Roger Engelmark,[1] Ulf Segerström,[2] Jan-Erik Wallin[2]

THE PALAEOECOLOGICAL RECORD OF CULTIVATION IN OSTROBOTHNIA DURING THE IRON AGE

In *Fennoscandia archaeologica* IX (1992) E. Orrman has presented a 7 page review of the book *Järnåldersbygd i Österbotten. En ekologisk arkeologisk studie av bosättningskontinuitet och resursutnyttjande* (Baudou *et al.*1991. *Iron Age Settlement in Ostrobothnia. An Ecological-Archaeological Study of Settlement continuity and Resource Utilisation*), and has directed his strongest criticism at the ecological and botanical sections of the book. He attacks the hypothesis, proposed and tested by us, concerning the dependence of agriculture and therefore settlement on proximity to natural coastal meadows. He is strongly critical of our interpretation of the palaeobotanical data. We welcome an open discussion, because in an objective research community, research deserves to be discussed and evaluated. But such debate must be based upon a logical analysis of the available data. Orrman's (1992) review regrettably does not live up to these expectations. We present here our reaction to his criticism. Our discussion rests on scientific principles, and we largely restrict ourselves to a number of key questions: Interpretation of palaeoecological data; definition of slash-and-burn; the use and significance of coastal meadows during prehistoric times; fertilised fields; and topography and soil types. We discuss particular sections of Orrman's (1992) review, even though his arguments frequently suffer from uncritical use of sources and a weak scientific basis.

Interpretation of pollen diagrams

A modern pollen diagram is usually presented in a percentage form, with the sum of all terrestrial plants forming the basis for calculation (Moore *et al.* 1991). Thus if a few pollen types dominate the pollen assemblage, every major change in the representation of a single important species will result in a corresponding adjustment in the percentages of the other dominant pollen types. Tree pollen usually dominates in diagrams from northern Scandinavia, and thus felling of spruce forest close to the sampling site is recorded both by a decline in spruce pollen percentages and a simultaneous increase in the percentage values of the other major types, e.g. birch and pine. In this example birch and pine have not increased their cover on the ground, but only increased their pollen percentage because of the way the diagram is composed.

Orrman (1992, 100) claims that *the decline of spruce, and the increase of birch and alder, for example in the sample from Katamossen bog, clearly supports the case for slash-and-burn farming.* It is not that easy to interpret a pollen diagram, because regardless of the system of cultivation used, it was the more easily cultivated spruce dominated soils which were first exploited in the boreal forest (Engelmark 1976).

In order to establish the type of cultivation that was used, one must ascertain which cereals were cultivated and which weed species appeared. Rye was almost exclusively cultivated in the type of slash-and-burn (Fi. *huuhta*) which was practised in spruce forest (Heikinheimo 1915, 83–106, Soininen 1974, 62–65, Pirinen 1982, 360). Rye pollen is exceedingly rare in the diagrams from Ostrobothnia during the Iron Age, and was hardly cultivated at all in those parts of Ostrobothnia that we have investigated. Thus Orrman's (1992) argument collapses. It is inappropriate to present information about the expansive and intensive agriculture from the 1500's–1800's, as an analogue for cultivation that took place between 500 and 1000 years earlier. Neither is it justifiable to compare uncritically the coastal area of Ostrobothnia with southern or

[1] Department of Archaeology, University of Umeå, S-901 87 Umeå, Sweden.

[2] Department of Ecological Botany, University of Umeå, S-901 87 Umeå, Sweden

eastern parts of Finland, which experience completely different climatic conditions.

As regards the weed flora (Orrman 1992, 100) several palaeoecological studies backed up by modern cultivation experiments have shown that different agricultural systems are characterised by indicator weed species, and that species diversity increases with the transition from slash-and-burn to farming of permanent, fertilised fields (Vorren 1979, Behre 1981, Hicks 1985, Grönlund & Asikainen 1992). A recently published pollen analytical study has described in detail the plant succession from an isolated fifteenth century slash-and-burn episode. The major weed species recorded were *Rumex acetosa/acetosella* type, *Ranunculus* type and *Epilobium* type, i.e. grazing and burning indicators (Segerström 1992). The pollen stratigraphy, which was from a 'closed canopy site' (Bradshaw 1988) in the Västerbotten coastland (N. Sweden), recorded conditions both prior to and after the slash-and-burn episode. There was no indicator characteristic of permanent field cultivation. Weed species like those mentioned above that are indicative of slash-and-burn, are scarcely found at all in the seed material from Kalaschabrännan (Engelmark 1991, 86– 102).

Orrman (1992, 105) erroneously claims that we do not discuss alternative interpretations of the pollen data. Such a statement from his side must be intended to mislead those who have not read our book. In reality our position was reached by considering the possibilities that the pollen record could reflect a natural shore ecosystem, long distance pollen or even slash-and-burn (Segerström & Wallin 1991, 70–72). We have also discussed our results in the context of earlier research in the same area (Segerström & Wallin 1991, 72–74).

Interpretation of pollen diagrams must be based on a sound botanical and ecological knowledge, giving due consideration to topography, climate, soils, hydrology and the possible effects of human impact. It is unscientific to allow interpretation of botanical data to be controlled by pre-conceived assumptions, which in the absence of archaeological evidence, are based on historical information from a far later period. Such an interpretation will be misleading. We have proposed an interpretation based on natural sciences, describing a model which has been found to be generally applicable from ca. 200 B.C. until the Middle Ages. We have tested the model and it is thoroughly consistent with the palaeoecological data.

Slash-and-burn cultivation

There is no single generally accepted definition of slash-and-burn cultivation, despite an extensive literature. A suitable definition must imply that the nutrient store in the soil and vegetation is made available for cultivated crops by burning (Myrdal in print). After the store of nutrients has been used, and crop productivity has become uneconomical, the ground is left to develop back into forest for a while to replenish the store of nutrients. The latter process takes a long time. The cultivation phase lasts for 1–4 years, while the forested phase lasts between 25–50 years and sometimes even longer in a cyclic system (Heikinheimo 1915, Soininen 1974, Kardell *et al.* 1980, Hicks 1985). The forested phase is often exploited for grazing (Heikinheimo 1915, 105). The advantage of this system was that the soil required no mechanical treatment, or manure.

It is clear that the *huuhta* method with its use of coniferous wood represented a major breakthrough in the cultivation of the boreal forests (Pirinen 1982, 352). However, the intensification of the system during the historic period, when the forested phase was reduced to less than 20 years and the soil both ploughed and harrowed (Heikinheimo 1915, 106) was most likely the result of overexploitation. A considerable increase in population together with an intensification of slash-and-burn cultivation in certain regions resulted in a shortage of suitable sites. Trees never had the chance to regenerate on the exploited areas before they were again pressed into service. Heavily grazed areas supporting only a low-growing shrubby vegetation were burnt and cultivated. A proper nutrient reserve was never given the opportunity to accumulate either in the humus layer or in living plant tissue. The need arose to treat the soil mechanically to release the nutrients bound up in root tissue. The use of such deciduous or mixed shrubby wood (i.e. Fi. *rieskamaakaski, pykälikkömaa*) has been regarded as a fall-back system, only used when suitable land for slash-and-burn was not available (Pirinen 1982, 354, 356).

Rye was the chief cereal associated with slash-and-burn, even though historical sources mention the use of other crops. Other crops were often cultivated during the second or third season after further burning, and usually after soil preparation (Soininen 1974, 58–65). In Savo, rye was sowed first of all in the swidden, then the ground was cleared for subsequent spring sowing (Pirinen 1982, 360). Barley was the cereal least suited to slash-and-burn, and was therefore the first cereal cultivated in permanent fields (Soininen 1974, 65). Orrman in his paper refers to a number of historical sources to strengthen his argument that other cereals than rye were equally common in slash-

and-burn cultivations. However, there are problems both with the source material, e.g. how clearly different sources define the terms slash-and-burn, swidden, burn-clearing etc., and with a lack of knowledge about how the farmers interpreted the terms. The inherent dangers in over-interpretation of such data has also been pointed out by Heikinheimo (1915, 48) among others.

To state categorically, as Orrman (1992) does based on material from the 1500s–1700s, that slash-and-burn cultivation was also practised during the Iron Age, is highly speculative. Orrman also totally ignores the fact that the historical sources that he cites clearly show that slash-and-burn cultivation scarcely existed, even during the historic period, in the coastal communities now under discussion (Heikinheimo 1915, maps N:o 1–4, Soininen 1974, 55–58).

The fact that fire has long been used for clearance does not justify the use of the term slash-and-burn to describe all types of cultivation in which fire is used in the initial removal of vegetation. Fire has clearly also been used in the establishment of fields, hay meadows and grazing land, primarily as a labour-saving device. Orrman (1992), however, has grouped together several terms: Swiddens; burn-cleared fields; burn-cleared plots; burn-clearing; slash-and-burn plots; slash-and-burn cultivation; and *kytömaa*. This is a careless use of terms that are not clearly defined, and one wonders if E. Orrman himself has thought through his own usage of them. Several of the afore-mentioned terms seem applicable to burn-clearing with the aim of establishing fields or pastures, and should not be confused with the rotational slash-and-burn cultivation itself. Similarly, *kytömaa* cultivation, (the burning of peatland to create fields), which was widespread in Ostrobothnia during the historic period, ought to be distinguished from slash-and-burn cultivation (Soininen 1974, 138–148).

As an alternative interpretation of our results, Orrman (1992, 104) proposes that Ostrobothnia during the ninth century and for a few hundred years afterwards *was a wilderness zone utilized by people from the inland, mainly Satakunta.* Even though he carefully points out that *evidence of cereal pollen from the 9th century and later times poses a number of problems for the above interpretation, as cultivating grain in far-off hunting areas does not, at first sight, appear to have any meaningful function in the economy,* he defends his position by saying that *cereals, however, were an indispensible element of the diet of Nordic peoples.* One can raise several objections to this conclusion:

1) Cereal cultivation was not introduced into most of Norrland until the Middle Ages and the historic period (Segerström 1990). The land was colonised first by hunters and fishermen, and subsequently animal husbandry came to dominate the economy for a long time. By no means all societies have cultivated cereals. This even applies to Finland! Orrman (1992) greatly over-interprets Sandnes' (1980) work in this matter. Sandnes was discussing Norwegian farms, and presented a far more complex situation than Orrman suggests.

2) The pollen diagrams show no change at the transition, postulated by Orrman (1992) and others, from a well-developed agricultural community to the low intensity, shifting slash-and-burn economy presumed to have been practised by travelling hunters. Pollen analysis from Ostrobothnia provides no evidence to show that agriculture was more intensive or widespread during the Older Iron Age than during the Younger Iron Age. On the contrary, Orrman himself concludes (1992, 104) that agriculture seems to have been more permanent at Lampeltmossen during the Viking and Crusade Periods, but he still maintains that the cultivation was only temporary slash-and-burn. He omits to add that the simultanaeous cultivation at Katamossen, from the same region, was also "more permanent". This does not make any sense: Orrman (1992) suggests there was a more or less permanent slash-and-burn cultivation during the late Iron Age, but it can not be pollen analytically distiguished from the cultivation economy that persisted during the early Iron Age, which was indisputably field cultivation, not the least on the basis of macrofossil and ard mark evidence from Kalaschabrännan (Engelmark 1991, 86–102, Liedgren 1991, 126–129).

Division of cereal pollen records into three quantitative categories which can be individually interpreted is not permissible, and would never have been done by a palaeoecologist. Doing so is only intended to fragment the overall picture which can be obtained from a large group of analyses. Furthermore to pursue such reasoning, due consideration must be given to the relative pollen representation of the individual species in the diagram. This is a central issue within palaeoecology, about which there is continuous scientific debate. E. Orrman lacks the expertise necessary to discuss such an issue.

Orrman further proposes (1992, 104), with reference to his Figure 1, that there is no connection between the cultivation activity and the coastal zone at the various sites. As further support for this argument, he claims that six of the sites were close to the coast around 250 A.D. and four sites near the coast around 800 A.D. (of which site 10 occurrs in

both groups according to Orrman). This is an extraordinary claim. He totally ignores the fact that our sites lie at widely differing altitudes (between 30 and 10 m above sea level), and given the consequences of land uplift, his two postulated groups cannot each be of similar age. Such a basic misunderstanding should never have been printed even in error!

Orrman's Figure 1 (1992, 103) shows that the level of recorded cultivation lies 1–2 m higher than the model line for coastal uplift. This is totally correct, because cultivation did not occur precisely at the water's edge, but rather some metres higher on recently reclaimed land (Engelmark 1991, 95, Fig. 4:4). It was important, however, to position the settlements close to the coastal meadows which straddled the water's edge and the nearby seasonally flooded ground. Apart from the different symbols that Orrman (1992, Fig. 1) uses for cereal cultivation, which are only misleading, his figure provides powerful support for our hypothesis and model.

3) The importance of rye in slash-and-burn cultivation is regarded as indisputable, but the cereal types identified in the pollen analyses indicate no re-organisation of the agricultural economy during the latter part of the Iron Age. A complete agricultural re-organisation, such as suggested by Orrman (1992), ought to be reflected in the cereals cultivated.

4) Slash-and-burn cultivation was both labour-intensive and hazardous (Pirinen 1982, 362). It is scarcely plausible that temporary visitors to a marginal area, would base their activity on unreliable slash-and-burn.

5) Cultivation was evidently closely linked to the coastal zone (though not located on the actual beach), where there was also good access to winter fodder in the form of natural coastal meadows. It is hard to believe that temporary visitors would position their slash-and-burn cultivation (if practised) in the coastal zone, where both the forest and the soils were young and poorly developed. It is natural to locate slash-and-burn cultivation in older, spruce forest, where a large nutrient store has developed both in the humus and in the vegetation. This was not done during the Iron Age because the economy was apparently not based on slash-and-burn cultivation.

6) Orrman's (1992) entire argument rests on source material from the 1500s–1800s, i.e. the intensive and expansive agriculture of the historic period. It is not scientifically permissible to uncritically apply such data to an economy that is 500–1000 years older.

Coastal meadows

We know that animal husbandry was important to the Iron Age economy because of the types of buildings found. Animals were housed indoors, and access to winter fodder was the critical factor for success. The exploitation of natural meadows, such as along the river and lake shores and along the flat coastal areas around the Bothnian bay, has been an important basis for the entire northern farming economy (Frödin 1952, Elveland & Sjöberg 1981, Elveland 1983, 1984). This natural resource most reasonably was of great importance for the animal husbandry economy that spread throughout Scandinavia during the Iron Age. Settlements were often located near to seasonally flooded land, and beside shallow, sheltered bays where natural coastal meadows offered rich fodder resources. Fields, however, were not laid out within these meadows, or in areas that were prone to flooding, but rather on better drained, warm, morainic soils lying upslope. Slash-and-burn on the contrary, was independent of access to fertilisers, animals or fodder. There was no reason for temporary visitors to site a slash-and-burn culture close to the shore-line, where conditions for such cultivation were less favourable than in the older, well-developed forest lands.

Pollen and seed analyses have clearly shown, however, that the coastal meadows were used as fodder resources. The sustained presence of coastal meadow communities dominated by grasses or sedges is a sign that they were kept in use (Hicks 1985, 1992). Pollen from cultivated plants or weeds is swamped by the massive representation of grass and sedge pollen of local origin. A rapid establishment of meadowsweet, willow, and the previously suppressed tree flora (e.g. alder, birch and pine) takes place when cultivation ceases. Grasses and sedges are quickly outcompeted due to a natural succession which incidentally has nothing to do with slash-and-burn cultivation. This was the typical pattern at Torvströmossen, Vitmossen, Pane skogen, Skräddaris, Vikperä, Nedre skogen and Träskismyren. Lampeltmossen and Katamossen are exceptions, but these should be considered more as regional rather that local sites. At Rimal the topography was quite different from the other sites. Unutilised coastal meadows become forested more quickly, provided that the conditions permit tree establishement (Ericson 1980).

Clay-rich soils

Orrman (1992) claims that there is a connection between clay-rich soils and Iron Age settlement,

because fields were preferentially located on such soil types. Our position is that the connection exists because low lying, clay-rich soils supported good hay meadows. Fields comprised the smallest area of utilized ground, and were therefore not the decisive factor in settlement location. The average size of Ostrobothnian fields was 1–2 ha during the 1500s (Österholm 1983), while even a single cow requires at least the same area of meadow. The average cattle-holding during the same period was 5–8, which means that a considerable amount of grazing land and hay meadows was needed. We have studied the prehistoric period, but fields were unlikely to have been larger then. Agriculture with permanent fields also requires a certain number of stock to provide fertiliser for sustainable yield. 4–6 animals per ha of field are reckoned to be necessary for permanent field cultivation (Sw. *ensäde*) systems, and slightly less with two or three field rotational system (Sw. *två- och tresäde*). Iron Age agriculture in Scandinavia, including southern and western Finland, was dominated by permanent field cultivation (Sw. *ensäde*) according to results of macrofossil analyses. Sufficient meadowland was therefore a prerequisite for agriculture.

Fields must be well drained and in warm soil. Recently germinated cereals are specially sensitive to wet soils. The further north one cultivated, the more critical it was that sowing was early so that the cereal had time to ripen. Fields therefore had to be located on light, well-drained soils. Drainage and banking-up fields was not practised before the Middle Ages (Myrdal 1986). Soil preparation techniques also argue against cultivation on heavy clay soils (Ahtela 1981). The field weed flora and the ard traces from Kalaschabrännan, show clearly that the fields lay on coarser soil types.

We stand by our interpretation of the palaeoecological data based on the reasoning above. Our hypothesis concerning Iron Age agriculture and settlement stands fast. The results clearly show that we have agricultural continuity in the region, with cultivation of fertilised fields throughout the Iron Age, but with the siting of settlements moving gradually westwards keeping pace with shore-line displacement through uplift. The position of the coastal meadows was the decisive factor in settlement location. Orrman's (1992) arguments do not stand up to scientific analysis, and his criticisms therefore do not dislodge our thesis.

Orrman's (1992) article reveals a surprising ignorance in many areas, and one cannot escape the feeling that he has unconsciously been influenced by unscientific ideas. Unfortunately he may confuse the unwary reader with vague statements, poorly-defined terms and references to obscure and unreliable literature. He misquotes and twists facts from the literature he cites, in addition to deliberately witholding information that disagrees with his own view. We are honoured that Fennoscandia archaeologica consider that our book merits a seven-page review, showing that we discuss issues of considerable importance. However, we expected a more scientific discussion.

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