Comments on "Neolithic farming practice - an archaeological response to the Göransson hypothesis"
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Fornvännen 1994:3, 168-184
Ingår i: samla.raa.se
Comments on ‘Neolithic Farming Practice—An Archaeological Response to the Göransson Hypothesis’

This article is a comment on Kristian Kristiansen’s comments in *Fornvännen* 88, pp. 247–251, where he reviews my work *Neolithic Man and the Forest Environment around Alvastra Pile Dwelling* (in my comment called *Neolithic Man*) (Göransson 1987).

In *Neolithic Man* I put the following question: how can the pollen curves of elm, lime and oak rise at the same time as there is an unbroken curve of cereals—or at the same time as the cereal curve starts? The main theme of the book was to answer this question. The forest was a prerequisite for farming—before the introduction of manured fields. Thus the pollen curves of the broad-leaved trees during the Middle Neolithic and the Early Bronze Age reflect cultivation—not the opposite.

The regression school found its most distinct expression in the following lines: “Neolithic expansion had temporarily outstripped the capacity of the system to support it” (Bradley 1978 p. 106). Kristiansen has adhered to this school until quite recently (see Kristiansen 1988 p. 68).

Kristiansen states that I “largely ignore the archaeology of the period”. I do not at all ignore archaeological evidence but I do not yield to the temptation to confuse pollen diagrams and archaeological tools.

At the end of the present article I will describe my model for farming during “Alvastra time” (or “Passage Grave time”) as Kristiansen has omitted to do this (although half my Alvastra book deals with this type of early Middle Neolithic farming). The Neolithic axes indeed were very suitable for tree-felling, not least during the Middle Neolithic. First, however, I will show the reader that conventional archaeologists have a blind faith in the Neolithic axes as necessary tools in transforming the forests.

In the present article I use conventional C¹⁴-years B.P. ([T₁/² = 5568, 0-year = A.D. 1950](https://www.nature.com/articles/nclimate2162)). Some archaeological papers are unreadable as the authors use calibrated C¹⁴-values without mentioning the values (conventional C¹⁴-years) from which they performed the calibrations.

The Mesolithic

Let us—for a moment—ignore the very delicate and evidently very shocking discussion on cereals before the elm decline (I will return to this theme below).

All over the forested parts of the world, before the introduction of agriculture, man utilized the forests for thousands or even tens of thousands of years in order to favour grazing and browsing wild animals and in order to get better yields of wild edible plants (for instance the aborigines in Australia, the Indians in pre-European North America etc.). Mesolithic southern Scandinavia was no exception to that rule. I think that the opposite view—that the Mesolithic hunter-gatherer did not utilize the inland resources—is a reflection of an old-fashioned outlook on “primitive savages”, an outlook which has survived as an unconscious current since the 19th century. This strange outlook (which is thus strongly supported by Kristiansen) is concentrated in the following sentence written as late as in 1991: “It is reasonable to estimate that human influence on the ecosystems [in the Ystad area during Mesolithic time, my comment] was no greater than that of wild vertebrates” (Berglund et al. 1991 p. 427).

Forest fires and forest ground fires during the Mesolithic

I have performed pollen analytical investigations from westernmost Ireland in the west via Scania to the provinces of Småland and Östergötland in the north-east. The most often mentioned sites in the following are the Dags Mosse bog in the westernmost part of the province of Östergötland and the Masbo Mosse bog in the north-easternmost part of the province of Småland (Göransson 1977, 1987, 1989). These two well-dated pollen diagrams are here called “prehistoric calendars”.

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In all pollen diagrams from the very large area investigated by me the curve of microscopic charcoal particles has high values during the Mesolithic. In the Mabo Mosse bog microscopic charcoal particles have been registered since about 9,000 B.P.

When forest fires and forest ground fires take place the charcoal particles rise in the air, above the canopies of the trees. There the particles are caught by the winds and brought to lakes and bogs in the same way as tree pollen grains. Naturally, charcoal particles from hearth fires also are transported in the same way. Not infrequently, however, the curve of bracken (Pteridium) more or less coincides with that of charcoal dust. Bracken is favoured by forest fires and forest ground fires. Aspen (Populus) quickly occupies burnt areas and it grows tall if the environment remains unshaded.

Microscopic charcoal particles, bracken spores and Populus pollen may thus be named "forest fire indicators" or "forest ground fire indicators". (As demonstrated by me, Artemisia vulgaris [seeds of which are found in great amounts in the occupation layer of the pile dwelling] was highly favoured by the "mild" Middle Neolithic fires [Göransson 1987 fig. 28]). These fire indicators demonstrate that forest fires and/or forest ground fires occurred from Ireland in the west to Östergötland in the north-east during most of the Mesolithic.

Of course the Mesolithic hunter-gatherer wanted to create a good environment for the grazing and browsing game and of course he wanted to favour hazel and berries of different kinds. By killing trees by girdling or by setting fire to wood piled around the bases of the trees such an environment was easily produced (Cronon 1984). No big axes were necessary in this work. This selective burning may have promoted a mosaic quality and "the edge effect" of the ecosystem (op. cit.).

From the two "prehistoric calenders" (the Dags Mosse bog and the Mabo Mosse bog) we can observe that forest fires were very intensive about 6200-6300 B.P. that is ca. 1,000 years before the elm decline (Göransson, e.g., 1987, 1989, 1993). It is of great interest to observe that on the island of Wolin (only ca. 165 km to the south of southernmost Sweden) forest fires were widespread at this time (Latalowa 1992). "It is not an exceptional case, when the vegetational changes detected by pollen analysis can be linked with the Mesolithic disturbances, although the area seems devoid of Mesolithic sites and artifacts" (Latalowa, op. cit. p. 199, citing Chambers et al. 1988).

Is it really possible that the forests on high ground—especially oak and lime—could burn during the Mesolithic? By studying small kettle holes on slopes this hypothesis can be tested.

The kettle hole at Näsja

Twenty km to the north of the Dags Mosse bog an "extremely small" kettle hole (dead-ice hole) was found at the base of an imposing glaciofluvial esker (Göransson 1991 a, b). The kettle hole is only 29×14 metres. The sedimentation in the kettle hole started some time during the last third of the Mesolithic. Layer upon layer of macroscopic charcoal particles, deposited during thousands of years, were found in the sediments. No big hearth charcoals were found—only small particles (1–10 mm). The largest particles were identified by genus (by T. Bartholin). A combined pollen-charcoal diagram could thus be constructed. Some seeds are also plotted in this diagram. The beetles which have been examined by G. Lemdahl will be plotted in a future diagram (Göransson & Lemdahl in prep.).

To all appearances the macroscopic charcoal particles found in the kettle hole derive from forest fires. An accelerator dating of a macroscopic charcoal particle from a stem of Tilia in the understory part of the sediment sequence (layer 10—at ca. 1.34 m below surface) gave the C^{14}-age of 6435±100 B.P. A macroscopic charcoal particle found in Mesolithic layers in the kettle hole at Isberga, 2 km to the east of the Alvastra spring mire, gave the C^{14}-age of 6480±120 B.P.

It thus seems to be confirmed that the forests of lime, oak etc. did burn during the Mesolithic. Only dead and dry broad-leaved trees could burn. For that reason it is sup-
Fig. 1. The left part of the pollen-charcoal diagram from the kettle hole at Näsja ca. 20 km to the north of the Alvastra pile dwelling. The right part, comprising herbs, graminids and beetles will be published elsewhere.
posed that the Mesolithic hunter-gatherer killed big trees here and there in the way suggested above. This means that the forests were transformed by man during the Mesolithic in order to favour grazing and browsing wild animals and to create areas where hazel, cherry trees, crab apple trees, wild strawberries and other berries thrived. I find it self-evident to assume that Mesolithic man (in this case very likely woman!) planted some of the species mentioned. Thus it may be said that the Mesolithic hunter-gatherer was also a cultivator and that the land "was taken" long before the so-called Landnam (see below).

Cultivation of cereals during the latest part of the Mesolithic?

Excavations of settlements and shell middens in Jutland and bog sites in central Zealand show that the change from Mesolithic material culture to Neolithic material culture was completed in ca. 100 years, between 5100 and 5000 B.P. (cf. compilation by L. Larsson 1990 p. 294). There need not, however, as far as I understand, be any immediate connection between this "material Mesolithic/Neolithic border" and the introduction of cereals.

As has been discussed above, it is a mistake to believe that Neolithic implements were necessary to transform the forests during the Stone Age. Man’s strongest and most effective tool was fire. Mesolithic know-how and Mesolithic implements were quite sufficient to kill big trees and to create the mosaic structure of the forests which has been described above. If we are able to interpret the pollen diagrams without looking at them through the glasses of convention we will understand that the forests were transformed over very large areas during the Mesolithic. This is, however, almost impossible to see in conventional diagrams from medium-sized or large basins.

Jennbert demonstrated that grain and cattle, in all probability, were introduced during the Ertebølle, before the Neolithic, as luxury goods—as "fertile gifts" (Jennbert 1984). An extensive network for exchange of prestige goods may have existed (Jennbert 1984, 1986, see also Fischer 1982, Göransson 1988b). Jennbert’s suggestion is supported by the fact that pollen of cereal type occurs before the elm decline at several sites in southern Sweden, Denmark and in the British Isles (see below). Even if some—or many—of this cereal type pollen may have come from some wild grasses, all cereal pollen types surely did not come from wild grasses.

When I investigated the kettle hole at Isberga in 1977 (see below), I was not aware that I was studying the Late Atlantic part of the core—because such local diagrams may be difficult to interpret before you are used to them! At the undermost level in the Isberga III diagram (Fig. 4) a beautiful cereal pollen (total diameter 55 μm, diameter of annulus more than 12 μm) was found. This pollen grain is of Mesolithic age. It cannot, however, be refound after all these years—at least not at the moment of writing. It should be mentioned that in the Färarps Mosse bog in the Ystad Area Hjelmroos found Plantago lanceolata and cereal pollen type before the elm decline (Berglund et al. 1991).

Kolstrup also found pollen grains of cereal type and Plantago lanceolata well before the elm decline at Trundholm, northwestern Zealand (Kolstrup 1987, 1988). In the older pollen diagram from Lake Bjärjsjöholmsjön, southernmost Scania, cereal pollen and Plantago lanceolata were recorded before the elm decline (Nilsson 1961). Plantago lanceolata can not grow in closed forests. (Hjelmroos has recorded pollen grains of Plantago lanceolata and other grazing indicators ca. 3900–3500 B.P. in northwestern Poland, Hjelmroos & Ericsson 1981.) Pollen grains of cereal type and of Plantago lanceolata before the elm decline were recorded long ago in the British Isles (cf. compilation by e.g. Lynch 1981).

Engelmark’s suggestion that “the cereal pollen grains occasionally found in south Scandinavian pollen diagrams from pre-Neolithic levels should be considered as an ‘expected’ influx from the continental Linear Pottery culture” seems to be a strange idea (Engelmark 1992 pp., 374 f.). The probability that pre-elm decline cereal pollen which—according to Engelmark—blew in from the Continent should happen to land in—above all—small kettle holes is indeed negligible. The
probability is still more negligible if pollen of *Plantago lanceolata* is found in the same pre-elm decline samples.

As I have demonstrated in a series of papers, the *Middle Neolithic* forests were not untouched forests but highly utilized forests. That the *Middle Neolithic* forests were transformed by man is difficult to observe in conventional pollen diagrams. In the same way, it is difficult to observe that the *Mesolithic* forests were utilized by man by studying conventional pollen diagrams. In my opinion the archaeologist must first understand that the Mesolithic hunter-gatherer was able to transform the forests although there were no large axes present at that time. If the archaeologist is able to understand that, *then* he will be able to start thinking in the way Jennbert has done (Jennbert 1984). Then the archaeologist will be able to clearly see the importance and the effect of "fertile gifts" (Jennbert, op. cit.).

**The elm decline**

In *Neolithic Man* (Fig. 22) (and in many other papers) I write that the elm decline was caused by *interacting physical and biological factors*. Rasmussen has demonstrated that elm was not used to a greater extent as leaf-fodder than other trees (Rasmussen, e.g. 1993) (see also my coming work on the palaeoethnobotanical material from the Alvastra pile dwelling).

Even within the Ystad Project—which I joined in 1986—the elm decline was renamed "the elm catastrophe" (Berglund 1991). There is, indeed, very much to write about the elm decline, but I content myself by citing the pollen analyst Sylvia M. Peglar who in a fresh thesis writes:

The year-by-year evidence presented here is thus entirely consistent with the hypothesis put forward by Rackham (1980) and Göransson (1984, 1986, *inter alia*), namely that the mid-Holocene elm decline was caused by a *combination* of disease and human activity, a virulent attack taking place in disturbed woodland, where the *Ulmus* trees had already been disturbed as a result of human activity for at least 160 years (Peglar 1992).

To this statement should be added that I—like Iversen (1944), Nilsson (1961) and Berglund (1966 p. 131)—also include climatic changes as "triggering" factors for the elm decline (and the simultaneous *Hedera* decline etc.)—that is, for the course of events at the elm decline level.

*The period from the Early Neolithic up to the Early Middle Neolithic—comparisons between pollen diagrams from different areas in southern Sweden*

In Fig. 2 we shall compare two C\(^{14}\)-dated pollen diagram sections from two different parts of southern Sweden. The diagram sections—the period of time—which we shall discuss start at the elm decline level and end at the first part of the Regeneration Phase—at the very point of time when the Alvastra pile dwelling was built.

One of the diagrams is the diagram from the Dags Mosse bog. The other diagram is from Lake Bjärsjölholmssjön, which is situated in southernmost Sweden, about 3 kilometres to the north of the coast of the Baltic and the town of Ystad. The distance between Lake Bjärsjölholmssjön and the Dags Mosse bog is 325 kilometres. Also the diagram from the Mabo Mosse bog is referred to in the text. This bog, as mentioned earlier, is situated 85 kilometres to the southeast of the Dags Mosse bog.

The C\(^{14}\)-sample for the elm decline (U-decl.) in Lake Bjärsjölholmssjön has its focal point 2.5 cm above the elm decline level. Thus the date of the elm decline level is somewhat older than 5100 B.P.—that is, of the same age as in the Dags Mosse bog (5180 ± 60 B.P.). The *Ulmus* decline was dated to 5130 ± 60 B.P. in the Mabo Mosse bog. Thus the elm decline is reasonably synchronous from southernmost Sweden to Östergötland—from Ystad to Alvastra.

Nilsson’s index horizon AT/SB is above all characterized by an accelerated fall of the *Ulmus* curve—and most often also by a fall of the *Tilia* curve. It obviously has a C\(^{14}\)-age of 5040 ± 60 B.P. in Scania (for details see Göransson 1991 a pp., 17 f). This level is easily identified also in the Dags Mosse bog, where it was dated to 5020 ± 60 B.P. Thus AT/SB is fairly synchronous from Scania to Östergötland. (There is no need for a deeper
Fig. 2. Comparisons between pollen diagram sections from Lake Bjärsjöholmssjön, southern Scania and the Dags Mosse bog, western Östergötland. For details see text. The C\textsubscript{14}-dates for the Lake Bjärsjöholmssjön diagram outside the brackets are correct—most of them are transferred from the nearby Ageröds Mosse bog (Nilsson 1964) (the C\textsubscript{14}-dates within brackets are not discussed here—for details see Göransson 1991 a). The C\textsubscript{14}-dates from the Dags Mosse bog are from peat and they are correct. The “index horizons” are after Nilsson (Nilsson 1961).
discussion of these index horizons here or the abbreviations used. The interested reader is referred to Nilsson's work. That I use these horizons here does not mean that I have abandoned the Chronozone system suggested by Mangerud et al.—something which naive students have believed.)

Another level which is found in all “fully developed” pollen diagrams from Scania to Östergötland is index horizon SB1 g. It is, above all, characterized by the very Ulmus minimum after the decline and by a marked Betula maximum. This level was not dated in Scania. Unfortunately SB1 g was the only C¹⁴ sample from the Dags Mosse bog which—for unknown reasons—collapsed. In the Mabo Mosse bog this index horizon was dated to 4740±60 B.P. It seems very likely that SB1 g is synchronous from Scania to Östergötland and that it has a C¹⁴-age of ca. 4750±60 B.P.

The important index horizon SB1 / corresponds to the very level where the Ulmus curve begins to rise again after the elm decline. At the same time Corylus has a maximum while Betula is falling. This is the very level where the “forest regeneration” starts after the elm decline. SB1 / was dated to 4510±60 B.P. in Scania, to 4520±60 B.P. in Mabo Mosse and to 4590±60 B.P. in Dags Mosse. SB1 / thus seems to be synchronous over the whole of the eastern part of south Sweden and it coincides with the start of the Middle Neolithic.

Index horizon SB1 e is slightly, although distinctly, younger than SB1 / . It is characterized by a further rise of the Ulmus curve (and of Tilia and Fraxinus) and a decline of Betula (and a slight decline of Corylus). Often the Quercus curve has a peak at this level.

SB1 e was dated to 4450±60 B.P. in the Dags Mosse bog. The Alvastra pile dwelling was built at a time which corresponds almost exactly to this pollen-analytical horizon (the mean value of the C¹⁴-datings from the pile dwelling is slightly younger than ca. 4450 B.P.). At SB1 e the regeneration of Ulmus, Tilia etc. has thus lasted 60–140 years. The “Regeneration Phase” is under full development.

From the above discussion we have now learnt that the forest history of the Early Neolithic is reflected in our pollen diagrams from southern Sweden between the (initial) fall of the elm curve and the very level where the Ulmus curve begins to rise again—at SB1 / . The elm decline is, as mentioned above, dated to ca. 5150 B.P. and SB1 / is dated to ca. 4550 B.P.

It is of great interest to observe that we find the same fall and regeneration of the elm curve in western Russia too. There, however, the maximum of birch (SB1 g) after the elm decline is replaced by a maximum of spruce (Levkovskaya pers. comm.). This speaks in favour of some unknown natural forces being involved in the forest development and the forest changes described above, that is, man was not the only operating factor.

It seems to be impossible for me to make clear to some archaeologists that man indeed was uninterruptedly active within the forests during prehistoric time—at the same time as the forest ecosystem, during certain periods, was strong enough to react in its “own way”. The section between the elm decline and SB1 / corresponds in the main with the period which Iversen once upon a time called the “Landnam”.

Kristiansen and the Landnam

For the last time I will write a few lines on the hypothesis of the “Landnam” as Kristiansen still believes in it. The Neolithic axes were very useful and fire was widely used during the Neolithic. That is one thing. Another thing is what we see in our pollen diagrams from the elm decline level up to the regeneration of elm and lime.

According to Iversen the Landnam is found a little above the elm decline or at the elm decline (Iversen, for instance, 1973 pp. 86 f). Iversen’s Landnam phase can be divided into three stages “in all detailed pollen diagrams” (op. cit.) (see Fig. 3) (Note that Iversen developed his hypothesis long before the introduction of the C¹⁴-method.)

I have tried to “date” Iversen’s diagram after Iversen’s description. Iversen’s stage 1 begins “year 0” and ends about “year 20”. The C¹⁴-datings demonstrate, however, that stage 1 ends about “year 150” (!). The middle
Fig. 3. This diagram was published by Iversen as early as 1956 (with alterations in 1973). I have added C\textsuperscript{14}-datings and Iversen’s datings to the right. Iversen’s Landnam model is demolished by the C\textsuperscript{14}-dates. After Iversen (ed. S. T. Andersen 1973).

part of stage 1 has an age of two years according to Iversen, while a C\textsuperscript{14}-date of ca. 75 years is to be expected.

The middle part of stage 2 should, according to Iversen, have an age of ca. 60 years. The C\textsuperscript{14}-datings give an age of ca. 400 years as we have already seen in Fig. 2. Iversen’s stage 3 ends, approximately, in “year 100”. The C\textsuperscript{14}-datings demonstrate that stage 3 ends about “year 650”. Note that the C\textsuperscript{14}-dates are very reliable. The levels mentioned are, as discussed earlier, fairly synchronous over large areas.


I think the Landnam discussion can end here. However, as I automatically and always will be misinterpreted (consciously and unconsciously) I want to add a few lines. Of course man during the Early Neolithic cut down trees, burned the dry stems and twigs (as during the Mesolithic) and sowed corn in the soil (as during the Middle Neolithic)—I have never denied that. Of course the Early Neolithic farmer wanted to create grazing areas by burning the forest ground during the Early Neolithic (earlier I called “stage 1” and “stage 2” “the fire-grazing phase”, while subsequently I have called the same period the “Early Neolithic destruction phase”). The expression the “Landnam Phase” is, however, totally misleading—and even Iversen seems to have understood this after having read Nilsson’s paper, cited above. I could write half a book about the problems involved in the “Landnam syndrome”. I am grateful to the editors for the space I have been given here!

The use of fire during the Early Neolithic

The Neolithic forest fires are, according to the pollen diagrams and the pollen charcoal diagram (Fig. 1), stronger than the Mesolithic forest fires. In very many pollen diagrams from southern Sweden the curve for microscopic charcoal particles rises distinctly at—or slightly above—the elm decline level. In most of my diagrams from the investigation area there is at the same time a strong rise of the Pteridium curve. In Lake Striern we observe a strong rise of the Populus curve immediately above the elm decline (Göransson 1977, 1987 fig. 36). An extremely strong rise of the Popu-
lus curve was observed at Mogetorp in the province of Södermanland (Florin 1957). As mentioned earlier, *Pteridium* and *Populus* are strongly favoured by forest fires.

Pollen grains of Cerealia-type, reflecting cultivation of cereals, are found during this "fire phase", as are pollen grains of the grazing indicator *Plantago lanceolata*. Soon after SB1 g (see above), that is, soon after 4750 B.P. there is a very distinct decline in the curve of microscopic charcoal particles. This phenomenon is also observed in westernmost Sweden (Thelau 1989 p. 36). The decline of microscopic charcoal particles, *Pteridium* and *Populus* does not correspond to a decline of pollen of Cerealia-type or of *Plantago lanceolata* (see below).

In extremely small kettle holes microscopic charcoal particles “turn into” macroscopic charcoal particles (Göransson 1991 b, c; see also above). Thus in the kettle hole at Nässja (Fig. 1) macroscopic charcoal particles from the Early Neolithic are, as mentioned earlier, found in layer upon layer—upon Mesolithic charcoal. These macroscopic charcoal particles derive from stems and branches of *Tilia*, *Quercus*, *Corylus*, *Alnus*, *Salix*, *Pomoideae* (*Crataegus*, *Malus* or *Sorbus*), *Betula* and *Populus*. Because of lack of funds it has not been possible to complete the investigation at this site. A sample from the charcoal layers between 1.18 m and 1.27 m below surface gave the C*14*-age of 4750 ± 60 B.P.

Very likely the forests were cleared by burning in order to create areas for cultivation of cereals. It is not necessary to assume that these clearances by burning were of the same type as historical burn-beating. Probably already then—during the Early Neolithic—clumps of stump sprout forests ("coppice woods") of different ages were found on the eskers near the kettle hole. Burning also created grazing areas, as during the Mesolithic. The difference is that man’s livestock now grazed on the cleared areas where deers etc. had grazed and browsed during the Mesolithic.

At Munkeröd to the north of Gothenburg in westernmost Sweden G. Lindman found a variable pattern of charcoal layers alternating with thicker layers of sandy, sooty humus as well as thin layers of peat (Lindman 1993). The charcoals were found in sand-filled erosion gullies which contained from 1 to 6 charcoal layers. The charcoal originated from trunks, branches and twigs of birch, oak, hazel, alder, aspen, rowan/sallow as well as other deciduous trees. The oldest charcoals were dated to 4800 ± 70 B.P. “Some form” of slash-and-burn took place in the Munkeröd area, followed by grazing (Lindman, op. cit. p. 111). No Mesolithic charcoal particles were found in the Munkeröd area.

The Neolithic forest fires initiated by the forest farmers are thus reflected in many pollen diagrams by high values of microscopic charcoal particles, *Pteridium* and *Populus* (see Göransson 1987). The study of extremely small kettle holes gives us, as we have seen, information about the genera of broad-leaved trees that were burnt (Göransson 1991 b, c). Archaeological excavations of the type described by Lindman show us where these Early Neolithic forest fires occurred within a certain area and which genera were burnt (Lindman 1993).

The terminology concerning the forest fires which were initiated—on patches—by the Early Neolithic forest farmer is not yet stabilized. The terms “slash-and-burn” or “burn-beating” must be considered provisional arrangements. It is strange that the term “clearance fires” must not be used, this term being reserved for the fires which were initiated on sites which were selected for the creation of permanent fields (the Seminar on slash-and-burn and clearance fires in Norden, Stockholm 1992). “Slash-and-burn” or “burn-beating” is surely not an adequate term for the “mild” fires which took place on newly cleared coppice wood areas during the subsequent Middle Neolithic (see below).

The art of quoting

Kristiansen writes in his article: “Recent pollen analyses from dolmens and passage graves, however, basically confirm Iversen’s perception of slash and burn practice . . . They also confirm the existence of pastures . . .” Why does Kristiansen not mention my investi-
gations in Alvastra when he states that he has read *Neolithic Man* and other papers by me? Why does he not mention what I have written about grazing during the Early Neolithic and the Middle Neolithic? I have said in *Neolithic Man*—and in a lot of earlier and later works—that Middle Neolithic cultivation took place in coppice woods on "wandering arable fields" (see below). These fields were burnt off so skilfully that the stump-sproiits were not damaged (Fig. 5).

It is of interest to observe that Andersen in his review of *Neolithic Man* does not accept my model for the Middle Neolithic coppice woods. For unknown reasons he places the pile dwelling in the Early Neolithic part of my pollen diagrams (Andersen 1989). Recently, after having written his review, Andersen has changed his mind and accepted my model for the Middle Neolithic coppice woods—but without citing me (Andersen 1993)—and Kristiansen cites Andersen.

The expansion-regression model for the Early and Middle Neolithic

The ca. 600 C¹⁴-year long period with low values for elm, lime and ash and high values for birch reflects—according to tradition—the Early Neolithic "expansion phase" (Berglund e.g. 1991). Then comes the Middle Neolithic "regression phase", which is characterized by a decline of birch and an increase of elm, lime and ash (starting at index horizon SB1 f). Berglund's model has developed from Iversen's—and earlier—from Troels-Smith's hypotheses. This expansion-regression hypothesis has been fully accepted by Kristiansen.

The Alvastra pile dwelling itself (built at SB1 e, see below) demolishes the regression hypothesis for the early Middle Neolithic. There seems to be some unknown factors lying beyond man's control, beyond man's activities (tree-felling, burning etc.) and beyond the effect of grazing on a large scale which cause the synchronous vegetational changes over large areas described above, from the elm decline level (ca. 5150 B.P.) up to index horizon SB1 f (ca. 4550 B.P.) and further upwards in time.

The pollen-analytical dating of the Alvastra pile dwelling

*Hordeum vulgare* (in the main naked four-row barley) and *Triticum dicoccum* (emmer wheat)—the cereals which were cultivated by the population who built the pile dwelling in the Alvastra area—spread extremely small amounts of pollen during flowering time as the pollen was "trapped" within the chaff. Only when the ears were dried on the hearth stones and threshed were great amounts of pollen released. (It also seems as if during harvest time pollen may be released when the straws are cut and thus "shaken" and disturbed, see further on.) Most of this cereal pollen fell down on the floor but it also spread over the spring-mire, forming a small cereal pollen peak (Göransson 1987 fig. 28).

Only a few metres outside the floor of the pile dwelling the cereal pollen values are very low compared with those of the occupation layer, and tree pollen strongly dominates over cereal pollen. The percentage (or per thousand) value of cereal pollen in the spring-mire at the "Alvastra time level" is, however, much greater than we ever find during the Regeneration Phase in even the most carefully chosen "peep-hole" (see below). Thus, 32 m to the north-east of the eastern trench five cereal pollen grains were found among 874 tree pollen grains (Göransson op. cit. fig. 31).

As the pile dwelling is dated to ca. 4430 ± 50 B.P. it was built and used at a point of time which corresponds to index horizon SB1 e (Fig. 2). As we have already learnt from the above discussion, this level corresponds to a time when the Regeneration Phase had lasted about a century. The Alvastra pile dwelling was—according to the archaeologists—a social and cult centre for a prosperous farming population a part of which lived in the vicinity of the Dags Mosse bog. (As will be discussed in a coming publication, the pile dwelling may also have functioned as a byre for cattle, sheep and goats during winter time.) In spite of the presence of a farming population the pollen diagram from the Dags Mosse bog shows us a distinct regeneration of elm, lime etc., as we can observe in almost all other pollen diagrams from southern Sweden dur-
Fig. 4. The pollen diagram from the kettle hole at Isberga (Isberga III).
ing that epoch. The early Middle Neolithic farming is thus characterized by rather high values of elm, lime, oak and ash.

Because of the filtration effect (Tauber 1965) or “curtain effect” (Göransson 1984, 1987, 1991a) of the growing forests, only very seldom are there any finds of cereal pollen from the early Middle Neolithic in pollen diagrams from medium-sized or large basins. Furthermore, pollen from four-row barley and emmer wheat spread extremely small amounts of pollen during flowering time (see above). As we have seen, most of the pollen which is released near ground level is spread very short distances.

*Cultivation of cereals in the Alvastra area during the Early Middle Neolithic*

As mentioned earlier, during harvest time pollen of the Middle Neolithic cereals may have been released when the ears were cut (or broken) off and thus “disturbed”. This implies that it should be possible to trace the Early Middle Neolithic fields of corn which once bordered on very small basins, surrounded on all sides by light, lime-rich soils. Such a basin is found 2 km east of the pile dwelling at the Isberga Nature Reserve.

In the middle of the Isberga Nature Reserve there is a small kettle hole. Pollen analysis and stratigraphical investigations were performed in 1977–78 (Göransson 1987). As no datings could be obtained—the analyses were performed before the introduction of the accelerator dating method—my argumentation that “there are only few cereal pollen grains registered in the Early Neolithic part of the Isberga pollen diagram” (Göransson 1987 p. 57) was wrong (Göransson 1994a p. 127, 1994b). Not only I, but also my colleagues and my reviewers misinterpreted the pollen diagrams from Isberga. The Isberga I and Isberga II diagrams should thus be omitted and the redated Isberga III diagram should be used.

A charcoal particle found in the kettle hole at 97 cm below the surface was dated to 6435 ± 165 B.P. The Isberga III diagram thus starts during the Late Atlantic. At 80 cm we find the Ulmus decline which coincides with a steep fall of the Tilia curve. Already at the beginning of the elm decline the unbroken Plantago lanceolata curve begins, revealing grazing from the very first part of the Early Neolithic up to our days.

At 68 cm we find the level which broadly corresponds to “Alvastra time”. In the Isberga area the cultivation of cereals, like the grazing, has uninterruptedly gone on since the start of the Early Neolithic. In fact, the pollen curve for Cerealia starts well before the elm decline, as mentioned above. The redated Isberga III diagram strongly strengthens my coppice-wood model for the Middle Neolithic.

*Stone Age trees and the dragon’s head phenomenon*

It is suggested that the Middle Neolithic “forest farmer” utilized the light, calcareous soils—that is, glaciofluvial deposits of different kinds—in the Alvastra area for cultivation of cereals. During the Stone Age these glaciofluvial deposits were covered with, above all, lime, oak and hazel.

If a lime-tree, an oak or a hazel is cut down in the autumn, winter or early spring the stumps will sprout in the following summer. These sprouts will quickly grow up into “stump-sprout trees”. Many such trees will form a “stump-sprout forest” or a “coppice wood”.

The growing sprouts will soon become fertile. I myself have studied stump-sprouts of oaks in my own garden. They began to flower when they were 13 years old. Hazel gets catkins when the sprouts are two years old (Sjöbeck 1964). Probably lime-trees which have grown up from stumps will flower when they are 10–15 years old. Also elm, ash and alder sprout richly after having been cut down. As far as I understand, the growing sprouts of these species will also flower within 10–15 years. It should thus be very difficult to observe clearings in forests of the above-mentioned trees—the trees of the Stone Age—by studying pollen diagrams from that epoch.

When the hero of the fairly-tale cut off the dragon’s head, seven new heads grew up immediately from the decapitated monster. In
the same way, sprouts thus "immediately" grew up when Stone Age man cut down trees in his forest. I think the term "the dragon's head phenomenon" may be useful when we talk about man and the Stone Age forests. Why should we then be surprised if we find that cultivation of cereals took place at the same time as lime, oak, hazel etc. flower richly during the Stone Age? Why must we go on saying that high values of these species show absence of cultivation during the Middle Neolithic?

It is much more astonishing that the effect of the dragon's head phenomenon did not take place or did not function between the elm decline level and the horizon SB1 f, that is, during the ca. 600 C\textsuperscript{14} -years of the whole of the Early Neolithic. Why did not, for instance, all the lime-trees grow up "immediately" when they were cut down for cultivation of cereals during the Early Neolithic?

What is the cause of the Early Neolithic forest destruction?

What is the cause of the Early Neolithic "forest destruction"? It is difficult to accept that cultivation, grazing and browsing could have such an effect on the forests over hundreds of thousands of square kilometres simultaneously from Ireland in the west over the whole of North-West Europe to Östergötland and western Russia in the east. If grazing and browsing and cultivation on such a large scale were the cause of the Early Neolithic forest destruction, then the grazing and browsing animals must have been attacked by some epizootics at the beginning of the Middle Neolithic. According to the expansion-regression model the cereals too must have been affected in some way (by some sort of plant pathology?), or was the human population attacked by a Neolithic Black Death? Or did the Early Neolithic farmers abandon the forest farming and turn to the life of the hunter-gatherer again?

I do not accept the regression hypothesis. My model for the forest farming during an early part of the Middle Neolithic was presented for the first time at a meeting in Oslo in 1980 and it was described in detail in my pollen-analytical work on the Alvastra pile dwelling in 1987. A short summary is given below.

The Middle Neolithic forest farming
in stump-sprout forests ("coppice woods")

It has thus, as described above, been possible to place the Alvastra pile dwelling in an exact position in the forest-historical succession with the aid of the pollen diagrams from the Alvastra spring-mire (Göransson 1987 figs. 29 and 31). Cereal pollen was transported by wind from the dwelling site to the points investigated in the mire. The cereal-pollen peak pinpoints exactly the pile dwelling in the forest-historical succession. It was built and in use at a point of time which corresponds to index horizon SB1 e when the forests of elm, lime and ash were under strong regeneration ca. 700 C\textsuperscript{14} -years above the elm decline and when hazel was still of very great importance. (That Andersen in his review, Andersen 1989, has tried to "move down" the pile dwelling in the forest-historical succession—into the Neolithic—is to me a great enigma, the solution to which is not of a scientific nature.)

That cereals were cultivated at the same time as the forests of the above-mentioned trees increase so distinctly and when hazel-bushes were very common is in my opinion, direct evidence of the presence of coppice woods. As underlined above, the coppice woods of the Middle Neolithic are not equivalent to the strict coppice woods of the Middle Ages and later on (see, for instance, Emanuelsson & Bergendorff 1982, Worsée 1979). A better name for these early coppice woods is perhaps "stump-sprout forests". As this name is unwieldy, however, I prefer to use the term "coppice woods".

My model for the Middle Neolithic coppice woods was thus described by me about 15 years ago and it may be summarized as follows. Certainly the forests of, for example, hazel were also coppiced during the Early Neolithic, the coppice wood tradition thus being very long. During the Late Atlantic coppice woods arose automatically when sprouts grew up from the stumps of the fallen trees which were killed by "fire-girdling" and from...
Fig. 5. Symbolic drawing of coppice wood groves of different ages during the Regeneration Phase. (1) 20–25-years-old grove just before felling. There are no weeds in the very dense grove. (2) The grove has been cut down and the ground has been cleared by burning. (3) One-year-old stump-sprouts and emmer wheat (in August) on the cleared area. A part of a fence, made of coppice wood trunks, is seen. Not only fences but also pile dwellings could be built of coppice wood trunks. (4) A two-years-old coppice wood in the previously utilized area. (5) A four-years-old coppice wood in the same area. Soon the coppice wood will start producing pollen. In the coppice wood landscape the megalithic graves were distinctly seen. Drawing: Hans Göransson 1981, redrawn in 1985 and published as fig. 33 in Neolithic Man 1987.

very young cut-off trees (Göransson 1987 p. 46). At the beginning of the Middle Neolithic the utilization of coppice woods was accomplished.

The coppice wood system was introduced to give a secure supply of mineral nutrients and of nitrogen so that continuous cereal growing could be maintained. We have to imagine a system of coppice wood groves of different ages on light soils. These coppice-wood groves were allowed to grow very dense so that the weeds were choked. Every year one coppice-wood grove was cut down by axe, and twigs and small stems were burnt. On the slightly burnt and cleared coppice wood areas emmer wheat and four-row naked barley (and probably small amounts of hulled six-row barley) were cultivated. The large stems were probably used as fences or for building and firewood. Only one harvest was taken on the cleared area. By harvesting time the stump sprouts had already started to grow.

The cleared area was left alone for 20–60 years. By taking harvests with such a time interval in each small area, the light soils in the investigation area could have been utilized for cereal cultivation— theoretically— over thousands of years. My hypothesis has recently been confirmed by plant ecologists (Olsson 1991 pp. 36, 118). M. Larsson has made the very interesting observation that the habitation sites of the Early Middle Neolithic in southern Scania moved around according to a fixed pattern within limited areas (M. Larsson 1992 p. 83).

Perhaps one harvest was taken within the Isberga area every second or third year, which means that there were ca. 6–20 groves of different ages within that area. A harvest interval of the kind suggested above would give us an unbroken cereal curve such as that found in the Isberga diagram at the same time as the values for lime rise in the pollen diagram (probably lime—and above all hazel—produced the best “manure” in the coppice woods, their decaying leaves giving a very rich soil). We can observe, however, that the pollen production from the coppice woods is lower (the very local Isberga III diagram) than that from coppice woods plus “real” regener- ated forests (the regional Dags Mosse diagram).

My pollen diagrams from other parts of the inland of southern Sweden demonstrate that grazing and probably even cultivation of cereals took place also outside the “megalithic areas”. Now—after having read Kristiansen—I understand that it will take at least another decade before the archaeologists will accept my observations.
Other models for cultivation of cereals during the Middle Neolithic were also presented by me in *Neolithic Man*. One of these models will be further developed in my coming work on the palaeoethnobotanical material from the Alvastra pile dwelling (Göransson, in print) (see below).

*Dendrochronological evidence of stump-sprout forests (coppice woods) in the vicinity of the Alvastra pile dwelling*

Bartholin investigated no less than 200 oak logs from the pile dwelling (Bartholin 1978, 1983). They were all cut down on high ground in the vicinity of the pile dwelling. All oaks had begun to grow at the same time, which demonstrates that they had grown up from stumps. When the cutting and building activities started, the oaks were ca. 40 years old. The building activities ended after 42 years. The oaks which were felled at “year 42” were thus slightly more than 80 years old. Also the lime and aspen trunks had started their growth at the same time as the oaks. Hazel is the most common tree species used in the construction work (see Bartholin in print).

The ca. 20 elm logs investigated by Bartholin also grew up from stumps, as is seen in the form and the growth manner of the stems (Bartholin in print). The elm logs are older than the oak logs. The forests of oak, lime, hazel, elm, aspen, etc. grew denser and denser during the 42 years the pile dwelling was in use. The pile dwelling was more or less intensively used only during the first 18 years (during that time with breaks in the building activities). At the end of this first period of activity a fire probably affected the forest. After a 22-year pause in the construction work the activities started again and went on for two years. After “year 42” these activities ended.

**Conclusion**

It can thus be concluded that Kristiansen’s comments demonstrate that it may be difficult for an archaeologist to read papers in vegetational history. The archaeologists of the expansion-regression school never ask how the cornfields were manured. Thus a “down” in the broad-leaved trees means an “up” in the cultivation, and an “up” in the broad-leaved trees means a “down” in cultivation for the archaeologist of this “accordion” school.

The archaeologists of the accordion school seem to believe that the forests of broad-leaved trees were an enemy to the Neolithic farmer (and of course to the horror-struck Mesolithic hunter-gatherer). For an urban Dane of today it may be natural to think in that way. During prehistoric time, however, there were no artificial fertilizers in Denmark (it cannot be excluded that small manured fields may have existed during the Middle Neolithic). In the first hand, however, the farmer had to utilize the forest—both as plough and manure-spreader, forests which quickly grew up from stumps. Thus high values of *Tilia, Quercus, Corylus* and other broad-leaved trees need not reflect absence of cultivation.

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