Food Production in Prehistoric Europe

The spread of farming from the Aegean to the North Sea between 8000 and 3000 B.C. is discussed.

H. T. Waterbolk

By about 3000 B.C. all the plains south of the Scandinavian mountains were inhabited by people who lived together in villages of a more or less permanent character. These settlers cut the deciduous forest with stone axes, cultivated a variety of crops, and raised cattle, sheep, goats, and pigs. Hunting was of little importance.

The art of pottery was known everywhere. From highly varied shape and ornamentation, archeologists have been able to distinguish a number of cultures of limited geographical and chronological occurrence and various degrees of relation.

How different is the picture if we go back in time another 5000 years, to about 8000 B.C. The last cold spell of the Ice Age was then almost over. Hunting and gathering were the major means of subsistence. Animal domestication and plant cultivation were unknown. Camp sites were relatively impermanent, shifting from one place to another.

Nuclear and Nonnuclear Cultures

From 8000 to 3000 B.C. in southwestern Asia there was a progression from food collecting to urban civilization, through the levels of incipient cultivation and domestication, of primary effective village farming, and of developed village farming and town life (*1*). For the purposes of this discussion, the nuclear development must be accepted as a given fact, though in its later stages some parts of southeastern Europe also participated (*2*).

In other parts of the Old World, cultures had, in principle, been developing along lines independent of those of nuclear development. According to Caldwell (*3*), who treated eastern North America in its relation to nuclear Mesoamerica, a nonnuclear type of culture may attain a "primary forest efficiency"—the successful exploitation of the natural food resources that brought about residential stability, great material wealth, development of craftsmanship and art, disposal of goods with the dead, and the building of large earthworks. Forest efficiency could even lead to resistance to the introduction of food production. We shall see that this concept of forest efficiency can be usefully applied to Europe.

The terms Paleolithic, Mesolithic, and Neolithic have little meaning for the study of the introduction of food production. There are very different types of "Mesolithic" economies, and "Neolithic" elements like polished axes, pottery, and domesticated sheep are introduced quite independently; not even the additional presence of cattle and pig and of cultivated wheat and barley need result in full dependence on food production.

Climate and Relief

Any cultural development in Europe has to be seen against the background of two major natural factors, namely climate and relief. The most significant climatic event is the Ice Age.

The last cold stage had a much more intense effect in northern Europe than it did in southern latitudes. Correspondingly, the environmental fluctuations in the early postglacial were of much greater importance in the north than in the south, where the major climatic improvement had started long before and had not been interrupted by pauses and minor readvances.

As to the bearing of relief, mountain areas are less suitable for agriculture than are the plains, where soil conditions generally are good, and internal communications are easy. Not only the lowland plains, but also the higher plains, such as the south German plain, should be considered in this connection. An ordinary contour map gives a false picture of the size of the habitable areas.

The irregularities of coastlines and mountain chains differentiate coastal plains from the continental plains. Continental plains generally communicate with each other along the coast and overseas; the continental plains communicate with the coastal plains and with each other through river valleys or low passes. The major plains and their connections are indicated on Fig. 1 (*4*).

Low ridges or even watersheds can be important boundaries between cultural provinces by a combination of factors including soil, climate, and vegetation, as well as by the absence of waterways. For instance, in the hills between Bohemia and Moravia there are no geographically determined channels of communication.

Food Collectors before about 6000 B.C.

Here I emphasize southeastern, central, and northwestern Europe; Iberia, North Africa, Russia, and Scandinavia get less attention.

For a rough chronological arrangement of the evidence, three periods can be distinguished. The appearance of the first village farmers in Greece (about 6000 B.C.) and the expansion of Bandkeramik farmers toward northwestern Europe (about 4500 B.C.) serve as boundaries to separate the three (*5*).

In the period in which the first evidence of incipient food production in southwestern Asia is recorded (*6*), reindeer hunters still roamed the plains of northern Europe from Belgium to Poland. In this area the Upper Dryas climatic deterioration had again opened up the forest cover which had earlier expanded northward during the preceding Alleröd-interstadial (10,000 to 9000 B.C.).

These reindeer hunters belong to the "Tanged Point" tradition (Fig. 2), a late phase of which is known as the Ahrensburg culture. In the deep tunnel-valley sediments adjacent to the Stellmoor (*7*) settlement, remains have been

The author is professor of prehistory and director of the Biological-Archeological Institute of the University of Groningen, the Netherlands.

found of at least 650 reindeer, whereas only a few specimens of elk, bison, wild horse, lynx, beaver, fox, and wolf, and of such fowl as ducks and geese have been uncovered. The flint industry comprised tanged points, "Zonhoven" points, gravers, and scrapers. Harpoon points have also been found. Ornamentation is rare: simple geometrical designs are engraved on some reindeer ribs. In the bog, a wooden post with a reindeer skull on its top was found.

Cave sites from a late variety of the Ahrensburg culture with a fauna comprising both tundra and forest animals are known (*8*). These sites testify to the adaptation of the reindeer hunters to the forest environment.

Another tradition in the lowlands of western Europe is the Federmesser tradition, which included various local groups such as the Azilian, the Tjongerian, the Creswellian, and others (*9*), and probably resulted from an adaptation of Magdalenian reindeer hunters to the forest. In the Alleröd period, a northward expansion of these Magdalenian survivals took place. Their sites occur along river valleys or lakes, but there is no indication of any means of subsistence other than the hunting of big game, such as red deer, elk, and aurochs.

Another development within the same tradition can be observed in the western Mediterranean where a number of coastal cave sites are known, the Romanellian (or Grimaldian) (*10*), which have yielded remains not only of big game, but also of small animals such as hares and birds, and considerable quantities of land snails and of shells collected at the seashore. This is the earliest evidence in Europe for the exploitation of this important natural resource.

Soon after 8000 B.C., the final postglacial climatic improvement started. It caused changes in the environment that were particularly drastic in the northern parts of Europe. In the "Preboreal" the birch-pine woods regained the areas from which they had been pushed during the Upper Dryas period. Deciduous trees, beginning with hazel, moved northward. In Europe nearly everywhere outside the Mediterranean zone a pine-hazel period can be distinguished in the early postglacial ("Boreal"). Into these woods moved elm, oak, lime, and somewhat later ash and alder; after these deciduous trees had gained dominance ("Atlantic") beech, white pine, and hornbeam moved in ("Subboreal"). On the French Mediterranean coast the land snail fauna indicates a change toward a drier climate (*11*).

It apparently took some time before man could efficiently adapt to the new environment. In many well-investigated areas, the frequency of sites that can be dated between 8000 and 7000 B.C. (Preboreal) seems to be significantly lower than those from the preceding and following millennia. It is therefore difficult to find a continuous series of intermediate assemblages between the Federmesser and Tanged Point traditions and their successors, and to localize the areas where the transition and readaptation took place.

Fig. 1. Major plains of Europe are indicated, irrespective of elevation. High mountain areas (above 1000 meters) are shaded. The interconnections of the plains are shown by a double headed arrow. *1*, Vardar-Morava gate; *2*, Iron Gate; *3*, Moravian Gate; *4*, Linz Gate; *5*, Elbe Gate; *6*, Burgundian Gate; *7*, Aquitanian Gate.

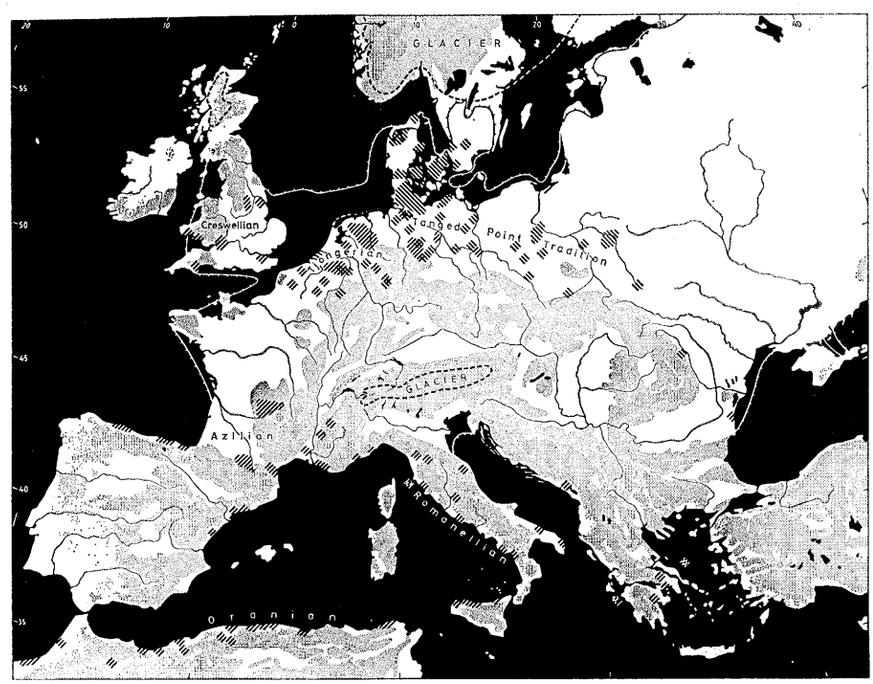

Fig. 2. Distribution of hunting-collecting cultures, about 9000 to 8000 B.C.

Perhaps this is a general phenomenon—we may expect a rapid alteration in the environment to result in a change in the quantity of food that can be obtained with traditional methods, and in many cases to bring about diminution of population, or emigration. Only after adjusting the hunting and collecting methods to the new fauna and flora can the population expand again. A similar situation seems to be present in the early Atlantic period in the western Baltic.

In the early postglacial period at least three traditions can be distinguished in the human habitation (Fig. 3): Maglemosian, Sauveterrian-Tardenoisian, and Montadian. The center of the Maglemose tradition was in the western Baltic area. It also included parts of Britain and the present North Sea. We know of a seasonal settlement (Star Carr in England) (*12*), as early as in the Preboreal period, in a river valley bog, where man lived as close to the water as possible during winter and early spring. People hunted red deer (dominant), roe deer, elk, aurochs, wild boar, and other furbearing animals such as fox, marten, and beaver. Birds were not numerous, and fish remains were conspicuously lacking. The preference for settling at the lakeside thus does not seem to have been determined by fishing or hunting of waterfowl. A wooden paddle is evidence of water transport.

Sites dating from the Boreal period are much more frequent. Seasonal culture layers, mainly known from the bogs of Denmark, Schleswig-Holstein, and Scania, now also contain large quantities of hazelnut shells and fish remains (*13*).

In all stages of the Maglemosian tradition, macrolithic tools occur with microlithic flint types. Core and flake axes and adzes were made, which though still unpolished, could efficiently cut small trees to be used, for example, as substructures for huts. Other stone was also used for making tools, such as mace heads, hammers, and axes, some of them perforated and made by pecking. There was also some art: amber model animals and geometrical ornaments made by incision and pricking on bone and antler tools.

Much less specialized were the groups belonging to the Sauveterrian-Tardenoisian tradition of western Europe, from parts of Britain, the Low Countries, and France to inland Germany (*14*). The flint industry was predominantly microlithic.

People lived mainly on game hunting and their settlements were frequently shifted. They would certainly have taken advantage of the hazel, but it is doubtful that fishing was of any importance. In hilly countries cave sites occur rather frequently, and heavy soils are avoided.

Microlithic flint industries of Sauveterrian-Tardenoisian affinity, and therefore probably of Boreal age, occur as far eastward as lower Austria and Slovakia, where they seem, however, to be rare (*15*). Southeastern Europe has so far yielded very little that can be attributed with any certainty to this period. Some Rumanian and Moldavian sites may belong here.

Along the Mediterranean coast, habitation continued (*11*). In the Rhône delta, a continuous sequence of industries has been established from the Romanellian to the food-producing Chasseen. It is probable that the first stage after the Romanellian, the Montadian, is to be dated from the Preboreal and Boreal periods. The settlements occur in rock shelters. The culture layers are very rich in mollusks, both terrestrial and marine. Further, there are aurochs, red deer, wild boar, and large quantities of hare or rabbit. The flint industry has a degenerated character.

Flint industries of this type also occur elsewhere in the Mediterranean area, as for example, in Liguria, near Salerno (16), and also along the Adriatic coast of Jugoslavia, in the cave Crvena Stijena (*17*).

Village Farmers Appear in Greece

Sometime around 9000 B.C., incipient food production had started locally within what Braidwood calls the natural habitat zone in southwestern Asia among cultures that have a microlithic component strongly reminiscent of that in the later cultures of western and northern Europe. Around 7000 B.C., the first village-farming settlements were present in that area. Pottery was still, however, lacking, and it did not become common for perhaps another 1000 years.

In the prepottery stage, the European continent was hardly influenced by the nuclear development. Only in Thessaly have preceramic levels with remains of a farming culture been reported. Here, people cultivated wheat, barley, millet, lentils, and other legumes. They raised mainly sheep, but also had goats, swine, and cattle. Hunting and collecting were of minor importance (*18, 19*).

Such sites have also been found on Crete and Cyprus. The sea apparently posed no more problems: it unites the sites—all in coastal plains—more than it separates them. There are various archeological connections with Anatolia, and it is probable that this area or its lowland flanks in Syro-Cilicia and in the prehistorically little-known western littoral of Turkey was the place of origin of the first colonists on European ter-

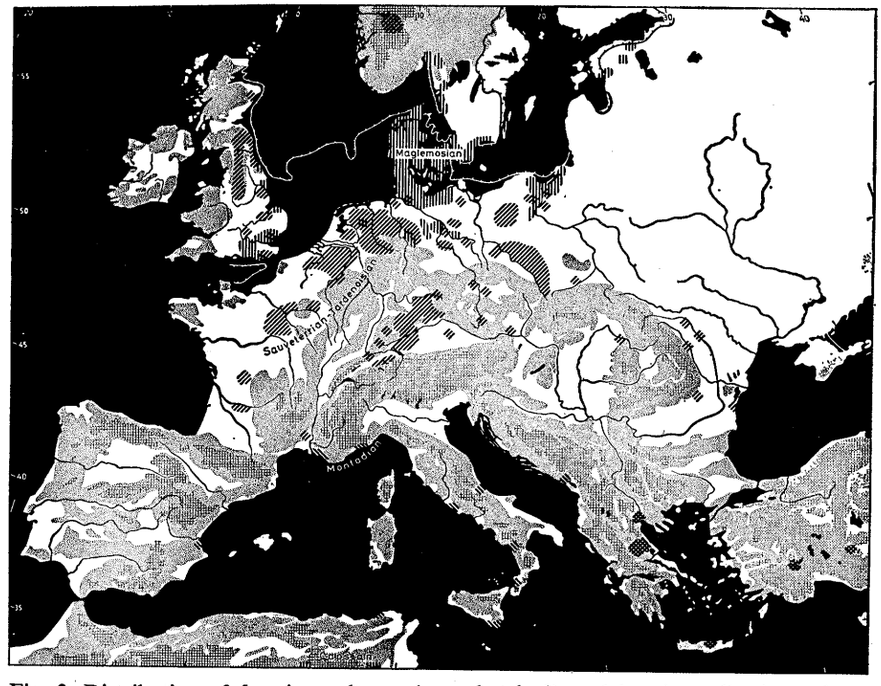

Fig. 3. Distribution of farming cultures (cross-hatched) and hunting-collecting cultures about 6000 B.C.

ritory. Admittedly, there is evidence for the presence of hunting and collecting communities in Greece in late-glacial or early postglacial times (*20*), but their persistence up to the time immediately preceding the first evidence of farming is still to be proven.

Dramatic Environment Change

With the Boreal-Atlantic transition, about 5500 B.C., there was much environmental change north of the Alpine belt. Pine and hazel lost their prominent place to a mixed deciduous forest. Marine transgressions enlarged the North Sea and brought salt water into the Baltic.

Increase in precipitation promoted the vegetation on lakeshores and the filling up of basins. Raised bogs appeared in former lakes or marshes, which was disastrous to fish and waterfowl.

The mixed oak forest was more shady than the fairly open pine woodland, and there was less grazing for large animals. Big game such as aurochs and red deer decreased in number. All these changes required readaptation by man, who now faced a rapid decrease of the natural resources he had been relying on for two millennia.

Danish investigators have noticed an increase in the importance of waterfowl hunting, fishing, and collecting of wild fruits and berries in the Maglemose area, toward the end of the Boreal period, as evidence of elk and aurochs become rare. Only very few habitation sites from the early Atlantic period are known (Fig. 4). In contrast to those from the preceding period, these sites all seem to lie on the coast. At the site of Vedbaek, north of Copenhagen, remains were found not only of red deer, roe deer, and wild boar, but also of sea mammals such as grey seal, ring seal, porpoise, and fish such as cod and haddock. Sea hunting and fishing appear here as a new means of subsistence and compensate for the decrease in big game and inland fish. Shellfish, however, were not collected. Pottery was unknown, and there is no evidence for food production (*13*).

As was the case in the Preboreal period, there seems to be a decrease in population during the adaptation to the new environment. In the Low Countries, one early Atlantic site is known, de Leijen. It is situated at the shore of a depression which was still open water at the time of habitation. People collected hazelnuts and also water nuts, and must have lived on fish as well (of the possible organic materials, only carbonized fruit remains were preserved at this site). Generally, however, higher grounds had become unsuitable for human habitation. But there is reason to believe that parts of the Rhine delta in the North Sea that are now deeply subsubmerged were inhabited during the Atlantic period (*21*).

Further south, in Belgium and France, there is as yet no proof of inland habitation during the Atlantic period (*22*). But a few shell middens of of this age are known from the coast of Brittany, and the rise of the sea level since about 3000 B.C. in that area makes it probable that their number had been much larger. At Téviec and Hoedic, interesting cemeteries have been excavated with graves containing one to three individuals and grave goods—antlers, bone tools, and shell necklaces (*23*). Other shell middens of Atlantic age are known from Britain (*24*), Portugal (*25*), and northwest Spain (*26*).

As the Boreal-Atlantic transition set in, people everywhere in western, northwestern, and northern Europe moved toward the coast and added coastal hunting, fishing, and collecting as means of subsistence to the traditional hunting of big game and inland collecting and fishing. The Atlantic forest as such was an unfavorable environment for man, and European man could best survive by adapting himself to the coast. In making this adaptation, however, there was an important consequence. The coastal resources allowed a considerably higher degree of sedentary occupation, freeing man of the necessity of continuous wandering. One precondition for the acceptance of farming (*3*)—residential stability—was thus automatically fulfilled.

In the narrow zone between Alps and Jura mountains there are many lakes and streams. Here we find a very varied environment, especially if the high mountains are included as suitable area for seasonal hunting. It is not surprising that in this area there is proof of human habitation during the Atlantic period, in caves (*27*) and open air sites, such as the Lautereck (*28*), a rock shelter on the upper course of the Danube where people specialized in carp fishing. Elsewhere in central Europe there is no proof of human habitation between 5500 and 4500 B.C.

Along the western Mediterranean coast, adaptation had, as seen in the preceding section, taken place long before. Possibly it was the Alleröd climatic improvement which had here brought about the same necessity of movement toward the coast as the Boreal-Atlantic change was to bring about in the north.

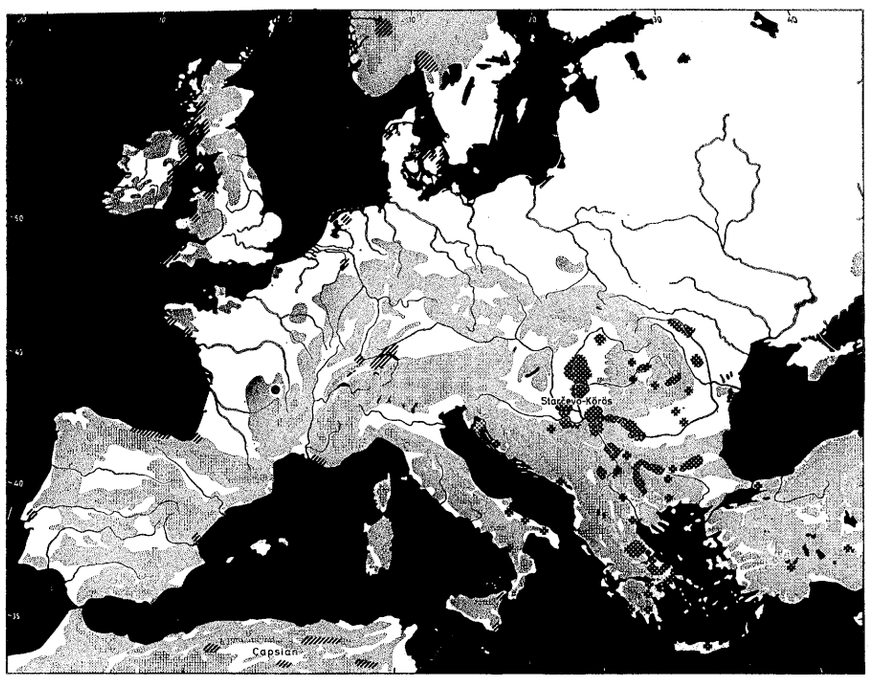

Fig. 4. Distribution of farming cultures (cross-hatched) and hunting-collecting cultures about 5000 B.C.

Southeastern Europe (6000 to 4500 B.C.)

At about 5500 B.C., in the coastal plains of the Aegean area ceramic farming villages were present everywhere (*2, 18*). Large rectangular buildings have been excavated at Neo Nikomedeia. Early sites also occur in the inland valleys of Macedonia and Bulgaria.

At about 5000 B.C. the plains of southeastern Europe were inhabited by agricultural groups of the Starčevo-Körös tradition with their main distribution area in the southern part of the Hungarian plain. Here natural steppe conditions may have prevailed, but sites of this tradition also occur in areas such as Bosnia, which most probably had a forested character. The use of heavy wood in the house construction in Macedonia may be seen as a first adaptation to European forest conditions. This adaptation probably continued in the Hungarian plain, which certainly had gallery forests along the rivers, and was bordered everywhere by wooded hills.

Most of these settlements seem to be completely dependent on food production (*29*). There is, however, some evidence for the persistence of a food-collecting economy. On an island in the flood plain of the river Theiss a site has been found (*30*) with remains of forest animals, many fish, many birds, and layers of shells up to 30 centimeters thick. There was evidence for the local domestication of cattle. At some sites in the Bug-Dnestr area, a "Mesolithic" level is reported below a series of "Neolithic" levels (*31*). The lowest Neolithic level contains many bones of wild animals alongside domesticated cattle, and many fish remains. There are sites on river banks. The flint industry is microlithic.

In both areas we must reckon with the possible persistence of communities which did not produce food and instead specialized in fishing and thereby attained sufficient residential stability to be receptive to new ideas on food production. In this connection, mention should also be made of the recently excavated site of Lepenski Vir (*32*), situated on a bank of the river Danube in the Iron Gate. There were three main horizons. The lower horizon comprises five layers, with a total of 59 trapezoidal house foundations, each with an elaborate hearth. The most spectacular finds are large sandstone pebbles that are worked into human faces with a fishlike mouth. Agricultural tools are lacking. Bones of deer, boar, and various fish species have been found. Fishing and hunting thus seem to have been the major means of subsistence. Pottery appears only in the two uppermost layers of the lower horizon. Horizon III, separated by a sand deposit from the foregoing horizon, belongs to the Starčevo culture.

In large parts of the Hungarian plain, Bulgaria, and Rumania, which were inhabited by the Starčevo-Körös farmers, evidence for the presence of such food-collecting communities is lacking. We therefore assume that there was an actual colonization by people from the narrow coastal plains of the Aegean coast, through the Vardar-Morava gate and parallel valleys, and up the Marcia valley, and from there either westward toward Serbia or northward along the Black Sea coast into the Dobroucha and Walachia. There is also the possibility of migration over sea through the Dardanelles and the Bosporus. Unfortunately, there is little evidence from the coastal plains of western Anatolia and Thrace.

In the Thessalian standard sequence of cultures (*33*), Milojčić is found below the Sesklo level, which should be parallel to Starčevo, a level characterized by a pottery that is ornamented by impressions of shells (Cardium). Related pottery occurs in many places along the Mediterranean coasts. It probably originated in the Levant (for example, Mersin) and spread westward (*34*). It is found along the Dalmatian coast, in Apulia, Sicily, Liguria, south France, Spain, and even Portugal, always in areas (often at the same sites) that were already inhabited by coastal hunting-collecting communities (*35*). From the few radiocarbon dates available it is probable that this pottery had reached the western Mediterranean by 4500 B.C. It may have been preceded by the domesticated sheep and goat, or both. In the section of Châteauneuf-lez-Martigues in the Rhône valley, bones of these animals occur well below the first pottery (of Cardium type) (*36*). They are also reported in late Tardenoisian layers of Rouffignac and in aceramic shell middens of Portugal, Asturia, Brittany, and Ireland.

The Final Phase (4500 to 300 B.C.)

By 4500 B.C., then, the foundations were laid for the final spread of food production throughout Europe. Evidence for this general moment of time suggests (i) that the Hungarian plain was a dominant center which had incorporated all the major achievements of the nuclear area in the Near East,

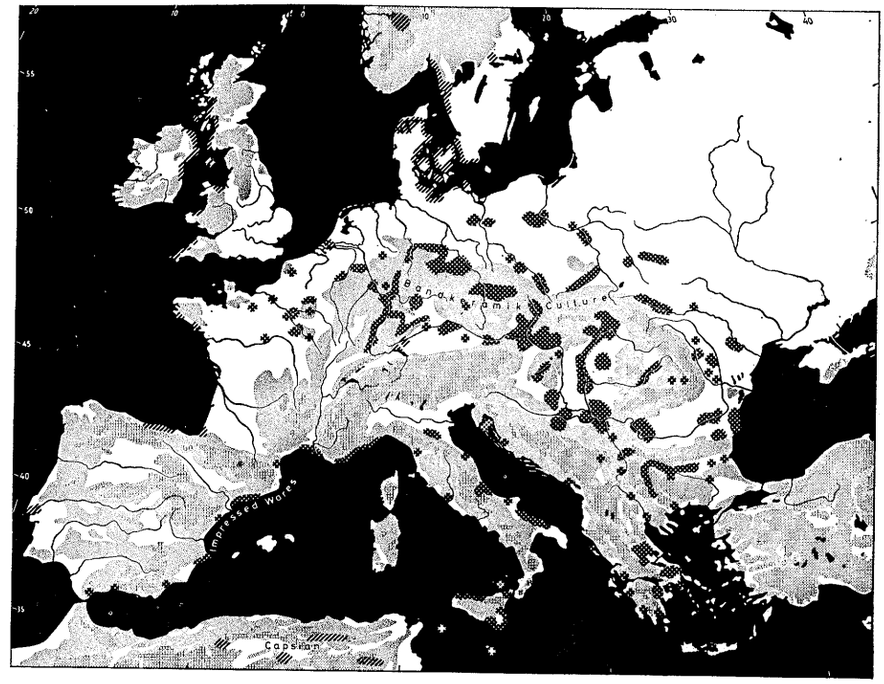

Fig. 5. Distribution of farming cultures (cross-hatched) and hunting-collecting cultures about 4200 B.C.

and which had added to these an adaptation to the European deciduous forest; (ii) along the Mediterranean coast, a diffusion sphere connected with the Levant and the Aegean; (iii) along the Atlantic and Baltic coasts, populations of hunters, fishermen, and collectors, who by a many-faceted exploitation of natural resources had attained a fair degree of residential stability; and (iv) finally, locally in inland Europe, small groups of people who had been increasing their economic potential by specializing in river and lake fishing and collecting.

One of the most remarkable events in European prehistory is the explosive spread of the Bandkeramik culture. From about 4400 B.C., large loess areas north and west of the Hungarian plain were colonized in a short time (Fig. 5).

Permanent settlements were founded everywhere. They consisted of some 10 to 20 wooden buildings up to 40 meters long and 5 to 6 meters wide, the roof of which was supported by three rows of posts inside the houses. In each village, one building is larger and of heavier construction than the others (*37*). The people lived by agriculture and husbandry. Hunting was of minor importance; the percentage of wild animals never exceeds 10 percent of the total bone remains (*29*).

The pottery is very homogeneous. In a period of several centuries a parallel development of form and ornament took place over the whole area of distribution. Toward the end, regional differentiation increased.

A possible center of this large-scale colonization is the northwestern part of the Hungarian plain. An early pottery stage with Starčevo influences has recently been distinguished in this area (*38*). It also occurs in Bohemia, South Germany, and Saxony-Thuringia.

Although the river valleys clearly directed the distribution of the Bandkeramik, it is by no means a riverine culture. Sites occur mainly on well drained loess plateaus, with no direct relation to rivers or streams. In this large area there is no conclusive evidence that earlier populations took over agriculture and husbandry and were assimilated into the Bandkeramik culture.

We mentioned the site of Lautereck. Here, Bandkeramik pottery appeared in the otherwise normal collecting inventory of a carp fishing settlement on the Upper Danube, outside the loess area. In a still later stage, Aichbühl pottery (about 3800 B.C.) also occurred at the same site in an inventory that was otherwise still unchanged. This is one of the few sure contacts between the Bandkeramik culture and an indigenous inland culture, and it certainly does not suggest a fast rate of assimilation.

Contacts of the same kind can be expected at all points where the Bandkeramik culture occurs far down the river valleys so that it meets the costal communities. The results of such contacts are evident much later, when the Bandkeramik culture had been succeeded by regional cultures such as Rössen in the west, Stichbandkeramik in central regions, and Precucuteni in the east (Fig. 6). For this level, dates of 3800 to 3500 B.C. are probable.

For northwestern Europe, the Rössen culture appears to be of great importance (*39, 40*). Rössen settlements with long houses are known from the same loess soils and the same areas as were occupied by the Bandkeramik farmers. But isolated finds of Rössen pottery occur at sites along lakes and rivers where the traditional means of subsistence are maintained with small-scale agriculture and husbandry.

In the western Mediterranean area, the communities of coastal collectors which, by way of diffusion, had learned to make pottery and to herd sheep and goat, or both, now also took over agriculture. They no longer lived exclusively on a narrow strip along the coast, but moved onto the coastal plains behind. Minor geographical barriers were crossed. Cardium pottery penetrated from Liguria to the Po plain, from the Provence into the Garonne plain through the Aquitanian gate, from the Catalonian coast into the Ebro valley. The new economy seems to have resulted in an increase of the population, and, with the coastal plains as the starting point, all available open spaces were occupied.

At the same time, the traditional communication lines along the Mediterranean and Atlantic coasts were maintained. A network of connections thus extended all over western Europe, including the British Isles. The coastal communities served as connecting points in this network and as nuclei of cultural innovation. They became starting points for the final spread of farming over the plains of western Europe. In this area a certain cultural uniformity prevailed—the "Western Neolithic" tradition. This tradition is characterized, for example, by certain pottery types, hilltop settlements ("causewayed camps"), and megalithic monuments (menhirs, alignments, collective tombs).

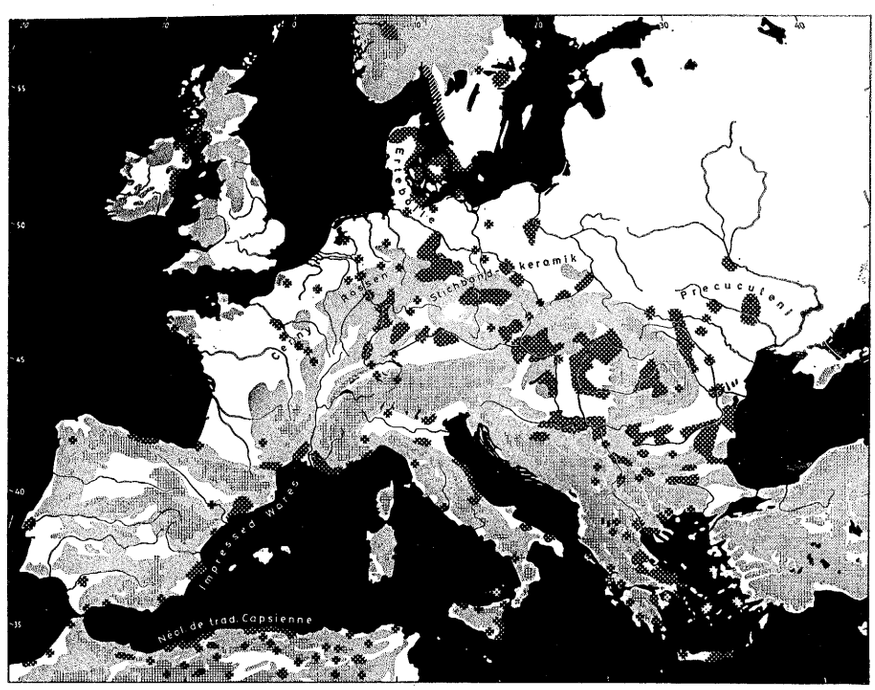

Fig. 6. Distribution of farming cultures (cross-hatched) and hunting-collecting cultures about 3500 B.C.

Western and Danubian Traditions Meet

So far in this account of the spread of food production into Europe, the new economy has moved into and developed in a succession of regions where food production was unknown. We now have the problem of what happened when the Western Neolithic tradition and the Danubian tradition (as evidenced by the regional successors of the Bandkeramik) met. Keeping in mind the maritime emphasis of the Western tradition and the predilection for loess soils shown by the Danubian tradition, we can find on Fig. 6 the areas where both traditions can be expected to meet: the western part of the Alpine foreland, Burgundy, the upper Rhine lowland, the Seine basin, and the coastal plains along the North Sea.

In the Alpine foreland (*41*), the Lautereck site shows that the first influence of local groups in this area could have taken place even before 4000 B.C., but probably it was half a millennium later, in Rössen times, that the reorientation became manifest. Here again, the actual transition from food collecting to food production is not observed; but this is a general phenomenon. We see only the result of the adaptation, not the adapting process itself, because it concerned only a small number of people, and the chance of finding their settlements is small. Only where man used caves and rock-shelters as settlements—as in Châteauneuf-lez-Martigues—may we expect to observe gradual transitions in the occupation layers. For them the choice of settlement sites was much more restricted; and furthermore, caves and rock shelters are obvious places for archeological exploration.

The first agricultural groups in the Alpine foreland preferred lakeshores or bogs as settlement sites. There are few early sites. The earliest may be those of the Aichbühl culture. Others show Rössen influences (for example, the Egolzwil culture). This level can be dated at about the middle of the 4th millennium B.C.

About 3000 B.C. (Fig. 7) the population had apparently increased considerably. There were many farming villages, all situated on the marshy shores of the lakes. The old familiar "Swiss lake dwelling" sites are now known to have been built on the shores of lakes or bogs, but not built out over the water. Cereal grains are common in most of the settlements, but collecting of wild fruits and berries was practiced as well. Locally, fishing remained important. Hunting was a major occupation; in some sites, bones of wild animals dominated over those of domesticated animals. The pottery shows a great diversity in form and ornament. West of Lake Zürich the Younger Cortaillod culture which belonged to the Western tradition developed; east of this lake the Pfyn culture of clearly Danubian affinity developed. This diversity can best be explained by assuming that the hunting and collecting communities in this area had undergone influences from both the west and the east. Two other groups further eastward have the same preference for lakeshores: Schussenried (South Germany) and Mondsee (Austria).

In the North German–Danish area the Ertebølle culture (*40, 42*) originated at about 3800 B.C. as a successor of both the early Atlantic Vedbaek culture (on the Danish islands) and the Oldesloe culture (a lakeshore, inland hunting and collecting culture in Schleswig-Holstein of Atlantic age). The Ertebølle culture not only combines coastal hunting with inland hunting, fishing, and collecting, it adds new elements: coastal collecting of oysters and other shellfish, and, on a restricted scale, grain growing and cattle raising. Settlements with the same type of flint inventory occur along the coast, on inland high ground, and in freshwater bogs. This situation was maintained for half a millennium; it is not until about 3000 B.C. or even later that food production gained dominance.

The origin of the well-known Ertebølle pottery has been much debated. The Rössen culture certainly influenced the Ertebølle culture, but the pottery could have come from western Europe. In view of the long range of the connections along the Mediterranean and Atlantic coasts it is not surprising that influences should have reached as far as Denmark. The spread of the megalithic "religion" over this same area, soon after the establishment of village farming is another illustration of the strength of this Western diffusion sphere.

The fully food-producing culture of southern Scandinavia is known as the TRB culture. It is probable that the population stock of this culture is of Ertebølle origin (*43*), that elements of both the Western and Danubian tradition have been incorporated and transformed, and that an expansion of population had taken place after the establishment of food production. Expansion went northward to south Norway, westward to northwest Germany and Holland, and eastward to Poland. Just as the megaliths illustrate the persistence of the Western tradition in the TRB

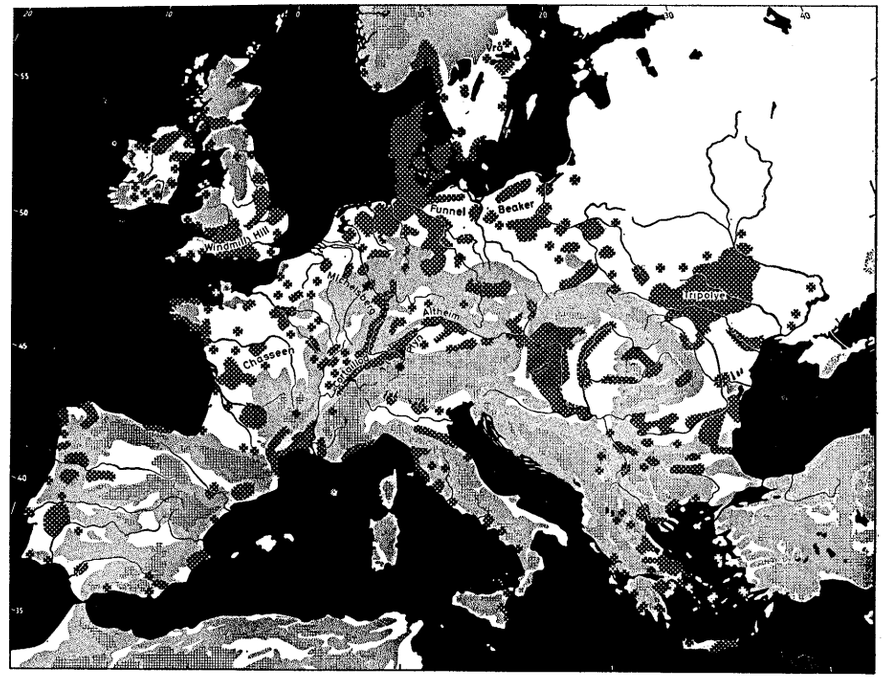

Fig. 7. Distribution of farming cultures (cross-hatched) and hunting-collecting cultures about 3000 B.C.

culture, copper imports from the Hungarian plain, knob-ended battle-axes (*Knaufhammeräxte*), and long houses illustrate the long-distance contacts with the Danubian tradition.

In France the main food-producing culture is the Chasseen, of which Bailloud distinguishes four regional varieties (*44*). The southern variety could have developed out of the Cardial (*45*). In Brittany the Chasseen is characterized by megalithic grave monuments of clearly Iberian affinity, and by polished axes made of locally quarried greenstone, which were exported over wide areas in France. One megalithic tomb was found on top of a shell midden with a carbon-14 date of 4000 B.C. (La Torche). The presence of goat in the shell middens of Téviec and Hoëdic is another indication that the coastal culture of Brittany could have played a part in the development of the western variety of the Chasseen. The eastern variety occurs in Savoy and Burgundy; it is hardly different from the younger Cortaillod culture of Switzerland, and has the same preference for lakeshores.

In the Paris basin, the Chasseen is preceded by the *Groupement de Cerny* which Bailloud thinks followed the late variety of Bandkeramik in this area, and thus belonged to the Danubian tradition. It occurs far to the west and seems to reach the coast of the North Sea. It should be a contemporary of the Rössen culture. In this area the western influences seem to have become more important than the Danubian. The northern variety of the Chasseen is the only one in which the polished flint axe, which it has in common with the Funnel Beaker culture, is known.

For their axes and adzes the Bandkeramik and Rössen cultures depended largely on an amphibolite which occurs naturally in Silesia (*46*). Rössen-type adzes are lightly distributed over large parts of the plains of northwestern Europe. It is clear, however, that for a large-scale expansion of farming, a local source of material for axes and adzes would be essential. In the western Baltic area, suitable unweathered flint occurs abundantly both as boulders in cliffs and in the chalk. Here large flint tools had been in use for many millennia and the step toward polishing was a small one.

In north France and Belgium crude macrolithic flint assemblages are known as the "Campignian." Most investigators now agree that it is the flint exploitation "facies" of food-producing cultures (Chasseen, Michelsberg). Both at Spiennes (Belgium) and at Rijckholt (Netherlands), flint mines were in operation before 3000 B.C. (*47*).

In the British Isles early carbon-14 dates for food-producing cultures have been obtained along the Irish Sea (*48*). In this area coastal settlements of Atlantic age are present (Larnian, Obanian) which have yielded evidence for the gradual introduction of elements of food production (polished axes, sheep, or goat). Some of the major stone axe factories are situated in the same area (Tievebulliagh in Ulster, Langdale in the Lake District, Graig Lwyd in North Wales, and Cornwall), and these sent their products as far as Wessex (*49*), although flint was available there.

It is therefore possible that the Early Neolithic culture of southern Britain was not entirely due to an invasion from France (*50*), but had its origin in the expansion of an Irish Sea population which had gradually acquired the elements of an agricultural economy through its coastal contacts.

In the transitional zone between the Western and Danubian spheres, there is another group whose origin has been much debated (*51*)—the Michelsberg culture, with its main distribution along the upper Rhine with some outliers as far as Bohemia and Belgium; its pottery occurs in the Spiennes flint-mining area. Radiocarbon dates from Spiennes, Ehrenstein, and Thayngen suggest an age between about 3400 and 2900 B.C. The Michelsberg culture is probably a local successor to the Rössen culture, and its population stock is therefore of ultimate Danubian origin, but it has incorporated various western elements. The relation of Michelsberg with TRB, Altheim, Baalberg, and other contemporary groups north of the Alps need not be explained by one common origin of these groups, but could be due to a phenomenon of acculturation of groups of heterogeneous origin.

By about 3000 B.C. the map of Europe had been filled with a complicated pattern of food-producing cultures of the village-farming type, each with a certain individuality. This individuality seems to have been the result of both environmental and historical factors. The environments called for adaptation to local circumstances of soil, relief, climate. But historical factors, such as migration, diffusion, acculturation, and local tradition were important in establishing boundaries and relations. It will take a long time to unravel the complicated processes which have led to the formation of these cultures.

Final Considerations

The major factors in the spread of food production over Europe seem to have been the following. (i) The presence of the nuclear area in southwestern Asia, from which the first fully food-producing groups migrated into Greece, and from which ideas were diffused along the Mediterranean and Atlantic coasts. (ii) The coastal adaptation of the descendants of the upper Paleolithic hunters and collectors. This adaptation was gradual and progressive, and the western Baltic area demonstrates that at least in that area it was provoked by successive environmental changes. Along the Mediterranean coasts such factors had probably been operating too, but at an earlier date. Coastal adaptation meant a greater variety in means of subsistence and, by its very nature, a greater residential stability—both preconditions for the acceptance of the farming way of life. (iii) The successive building up in southeastern Europe of potentials for the expansion of population over large areas. In this process adaptation to a fully forested environment was an essential element. The first wave of expansion comprised large parts of the Hungarian plain (Starčevo-Körös), the second, the loess areas northwest, north, and northeast of the Alpine and Carpathian mountain chains (Bandkeramik). (iv) The slowness in turning to food production exhibited by the sessile coastal and inland groups, doubtless because of the effectiveness of their mode of life. Mixed economies resulted in which agriculture and husbandry played a subordinate role (for example, Ertebølle). (v) The rapid colonization of the coastal plains after food production had gained dominance and a potential for population expansion had been built up. (vi) The interaction of the continental (Danubian) and coastal (Western) movements in a broad zone of contact between the Alps and the North Sea, where cultures with a mixed Danubian and Western character originated.

There is no proof in Europe for the presence of a level of incipient food production in Braidwood's sense. Any domestication of indigenous cattle and pigs ensued after the introduction of domesticated animals in the area. It has been alleged that in the south of France (*35*) wild sheep was domesticated in the Atlantic period, but this is contradicted by the natural distribution of the species in Asia and by its absence among the animals that were hunted in earlier pe-

riods. Only the apparent strong specialization of the Ahrensburg people on the reindeer might have had aspects of domestication, in the same way as with some recent arctic peoples. But with the disappearance of tundra conditions this could not have had any lasting effect, and the successors of the Ahrensburgian were hunters.

There is also no botanical proof for food production before the introduction of wheat and barley from southwestern Asia. Still, there is the hazel, the fruits of which are extremely common in some culture layers, and the postglacial spread of which was so rapid that Firbas has suggested that man played a part in this spread (*52*). Of course, it would be easy to promote hazel growth by cutting down other shrubs. But man would only do so if he would be sure of coming back regularly. This might be the case in the Maglemosian area. Here seasonal lakeside settlements are known, where man specialized in fishing. In this rich environment, wanderings were certainly less necessary than in other areas. One might even see the core and flake axes as useful tools for such a purpose. It is doubtful, however, whether we shall ever be able to prove anything like the cultivation of hazel, and it must be said that such a contrivance had no decisive effect, for the addition of coastal collecting was necessary to overcome the effect of the Boreal-Atlantic environmental change (*53*).

The development of prehistoric culture in Europe does indeed agree in broad outline and many details with the nonnuclear development in eastern North America. The increasing efficiency in the exploitation of natural resources, the trend toward residential stability, the importance of the shellfish economies, the development of art, the disposal of goods to the dead in the later stages, are all features of the nonnuclear cultures of the eastern United States and southeastern Canada which we also find in northwestern Europe. Admittedly, we do not know a European counterpart for ceremonial centers and earthworks, as there were with the Hopewellian and Adena peoples before food production gained dominance. But the slowness to add animal husbandry and grain growing to an already effective food economy is again a feature which both areas have in common. This cultural slowness—Caldwell calls it resistance—is the main reason why it took as much as 3000 years for village farming to travel by way of diffusion from the Aegean to the North Sea along the coastal route.

The shorter continental route was not much faster, for the obvious reasons that it was barred by mountain chains and depended only on expansion of population and migration. But even so, by 4400 B.C. fully food-producing communities had reached the edge of the north German lowland plain at a distance of 300 kilometers from the heart of the Ertebølle area. A distance of 2000 kilometers—as the crow flies—had already been covered in the same time which thereafter was necessary to cover these last 300 lowland kilometers and to establish fully effective village farming in the Ertebølle area and its surroundings.

Summary

Against the background of the postglacial climatic development and the major physiographic features of Europe, a description is given of the spread of food production over the continent. After the immigration of the first farmers into Greece from Anatolia, adaptation to European forest conditions took place and potentials for successive population expansions were built up. Large parts of continental Europe appear to have been uninhabited at the time immediately preceding the immigration of farmers. The reason was probably that the forest had become unsuitable for human occupation after the deciduous species had gained dominance. Along the Mediterranean and Atlantic coasts, hunting and collecting communities had been able to maintain themselves by adding sea hunting and fishing and shore collecting of shells to the traditional inland hunting, fishing, and collecting.

These communities were sufficiently sessile to be receptive to new ideas on food production that arrived successively by way of diffusion along the coasts. They became centers of population expansion and cultural innovation after food production in the course of time had gained dominance. In a broad zone between the Alps and the North Sea the coastal (Western) and continental (Danubian) traditions interacted.

References and Notes

1. R. J. Braidwood and L. Braidwood, *J. World Hist.* **1**, 278 (1953); R. J. Braidwood, *Atti del VI Congresso Internazionale della Scienza Preistoriche e Protostoriche* **1**, 116 (1962).
2. R. J. Rodden, *Sci. Amer.* **212**, 83 (1965); *Balkan Stud.* **5**, 109 (1964).
3. J. R. Caldwell, *Trend and Tradition in the Prehistory of the Eastern United States* (Springfield, Ill., 1958).
4. The maps are based on the U.S. Air Force Operational Navigation Charts 1 : 1,000,000, which have a special tint for relatively level areas. For obvious reasons of unequality in the published basic information and the uncertainty of the age of many cultural stages, it was impossible to make anything but extremely tentative distribution maps. They should only be considered as serving the purpose of illustrating the main argument in this paper. Apart from the works mentioned in the other notes, the major sources were the following books and papers. J. Arnal and C. Burnez, *Berichte der Römisch-Germanischen Kommission* **37-38**, 1 (1958); L. Bernabo Brea, *Sicily before the Greeks* (Thames and Hudson, London, 1957); F. Bourdier and H. de Lumley, *Bull. Soc. Préhist. Franc.* **51**, 307 (1954); J. Brøndsted, *Danmarks Oldtid Stenalderen* (Gyldendal, Copenhagen, ed. 2, 1957), vol. 1; J. G. D. Clark, *Prehistoric Europe, the Economic Basis* (Methuen, London, 1952); J. G. D. Clark, *Proc. Prehist. Soc.* **21**, 3 (1955); J. Driehaus, *Die Altheimer Gruppe* (Habelt, Bonn, 1960); V. von Gonzenbach, *Die Cortaillodkultur in der Schweiz* (Birkhüser, Basel, 1949); A. Hagen, *Norway* (Thames and Hudson, London, 1967); K. Jażdżewski, *Poland* (Thames and Hudson, London, 1967); H. Knöll, *Die nordwestdeutsche Tiefstichkeramik und ihre Stellung im nord- und mitteleuropäischen Neolithikum* (Aschendorff, Münster, 1959); G. Leisner and V. Leisner, *Die Megalithgräber der Iberischen Halbinsel. Der Süden* (Berlin, de Gruyter, 1943); *Der Westen* (Berlin, de Gruyter, 1956); F. L. van Noten, *Bull. Soc. Roy. Belge Anthropol. Préhist.* **78**, 197 (1967); H. Obermaier, *Fossil Man in Spain* (Yale University Press, New Haven, Conn., 1924); S. Piggott, *The Neolithic Cultures of the British Isles* (University Press, Cambridge, 1954); *Ancient Europe* (University Press, Edinburgh, 1965); R. Pittioni, *Urgeschichte des österreichischen Raumes* (F. Deuticke, Vienna, 1954); in *Realencyclopedie der classischen Altertumswissenschaft*, P. Wissowa, Ed. (Druckenmüller, Stuttgart, 1962), Suppl. 9, pp. 106–371; J. Preuss, *Die Baalberger Gruppe in Mitteldeutschland* (Deutscher Verlag der Wissenschaften, Berlin, 1966); D. de Sonneville-Bordes, *Le Paléolithique Supérieur en Périgord* (Delmas, Bordeaux, 1960); M. Stenberger, *Sweden* (Thames and Hudson, London, 1965); K. Tackenberg, *Fundkarten zur Vorgeschichte der Rheinprovinz* (Habelt, Bonn, 1954); J. Tixier, *Typologie de l'Epipaléolithique du Maghreb* (Art et Métiers Graphiques, Paris, 1963); R. Vaufrey, *Préhistoire de l'Afrique*, vol. 1, *"Le Maghreb"* (Masson, Paris, 1955); R. Wyss, *Z. schweizer. Archäol. Kunstgeschichte* **20**, 55 (1960).
5. For radiocarbon dates used in this article see *Chronologies in Old World Archaeology*, R. W. Ehrich, Ed. (Univ. of Chicago Press, Chicago, Ill., 1965); *Radiocarbon* **8** (1966); *ibid.* **9** (1967).
6. R. J. Braidwood, in *Vorderasiatische Archäologie: Studien und Aufsätze* (Anton Moortgat Festschrift), Kurt Bittel *et al.*, Eds. (Mann, Berlin, 1964), pp. 57–67.
7. J. G. D. Clark, *The Mesolithic Settlement of Northern Europe* (Cambridge Univ. Press, Cambridge, England, 1936); A. Rust, *Vor 20,000 Jahren* (Karl Wachholtz, Neumünster, 1962); J. Troels-Smith, *Fra Nationalmuseets Arbejdsmark*, pp. 129–153 (1955).
8. H. Schwabedissen, *Die mittlere Steinzeit im westlichen Norddeutschland* (Wachholtz, Neumünster, 1944); J. Gutmann and W. Taute, *Die Kunde N. F.* **15**, 88 (1964).
9. H. Schwabedissen, *Die Federmesser-Gruppen des nordwestdeutschen Flachlandes* (Wachholtz, Neumünster, 1954); A. Bohmers, *Palaeohistoria* **8**, 15 (1960); W. Taute, *Berliner Jahr. Vor- Frühgeschichte* **3**, 62 (1963).
10. R. Vaufrey, *Archives de l'Institut de Paléontologie Humaine* **3** (1928); M. R. Sauter, in *Préhistoire de la Méditerranée* (Payot, Paris, 1948); *Piccola Guida della Preistoria Italiana*, A. M. Radmilli, Ed. (Sansoni, Florence, 1962).
11. M. Escalon de Fonton, *Bull. Soc. Préhist. Franç.* **52**, 379 (1955); *Préhistoire* **12**, 1 (1956); *Bull. Soc. Préhist. Franç.* **63**, 66 (1966); *Palaeohistoria* **12**, 199 (1967).
12. J. G. D. Clark, *Excavations at Star Carr* (University Press, Cambridge, England, 1954).

13. J. Troels-Smith, *Frea Nationalmuseets Arbejdsmark*, pp. 101-133 (1957).
14. A. Bohmers and A. Wouters, *Palaeohistoria* **5**, 27 (1956); C. Barrière, *Les civilisations Tardenoisiennes en Europe Occidentale* (Brière, Bordeaux-Paris, 1954).
15. A. Guider, *Arch. Austr.* **12**, 5 (1953); J. Barta, *Slovenska Arch.* **7**, 241 (1959); L. L. Kmoch, *Arch. Austr.* **40**, 13 (1966).
16. A. M. Radmilli and E. Tongiorgi, *Rivi. Sci. Preistor.* **13**, 91 (1958).
17. M. Brodar, *Quartär* **10-11**, 227 (1958–59); A. Benac, *Ber. Röm.-Germ. Komm.* **42**, 1 (1962).
18. V. Milojčić, J. Boessneck, M. Hopf, *Die deutschen Ausgrabungen auf der Argissa-Magula in Thessalien* (Habelt, Bonn, 1962), vol. 1.
19. S. S. Weinberg, *The Cambridge Ancient History* (University Press, Cambridge, England, 1965), vol. 1.
20. R. Stampfuss, *Mannus* **34**, 132 (1942); described materials from the Seidi cave in Boeotia, which according to Escalon de Fonton (*11*) could belong to an early stage of the Montadian. S. S. Weinberg (*18*) mentions similar finds from other sites in Greece.
21. The evidence is mostly of indirect nature, as, for example: (i) Maglemosian influences on the flint industry of de Leyen; (ii) the uniformity of the Ertebølle, Lower Halstow, and Campignian flint industries; (iii) the presence of a settlement site with Rössen influence on a bank of the IJssel river, at 5 m below O.D. in a Zuiderzee polder; (iv) the presence of communities (Vlaardingen culture) on creek banks in the delta around the middle of the 3rd millennium B.C., which, although in the possession of cultivated grain and domesticated animals, still rely heavily on hunting, fishing, and collecting.
22. The radiocarbon dates of about 2800 to 3100 B.C. recently reported from the Tardenoisian type area (*Radiocarbon* **8**, p. 82) are evidently too recent.
23. P. R. Giot, *Brittany* (Thames and Hudson, London, 1960), pp. 24–26.
24. D. M. Churchill, *Proc. Prehist. Soc.* **31**, 74 (1965).
25. J. Roche, *Bull. Soc. Préhist. Franç.* **62**, 130 (1966).
26. No C_{14} dates are as yet available, but the shell fauna in the middens should point to the time of the postglacial climatic optimum according to Obermaier, in *Reallexikon der Vorgeschichte*, M. Ebert, Ed. (Walter de Gruyter, Berlin, 1924), vol. 1, pp. 246–250.
27. R. Wyss, *Z. Schwei. Archäol. Kunstgeschichte* **20**, 55 (1960); H. G. Bandi, in *Birsmatten-Basisgrotte* (Stämpfli, Bern, 1963).
28. W. Taute, *Palaeohistoria* **12**, 483 (1967).
29. A. T. Clason, *Animal and Man in Holland's Past* (J. B. Wolters, Groningen, 1967).
30. S. Bökönyi, *Archaeol. Értesítö* **91**, 87 (1964).
31. V. Titov, private communication.
32. D. Srejović, *The Illustrated London News* **252**, 20 January 1968 and 3 February 1968.
33. V. Milojčić, *Jahrb. Röm.-Germ. Zentralmuseum Mainz* **6**, 1 (1960).
34. J. D. Evans, *Univ. of London Inst. Arch. Annu. Rep.* **13**, 49 (1958); S. Batović, *Diadora* **2**, 31 (1962); J. Arnal and C. Burnez, *Ber. Röm.-Germ. Kommission* **37–38**, 1 (1958).
35. A. Arribas, *Palaeohistoria* **12**, 11 (1967).
36. P. Ducos, *Bull. Musée Anthropol. Préhist. Monaco* **5** (1958).
37. H. T. Waterbolk and P. J. R. Modderman, *Palaeohistoria* **6–7**, 171 (1959); H. T. Waterbolk, in *Courses toward Urban Life*, R. J. Braidwood and G. R. Willey, Eds. (Aldine, Chicago, 1962), pp. 227–253.
38. H. Quitta, *Praehist. Zeitschrift* **38**, pp. 1–38, 153-188 (1960); in *Varia Archaeologica*, P. Grimm, Ed. (Akademie, Berlin, 1964), pp. 14–24.
39. H. Behrens, *Die Kunde N.F.* **10**, 44 (1959).
40. H. Schwabedissen, *Palaeohistoria* **12**, 409 (1967).
41. E. Vogt, in *l'Europe à la fin de l'âge de la pierre*, J. Böhm and S. J. de Laet, Eds. (Editions de l'Académie tchécoslovaque des Sciences, Prague, 1961), pp. 459–488.
42. J. Troels-Smith, *Fra Nationalmuseets Arbejdsmark*, p. 95 (1960); *Palaeohistoria* **12**, 505 (1967); H. Lüttschwager, *Schr. Naturw. Ver. Schlesw.-Holstein* **37**, 53 (1967).
43. This does not apply to the southern TRB groups, which occur in loess areas which had been inhabited since Bandkeramik times, and which contributed much to the origin of the TRB culture.
44. G. Bailloud, *Le Néolithique dans le basin parisien* (Centre National de la Recherche Scientifique, Paris, 1964).
45. H. M. Escalon de Fonton [*Palaeohistoria* **12**, 240 (1967)] sees the Chasseen of the Rhône valley as an intrusive culture, coming fully developed from the east.
46. K. Schietzel, *Müddershein* (Böhlau, Köln-Graz, 1965).
47. S. J. de Laet, *Palaeohistoria* **12**, 335 (1967).
48. W. A. Watts, *Antiquity* **34**, 111 (1960); J. G. D. Clark, *Proceedings of the Prehistoric Society* **31**, 58 (1965).
49. J. G. D. Clark, *The Economic Historic Review* **18**, 1 (1965).
50. ———, *Antiquity* **11**, 172 (1966).
51. See various contributions in *l'Europe à la fin de l'âge de la pierre*, J. Böhm and S. J. de Laet, Eds. (Editions de l'Académie tchécoslovaque des Sciences, Prague, 1961).
52. F. Firbas, *Waldgeschichte Mitteleuropas* (G. Fischer, Jena, 1949), vol. 1.
53. Another European plant of which the fruits have been collected and that one might think of as possibly being furthered by man, is the water nut (*Trapa natans*).
54. For discussions and for reading the manuscript I thank R. J. Braidwood, L. Braidwood, J. Caldwell, R. Hall, and my collaborators at the Biological-Archaeological Institute, J. J. Butler, A. T. Clason, R. R. Newell, J. D. van der Waals, and W. van Zeist. J. J. Butler improved the English text, M. Bierma prepared the typescript, T. Appelboom assisted in the preparation of the distribution maps, which were drawn by H. Roelink.

NEWS AND COMMENT

Arms Control: Demand for Decisions

Nuclear Weapons . . .

The Czech crisis and the delays and uncertainties associated with the impending change of administration in the United States clearly have lessened, though by no means eliminated, the prospects for early advances in nuclear arms control. When the nonproliferation treaty (NPT) was signed on 1 July by the United States, the United Kingdom, and the Soviet Union, the prospects for arms control had seldom looked better. As this important first step toward ratification of the treaty by its sponsors was being taken, President Johnson announced that the United States and the Soviet Union had agreed to begin, in the near future, talks on limiting and reducing strategic arms, including both offensive weapons and antiballistic missile (ABM) defense systems. The nonproliferation treaty itself, besides forbidding the nonnuclear states to receive or manufacture nuclear weapons, forbids the nuclear powers to assist such states in acquiring nuclear arms and, further, pledges these powers to negotiate to end the nuclear arms race.

(Continued on page 1103)

And CBW

Chemical and biological weaponry is a subject which has usually been discussed behind closed doors when it is discussed at all. Nonetheless, in the last 2 years, and especially in the past few months, there has been increasing public attention focused on CBW by officials in various governments and by scientists and other concerned citizens. Discussions of these weapons, however, often are unreported in the press, probably because CBW remains a mysterious and forbidding subject even to most editors and reporters.

On 18 November, the Canadian and Polish governments introduced a resolution at the United Nations requesting that the Secretary General, with the assistance of qualified consultant experts, prepare a report on the effects of the possible use of chemical, bacteriological and other biological weapons. The resolution contains the following sections: (a) that governments, national and international scientific institutions and organizations cooperate in the preparation of this report; (b) that the report be ready for transmission to

(Continued on page 1106)