end of record" sign, i.e., ASCII-sign no. 10.

In order to create a *.DAT* file, the variables A–C must be filled in and the variables D–G must be duplicated for each test. A file consisting of 15 tests, in other words contains 17 lines: the first line, 15 lines containing the values of one test each, and the last line.

If a pattern for the *.DAT* file is required, then one or two calibrations should be made, choosing *method A*, interactively from the keyboard and the data saved on the temporary file *C14FIL.DAT*. Later, when the word-processing program is started, this file can be imported and used as a model, duplicating the line to fit the number of tests in the sample, making the necessary changes by overwriting the lines and saving the file under a practical name.

The structure of the databases used by the application ÖVERFÖR.PRG

Structure for the database *c:\dbase\c14datum\c14år.dbf**

Field	Field name	Type	Width	Dec	Index
1	ÅR	Numeric	6		N
2	SANNOLIK	Numeric	9	7	N
** Total **			16		

Structure for the database *c:\dbase\c14datum\c14histo.dbf**
Number of data records: 451

Field	Field name	Type	Width	Dec	Index
1	KLASS	Numeric	6		N
2	KUMM	Numeric	12	7	N
** Total **			19		

Structure for the database *c:\dbase\c14datum\c14tid.dbf**

Field	Field name	Type	Width	Dec	Index
1	ÅR	Numeric	6		N
2	SANNOLIK	Numeric	9	7	N
** Total **			16		

* = These databases need only to be empty structures in the subdirectories. Records are appended and deleted from them by the application ÖVERFÖR.PRG
* = This database must from the beginning contain 451 blank records.

The application ÖVERFÖR.PRG together with the necessary databases can be ordered from the Dept. of Archaeology, Uppsala University, S-753 10 Uppsala, SWEDEN

```
*******************************************************************
*
*  This is the program ÖVERFÖR.PRG
*  It fetches the values in the file C14fFIL.PRB
*  created by the calibration program and leaves the values
*  in a file based on year classes in A:\DIAGRAM.TXT
*
*******************************************************************
*
set safety off
set decimals to 7
set echo off
set talk off
set status off
set path to c:\dbase\c14datum
CLEAR
*
*******************************************************************
*
?'
==================================================
=============='
?
?'       This is the program C:\DBASE\C14DATUM\ÖVERFÖR.PRG'
?'       It fetches the values in the file C:\C14\C14fFIL.PRB a file'
?'       created by the calibration program and leaves the values to a'
?'       diagram file, based on year classes, e.g., 5-years clases.'
?'       The diagram file is an ASCII-file called A:DIAGRAM.TXT'
?
?'
==================================================
=============='
?
?
?'            BE SURE THAT THERE IS A DISKETTE IN A:'
?'            ..................................'
?
?
?
?
?
WAIT
CLEAR
*
*******************************************************************
*
?'           THE PROGRAM IS WORKING - PLEASE WAIT!!     '
use c:\dbase\c14datum\c14tid
zap
?
?'Appending records!!                   |'
?' from:                              |'
?'     C:\C14\C14FIL.PRB                  |'
?'  to:                              |'
?'     C:\DBASE\C14DATUM\C14TID.DBF          |'
?'                                    |'
?'....................................┘'
append from c:\c14\c14fil.prb delimited with blank for sannolik <2
?
?
?'Sorting the file!!                    |'
?'             C:\DBASE\C14DATUM\C14TID   |'
?'   on years to!!                      |'
?'             C:\DBASE\C14DATUM\C14ÅR    |'
?'....................................┘'
?
sort on år to c:\dbase\c14datum\c14år.dbf for sannolik <> 0.00000
close databases
*
*******************************************************************
*
SELECT 1
use c:\dbase\c14datum\c14histo
replace klass with 0 all
replace kumm with 0 all
store 2 to stapel
store 0 to ku
*
*
SELECT 2
use c:\dbase\c14datum\c14år
CLEAR
?
?
?
?
go top
display år
store år to sta
go bottom
display år
store år to slu
go top
store slu-sta to årmål
?
?' ┌..............................................┐'
?' |         This is the first and the last calibrated calender year   |'
?' |         in the probability distribution of the test(s)!!          |'
?' |                                              |'
?' |         The distribution covers '+',årmål,'+' years           |'
?' |                                              |'
?' | REMEMBER!! More than 300 classes in a graph-in-the-box diagram       |'
?' | + + + + + + + + + + makes calculations based on the spread sheet difficult!     |'
?' |                                              |'
?' └..............................................┘'
*
    input '         Write the first year of the first year class 'to start
    input '         Write the breadth of the year classes:      'to step
```

The program ÖVERFÖR.PRG.

```
*
?
?
?'           THE PROGRAM IS WORKING - PLEASE WAIT!!
?
*
*******************************************************************
*
 store sannolik to sanno
 store år to åår
 do while .not. EOF()
 *
     do case
     *
      case start+step > åår
      store sanno+ku to ku
     *
      case start+step <= åår
      SELECT 1
      go stapel
      replace klass with start
      replace kumm with ku
      store 0 to ku
      store stapel+1 to stapel
     *
      do while start+(step*2) <= åår
      SELECT 1
      store start+step to start
      go stapel
      store stapel+1 to stapel
      replace klass with start
      enddo
     *
      store start+step to start
      store sanno+ku to ku
      SELECT 2
     *
     endcase
skip
store sannolik to sanno
store år to åår
enddo
*
SELECT 1
      go stapel
      replace klass with start
      replace kumm with ku
*
*******************************************************************
*
SELECT 1
   sum kumm to TT
      store TT/1000 to TTOT
   *
      go top
      store 1 to x
   *
      do while x <= stapel
          store kumm/TTOT to vägt
          replace kumm with vägt
          skip
          store x+1 to x
            enddo
      *
*******************************************************************
*
    copy to a:\diagram delimited for recno() <= stapel
*
*
CLEAR


*******************************************************************
*
close databases
clear
?
?
?
?
?'    ***************************************************************
?'    *-* Values for the diagram have been transferred to A:DIAGRAM.TXT *-*'
?'    ***************************************************************
?
?
?
?
?
?
?
?
?
?
?
Wait
Set safety on
set echo on
set talk on
set status on
*
*******************************************************************
*
*............................................................
*             This is the end of ÖVERFÖR (10.05.1991 F. H.)
*............................................................
→
```