Milton Nunez

ON SUBNEOLITHC POTTERY AND ITS ADOPTION IN LATE MESOLITHIC FINLAND

Abstract

Various aspect of Subneolithic pottery and its adoption by the late Mesolithic inhabitants of Finland are discussed. A tentative model for the diffusion of Subneolithic lifeways and pottery into the Mesolithic territories of the East European forest zone and, particularly, Finland c. 4500–3500 bc is derived on the basis of environmental, archaeological and ethnographical data. It is suggested that Subneolithic pottery may have spread north through exogamy from first-generation Subneolithic groups that had formed along the Mesolithic-Neolithic frontier, and that this process was aided by the stabilization of favourable Atlantic environments which gave rise to the degree of sedentism needed to make the adoption of pottery feasible. In Finland and the Circum-Baltic region the favourable effect of the Climatic Optimum was enhanced by the onset of maritime environments in the Baltic basin c. 6500–5500 bc.

Milton Nunez. Museibyrån, P.B. 60, SF-22101 Mariehamn, Åland, Finland.

INTRODUCTION

Within a period of 1000 years, approximately between 4500 and 3500 bc[1], pottery was adopted by most food-gathering human groups occupying the vast forest zone that extended from southern Scandinavia to the Urals and even beyond, a process that gave eventually rise to what is generally known as the Pit-comb ware technocomplex of the East European forest zone. This paper explores the environmental and cultural phenomena that were possibly related to Subneolithic[2] pottery and its introduction in that region, especially those that may have led to its adoption in Finland in the late fifth millennium bc.

The early pottery of one or more of the geographical regions occupied by this vast technocomplex has been described in a number of works; but for one of the best general description in English one must return to the 60-year old essay on the North European "Forest cultures" by Childe, who was able to grasp the concept despite the limited information available at the time.

> The several kinds of agreement which unify the Forest culture are . . . best illustrated by the pottery. Despite the variety of styles the traits common to all the dwelling-place ceramics are very striking. All the pots seem to have been built up by rings. All have rounded bottom, very small in proportion to the mouth and sometimes pointed in the same sense as Ertebølle pots. In the more primitive and generalized form the walls rise in continuous unbroken curve from base to rim. But . . . it is possible to cite vessels . . . in which the sweep of the curve is broken by a distinct shoulder surmounted by a short concave "neck". At the same time the rim may be thickened, bevelled, or moulded. Lugs or handles are nowhere found. An ornamental device common to all groups and all phases is a horizontal row of pits below the rim, accompanied often by parallel rows covering the body of the vase. . . . Finger-nail impressions, simple points, and short strokes, incised or stamped, and grouped horizontally, often even on the rim, are also common. Whipped-cord or twisted thread impressions appear in Finland already on the earliest Sperrings style or as the "maggot pattern". The maggots are arranged in horizontal rows obliquely or forming a herring-bone design. Later maggots give place to similarily shaped depressions executed with a short-

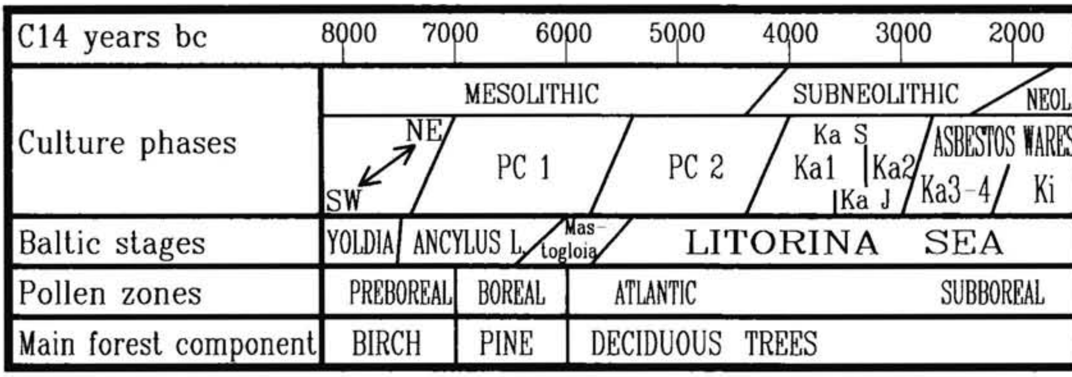

Fig. 1. Schematic representation of cultural and environmental sequences in Finland c. 8000–2000 bc.

toothed comb-like stamp (Childe 1931:345–346).

Some time during the second half of the fifth millennium bc, pottery made its debut in Finland, clearly labelling archaeological assemblages and sites which would otherwise have been practically indistinguishable[3] from their preceramic[4] counterparts. In other words, pottery was simply adopted by the Mesolithic inhabitants. From this it follows that tracing the origins of the Finnish Comb ceramic culture must include an examination of its local Mesolithic roots.

Archaeological data indicate that Mesolithic man reached Finland in the second half of the eighth millennium bc (Appendix A). It could not have been much earlier since the country lay then under ice and water. A modelling of the sequence of events that led to the colonization of the country by Mesolithic groups from east and south has been presented elsewhere (Nunez 1984, 1987b, 1989); and the Finnish Mesolithic has been discussed by several authors (eg. Äyräpää 1950; Luho 1956, 1967; Clark 1975; Siiriäinen 1981b; Matiskainen 1989a).

Despite the rather unstable and ever-changing environmental conditions characteristic of the period, Finnish Preceramic assemblages seem to have undergone a fairly smooth and gradual development for about 3000 years. Although true types are difficult to derive, it is possible to distinguish certain lithic forms with discrete chronological range with respect to the shoreline displacement. This is apparently the main reason why Finnish artefact classifications have relied more on shore displacement than on true typology: the fact that artefacts are more readily grouped according to their position above present sea level than on typological grounds has resulted in the tendency of dividing Finnish Preceramic assemblages on the basis of the different stages of the Baltic basin (eg. Luho 1948, 1967; Äyräpää 1950; Siiriäinen 1969, 1978; Nunez 1978a, 1978b, 1984; Matiskainen 1989a).

But let us now examine the environmental and socioeconomic factors that may have led to the adoption of pottery by the late Preceramic inhabitants of Finland. The environmental episodes experienced by the country and its people during the Mesolithic are summarized in Figs. 1–2.

ENVIRONMENTAL CONDITIONS c. 7500–4000 bc

When Mesolithic man reached southern Finland around 7500–7000 bc, he found a land in the midst of profound environmental changes. The remnants of the Scandinavian icesheet were being rapidly wasted by relatively mild late Preboreal climates, which were in turn stimulating the spread of vegetation into deglaciated areas. Ice-free Finland formed then an archipelago within a "great lake".[5] Fennoscandia had been depressed by the heavy icesheet during the glacial maximum, and the water levels of the isolated Baltic basin were high due to massive glacier ablation. Consequently, despite powerful isostatic rebound, much of ice-free Finland lay still under water at the arrival of Mesolithic man in the region (Hyvärinen 1975; Donner 1976).

Shoreline displacement

As most major centres of glaciation during the ice ages, Fennoscandia has been undergoing

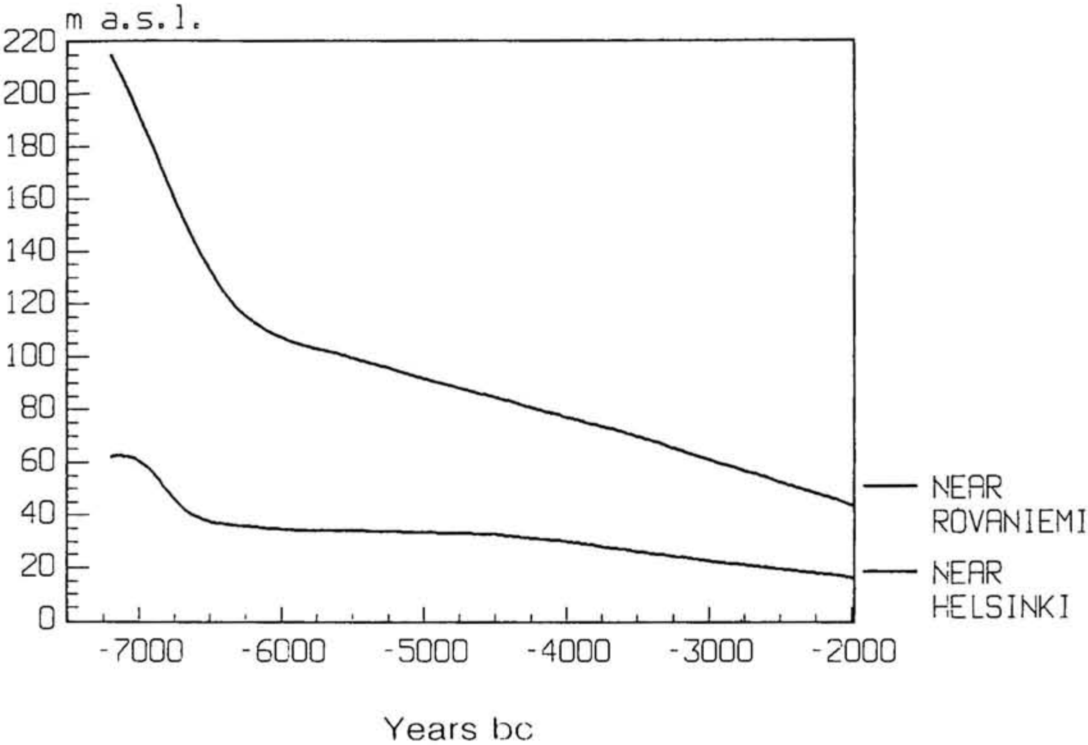

Fig. 2. Shoreline displacement curves for the Pello-Rovaniemi area in the north and for the Vantaa-Helsinki area in the south during 7000–2000 bc. For approximate location see points numbered respectively 25 and 1 in the map of Fig. C3. (Based on data from Nunez 1978a; Saarnisto 1981; Eronen & Haila 1982; Hyvärinen 1982, 1984).

isostatic recovery since it became ice-free. Although the uplift rate has been slowing down since deglaciation, it still approaches the impressive figure of one metre per century in some districts of northern Finland. This continuous land rise has been responsible for the gradual emergence of Finland from the waters of the Baltic. Post-glacial shoreline displacement has been generally regressive; but there were episodes when the level of the Baltic basin rose faster than local uplift rates, leading thus to transgressive events: for example, upon most ice-free shores during the Ancylus transgression c. 7500–7000 bc; or when the eustatically rising sea level caused the Litorina transgression in southeast Finland c. 5500–5000 bc. (Eronen 1974, 1976; Saarnisto 1981; Eronen & Haila 1982).

Certain uplift-related phenomena may be seen as potentially influential to cultural development in Stone Age Finland. First of all, the ever-changing shoreline and its related metachronic phenomena of never-ending environmental sequences such as bay-lagoon-lake-bog or island-peninsula-mainland; in general the continuous transformation of coastal environments to inland ones. The repercussions of isostatic upheaval were not restricted to the coastal zone, however. The fact that the land rose faster on the northwest than on the southeast caused lake basins to tilt and, consequently, considerable environmental changes also inland (Saarnisto 1971; Donner 1976). Although these changes seldom reached catastrophic proportions, they were rapid enough to be detected within human life spans and must have influenced various aspects of culture as a long-term effect.

The Baltic basin

Glacier melt caused the Ancylus Lake to transgress upon most its shores c. 7500–7000 bc; but by 7000 bc the considerably shrunken icesheet could no longer sustain high water levels and the Ancylus Lake receded to ocean level. Although this regressive event took place within a period of 500 years, in combination with the isostatic uplift it resulted in regression rates in the range of 12–4 m/century in the parts of Finland inhabited then by man (Eronen 1974, 1976; Nunez 1978a, 1978b, 1984, 1987b; Saarnisto 1981; Eronen & Haila 1982).

The opening of the Danish sound around 6500 bc put eventually an end to the "great lake" Ancylus stage with the influx of salt water and the onset of marine environments in the Baltic region. These conditions were slow to spread to the Finnish side of the Baltic: a tenuous marine influence in the form of slightly brackish sediments (Mastogloia phase) did not reach the Helsinki area until after 6000 bc. (Eronen 1974, 1976; Alhonen et al. 1978; Hyvärinen 1980, 1982, 1984).

By 5500 bc, however, the Litorina Sea was washing Finnish shores. Diatom and mollusc data indicate that Litorina waters were more saline than those of the present Baltic, a feature which may be connected with higher evaporations rates under Hypsithermal conditions and/or the considerable extension and depth of the early Litorina Sea. This stage lasted through the remainder of the Stone Age (c. 5500–1500 bc), after which the Baltic basin began to resemble more and more its present conditions.

One may well wonder about the productivity of the northern Baltic, particularly the Finnish litoral, before the onset of marine conditions around 5500 bc. In addition to low water temperatures caused by calving and melting of the Late Glacial icesheet, powerful erosional processes related to such events as a considerable drop of the Yoldia Sea level c. 8200 bc followed by the Ancylus transgression c. 7500–7000 bc and, especially, by a subsequent rapid regression may have had a negative effect on nutrient production and, consequently, the development of aquatic life (Nunez 1989).

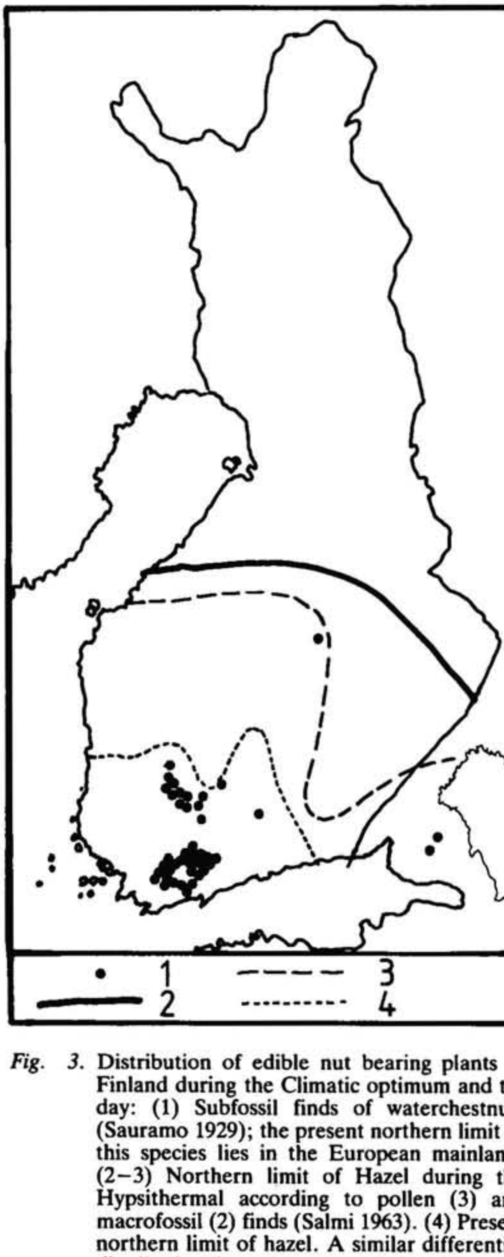

Fig. 3. Distribution of edible nut bearing plants in Finland during the Climatic optimum and today: (1) Subfossil finds of waterchestnuts (Sauramo 1929); the present northern limit of this species lies in the European mainland. (2–3) Northern limit of Hazel during the Hypsithermal according to pollen (3) and macrofossil (2) finds (Salmi 1963). (4) Present northern limit of hazel. A similar differential distribution for oak is suggested by the work of Birks & Saarnisto (1975).

Climate and vegetation

Finnish Post-glacial climates have been deduced by with the help of subfossil pollen and macroscopic plant remains deposited in bogs and water basins (Fig. 1). The late Preboreal birch-pine forests that grew in southern Finland at the arrival of the first Mesolithic settlers spread northwards into deglaciated territories and, except in the very north, shifted their composition from birch to pine dominance in the seventh millennium bc (Boreal period). Favourable environments helped the spread of warmth-loving plants, giving rise to the deciduous tree dominated mixed forests of southern Finland during the climatic optimum in the sixth and fifth millennia bc. (Donner 1976).

A period of warmer climate is also indicated by numerous subfossil finds of thermophilic species well past their present northern distribution limits. The classic sample is the waterchestnut[6] (*Trapa natans*), which grew at least 10° beyond the latitude of its present habitat in central Europe; but the same applies to other important edible nut-bearing species such as hazel and oak (Fig. 3; Auer 1924, 1925; Lumiala 1940; Valovirta 1957, 1960; Salmi 1963; Alhonen 1964; Donner 1976; Aalto & Uusinoka 1978; Vuorela & Aalto 1982).

Prehistoric faunas

Subfossil and archaeological finds suggest that, excluding a few man-induced extinctions and additions, the taxa composing Finnish prehistoric land faunas did not differ from those of historic times. Obviously their distribution and densities have fluctuated during the past 9000 years and, as suggested elsewhere, it is likely that such land mammals as roedeer, wild boar, bison and aurochs would have "ventured sporadically into Finland in prehistoric times" (Nunez 1984:135). This is supported by actual finds of skeletal remains at least in the case of roe deer, boar and bison (Kalela & Salmi 1944; Matiskainen 1989b).

Migratory birds may have been more sensitive to climatic changes. Species that now spend the summer in Lapland, would have nested further south when colder early Post-glacial conditions prevailed. On the other hand, many waterfowl species that winter today in the southern Baltic may have stayed in Finnish waters during the milder winters of the Climatic Optimum.

Most affected was probably the fauna of the Baltic basin, which is understandable considering the profound transformations it experienced during 9000–5000 bc: from an ice-dammed lake (Baltic Ice-lake) to an arctic sea (Yoldia Sea), to a "great lake" (Ancylus Lake), to a mediterranean sea (Litorina Sea). Of special interest are the faunal changes that took place as a result of the opening of the ocean connection c. 6500 bc and the onset of true maritime conditions around 1000 years later, all which gave eventually rise to the migration of new exploitable marine species into Finnish waters (Eronen 1974, 1976; Hyvärinen 1975, 1980, 1982, 1984; Donner 1976, 1982; Nunez 1987b, 1989).

Ringed seals had entered the Baltic basin during the Yoldia Sea stage (c. 8200–7500 b) and even formed separated populations as the major lake systems became isolated through isostatic upheaval (Forstén & Alhonen 1975). But the new maritime conditions led to the immigration and thriving of two larger and more gregarious species: gray[7] and harp seals. As it was the case with land mammals, the sporadic occurrence of other sea mammals such as harbour seal and porpoise is indicated by certain refuse faunas of Subneolithic or later date (Welinder 1977; Nunez 1986b, 1990; Seger 1987).

Fish resources were also influenced by the ecological changes experienced by the Baltic basin. For example, it seems unlikely that salmon runs would have taken place prior to the Litorina period. Yoldia Sea environments were probably unsuitable and, subsequently, the Finnish coast would not have been accessible until after the opening of the Danish Sound c. 6500 bc or, more likely, after the onset of true maritime conditions c. 5500 bc (Nunez 1984, 1987b, 1989, 1990).

ORIGINS OF FINNISH POTTERY

The origin of Finnish pottery is somewhat obscure. Analogies can be, and often have been, sought in the pottery of the southern Baltic, in the Ural region, and in the Dnieper area. (eg. Äyräpää 1945, 1955; Brjussow 1957; Jaanits 1959, 1974; Gurina 1961, 1973; Indreko 1964; Tretiakov 1966; Pankrushev 1978; Dolukhanov 1979, 1986b; Edgren 1982; Meinander 1984; Nunez 1984, 1987b; Timofeev 1988).

The early Narva-type wares from the East Baltic appear to be roughly contemporaneous or slightly earlier than early Finnish Comb ceramics (Appendix A), but they are difficult to relate typologically. Edgren (1982) found little in common between the early manifestations of Narva and Comb ceramics, seeing them as the result of impulses from different directions. I reached basically the same conclusions, though regarding the few traits shared by the two wares as the result of a common origin (Nunez 1984). The two interpretations are not necessarily exclusive of each other, since the basic forms for both pottery groups occur in the Dnieper area (Telegin 1968, 1973; Dolukhanov 1979).

The early Subneolithic pottery from the Urals (eg. Gorbunovo/Shigir-type ware) does not seem to be old enough. Estimates and a few radiocarbon determinations have placed it in the fourth and third millennia bc[8] (Brjussow 1957; Indreko 1964; Vinogradov et al. 1966; Bader 1970; Sulimirski 1970; Chernetsov & Moszyn'ska 1974; Timofeev 1988). Furthermore, as pointed out by Luho (1950, 1952) the early pottery of Gorbunovo/Shigir-type (cf. Brjussow 1957; Indreko 1964; Serikov 1984) is closer to the later phase of early Finnish Comb ceramics (Ka 1.2, c. 3500–3300 bc), which is actually several centuries younger than the earliest pottery from Finland (Ka 1.1, c. 4200–3500 bc). Consequently, regardless of any possible connections between Finnish Ka 1.2 and Gorbunovo/Shigir-type ware, it seems unlikely that the latter could have been directly ancestral to the earliest Finnish pottery, Ka 1.1. The question of any possible relationship between early Finnish Comb ceramics (Ka 1.1) and Ural wares must remain open until more information about the chronology of the Ural region is made available.

On the other hand, early Middle Dnieper pottery seems to have both the necessary antiquity and, above all, typological features to be ancestral to the earliest Finnish Comb ceramics (Ka 1.1), and to other northern Subneolithic wares as well. The early pottery from the Middle Dnieper area is characterized by large grass/sand-tempered egg-shaped vessels decorated with rows of fine comb stamps, parallel incised lines, pits and other impressed motifs. Telegin (1968) estimated a date of c. 4250 bc for the beginning of the Dnieper-Donets culture. But a better approximation may be obtained from the similar and obviously related ware of the neighbouring Dniester valley, where the earliest pottery levels have yielded radiocarbon ages in the range of 4800–4500 bc. Radiocarbon ages for the middle and late phases of the Dnieper-Donets culture fall within the 4100–2000 bc range (Äyräpää 1955; Telegin 1968; Sulimirski 1970; Gurina 1973; Dolukhanov 1979, 1986b).

Unfortunately, the early pottery sequences from the c. 1000 km stretch that separates Finland from the Middle Dnieper area are somewhat unclear. The pottery traditionally regarded as oldest in Central Russia is that of Lialovo, with radiocarbon dates no earlier than c. 3600 bc (eg. Sulimirski 1970; Gurina 1973; Kraynov 1977, 1978; Dolukhanov 1979, 1986b). However, it appears that Lialovo is the most common, but not the earliest pottery of the region. Already 60 years ago, Joukov reported the occurrence of non-Lialovo sherds stratigraphically inferior to the Lialovo layer at the Yazikovo I site.

> Le groupe le plus ancien de la céramique des emplacements examinés est représenté par des fragments isolés provenant de Iazikovo I. Ce groupe peut être caracterizé comme un groupe de céramique à parois épaisses avec un mélange abondant de gravier dans la pâte argileuse; il a une ornementation en forme d'incisions longues et parallèles et peut-être encore d'autres éléments; la forme des vases de ce groupe n'est pas encore déterminée. Le groupe de céramique suivan est celui à peigne (Joukov 1929:71).

More recent research has secured three radiocarbon ages within 4400–4000 bc for the earliest ceramic layer at Yazikovo I as well as additional information about this pre-Lialovo pottery at other sites (Appendix A; Kraynov & Khotinski 1977, Kraynov 1978; Dolukhanov 1979).

> In recent excavations carried out in central Russian sites (Ivannovskoye, Yazikovo, Borinka and others) ceramic bearing layers have been found below the oldest layers containing pit-and-comb decorated pottery. This oldest type of pottery from the the central regions of Russia is decorated with impressions of combs and small pits, but the ornamental pattern is similar to those used in Dnieper-Donetz pottery (Dolukhanov 1979:150).

Soviet archaeologists have finally classified the accumulating assemblages of Central Russian sites with this pre-Lialovo ware with as a separate culture group they call the Upper Volga culture.

> Cette culture est charactérizé par des vases modelés à la main, à gorge large, dont le fond peut être pointu ou arrondi, et qui portent des ornements au peigne et piquetés, ou bien des rayures. Le mobilier de silex a un faciès mésolithique. Les outils en lames sont dominants. Le mobilier osseux se compose de pointes de flèches, de harpons, de poignards, d'outils fixés dans des supports. L'aire de la culture de la haute Volga s'étend de la source du fleuve jusqu'à son cours moyen, et au Sud elle rejoint l'aire de la culture du Dniepr-Donetz, de Narvska, de Spérrings et de la Volga-Kama (Kraynov & Khotinski 1977:68).

Needless to say that there are clear analogies between early the pottery of the Upper Volga culture and the early Comb ceramics (Ka 1.1/ Sperrings) from Finland and Karelia (cf. Tretiakov 1966; Kraynov & Khotinski 1977; Meinander 1984). This is clear from a comparison of the sherds illustrated by Kraynov & Khotinski (1977 fig.4–6) with Finnish Ka 1.1 sherds,[9] for example in Europaeus-Äyräpää (1930 figs.1–25) or Edgren (1969 figs.2–3). Meinander (1984:31) accepts the obvious affinities between the early wares of these two areas but feels – and he is probably right – that the two pottery groups cannot be lumped into a single culture and that neither of them can be derived from the other.

Also of interest is the dated sequence recently reported by Dolukhanov et al. (1989) from the stratified site of Rudnya-Serteya in the Upper Duna Basin. The earliest pottery horizon was immediatly below a calcareous gyttja layer radiocarbon-dated to c. 4200 bc and contained a few lithic artefacts and sherds from 10–12 straight-walled egg-shaped vessels 30–40 cm high with 16–22 cm rim diametres. They were decorated throughout their outer surfaces with horizontal, vertical and/or inclined rows of triangular impressions made with the "retreating spatula" technique. Higher up, a second cultural layer with 30 radiocarbon ages ranging 4200–4000 bc contains sherds of c. 30 vessels with characteristic Narva form and decoration.

Dolukhanov et al. (1989:27) speak of a "hitherto unknown early Subneolithic culture" when referring to the lower horizon from Rudnya-Serteya; but the pottery resembles the wares from the Desna and Zozh valleys[10] described by Palikarpovich (1930) sixty years ago and more recently by Äyräpää (1955) and Smirnov (1989). According to Äyräpää (1955:34–35) the decoration of the earliest Finnish pottery resembles that of this Desna-Zosh ware, where he finds "alla ornament som äro typiska för Finlands tidiga kamkeramik [Ka 1.1]".

Although our knowledge about the origins and spread of Subneolithic lifeways into the East European forest zone is rather diffuse, recent finds do not contradict and seem in fact to support the general scheme proposed 35 years ago by Äyräpää (1955): two parallel lines of pottery diffusion from the Dnieper area, to the north and to the northwest.

> From Dnjepr leder en gren . . . vidare mot nordväst, till Vilna trakten. En annan går norrut till Valdai, där bland de kronologiskt heterogena krukbitarna från Pirossjöns omgivning och särskilt från Bologoje ornament kunna påvisas, som upprepas i Finlands tidiga kamkeramik (Äyräpää 1955:35).

Äyräpää's northwestern branch would be represented by the early wares from the Desna, Zosh and, possibly, the Upper Duna areas; the northern one by the mentioned pre-Lialovo pottery of the Upper Volga culture in Central Russia and early Comb ceramic (ka 1.1/Sperrings) sites from Finland and Karelia.

Meinander (1984) has commented that most scholars have limited themselves to acknowledge Äyräpää's old hypothesis without attempting to develop it any further; but the fact is that, despite certain flaws, Äyräpää's old interpretation has retained its feasibility in the light of new material. When dealing with this subject ten years ago I concluded that Äyräpää's interpretation connection agreed best with the extant archaeological material (Nunez 1984), and the same can be said on the basis of the data available to us today.

The presence of mutually related early wares in Central Russia, Karelia and Finland that are relatable and contemporaneous to pottery from the Middle Dnieper would support Äyräpää's Dnieper connection. But although we may have a good idea of their source, our knowledge of early Subneolithic wares is still too limited to provide an adequate picture of their possible diffusion mechanism.

DIFFUSION OF SUBNEOLITHIC POTTERY TO FINLAND

The diffusion of pottery among the foraging groups of Eastern Europe appears to be ultimately related to the rise of Neolithic lifeways in the south, as suggested by Dolukhanov's (1973) model for the genesis of the East European Subneolithic.

> The vast territories of eastern Europe . . . contained large quantities of [game]. This ecological niche throughout the Atlantic and Sub-Boreal periods was rich enough in natural resources to provide a substancial basis for mesolithic forms of economy. It seems logical . . . that a part of the surplus population was budding off from the initial neolithic zones into these ecological niches rich in natural resources. This population was gradually losing its agricultural habits and was acquiring a mesolithic way of life as the one most adapted to the local ecological conditions. Thus hunting provided the bulk of food to the Bug-Dniestr culture settlers, who were genetically connected with the Balkan neolithic. Hunting was the basis of the economy of the Dnepr-Donets culture in the Ukraine. An intense outflow of the surplus population from the neolithised zones into the areas which were productive in terms of a hunting/fishing economy took place in the 4th millennium B.C. (Dolukhanov 1973:335).

In accordance with the chronological estimates of the early 1970s, Dolukhanov placed these developments in the fourth millennium, but radio-

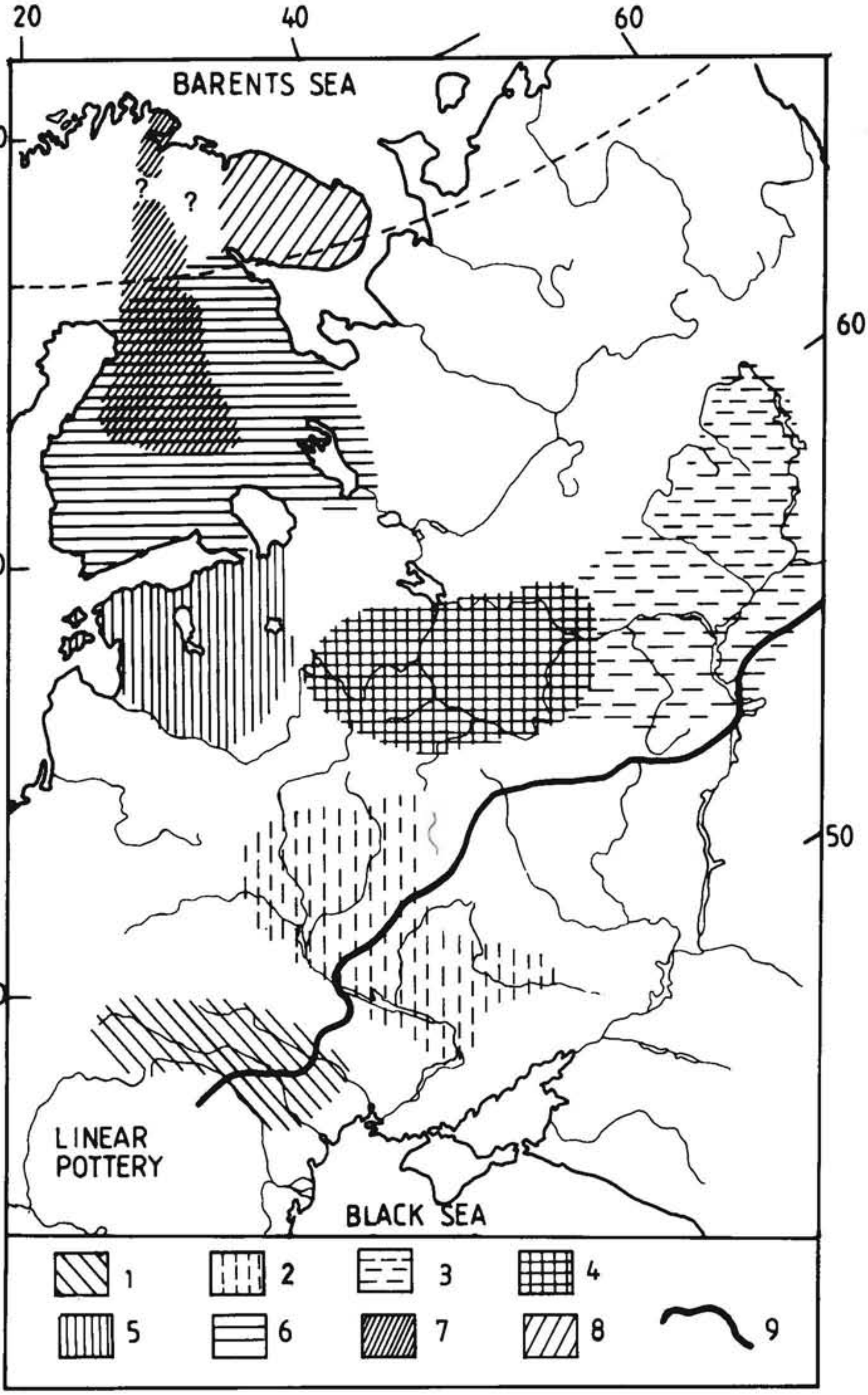

Fig. 4. Subneolithic groups in eastern Europe c. 4500–3500 bc: (1) Dniester-Bug; (2) Dnieper-Donets; (3) Volga-Kama; (4) Upper Volga; (5) Narva; (6) Sperrings (Ka 1); (7) Säräisniemi 1 (Ka S); (8) Kola; (9) southern limit of forest zone. The question marks indicate areas which are pottery-poor but little known archaeologically. The Säräisniemi 1 (7) and Dolukhanov's Kola (8) groups are considered separate due to lack of information on the pottery of the last group, but they may belong together. (Kraynov & Khotinski 1977; Siiriäinen 1971; Carpelan 1979; Meinander 1984; Dolukhanov 1986c).

carbon dates have now shifted them to the fifth (Kraynov 1978; Dolukhanov 1979). Otherwise, his model model agrees with the available archaeological material which reflects a continuation of Mesolithic lifeways with the addition of pottery to local preceramic tool kits.

However, although Dolukhanov's model may be applicable to the Dnieper-Donets and other areas in the proximity of Linear pottery or other Neolithic territories, it is difficult to picture surplus populations from the food-producing region budding off distances in excess of 500 km into Finland. A similar process did take place in Finland, but much later; not until after Neolithic lifeways were well stablished in the areas immediately to the south in the mid-third millennia bc.[11] But during the fifth and fourth millennium the territories surrounding Finland were still occupied by food-gathering groups. One would expect, therefore, that a different kind of diffusion mechanism would have been responsible for the introduction of pottery in Finland.

How, then, did pottery spread into Finland from the far-off Subneolithic areas adjacent to Neolithic territories? Trade is out of the question, given the size and fragility of early Subneolithic vessels. Although the possibility cannot be entirely discarded, local invention seems also unlikely.[12] The same applies to diffusion through imitation. Signs of early experimentation are lacking and the relatively fast rate of spread of a uniform, definitely finished product militate against theses ideas.

On the one hand, the characteristics of the earliest pottery from Finland suggests the physical presence of carriers of the knowledge of pottery manufacture; and on the other, the survival of tool kits and settlement patterns reflect a cultural continuity undisturbed by any break or change brought about by a new population. In my opinion, the mechanism that best explains this situation the practice of exogamy.[13]

According to ethnographic data from modern traditional societies, pottery is generally made by women (Murdock 1939, 1967). Since the basic difference between Finland's late Preceramic and early ceramic assemblages is pottery – a product generally made by women – it seems feasible that the craft may have been introduced by female potters via exogamy. Exogamic practices would have been capable of diffusing pottery at the rapid rate suggested by archaeological data: from the Middle Dnieper area to Finland within 4500–4000 bc.

Yellen (1977) cited an average distance of 70 km between the birthplaces of Bushman mates; but in areas with good waterways as the Russian Plain and Finland, distances could have been considerably greater. For example, the Mistassini of eastern Canada took most of their spouses within a 50 km radius, but some came from as far as Fort Rupert, c. 500 to the west, and Lake St.John, c. 500 km to the east (Rogers 1969).

The available archaeological data indicates that within 500 years, pottery spread apparently from Neolithic areas in the south through some 1000 km of Mesolithic territory into Finland, giving rise to a whole series of Subneolithic cultures in the process (Fig. 4). These developments would imply some sort of organized contacts, direct or indirect, among the various culture groups occupying the vast territory comprised between the southern Russian Plain and Finland. The existence of the social interaction network necessary for maintaining such long-distance exogamic activity are postulated in the model of metachronic human expansion proposed elsewhere (Nunez 1984, 1987b, 1989).

POTTERY AND SEDENTISM

The implications of the adoption of pottery by the late Preceramic inhabitants of Finland are obvious from Table 1, which shows a clear correspondence between pottery and the more permanent forms of settlement pattern. In those regions of North America with environments analogous to those of Finland, all pottery-making groups show at least seasonal sedentism.

The size (10–70 l), weight (6–12 kg), shape and fragility of Comb ceramic vessels do not suggest high mobility. Full pots must have been

Table 1. Statistics showing the correspondence between pottery and sedentism in traditional societies from Subartctic and woodland environments, which are roughly equivalent to those prevalent in Finland during the Stone Age. (Based on Murdock 1967).

Settlement Patterns	Studied Societies n	How many use pottery n	%
Nomadic	22	0	0
Seminomadic	27	3	1
Semisedentary	21	15	71
Sedentary	11	8	73
Totals	81	26	32

heavy and difficult to move. They were obviously not meant to be transported. It seems more likely that Comb ceramic vessels were used at the same site they were fired (Nunez 1984, 1986b, 1990).

Furthermore, the manufacture of pottery requires a fair amount labour for several days (See Appendix B). Most crucial in pottery making is the drying stage. Water must evaporate from the clay paste before the pots can be fired. In addition to the materials that go into the paste, the drying rate is affected by temperature, humidity and wind. Too rapid drying leads to cracking, insufficient drying causes vessels to deform, crack or break during firing. Pottery manufacture requires dry and stable warm weather. Humidity lengthens the drying period and increases the susceptibility to cracking/breaking (Shepard 1965).

For this reason, climate and wheather conditions constitute a major limitation to the manufacture of pottery, particularly under primitive kilnless Stone Age conditions. Cold and/or rainy weather would have been unsuitable. It has been suggested that the lack of pottery among the highly sedentary Indian groups of the Northwest Coast of North America was probably the result of their cool, humid and rainy climate (Arnold 1976).

It is difficult to imagine that much time and effort would be spent in pots that could be used for only a brief time. If the widely accepted theory that Comb ceramic pots were used mainly for the storage of foodstuffs is correct (see discussion further below), this would imply that food was stored and comsumed at the same place where their storage pots were made (Nunez 1990). Non-transportable pottery such as Comb ceramic vessels can be reconciled with mobile lifeways only if settlement patterns include regular seasonal stays at the storage site(s) for long enough time to allow the manufacture of pottery, the collection and storage of new foodstuffs, and the comsumption of previously stored ones; in other words, a certain degree of sedentism.

On this basis one may conclude that during the fifth millennium bc the Finland's Preceramic settlement had reached enough permanency to make the use of pottery feasible. Possibly Hypsithermal climates together with the spread of maritime resources into the Baltic after 5500 bc may have allowed longer seasonal stays, particularly at coastal sites.

Environmental grounds for sedentism

The available data indicate that after an initial period of considerable instability Finnish environments gradually became more and more stable after c. 6500 bc. This trend reached its culmination late in the sixth millennium bc with the stabilization[14] of the shoreline displacement, the onset of maritime conditions and climax Hypsithermal flora and fauna. All these favourable developments must have had a powerful influence on Preceramic lifeways.

Unfortunately our knowledge of Preceramic/Comb ceramic lifeways is limited and biased by poor preservation. Soil acidity has been responsible for the destruction of most of the oseous remains of animals utilized by man. As a general rule, only burnt bone has been preserved and, consequently, the bones identified in refuse faunas from Finnish Stone Age sites are the result of a long sequence of selective processes (Fig. 5). The subject has been touched by several authors (eg. Forstén 1974; Fortélius 1981; Lepiksaar 1989).

The refuse faunas from Finnish Stone Age sites provide only qualitative information about the species utilized by man, and do not allow reliable estimates about the possible importance of any given species with respect to others on the basis of their relative abundance. However, despite the biases affecting Finnish archaeological faunas, there is a consistent feature that must be regarded as a clear reflection of a shift in subsistence strategies. I am referring to the high proportion of seal remains in coastal sites from the early Comb ceramic period onwards, a pattern seldom observed at correspondingly situated Preceramic sites (Appendix C). Moreover, seal bones continue to dominate the faunas of coastal sites throughout the remaining of the Stone Age and even the Bronze Age (Appendix C; Forstén 1977). All this suggests profound changes in subsistence patterns, that a shift towards a maritime economy with heavy reliance on sealing took place in the late fifth millennium bc. (Siiriäinen 1981a, 1982; Edgren 1982; Nunez 1984, 1986b, 1987b, 1990).

It can hardly be a coincidence that the transition to maritime oriented lifeways corresponds chronologically with the adoption of pottery in Finland. This view is shared by several authors (eg. Siiriäinen 1981a; Edgren 1982; Nunez 1984, 1986a, 1986b, 1987b, 1989; Matiskainen 1989b). The general concensus is that the greater settlement stability lent by steady fishing/sealing resources led to the adoption of

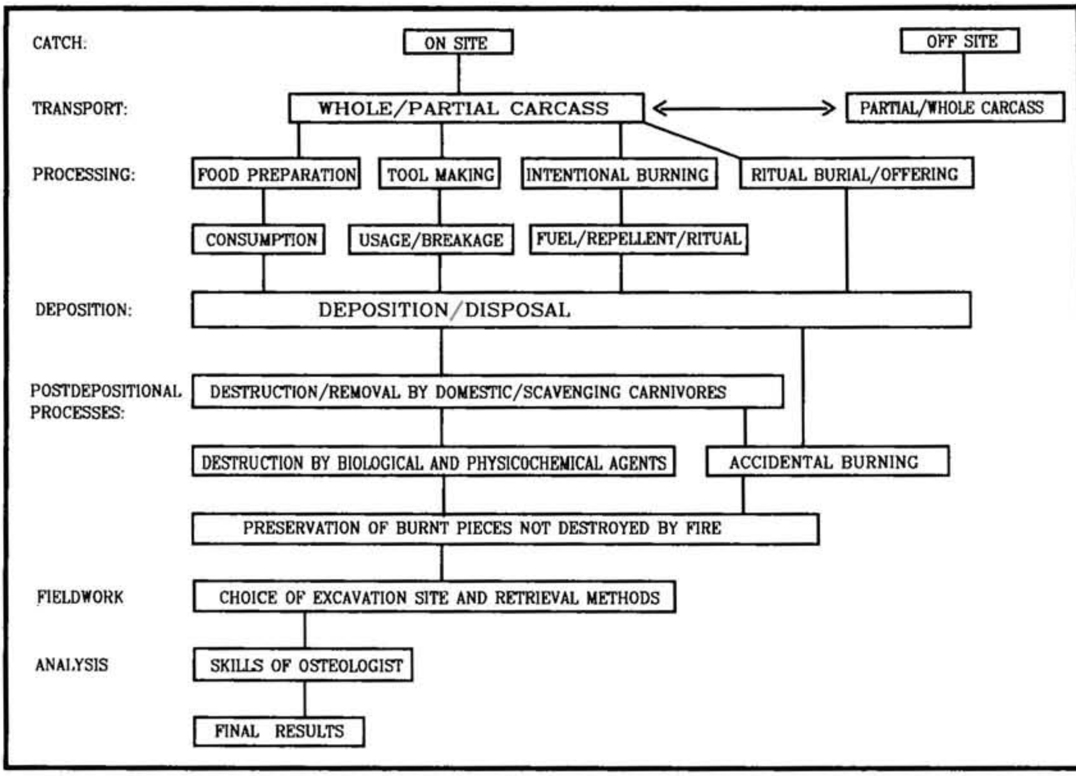

Fig. 5. Selective processes affectinganimal remains at Finnish sites, from their utilization and deposition in prehistoric times to their incorporation to our archaeological data.

pottery, though Matiskainen apparently feels that it was actually the adoption of pottery that led to maritime specialization:

> It was only in connection with the ceramic innovation of the Combed Ware period that opportunities arose for specialization in seal hunting, the over-kill [mass hunt?] of seal and the storage of blubbler for trade and exchange (Matiskainen 1989b:50).

Although Matiskainen supports this statement by citing Siiriäinen (1981a) and Edgren (1982), these authors do not imply that the introduction of pottery would have led to seal specialization. On the contrary, Siiriäinen clearly states that it was the stability lent by rich sealing/fishing resources that made the adoption of pottery possible.

> It cannot be said whether the stability of settlement and sealing were sufficient to make ceramics functional in Finland or whether it indicates the importance of fishing (Siiriäinen 1981a:19).

This is basically the same conclusion that I reached on the basis of faunal and ethnographical data (Nunez 1984). Edgren (1982) does not deal directly with this problem, but one gets the impression that he too sees maritime specialization preceding the adoption of pottery and not as a consequence of it.

> The introduction of pottery in Finland occurred in a purely mesolithic environment in which the culture had a clearly maritime character (Edgren 1982:72).

Hopefully by stressing the greater feasibility of the sequence of maritime specialization to sedentism to pot-making over the opposite, pottery to specialization, an unnecessary chicken-or-egg argument will be avoided. Needless to say that there is a certain logic in the latter alternative also: improved storage capability may lead to larger kills and longer seasonal stays at particular sites. But let us bear in mind that both ethnohistorical and archaeological data indicate that man has been able to solve his storage problems without pottery for millennia (eg. Wilson

1917:86–94; Itkonen 1921:106–111; Weltfish 1965:324–327; Bonavia and Grobman 1979; Soffer 1990). This was probably the case in Mesolithic Finland, and it was not until settlement patterns had reached the stability demanded by the manufacture of a ware like Comb ceramics that the adoption of pottery became feasible. Once the use of pottery had become established, however, then the improved storage capability provided by pots would have certainly contributed towards both further sedentism and specialization.

THE QUESTION OF FUNCTION

At this point one may ask what was the function fulfilled by pottery that made it so attractive to the late fifth millennium inhabitants of Finland that made them adopt these labour-expensive fragile vessels. Based on the high proportion of seal bones found at Finnish Comb ceramic sites it could be argued that the introduction of pottery in the Baltic sphere may have been somehow related to sealing activities, and the preparation and/or storage of blubber has been suggested as one of the possible uses of the large pots of coast-oriented Fennoscandian cultures (Edgren 1982; Meinander 1984; Lindqvist 1988). This would have been of course a local adaptation: seals did not occur in the continental region whence pottery appears to have spread to Finland, nor did they exist in the neighbouring aceramic territories to the east[15] where pottery was adopted around the same time. It seems more logical that the original function of these large clay vessels was related to activities common to the Subneolithic lifeways of Central and Northern Russia, Finland and the East Baltic lands.

According to Christian Carpelan (personal communication), who has studied Finnish ceramics for many years, there is no indication of the large Comb ceramic vessels having been used directly on fire for cooking purposes. Obviously this does not exclude the possibility of cooking by means of heated stones (cf.Salo 1989:7–8), but it is unclear whether the large poorly fired Comb ceramic vessels would have been capable of holding liquids[16] (Meinander 1961; Edgren 1982). As suggested by Edgren (1982) and others (eg. Meinander 1961, 1984; Huurre 1979; Nunez 1984, 1990), it is more likely that Comb ceramic vessels, particularly the large ones, were used for storage purposes. They may have been better suited for this function than containers made of organogenic materials. Smith (1976) has pointed out that even poorly fired pots of mud or clay have clear advantages for food storage because they cannot be penetrated by insects or small rodents and are more resistant to moisture.

The exceptionally high phosphorus content that has been detected in the clay paste of Comb-ceramic sherds could be explained as the result of storing animal foodstuffs, but it is not clear whether sherds could have absorbed their high phosphate from the phosphorus-rich cultural soil where they had lain for thousands of years (Nunez 1975, 1977, 1984). Recent research into the presence of phosphorus in pots has provided encouraging though yet inconclusive results about the possibility of determining vessel function through chemical analyses (Freestone et al. 1985; Cackette et al 1987; Dunnell & Hunt 1990).

Notwithstanding the difficulties surrounding the inference of prehistoric ceramic function, the preparation and storage of fish, seal and other animal products seem a feasible application of Finnish Comb ceramics. For a more thorough discussion of the possible function Finnish Subneolithic pottery see Edgren (1982). While dealing with function it is perhaps useful to digress briefly into a topic seldom discussed by archaeologists, namely the possible function fulfilled by pottery decoration.

The purpose of decoration

Finnish Comb ceramic vessels are characterized by having impressed/incised decoration throughout their outer surface. Exceptions to this rule are exceptionally rare (Luho 1957). It is therefore not surprizing that vessel decoration has traditionally played an important role in the classification of Finnish Stone Age pottery (eg. Ailio 1909, 1915; 1922; Pälsi 1920; Europaeus 1922). The realization that isostatic uplift could serve as a basis for a relative chronolgy of waterside Stone Age dwelling sites (Ramsay 1920, 1926) caused Finnish archaeologists to concentrate even more on pottery decoration (eg. Europaeus 1926; Europaeus-Äyräpää 1930; Äyräpää 1945, 1955). But despite this keen interest, few reseachers have stopped to reflect about the possible role played by decoration. This could be partly blamed on the need for regarding the basis of their chronological framework, decorative styles, as short-lived fashion-like currents.

But the fact that decoration completely covered the outer surfaces of the Comb ceramic vessels suggests more than merely non-utilitarian aesthetic purposes. This is further supported by the rounded/pointed bases which, unless we are prepared to accept that the pots were used upside down, imply that at least a considerable portion of the decoration would have remained buried in the ground (cf. Jaanits 1979).

The decoration of primitive pottery has sometimes been interpreted as vestigial from basketry prototypes (eg. Clark 1977) and this could very well apply to early Subneolithic pottery (cf. Boas 1940 fig.12). Decoration or decoration-like features as the textile/mat impressions of certain wares may be the result of manufacturing processes (eg. Pälsi 1916; Meinander 1954; Bedaux 1988), though it should be pointed out that intentional hand-stamped imitations of textile patterns occur as well (Carpelan 1970; 1979). Meinander (1961) has argued convincingly that the purpose of the characteristic row(s) of pits around the rims of early Finnish Comb ceramic vessels and many other Subneolithic wares was primarily technical, possibly similar to the perforations made to improve the baking of certain breads.

> Gemensamt för alla här nämnda kulturgrupper är, att de för en keramik gjord av grovt magrad lera och ornerad med stämpelornament och runda gropar i vågräta rader. . . . Emellertid är groparna tydligen ej att uppfatta som ett ornament, utan en teknisk finess. . . . De subneolitiska stammarna har . . . haft svårigheter att i sina keramikugnar nå högre temperaturer än ca 400° C. . . . Groparnas uppgift har varit att fungera som ett slags ringformiga nitar, som sekundärt har getts en ornamental uppgift. . . . Kamkeramikens ornering påminner verkligen ofta om de gropmönster, med vilka man perforerar rågbröd, för att de skall bli genomgräddat. I vartdera fallet har vi tekniskt betingade gropar, som utnyttjats ornamentalt (Meinander 1961:22).

This interpretation is supported by Edgren's (1982, 1966) observation that Comb ceramic vessels with pits tend to be better fired than pitless ones. In finished vessels, impressed decoration increases the cooling capacity of vessels and provides a rough surface for an easier grip (Hulthén & Janzon 1982; Bedaux 1988). The latter would be useful in the case of the earless Comb ceramic pots, though it is difficult to think that the heavy pots would have been moved much around. Ethnographic studies indicate a number of possible functions. Those most relevant with respect to Comb ceramics are emblemic and protective.

Decoration may serve as a "signature" to distinguish a potter's vessels from those made by others, or as a powerful message of ethnicity as in the case of the Shipibo-Conibo (eg. De Boer 1984). This is basically what many Soviet archaeologists, particularly Brjussow (1957), seem to have in mind in their interpretation of the various pottery-defined cultural groups or "tribes" within the Pit-Comb ware technocomplex.

The manufacture of pottery under primitive conditions is liable to fail due to various unexpected factors during the drying and firing stages, and, even when the process is successful, the resulting pots are indeed very fragile objects. Furthermore, if the purpose of Comb ceramic vessels was the storage of foodstuffs, the danger of stored goods becoming spoiled must have been always present. Bearing in mind that failure in the manufacturing process, subsequent pot breakage and/or the spoilage of the goods they were supposed to preserve may have been perceived as the work of evil spirits, it seems logical that there would attempts to deter the latter through some kind of magico-religious ceremony.[17] In this sense decoration, or some of its elements, may have been intended as protection during the manufacturing process and/or the life of the pot. For instance, the mentioned pits rows, which are likely to have had an improving effect in the baking of the clay paste, may have been perceived as one such protective measure. Similarly, the superposed anthropomorph on the decorated rim of a Ka 2 pot from eastern Finland (Taavitsainen 1982) or the ochre wash detected on some Comb ceramic vessels may have been meant as protection against the spoiling of their stored goods. There is incidently an interesting ethnographic parallel from Cameroon, where red ochre is used for protecting both pots and people.[18]

> Mafa pots, especially the larger vessels, are sometimes given a partial red wash, especially on the base, which is let into the ground and thus penetrates the realm of the ancestors. This is again explained as protective in intent, or more precisely, as apotropaic in that it wards off fate (David et al. 1988:371).

Non-utilitarian aesthetics may not be the only forces behind the decoration of Finnish Comb ceramics. Admitedly, some forms of prehistoric pottery decoration may be recognized by us as having functional and/or technical function; but as ethnographical data suggest, even these may have been perceived differently by prehistoric mind and culture. There is likely to be a message encoded in most pottery decoration. It need not be important or fully understood by the decorator, nor does it have to be read in the same manner by each one of the individuals it is directed to (cf. Boas 1927, 1940), but it is nevertheless present as an integral and recognizable aspect of a given group's culture. If and when they exist, the interpretation of such encoded messages in prehistoric pottery would be extremely difficult to say the least, and if we are to penetrate this realm some day it will have to be through a structural-semiotic approach. For this reason the results of this kind of research on Finnish Comb ceramics are eagerly awaited (cf. Kokkonen 1984:161).

CONCLUDING REMARKS

Much of the present interpretation, particularly what pertains to the possible source and spreading directions of Subneolithic lifeways, is based on archaeological data from neighbouring Baltic and Soviet republics. The task has not been easy. Aside from the complex nature of Subneolithic cultural processes and the vastness of the region where they took place, a reassessment of traditional interpretations about the Pit-Comb ware technocomplex has been going on for the last two decades,[19] and there has been the hindrance of linguistic and political barriers. Fortunately, recent developments within the Soviet Union have introduced new, hitherto undreamt, opportunities of research and cooperation. All this is heralded by a surge of eastern articles in western journals and by increasing visits of colleagues from Baltic and Soviet republics to our institutions and viceversa. The time may be ripe for Soviet, Baltic and Finnish archaeologists to join forces in a general study of *our* Subneolithic and related cultural phenomena. This paper is therefore to be seen as initial contribution in that direction, a view from the Finnish side of the Baltic, one of various possible preliminary basic models to be tested, modified or discarded in the light of results obtained through joint research efforts in the 1990s.

The present interpretation is a corollary of the general model for the settlement of deglaciated areas of northeastern Europe at the end of the last Ice Age (Nunez 1987b, 1989). Consequently, it assumes that the late Palaeolithic-Mesolithic groups occupying the marginal zone around the icesheet expanded metachronically in split-and-spread fashion into adjacent deglaciated territories all the way into Finland during c. 14000–7000 bc. A second basic assumption is that the mode of expansion into empty deglaciated territories laid the foundations for a wide interaction network[20] which was subsequently kept active for millennia thanks to a common linguistic and cultural background and traditional marriage and kinship ties. Having stated these basic assumptions, the proposed model for the diffusion of early pottery and Subneolithic lifeways in northern Europe can be summarized as follows:

(1) The stabilization of favourable Atlantic viroments in the East European forest zone by 6000–5500 bc gave gradually rise to optimal adaptation strategies that resulted in an increase in the degree of sedentism during the fifth millennium bc. In the case of the Circum-Baltic area region these developments were helped by the onset of maritime environments by 6500–5500 bc.
(2) Early in the fifth millennium bc surplus population from Neolithic areas were budding-off into the less densely populated and game-rich adjacent Mesolithic territories. These pot-making food-producing newcomers were rapidly mixing with the local Mesolithic populations, adopting the latter's lifeways but retaining and passing on to their new neighbours the knowledge of pottery manufacture (cf. Dolukhanov 1973, 1979). This process, which was giving rise to what could be called first-generation Subneolithic groups (eg. Dnieper-Donets) took place along the Mesolithic/Neolithic frontier c. 5000–4000 bc.
(3) From this marginal first-generation Subneolithic zone, potmaking spread fairly rapidly over hundreds of kilometres through exogamic practices along the existing millennia-old social interaction network c. 4500–3500 bc into the Mesolithic territories to the north and reached northern Finland by 4000 bc. These processes were responsible for the genesis of the second-generation Subneolithic groups associated with the first manifestations of Narva, Upper Volga and Finnish Comb ceramics in the late 5th millennium bc.

As in the model for the early settlement of

Finland (Nunez 1987b), the diffusion of Subneolithic pottery into Mesolithic Finland is seen here as an important but nevertheless localized aspect of the general cultural processes that took place in the vast scenario of the north European forest zone c. 4500–3500 bc. This not only implies seeing the Finnish archaeological record as a local version of broadly contemporaneous parallel developments throughout the East European forest zone, but also regarding this parallelism as the result of common underlying forces operating together with local variables. For instance, in the broad general scale of the north European forest zone, the adoption of pottery may be seen as the result of stabilization of favourable Atlantic environments by 6000–5500 bc – an event which gave gradually rise to optimal adaptative subsistence strategies and related settlement patterns with the degree of sedentism necessary to make the adoption of pottery feasible. In short, the combination of a stable mild climate and rich terrestrial and aquatic resources, particularly steady fishing, would have been responsible for an increased permanency of settlement. When zooming in the Circum-Baltic area we see this general trend of increasing resources being reinforced by the onset of true maritime environments in the Baltic basin, an event which after the opening of the Danish sound c. 6500 bc spread metachronically eastwards reaching Finland by c. 5500 bc. The economical potential of maritime resources is widely recognized and requires no further explanation (cf. Fitzhugh 1975; Bailey & Parkington 1988).

To conclude, it should be emphasised that the Subneolithic was no revolution. That although it did bring conspicuous changes to archaeological assemblages through the introduction of potsherds, the transition between Mesolithic and Subneolithic lifeways was considerably less dramatic. The fact that Mesolithic tool-kits and subsistence and settlement patterns remained virtually unchanged indicates gradual local transition processes without major population movements, except those associated with traditional exogamic practices. Nevertheless, the adoption of Subneolithic pottery is likely to have eventually brought about some changes in lifeways by improving storage capabilities and contributing further to the degree of sedentism of the already fairly stable late Preceramic settlement patterns that had made the adoption of pottery feasible in the first place. This may well be the reason for the population increase that seems to have taken place during the Typical Comb ceramic period (Ka 2) c. 3300–2800 bc (cf. Siiriäinen 1981a).

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NOTES

[1] Dates are given in uncalibrated conventional radiocarbon years (hence bc) rounded off for the sake of convenience. For original dates see Appendix A.

[2] By Subneolithic it is meant the concept of pottery-Mesolithic previously defined by Gimbutas (1956) and Meinander (1961).

[3] Meinander (1984) has rightly pointed out that certain Preceramic lithic forms do not seem to occur in clear Comb ceramic context and viceversa. However, the nature of the shore displacement during 5500–4000 bc makes it difficult to determine whether certain transitional lithic forms belong to late Preceramic, early Comb ceramic levels, or both. The problem is further complicated by the fact that under the non-stratified conditions of most Finnish sites, Preceramic assemblages will in all probability be made ceramic by the occurrence of sherds. For example, if a site has been utilized 200 years during the final Preceramic and then continued in use for a few years after the introduction of pottery, it will most likely be classified as a ceramic site. In other words, since sherds are likely to obscure the preceramic component and cultural affiliation of Preceramic artefacts, it is possible that those few artefact forms that may be regarded as early Comb ceramic may in fact have come in use in late Preceramic. Furthermore, the differences in lithic forms, which are probably due to the choice of raw materials and polishing and hafting techniques, can be seen as developments related to the socioeconomic developments that took place during the fifth millennium bc. In point of fact, more marked tool-kit changes are observable some 1500–1000 years earlier, well within the Preceramic period itself (Nunez 1984, 1987b; Matiskainen 1986, 1988, 1989b). A tendency to the smooth elliptical shape characteristic of Comb ceramic wood-working tools can be already detected in some adzes of South Finnish type (eg. Matiskainen 1988 fig.1–6), which belong to the Litorina Preceramic (PC 2, c. 5500–4200 bc). It should be also pointed out that elsewhere the adoption of Subneolithic pottery do not seem to be accompanied by any changes in Mesolithic tool-kits (eg. Dolukhanov 1973, 1979, 1986b).

[4] To avoid confusion with the somewhat questionable two-culture interpretation (Askola/Suomusjärvi) advanced by Luho (1956, 1967, 1976) the more neutral terms of Mesolithic and Preceramic are employed here. The c. 3000 year period of the Finnish Preceramic is divided here into Ancylus Preceramic (PC1, c. 7500–5500 bc) and Litorina Preceramic (PC2, c. 5500–4200 bc).

[5] This term is used as a loose but practical comparison with the Great Lakes at the US-Canada border.

[6] Zvelebil (1979, 1981) has suggested that the Comb ceramic people managed the waterchestnut and intentionally spread it into Finland. It should be pointed out, however, that human intervention would not have been necessary for the spread of Trapa into Finland: despite somewhat special ecological demands, waterchestnut has an effective dispersal mechanism and the Ancylus Lake stage would have offered optimal possibilities during the second half of the Preboreal. Therefore, it is not surprizing that the earliest subfossil waterchestnut finds from Finland were deposited during the Preboreal period. It seems nevertheless clear that Finland's Stone Age inhabitants utilized the plant, and could have aided the plant's dispersal by collecting and transporting the nuts (Auer 1924, 1925; Apinis 1940; Valovirta 1957; Hegi 1965; Meinander 1971; Vuorela & Aalto 1982; Aalto 1983; Siiriäinen 1983).

[7] Gray seals may have entered the Baltic basin already during the Yoldia Sea stage (c. 8300–7500 bc), i.e. before the opening of the Danish sound c. 6500 bc; but there are no indications that they would have thrived in Finnish waters prior to the onset of maritime conditions around 1000 years later (Forstén & Alhonen 1975).

[8] A possibly similar ware has been reported from a > 4500 bc Neolithic (30–40% domestic fauna) layer at Mullino II, southern Urals (Matyushin 1986 fig.5), but the question of any possible influences from the southern Ural-Aral region on the cultural development of Central Russia during the fifth millennium bc seems unclear (Tretiakov & Mongait 1961; Islamov 1966; Clark 1977; Gupta 1979; Dolukhanov 1986a; Matyushin 1986; Krizhevskaya 1990). Moreover, since the resemblance is suggested only by a small and somewhat fuzzy drawing, it must be taken with caution.

[9] It should be pointed that the unusual decoration on the c. 3800 bc pot from Kojonjoki, SW Finland, (Luoto & Terho 1988 fig.2) has also counterparts in the Upper Volga culture (eg. Kraynov & Khotinski 1977 fig.5).

[10] This comment is based on similarities detected from the description and illustrations in Dolukhanov et al. (1989) and not on an actual examination of the wares in question. It should also be pointed out that the early Desna-Zosh wares in question differ from the Desna sherds illustrated by Tretiakov (1985 figs.1–2), the great majority of which belong apparently to the later Lialovo phase of Central Russia.

[11] A similar process appears to have taken place in southwestern Finland c. 2500 bc, after Neolithic lifeways had reached the neighbouring areas of the East Baltic. I am referring to the Corded ware culture, which is known to have had a Neolithic economy in the continent, though to a lesser degree in the East Baltic, whence it apparently spread to Finland. The geographical distribution, settlement patterns and assemblages of this culture in Finland suggest a pastoral/farming economy, but no concrete evidence for this has been found yet. The idea of Neolithic newcomers turning to foragers in the face of a difficult marginal climate and abundant natural resources is certainly plausible. (Äyräpää 1940, 1973; Edgren 1970, 1984; Dolukhanov 1979, 1986b; Zvelebil 1979, 1981; Milisaukas 1980; Siiriäinen 1981a; Meinander 1984; Luoto 1986; Lindqvist 1988).

[12] Although the possibility of local invention seems now unlikely (see however Luho 1965), it should be borne in mind that pottery was first(?) invented c. 10700 bc under environmental and cultural conditions similar to those prevailing in Finland during the late fifth millennium bc: A fairly sedentary coast-oriented Mesolithic (Clark 1977; Akazawa 1986).

[13] The practice of exogamy among the various Subneolithic forest groups of northern Europe taiga was postulated long ago by Brjussow (1957) and Meinander (1961).

[14] By stabilization is not meant the cessation of shoreline displacement, but rather the normalization of this phenomenon with a shift to fairly constant regressive rates.

[15] West of Finland, with the exception of southern Scandinavia, pottery did not spread to neighbouring areas of Central and Middle Sweden. In fact it had barely penetrated beyond the 60th parallel by 3000 bc (Löfstrand 1969; Burenhult 1982; Baudou 1990).

[16] Contrary to Huurre's (1979:55) opinion, Meinander (1984:34) feels that not even when greased would Comb ceramic vessels have been capable of holding liquids; probably because he believes that it would have been difficult to reach temperatures over 400°C under primitive open-air firing conditions (Meinander 1961:22). On the other hand, as pointed out by Edgren (1982:43–44), the firing temperature of Comb ceramic vessels has been never determined. Thorough analyses have shown that Subneolithic Ertebølle pots were fired at temperatures around 500°C, sometimes higher, and that they were often used for cooking purposes (Hulthén 1977). This raises the question of if and why Comb ceramic firing techniques would have been less effective. In any event, regardless of firing temperature, it is difficult to think that the larger pots would have been able to withstand the hydrostatic pressure generated by 40–70 l of liquid. The walls could be reinforced by tight inbedding in the ground, but this may have been problematic in winter. Experimental archaeology is needed here!

[17] Ethnohistorical records indicate that pottery manufacture has often involved ritual or similar manifestations of patterned behaviour in traditional societies from both the New and Old World – even in ancient Greece: the Jívaro's song that prevents pots from cracking during firing; the Gorgon heads on Greek ovens to scare-off pot-cracking demons, etc. The association between handicrafts and ceremony is not uncommon among traditional societies (eg. Sheppard 1965:75; Muensterberger 1971; Birket-Smith 1972:260; Harner 1973:75; David et al. 1988).

[18] This analogy is given merely as a curious parallel without any implication that the ochre-wash on some Comb ceramic pots could have a connection with its African counterparts. Pot ochre-washing

may be a survival of a treatment given to containers of wood or other organic materials in Preceramic times. Both prehistoric and ethnohistorical data indicate that red has had a magico-religious association in Finland (eg. Karstén 1955; Edgren 1966; Luho 1971; Taavitsainen 1978; Nunez 1981, 1983, 1984, 1986a, 1987a). In Fennoscandia traces of red/yellow ochre have been detected in wooden objects of late prehistoric and medieval date (Arwidsson 1955; Vuoristo 1978), but their colour has been regarded as decoration and no reference is made about the possible preservative properties of ochre wash on wood. In any event, the preservative effect of ochre coating needs no explanation; but the question that arises is: Could washes of ochre pigments in media such as fat or blood have been used in Finland by the end of the Preceramic period? At least we know that they were being used for rock paintings during the Comb ceramic period, possibly earlier, and that red ochre was used as part of Preceramic burials and other ritual-related instances as early as the sixth millennium bc (Taavitsainen 1978; Purhonen 1980; Nunez 1983).

19 The research carried out by East Baltic and Soviet archaeologists during the past two decades has modified the traditional views about certain regional groups within the Pit-Comb ware technocomplex. This can be observed in Central Russia where modern research techniques and radiocarbon dating led to the identification of new cultural entity, the Upper Volga culture in the 1970s (eg. Kraynov & Khotinski 1977, 1984; Kraynov 1978, 1987; Tsetlin 1980, 1988). The same applies to important material brought to light in the East Baltic lands, where the revision made on the basis of the material collected during the 1970s is being modified once again by new information gathered during the 1980s (Zagorskis 1973, 1987; Jaanits 1974; Dolukhanov 1979, 1986b; Dolukhanov & Liiva 1979; Rimantienė 1980; Jaanits et al. 1982; Timofeev 1984, 1988; Zagorskis et al. 1984; Kempisty 1986; Loze 1988).

20 The concept of social interaction networks among hunter-gatherers has been discussed by Madden (1983). See also the related idea of innovation centres proposed by Meinander (1979).

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Appendix A. Radiocarbon dates mentioned in the text.

The radiocarbon ages are presented in tables A1 and A2. The first contains dates from the Soviet Union, the second from Finland. In addition to the ages, the site, cultural association and laboratory number have been included whenever possible.

Table A1. Fifth and fourth millenium bc radiocarbon dates associated with early Subneolithic levels from sites in Karelia, Central Russia, the East Baltic and the Dniester valley (Kraynov 1978; Dolukhanov 1979; Zhuralev 1983; Loze 1988).

DATE bc	SITE	CULTURAL ASSOCIATION	ID/SOURCE
Karelia			
4560 ±90	Pegrema IX	Sperrings (=Ka 1.1)	TA-1161
Central Russia			
4610 ±250	Sachtysh I	Upper Volga culture	LE-1021
3200 ±40	–,,–	–,,–	LE-1024
4420 ±70	Yazikovo I	–,,–	LE-1189
4300 ±60	–,,–	–,,–	LE-1080
4000 ±90	–,,–	–,,–	LE-1190
3540 ±70	–,,–	–,,–	LE-1188
3330 ±130	–,,–	–,,–	LE-1079
3610 ±100	Ivanovskoye V	–,,–	LE-1109
East Baltic			
4610 ±440	Osa	Narva/Osa ware	MGU-1009
4583 ±120	–,,–	–,,–	Ri-272
3930 ±80	–,,–	–,,–	LE-961
3830 ±70	–,,–	–,,–	LE-962
3780 ±50	–,,–	–,,–	LE-850
4585 ±60	Zvidze	–,,–	TA-862
4500 ±250	–,,–	–,,–	MGU-1008
4410 ±40	–,,–	–,,–	IGAN-614
4400 ±60	–,,–	–,,–	TA-1746
4365 ±60	–,,–	–,,–	TA-852
4310 ±60	–,,–	–,,–	TA-883
4260 ±80	–,,–	–,,–	TA-1593
4260 ±70	–,,–	–,,–	TA-1609
4250 ±240	–,,–	–,,–	MGU-1010
4245 ±40	–,,–	–,,–	Tln-812
4230 ±150	–,,–	–,,–	Vs-521
4220 ±70	–,,–	–,,–	TA-1592
4160 ±80	–,,–	–,,–	TA-1608
4130 ±70	–,,–	–,,–	LE-1724
4100 ±150	–,,–	–,,–	Ri-359
4100 ±100	–,,–	–,,–	TA-1798
4040 ±60	–,,–	–,,–	TA-1782
3920 ±60	–,,–	–,,–	TA-1819
3820 ±60	–,,–	–,,–	TA-1818
3560 ±70	–,,–	–,,–	TA-1799
3490 ±80	–,,–	–,,–	TA-1594
3370 ±50	–,,–	–,,–	TA-1800
Dniester valley			
4875 ±150	Soroki II	Bug-Dniester	Dolukhanov 1979
4545 ±100	–,,–	–,,–	–,,–

Table A2. Radiocarbon ages from early Mesolithic (PC 1) and early Subneolithic (Ka 1.1) sites from Finland. Symbols: Ka J= Comb ceramics of Jäkärlä type; Ka S= Comb ceramics of Säräisniemi 1 type. (Jungner 1979; Jungner & Sonninen 1983, 1989). The location of these sites is shown in Fig. A3.

DATE bc	SITE	CULTURAL ASSOCIATION	No./SOURCE
7360 ±140	Antrea	PC 1	Hel-1303
7280 ±210	–,,–	–,,–	Hel-269
4110 ±170	Kraviojankangas	Ka 1.1	Hel-1380
3600 ±100	–,,–	–,,–	Hel-1382
3360 ±110	–,,–	–,,–	Hel-1381
4810 ±240	Haveri	Ka 1.1/Ka S	Hel-275
4120 ±170	–,,–	–,,–	Hel-274
4100 ±170	–,,–	–,,–	Hel-273
4050 ±180	Nummenharju	Ka J/Ka 2	Hel-48
3880 ±140	–,,–	–,,–	Hel-46
3800 ±160	–,,–	–,,–	Hel-47
3550 ±160	–,,–	–,,–	Hel-45
3360 ±160	–,,–	–,,–	Hel-44
3080 ±180	–,,–	–,,–	Hel-63
4650 ±110	Jokkavaara	PC 2/Ka S	Hel-1580
4350 ±110	–,,–	–,,–	Hel-1581
4170 ±110	–,,–	–,,–	Hel-1620
3910 ±110	–,,–	–,,–	Hel-1619
4200 ±110	Kiikarusniemi	Ka S	Hel-1750
3840 ±140	Konjonjoki	Ka 1.1	Hel-2376

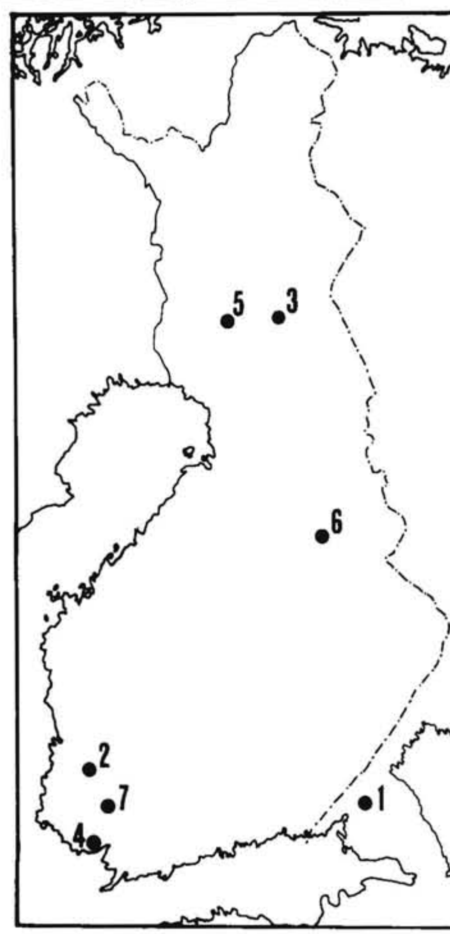

Fig. A3. Location of radiocarbon-dated sites mentioned in Table A2: (1) Antrea; (2) Kraviojankangas; (3) Haveri; (4) Nummenharju; (5) Jokkavaara; (6) Kiikarusniemi; (7) Konjonjoki.

Appendix B. On pottery manufacture.

The process of pre-wheel pottery manufacture has been discussed by Sheppard (1965:49–94). Although replicas of Finnish Comb ceramic vessels have been made, as far as I know there has been no attempts to experimentally manufacture them according to primitive Stone Age techniques. Useful information has been gathered through the experiments conducted in 1978 in Lithuania, where a group of female potters manufactured a total of c.250 replicas of vessels from several prehistoric cultures from the Soviet Union (Dahlman 1983). Among these were cultures with pottery with certain similarities to Comb ceramics, namely Djeitun and Kelteminar wares. On the basis of this and ethnographical information it is possible to estimate the time required by the various activities related to the manufacture of primitive pottery (Nunez 1990). A tentative reconstruction of the main stages in the process of Comb ceramic manufacture with estimates of their duration is presented in table B1, and their sequence is outlined below.

(1) *Gathering*. Since the manufacture of pottery under primitive kilnless conditions is very dependant on the weather, it would seem logical that Comb ceramic potters would have gathered all the required materials to be ready for use as soon as optimal weather conditions developed: a good amount of firewood, clay, water, tempering materials, etc. Even in the event that all these materials occurred near-by, a minimum of two work days (1 work day = 12 hours) is estimated for the completion of these chores. An important related task would be keeping these materials in good condition: wood must be dry, clay moist. Other possibilities would be the pre-treatment of certain ingredients; for example crushing/grinding temper materials, soaking or "aging" of the clay, etc.

(2) *Mixing*. This stage includes the preparation those ingredients that must be "fresh" when they are mixed into the clay paste (eg. blood, sap) as well as those which may be optionally prepared at this time (eg. stone crushing). It is difficult to estimate the time needed for preparation and mixing the clay paste since this is much dependant on the materials used and on the potter's traditions, technique and skills; but it probably could be accomplished in 3–12 hours.

(3) *Form giving*. Comb ceramic vessels were generally coil-built. The Lithuanian experiments suggest that about 6 hours are required for the coiling of a vessel comparable to middle-sized Comb ceramic pots. However, the duration of the process may have been doubled if, as suggested by observations made on Comb ceramic vessels, coils were decorated immediatly after they were joined (Edgren 1966; Vikkula 1981).

(4) *Surface treatment*. According to Sheppard (1965:65) surface treatment may be done either in connection with shaping the vessel or after a given period during which it is left to dry. There are indications that at least the first method was employed in Finland (Edgren 1966; Väkeväinen 1979: Vikkula 1981). In the Lithuanian experiments the vessels were left to dry for 1–2 days, after which their surfaces were smoothed down. The smoothing process itself lasted 1–3 hours per pot and decoration was applied on the next day. The time spent with decoration is not mentioned, but it could not have been more that a few hours per pot.

(5) *Drying*. Ethnographical data indicate a great variation in the length of time allowed for the drying of pots: from a few hours to several days. Drying time is dependent on such factors as the nature of the clay and the composition of the paste, the size and thickness of the vessel, and the prevailing conditions of temperature, humidity and wind velocity. As commented by Arnold (1976), scheduling plays a very important role in the manufacture of pottery under primitive conditions and, undoubtedly, this was the case in Stone Age Finland. Good scheduling – that is the successful selection of days with optimal potting weather – would certainly have had a shortening effect on drying time.

(6) *Firing*. Since signs of firing pits are lacking from Finnish Comb ceramic sites, it must be assumed that pots were fired under a heap of wood above the ground (cf. Hulthén & Jansson 1982 fig.13). This method tends to develop relatively high temperatures around 500–600°C, but not for very long. That this was the case is supported by the darker grey-brown core generally observable in Comb ceramic sherds. Given the large size of the pots, it is not likely that many would have been fired together under a single pire – probably 1–3 pots depending on their size. Firing time is difficult to estimate since fuel could always be prolonged through the addition of firewood, but the whole process, including preparation of the pire, the actual firing and cooling, and the retrieval of the pots could not have lasted more than one day. A likely practice may have been firing in the evening with the pot(s) being ready and cool the following morning.

Table B1. Estimates of how many work days (1 WD = 12 hrs) were spent in the manufacture of one and three Comb ceramic pots.

STAGES	1 POT	3 POTS
GATHERING OF MATERIALS	2–4	2–4
PREPARATION OF CLAY PASTE	1	1
VESSEL FORMING + SURFACE TREATMENT	1–2	2–5
DRYING	1–7	1–7
FIRING	1	1
TOTAL OF WORK DAYS	6-15	7-18

Appendix C. Osteological analyses

All osteological analyses conducted on Finnish archaeological faunas before 1980 have been summarized by Taavitsainen (1980). What follows is an updated version with all the osteological determinations faunas from Finnish Stone Age sites, where identified bones have been grouped into four categories (terrestrial mammals, sea mammals, birds and fish) with their relative frequencies calculated as percents. The total amounts of identified bones are provided as a measurement of the statistical reliability of every sample. In table C1 each site is presented separarately with its cul-

Table C1. Refuse faunas from Preceramic (PC), Comb ceramic (Ka), Kiukais (Ki) and Åland Pitted ware (Gr) dwelling sites from coastal (C) and inland (I) environments in Finland. The location of these sites may be seen in the map of Fig. C3.

Parish/SITE	CULTURE PHASE	C/I	LAND MAMM. %	SEA MAMM. %	BIRDS %	FISH %	N
1 Kerävä/PISINMÄKI	PC 1	C	18.7	75.0	–	6.3	48
2 Honkajoki/HIETARANTA	PC 1	C	50.0	24.2	–	25.9	62
3 Alavus/RANTALANVAINIO	PC 1	C	40.0	60.0	–	–	5
4 Alavus/VASIKKAHAKA	PC 1	C	100.0	–	–	–	9
5 Askola/HOPEAPELTO	PC 1	C	–	100.0	–	–	3
6 Askola/RAHKAISSUO	PC 1	C	9.1	81.8	–	9.1	11
7 Askola/TOPPINEN	PC 1	C	50.0	50.0	–	–	12
8 Askola/AHLSTEDINPELTO	PC 1	C	100.0	–	–	–	1
9 Askola/KOTOPELTO	PC 1	C	–	100.0	–	–	1
10 Askola/RUOKSMAA	PC 1	C	89.9	10.1	–	–	79
11 Askola/MYLLYPELTO	PC 1	C	50.0	–	–	50.0	2
12 Porvoo/HENTTALA	PC 1	C	50.0	38.5	–	11.5	26
13 Alajärvi/RASI	PC 2	C	30.0	65.0	–	5.0	20
14 Kuortane/YLIJOKI	PC 2	C	85.7	14.3	–	–	7
15 Kurikka/TOPEE	PC 2	C	18.5	40.7	11.1	29.6	27
16 Salo/PUKKILA	PC 2	C	82.4	17.6	–	–	17
17 Askola/SUURSUO	PC 2	C	100.0	–	–	–	1
18 Askola/SAUNAPELTO	PC 2	C	57.1	42.8	–	–	7
19 Askola/SILTAPELLONHAKA 1	PC 2	C	59.7	26.9	–	13.4	67
20 Askola/TALLIKÄÄRÖ	PC 2	C	26.5	60.3	–	13.2	68
21 Vantaa/KILTERI	PC 2	C	100.0	–	–	–	1
22 Vantaa/MÄTÄOJA	Ka 1	C	2.8	95.1	2.1	–	141
23 Askola/SILTAPELLONHAKA 2	Ka 1	C	42.9	26.2	2.4	28.6	42
24 Kiikoinen/UUSI-JAARA	Ka 1	C	15.3	18.6	5.1	61.0	59
25 Rovaniemi/TURPEENNIEMI	Ka 1	C	16.4	67.3	1.8	14.5	55
26 Rovaniemi/SIIKANIEMI	KA 1	C	25.0	50.0	–	25.0	16
27 Pomarkku/MYLLYTÖRMÄ	KA 1	C	–	91.5	–	8.5	71
28 Kokemäki/KRAVIOJANKANGAS	KA 1	C	5.1	93.2	0.1	1.9	1140
29 Åland Islands (4 sites)	KA 1	C	–	100.0	–	–	77
30 Kymi/JUURIKORPI	Ka 2	C	–	100.0	–	–	5
31 Kymi/MÄYRÄSMÄKI	Ka 2	C	–	100.0	–	–	1
32 Kymi/NIKKARINMÄKI	Ka 2	C	–	100.0	–	–	8
33 Kymi/NISKASUO	Ka 2	C	8.3	91.7	–	–	36
34 Kymi/PORKKA	Ka 2	C	50.0	50.0	–	–	6
35 Kymi/TUULI	Ka 2	C	–	85.7	–	14.3	7
36 Kymi/TÖYRYLÄ	Ka 2	C	33.3	–	33.3	33.3	3
37 Liljendal/KVARNBACKEN	Ka 2	C	6.0	86.9	0.2	6.9	435
38 Vihanti/PITKÄSAARI	Ka 2	C	25.0	50.0	25.0	–	4
39 Vantaa/MAARINKUNNAS	KA 2-3	C	4.9	57.3	5.8	31.8	716
40 Evijärvi/ISOKANGAS	KA 3-4	C	3.7	72.9	5.6	17.8	107
41 Pyhtää/BRUNAMOSSEN 1	KA 4	C	–	50.0	16.7	33.3	18
42 Harjavalta/MOTORCROSS	KA 4	C	13.5	72.4	1.1	13.0	445
43 Harjavalta/LYYTIKÄNHARJU	KA3-KI	C	1.1	86.9	2.2	9.8	92
44 Harjavalta/KAUNISMÄKI	KI	C	4.4	95.6	–	–	23
45 Eurajoki/ETUKÄMPPÄ	KI	C	6.3	64.6	2.5	26.6	158
46 Pyhtää/BRUNAMOSSEN 2	KI	C	27.3	72.7	–	–	11
47 Åland Islands (3 sites)	GR	C	0.5	38.8	3.6	57.1	3777
48 Paltamo/KAARRE	PC 1?	I	88.9	–	–	11.1	9
49 Saarijärvi/TARVAALA	PC 1+2	I	70.8	–	3.6	25.5	137
50 Virrat/MAJAJÄRVI	PC ?	I	100.0	–	–	–	14
51 Luopioinen/HIETANIEMI	KA 2	I	51.3	26.3	0.7	21.7	152
52 Sulkava/KAPAKKAMÄKI	KA 2	I	16.2	0.9	2.7	80.2	218
53 Sortavala/OTSONEN	KA 2-3	I	2.5	76.5	2.5	18.5	81

Table C2. Various groupings of the sites listed in table C1.

SITE GROUP DENOMINATION	LAND MAMM. %	SEA MAMM. %	BIRDS %	FISH %	N
COAST + INLAND PRECERAMIC	56.5	28.5	1.3	13.7	634
COAST PRECERAMIC (1+2)	50.4	38.2	0.6	10.8	474
COAST PRECERAMIC 1	55.6	35.1	–	9.3	259
COAST PRECERAMIC 2	44.2	41.9	1.4	12.5	215
COAST + INLAND COMB CERAMIC	8.9	72.2	2.0	16.9	3959
COAST COMB CERAMIC (1-4)	6.8	78.5	2.0	12.7	2508
COAST COMB CERAMIC 1	6.4	87.2	0.6	5.8	1625
COAST COMB CERAMIC 2	5.7	69.4	3.6	21.3	1221
COAST COMB CERAMIC 3-4	9.8	73.9	2.4	13.9	662
COAST KIUKAIS	7.3	68.7	2.1	21.9	192
INLAND PRECERAMIC	74.4	–	3.1	22.5	160
INLAND COMB CERAMIC	25.5	23.1	2.0	49.4	451
ÅLAND'S PITTED WARE	0.5	38.8	3.6	57.1	3777

tural affiliation and information on whether it was situated on the coast or inland. The only exception are the sites from the Åland Islands which are presented as two groups: those with early Comb ceramics, and those with Swedish Pitted ware. Table C2 contains different groupings of the sites in table C1. The great majority of analysis have been made by H.Winge, A.Forstén, M.Fortelius, J.Jernvall and P.Ericsson, and their results have been published by various authors (eg. Forstén 1974; Forstén & Blomqvist 1977; Rauhala 1977; Kokkonen 1978; Siiriäinen 1981a, 1982; Vikkula 1981; Edgren 1982; Nunez 1986b; Lindqvist 1988; Matiskainen 1989b).

Although the nature of Finnish Stone Age faunas allows no conclusions about the relative importance of the various species utilized by man, there are clear differences between the faunas from Preceramic and Comb ceramic sites. This can be observed both from the single sites in table C1 and from the groups in table C2, which show markedly higher percentage of seal bones in Comb ceramic and later coastal sites. The statistics are clear albeit the relatively low number of Preceramic bones call for a certain degree of reservation. An obvious dichotomy can also be observed in the faunas from Preceramic and Comb ceramic inland sites, the latter showing a clear seal component. This suggests that, unlike their Preceramic predecesors, the inland Comb ceramic people were exploiting the relict ringed seal populations that had been cut-off from the Baltic when the major lake systems became isolated c.7000–5000 bc (Saarnisto 1971; Forstén & Alhonen 1975; Donner 1976).

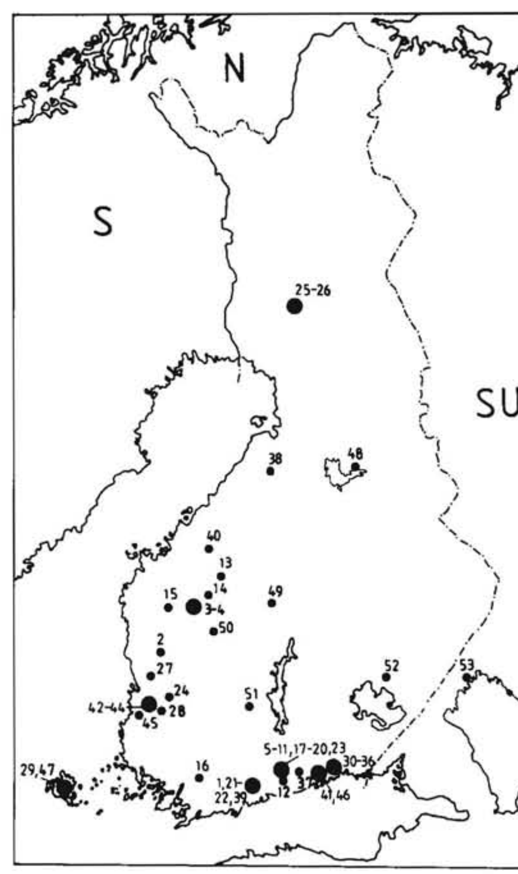

Fig. C3. Distribution of sites with analysed osteological remains. The numbers are the same used in Table C1.