

15 THE SIGNIFICANCE OF AGRICULTURAL DISPERSAL INTO EUROPE AND NORTHERN AFRICA

Karl W. Butzer

ECONOMIC MOTIVES FOR AGRICULTURAL DISPERSAL

FOLLOWING the establishment of village farming communities in the Near Eastern woodlands during the seventh millennium, a rapid dispersal of agricultural techniques in the Old World began about 5000 B.C. Food-production had been introduced into much of Europe, the Mediterranean region, and northern Africa within a millennium after the Hassunan farmers of Iraq (*ca.* 5900–5200 B.C.) had begun to colonize the grasslands fringing the Near Eastern woodlands. By that time also agricultural communities are archeologically verified for southern and eastern Asia, although their origins are not yet understood. Much of this dispersal of technological features may have been associated with some form of ethnic movement, at least on a local scale. Yet the archeological evidence does not substantiate direct relationships between the earliest European or North African farmers and their contemporaries in the Near East. Needless to say, the routes and rates of dispersal are imperfectly understood. But the evidence available does permit a tentative discussion of possible motives for cultural diffusion and of the new ecologic problems arising from introduction of agriculture into new environments.

The subsistence economy of primitive agriculture may be fundamental in explaining this obscure migration of races, peoples, economies, or ideas. Primitive agriculture today is largely confined to the tropical woodlands, and it would be unwarranted to equate

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prehistoric Near Eastern farmers with modern Bantu populations in Africa or Quechua peoples in South America. But in a very general way some of the traits of shifting agriculture (see Watters 1960, with references) may have been common to the prehistoric Near East as well. The very extensive use of land, left to fallow for periods of up to 30 years and more, may have led to periodic overpopulation in some areas occupied to the limit of their possibilities with existing technology. Colonization of fresh lands must have been an appealing economic solution for groups living near the margins of the *oikoumene*.

Another factor possibly associated with early agricultural dispersals was chronic overpopulation. The invention and adoption of new tools and a new economic subsistence would inevitably promote a great increase of population, made possible by the increased and more reliable food supply. Food production per unit area was much greater, and even during a bad crop year a certain amount of food would be available. There would not be complete dependence on the seemingly erratic movements and biological cycles of wild game. Life and death were no longer so precariously balanced; birth rates increased and infant mortality declined. However, when a settlement reached its new carrying-capacity at agricultural subsistence, the rate of increase had to level off, either by emigration or by higher mortality rates. As long as fresh lands remained such as could be cleared and planted by fire or wooden or stone tools, the agriculturists probably sent out daughter colonies that supplanted or absorbed the sparsely settled food-gathering populations.

It would seem that the practice of primitive agriculture as well as chronic overpopulation could account for agricultural dispersals. Non-economic motives are not necessarily excluded, but it is also unnecessary to resort to an environmental factor such as climatic change.

One major environmental theory does in fact attempt to explain agricultural dispersals through the agency of "Postglacial desiccation" in the Old World subtropics. In particular, Childe (1925; 1929) thought that progressive postglacial desiccation in the Near East continued after the first general and successful steps to plant and animal domestication. The food-producing peoples expanded rapidly in numbers but were faced with a deteriorating environment. Desiccation eventually caused or, as others have put it more cautiously, played a part in the rapid expansion of Neolithic peoples

and cultures into the moister lands of Europe. So, for example, Coon (1939:60–65) suggested that the dispersal of the Mediterranean race from the Near East (partly associated with early agriculture) was a consequence of desiccation incident upon the close of the Pleistocene. Childe (1958b:54) still suggests that Post-glacial desiccation of the Sahara promoted ethnic and cultural movements from North Africa into Spain in the fifth millennium. In practice these arguments have no foundation in fact. As discussed below, the period after *ca.* 5000 B.C. was on the moist side in many of the areas in question. Furthermore, agricultural expansion was not confined to Europe but also extended to the semiarid landscapes of western Asia and many arid regions of northern Africa.

SAUER'S THEORY OF AGRICULTURAL DIFFUSION FROM SOUTHEAST ASIA

C. O. Sauer (1952) has suggested that the primary hearth of first domestication was found in Southeast Asia, while several minor or "derivative centers of additional domestications" are postulated for India, the Near East, Ethiopia, and West Africa. Following E. Hahn, Sauer believes that vegetative planting of tropical tuber plants may have been the easiest and earliest step to domestication, and that this abstract concept subsequently spread throughout the Old World. Characteristic of this southeast Asian hearth in Burma and adjacent areas were household animals such as dog, pig; fowl, duck, and goose; non-seed, vegetative root plants such as banana, aroids, yams, sago, pandans, bamboo, sugar cane, and breadfruits. Postulated for the derived Indian-Himalayan center are plants such as the millets, pulses, gourd, jute, and other fibre plants, as well as some herd animals: goat, sheep, zebu, buffalo, and yak. The only herd animals allotted to the Near East are cattle, together with seed plants such as the wheats, grape, olive, fig, and flax. For Ethiopia, these additional domesticants are thought to include teff, sorghum, cotton, and sesame; for West Africa, the guinea hen, yam, and bush pig.

Although Sauer's ideas are only presented as a suggestive sketch, the sequence of archeological events presently available from the Near East and India (Sankalia 1962) suggest that agricultural origins were an essentially independent innovation in the former

area. Recent archeological work indicates strong possibilities that various leguminous plants were domesticated in North Thailand by 7000 B.C. (Gorman 1969), so lending support to Sauer's concept of advanced fishing and planting populations in southeastern Asia.

An elaboration of Sauer's dispersal concepts is due to H. von Wissmann (1957), who outlined several successive nuclei of cultural diffusion in their geographical characteristics: (a) the tropical forests along the rivers and coasts of the Bay of Bengal: fishers and planters; (b) the forest-steppe and savanna of India: seed-planters with millets and oil plants; (c) the subtropical highlands of Afghanistan: sheep and goat farmers; (d) the small oases of the highlands and deserts of western Iran and Armenia: wheat and barley farmers. From here the alleged wave of dissemination entered Mesopotamia, which is not considered a center of agricultural origins but rather of technological invention.

Several elements stressed by Wissmann are: (a) Each nucleus sent out waves of dissemination which may have caught up with each other or may have lost some cultural elements upon entering a different climatic region. Such waves were taken over, transformed, or rejected depending on physical or human factors. (b) Major movement of cultures is postulated in the wooded steppes where the soil is rich and supposedly easy to work. (c) The movements are compared with Postglacial climatic fluctuations: (1) the Holocene thermal maximum (ca. 5500–3000 B.C.) may have permitted the spread of food production over the cold Central Asian mountain zone; (2) a moist spell in the third millennium may have established agricultural contacts across the Central Asian deserts, possibly leading to the origins of horse nomadism. (d) The Postglacial rise in world sea level was responsible for "burying" the archeological remains of the presumed late Pleistocene fishers and shell gatherers of southeastern Asia through marine submergence or intensive alluviation in lower stream courses. Reduced flood-plain alluviation after 4000 B.C., when modern sea level was attained, may have been related to the beginnings of settlement and rapid technological advance in the lower valleys of the Tigris-Euphrates and Nile.

Although Wissmann's views are interesting and deserving of attention, they go far beyond the available archeological evidence and can therefore only be rated as a hypothesis.

EUROPEAN CLIMATE DURING THE ATLANTIC PHASE

The original dispersal of agricultural traits in Europe coincides with the warm, moist Atlantic phase (ca. 5500–3000 B.C.). The Scandinavian Glacier had completely disappeared, and many mountain glaciers of the Alps were smaller than they are today while others disappeared. The botanical evidence suggests a considerably warmer summer climate than today's (Firbas 1949–52; Frenzel 1966; Lüdi 1955; Iversen 1960). So for example the altitudinal tree-limit was 200–300 m. higher than today's in the Scandinavian highlands and in the Sudeten ranges, 300 m. higher in the northern and southern Alps. Various water plants and trees requiring considerable summer warmth occurred at higher elevations or at higher latitudes than is the case today. Tree pollen occurs in certain strata of bogs in the north European tundra, while plant fruits of now sterile perennials have been found on the Arctic islands. In fact a third of the 125 species of Spitsbergen do not reproduce under present climatic conditions. Massive oaks grew beyond the present limit of oak in northeastern Russia, while the hazel was found considerably north of its present distribution in Scandinavia, and even the submediterranean wild grape (*Vitis silvestris*) thrived in southern Sweden. Particularly illuminating is a comparison of growing season temperatures at the northern limits of hazel (*Corylus avellana*) distribution in Scandinavia (see accompanying tabulation):

Mean Temperature °C.	Apr.	May	June	July	Aug.	Sept.	Oct.
Former limit	0.3	5.5	11.7	13.7	11.8	7.8	1.7
Present limit	2.5	8.2	14.0	15.8	14.1	10.1	4.5
Difference	2.2	2.7	2.3	2.1	2.3	2.3	2.7

From this it may be concluded that summer temperatures in mid-latitude Europe were at least 2° C. warmer than they are today during the Postglacial thermal maximum. Evidence for warmer winter temperatures is contradictory and unconvincing so far. Maximum summer temperatures may only have been reached during the Subboreal (ca. 3000–800 B.C.), when the Alpine tree-line was at its highest, about 300–400 m. higher than the modern tree-limit (Lüdi

1955). A greater melting of the world's glaciers may have occurred during the fourth millennium and the first half of the second millennium B.C., judging by glacio-eustatic sea-level fluctuations (see Fairbridge 1961). Whether or not ocean surface waters were warmer than today (Emiliani 1955) is uncertain. Conditions were analogous to those of an interglacial maximum, although the time interval was comparatively brief.

The forest composition of temperate Europe during the Atlantic was largely that of a mixed oak forest, with oak, elm, lime, ivy, and alder dominant in the western half of the continent, while pine played an important role farther east. Colonization of the drier lowland basins of central Europe by alder, spruce, and fir suggests that the Atlantic was considerably moister than today in much of mid-latitude Europe (Firbas 1949-52:Vol. I, p. 290 f.). An extension of the forest into the present tundras and steppes is shown by Frenzel's (1960) palynological reconstruction of the Atlantic vegetation of European Russia.

ENVIRONMENTAL FACTORS INFLUENCING THE LOCATION OF EARLY AGRICULTURAL SETTLEMENT IN EUROPE

A key environmental problem for early agricultural settlement in mid-latitude Europe concerns the physical attributes of the settled land: Did early colonization coincide with open grasslands, woodlands, or forest? Which soils and terrain were favored? Knowledge of the particular ecologic niches selected by agricultural colonists is useful both for assessing cultural adaptation and for explaining the observed patterns of dispersal.

Among the areas first settled by farming populations, the contemporary physical environment of central Europe is probably best understood. The culture in question is known as the early Danubian (Buttler 1938; Narr 1956), and dates from the fifth and fourth millennia. The Danubians were village farmers with a subsistence economy based on shifting agriculture. Three species of wheat, as well as barley, lentils, flax, beans, and peas were cultivated and presumably formed the staple diet, judging by the quantity of milling and pounding stones. Stone adzes were probably used for felling trees, but no tilling tools are known. The cow was the common domesticated animal kept, with pig in second place. Sheep, goat, and dog were of minor importance. The refuse pits show evidence of hunting activity, with red and roe deer, boar, aurochs, and wood-

land bison as favored game. The Danubians occupied long rectangular, gabled houses of wood and wickerware, measuring 5 to 6 m. wide, and 15 to 40 m. long. Vertical posts supported the walls and roof. These structures suggest small clan dwellings, also serving the purpose of animal stalls. Various storage buildings were present. Individual villages, frequently abandoned and subsequently re-occupied, may have had 200 to 600 inhabitants. Animals were generally kept within a fenced enclosure surrounding the village.

The sites of the Danubian culture are very strictly limited to loess areas in the Low Countries, Germany, Poland, Austria, Czechoslovakia and Hungary. No sites occur north of the margins of the Würm till. For the most part the warm, dry lowland plains or river terraces were selected, and within these, the loess areas (Gradmann 1906; 1936). The natural vegetation of the central European loess lowlands has long been the subject of controversy. Gradmann (1933) argued that grasslands, parklands, or open woodlands were still widespread in late prehistoric times, and that such lands were optimal in terms of better soils, easier cultivation, good pasture, and more bountiful game. Others, including Nietsch (1939) and C. Schott (1939) have argued that more or less closed forests dominated even the drier basins, requiring clearance by felling or burning. Godwin (1944) was able to verify this second point of view in the case of England.

Palynological evidence (Firbas 1949-52:Vol. I, p. 356 ff.) does not support widespread grassland or parkland during the Atlantic, even though the mixed oak woodlands on comparatively dry loess soils may have been lightly stocked. On account of the gradual decrease of *Artemisia* in the pollen record, Firbas believes that exposed bedrock, talus slopes, and stoney gravel or sand surfaces were colonized by tree vegetation late in the Holocene. Such natural gaps in the forest cover would obviously not have attracted settlers. Firbas concludes that the moister loess lowlands (wherever annual precipitation exceeds 500 mm. today) were occupied by closed mixed oak forests during the Atlantic, although the drier basins probably had a parkland or open woodland vegetation. Areas qualifying as comparatively dry are the interior basin of Bohemia-Moravia, the Elbe-Saale plain, the Upper Rhine basin, and the Hungarian plain.

Soil studies appear to substantiate Firbas' conclusions. Loess sediments are highly permeable and evaporate more soil moisture than any other sediment, so that loess soils are comparatively dry in the

edaphic sense and do not favor tree growth. The climatically drier loess lowlands commonly have soils of the "degraded" chernozem type. Such chernozems originally developed under grassy vegetation with dry, warm summers—presumably during the continental climate of the Preboreal and Boreal. Subsequent woodland invasion during the moist, maritime Atlantic led to carbonate solution, increased acidity, and chemical weathering, with oxidation and some leaching (Scheffer, Schachtshabel 1960:275 f.; Wilhelmy 1950). These soils prove the former existence of grasslands in certain dry basins, at least until the beginning of the Atlantic. Consequently, with local agricultural settlement well under way a millennium later (*ca.* 4500 B.C.), a fair amount of parkland or open woodland was available to the Danubian colonists in the south and east.

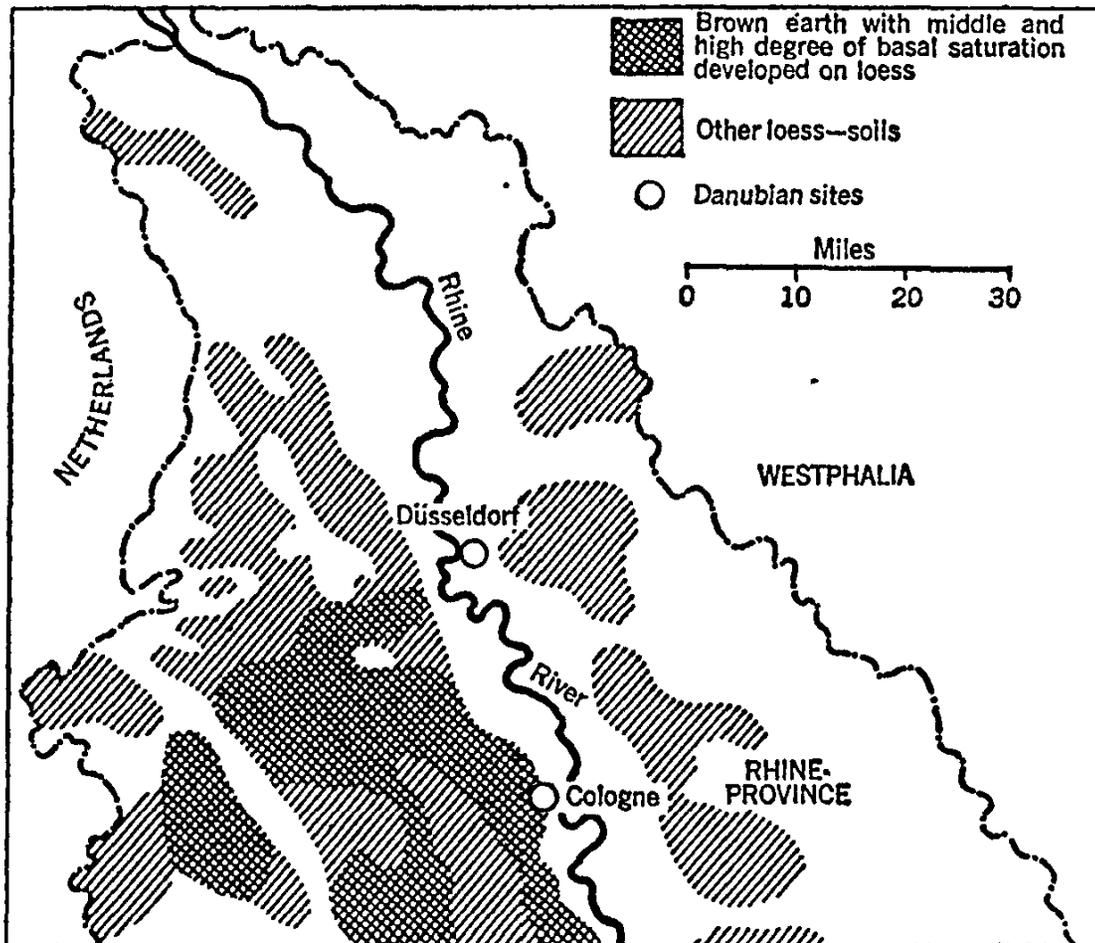


FIGURE 1 Danubian sites and soil types in the northern Rhineland (from K. J. Narr, 1956, copyright 1956 by the University of Chicago Press, with permission).

In overview, the earliest agricultural colonists entered the central European area during a period of optimal warmth and comparatively moist climate, increased rainfall more than compensating for increased evaporation. The settlements of the Danubian farmers are sharply restricted to loess sediments (Fig. 1), which obviously provided greater soil fertility. At the same time, these often were areas with parkland vegetation and calcareous, chernozemic soils, or otherwise they had base-saturated forest soils under closely stocked mixed oak woodland. It is no mere coincidence that primeval settlement, loess, calcareous or basic soils, dry lowland basins, and comparatively open, oak parklands or woodlands should provide a common denominator for the earliest agricultural lands of mid-latitude Europe. Only at a later date, when less demanding crops such as rye, oats, or spelt had been developed, was colonization extended to the more acidic and partly leached forest soils. Swampy terrain and heavy waterlogged soils were only occupied at a somewhat later date.

The new agricultural lands of mid-latitude Europe (Fig. 2) were not radically different from the subtropical or temperate woodlands of Asia Minor and Greece, particularly during the warm Atlantic and Sub-boreal phases. Despite an increase in winter cold and summer moisture, the landscape of the new environments was different in degree rather than in kind. It was probably not accidental that the pioneer farmers of Europe should select the environment most like that of their cultural antecedents: not the humid lands of the west, nor the cool, poorly drained till plains of the north, nor yet the snowy plains or open steppes of the east. Rather, the more intermediate environment of the Balkan peninsula and central Europe provided the most compatible solution in terms both of climate and edaphic factors. Just as open woodlands had probably witnessed the birth of agriculture in the Near East, they also provided the setting to the first agricultural venture into higher latitudes.

However, the change in crop ecology was important. Winters were cool rather than mild, whereas summers were decidedly moist. The winter cold may have eliminated some winter crops from the array of domesticated plants, although "winter" wheat and barley are still frequently planted in autumn in much of central Europe today. Somewhere, however, the idea of spring sowing of Mediterranean crops must have been experimented with and found to be expedient. Some of the evolution of new mutants and rapid hybridi-

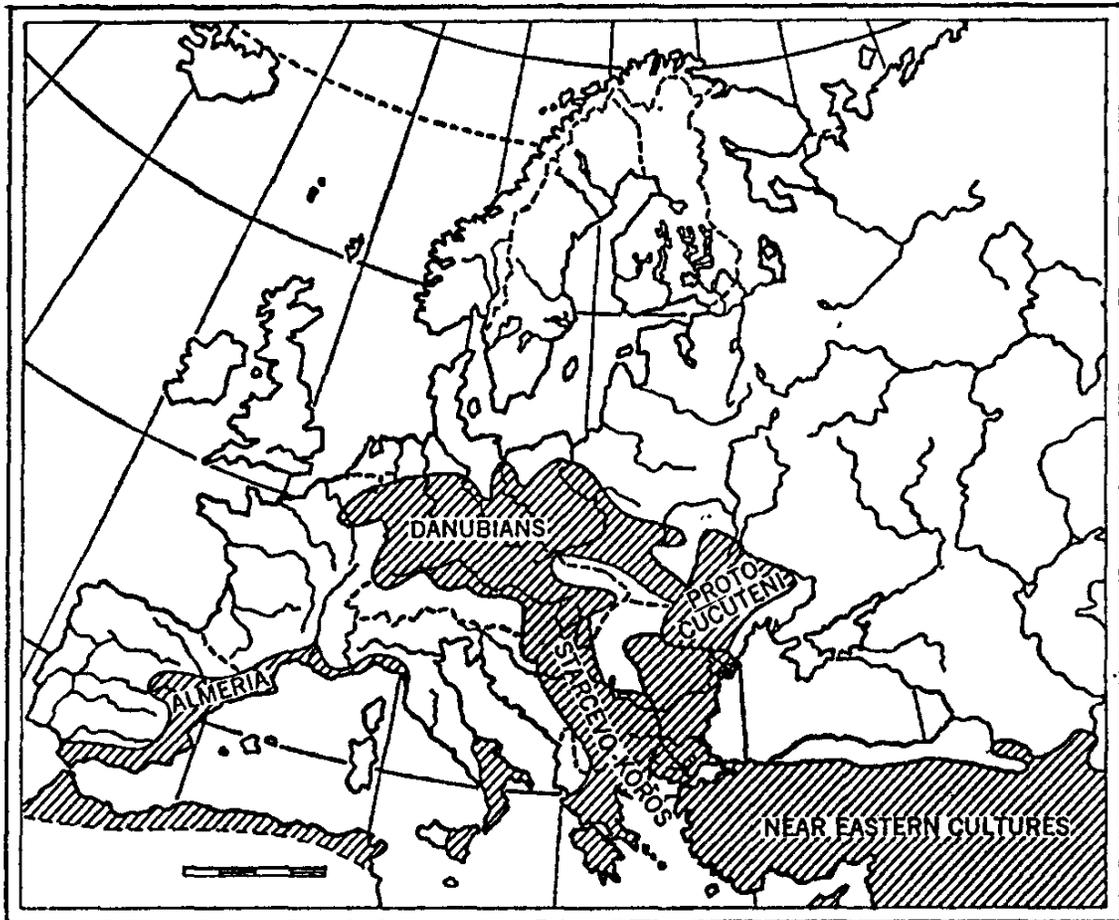


FIGURE 2 Early village farming cultures in Europe and adjacent areas ca. 4200 B.C. Modified after Bengtson and Milošević (1958) and Waterbolk (1968).

zation of wheat species in temperate Europe may have resulted from deliberate changes in plant ecology at the hands of man—just like those accompanying the deliberate cultivation of oats and rye on marginal soils and in cooler climates a few millennia later.

SAHARAN CLIMATE DURING THE MID-HOLOCENE

Agricultural colonization of the Mediterranean Basin, in particular of the coasts of southern Europe and northwestern Africa, did not encounter appreciable environmental differences anywhere in the summer-dry subtropical woodland belt. The settlement of truly arid lands, such as the Sahara, did however require considerable ecological adaptation. Fortunately for the early agricultural colonists, the Saharan area enjoyed an abnormally moist climate during a time

interval roughly synchronous with the Atlantic phase in Europe. The evidence in favor of several moist intervals during the mid-Holocene may be subdivided into three categories: faunal evidence, chiefly on the basis of rock drawings; botanical evidence, both macrobotanical and palynological; and geological evidence, generally of a rather specific and detailed type.

A moister climate during late prehistoric times was first inferred from the widespread distribution of human artifacts and rock drawings in desert areas, often many miles from existing waterholes. The wild animals shown on the rock art included gazelles, antelopes, and ostrich as well as species associated with more luxuriant savanna vegetation: elephant, both the single- and two-horned rhino, hippo, and giraffe. Certain paleoclimatic inferences can be attempted on the basis of these animal representations and their distribution and frequency (Mauny 1956; Butzer 1958b), but indirect data of this kind is not conclusive. Consequently, it is fortunate that much geological and palynological data have been collected in recent years, often fixed by radiocarbon dating. As a result, the archeological evidence can now be seen from a new perspective.

The evidence for post-Pleistocene moist interludes is unsatisfactory and unconvincing along the Mediterranean borderlands, in Morocco, Tunisia, or the Cyrenaica. It is best developed in the Saharan highlands and along the major wadis systems or depressions that drain the higher country. So, for example, the Guirian terrace fill of the Saoura Valley includes evidence for accelerated fluvial activity and widespread lake or swamp formation, with one date of 4210 ± 1700 B.C. (Chavaillon 1964; Beucher 1963). Pollen was examined from an exposure of gray sands, interdigitated with organic horizons and capped by a travertine layer. The limited pollen includes pine (*halepensis* ?) and acacia (*raiddiana* ?), but few grasses. The travertine, however, is dominated by pollen of xerophytic species (*Ephedra*, *Chenopodiaceae*) with some dubious traces of birch, elder, hornbeam, and pine.

In the Hoggar Mountains, silty-swampy fill accumulated in many of the valleys during Neolithic times, while pediment cutting proceeded in the uplands and organic swamp beds formed in some intradunal hollows of the lowland "sand seas" (Rognon 1967). Dating is generally insecure. The rock shelter at Meniet in the Hoggar contains strata from which 87 pollen grains were identified by Quézel and Martinez (1958). Of these pollen 56 per cent

belong to arboreal species. In order of numerical importance they include cypress, Aleppo pine, evergreen oak, wild olive, hackberry (*Celtis australis*), the thorn bush *Ziziphus*, juniper, and tamarisk. Macroremains of *Ziziphus*, lotus, and hackberry help substantiate the pollen record, which further includes cereal, grass, sedge, and *Artemisia*. The uppermost stratum at Meniet has a C^{14} date of 3450 ± 300 B.C. (Délibrias *et al.* 1959) and contains bones of an extinct buffalo. Similar results were obtained from a sample of hyrax dung from Taessa in the Hoggar, at some 2200 m. elevation. Pollen (3000 grains) included similar genera as at Meniet together with pistachio and walnut. A C^{14} date of 2730 ± 300 B.C. was obtained for the dung. Limited numbers of pollen grains were also studied from sediments with cattle bones found below rock drawings in the Tassili Mountains (Quézel, Martinez 1961). These grains included Aleppo pine, evergreen oak, and cypress. A more impressive but incompletely published sequence is available from the nearby Acacus hill country, near Ghat (1370 m.). Here the rock shelter of Uan Muhuggiag (Mori 1965:218-41) indicates occupation *ca.* 3500-2500 B.C. by food-producing people with domesticated cattle and sheep. *Typha*, a swamp plant, accounts for over 50 per cent of four samples in the horizon, with the desert shrubs *Aristida* and *Artemisia herba-alba* accounting for about 10 per cent each. Macrobotanical remains include abundant *Typha*, together with acacia and some desert trees or shrubs. In the upper horizon there is little or no evidence of swamp plants, but *Artemisia herba-alba* attains over 50 per cent, *Aristida* 25 per cent, and *Artemisia campestris* up to 10 per cent.

Like many other parts of the Sahara, the Tibesti area has a wealth of naturalistic rock drawings pertaining to prehistoric hunting groups. Giraffe, elephant, and, to a lesser extent, rhinoceros are fairly common among these drawings, both in the highlands and in the Borkou foothills. Although geological evidence is not yet available, elephant fossils have been reported, and palynological data are available from "Neolithic" cave sediments at Mosséi (Quézel and Martinez 1958). The pollen count here was 60 per cent NAP and included 35 per cent *Acacia flava*. However, over 80 per cent of the macroremains pertained to pine and juniper.

Near the Djado Oasis, southwest of Tibesti, several lacustrine deposits with subfossil mollusca have been studied by Llabador (1962). All appear to have been laid down during the moister

interval in "Neolithic" times. The Neolithic lacustrine beds of Adrar Bous, northeast of the Air Massiv, have yielded valuable paleoecological information concerning the local mid-Holocene environment. The fauna includes equids, cattle, antelope, wart hog, hippopotamus, tortoise, and crocodile. Two genera of fish, ostrich, and three species of gastropods complete the preliminary faunal inventory (Llabador 1962). Macrobotanical remains include the common reed and live oak. Two distinct palynological horizons are defined by Quézel and Martinez (1961). The lower consists of diatomite, attaining 3 m. in thickness, with 66 per cent of 251 identified pollen grains from NAP species. The upper horizon is a blackish swamp sediment of 10–30 cm. thickness, with 82 per cent of 192 grains NAP, almost exclusively chenopods. The arboreal species present in the diatomite include 13 per cent juniper, 12 per cent cypress, 5 per cent an extinct pine, 4 per cent myrtle, and 2 per cent pistachio. The limited arboreal species of the upper, swampy beds, dated 3180 ± 300 B.C. (Délibrias and Hugot 1962), contain 12 per cent myrtle, 3 per cent cypress, and 2 per cent juniper. A severe degradation of the open Mediterranean-type vegetation is evident between the two horizons that mark the mid-Holocene moist interval.

Faure (1966) has studied the lacustrine deposits of the intradunal depressions of the Ténéré, phenomena having a wider distribution along the southern margins of the Sahara. Fresh-water lakes, probably interconnected with Lake Chad, were well developed *ca.* 7250–5000 B.C., and a last lake episode is dated *ca.* 3550–1150 B.C. In the Senegal Delta the earlier wet phase appears to have been contemporary with the development of the deep red paleosol, under moist, warm conditions, while the second wet phase coincided approximately with silt alluviation of the Senegal.

The Nile Valley provides further details and confirmation of several moist intervals (Butzer, Hansen 1968). A period of accelerated wadi activity that began 9200 B.C. terminated by 6000 B.C. Shell proliferations suggest rather more vegetation in the wadis. A little later, *ca.* 5000 B.C., a red paleosol suggests a mat of vegetation, and more frequent, gentle rains. Finally, after a second dry interlude, accelerated wadi activity and extensive sheet washing—in the wake of sporadic but heavy and protracted rains—are indicated *ca.* 4000–3000 B.C. Historical and archeological documents suggest that the desert wadi vegetation of northern and

eastern Egypt was more abundant as late as 2350 B.C., when the prevailing aridity was established (Butzer 1959). At the same time, spring activity in the Kharga Oasis was greater, allowing agricultural subsistence by Neolithic settlers, while the static ground-water table was higher in much of the Libyan Desert, presumably facilitating cattle herding in now desolate areas (Murray 1951; also Knetsch *et al.* 1963, on the depletion of "fossil" water resources).

All in all the Saharan evidence indicates two or three moister interludes during the early and middle Holocene. Dates are slightly at variance from place to place, and since few of the local sequences are firmly dated, long-range correlations are difficult. Possibly three moisture peaks are indicated *ca.* 7000, 5000, and 3000 B.C., separated by dried interruptions, and followed—during the last three millennia—by conditions quite comparable to those of today. None of these changes in precipitation or effective moisture can be quantitatively estimated, and there is no evidence concerning possible changes of temperature. The impression obtains that the increase in moisture at the height of these moist intervals was ecologically significant, although not sufficient to qualify the "arid" or "hyperarid" nature of the climate. It appears that open woodland or parkland was present at edaphically favored localities in the high country, while fringing savanna-scrub and local swampy ground accompanied the major wadi lines and depressions. It is generally agreed that the paucity of modern vegetation in the Saharan highlands and wadis is due to human activity such as overgrazing and use of woody plants for fuel. However, the Sahara is exceptionally arid by standards of other world deserts, and this climatic aridity has not been accentuated by man. If left undisturbed over many generations, the plant life of the Sahara would indeed regenerate somewhat, but hardly in such a way as to permit wholesale faunal migrations or to provide resources for diverse agricultural and herding populations. The many categories of evidence for moist interludes during the early and mid-Holocene do provide evidence for real climatic variations.

PREHISTORIC CATTLE-NOMADS OF THE SAHARA

The rock paintings and engravings of the interior Sahara bear testimony to two amazing archeological complexes, an epi-Paleolithic hunting culture, and an early Neolithic food-producing

culture with cattle, sheep, and local cultivation of cereals (see Rhotert 1952; Lhote 1959, 1965; Forde-Johnston 1959; Mori 1965; Clark 1967a, b; Hugot 1968, all with references). Unfortunately, it has not been possible to link conclusively the different groups responsible for the rock drawings with the various stone industries and pottery types vaguely labeled as "Saharan Neolithic." In fact, the standard archeological inventory offers no proof for the distinctiveness of the hunters and herders at any one site, nor does it support the concept of a general ethnic identity through the interior Sahara at any one time. Nonetheless, the bulk of the "Neolithic" inventory—ground and polished stone axes and adzes; large, bifacial tools; stone platters and dishes; different types or traditions of arrowheads and pottery; bone harpoons—can be assigned to late prehistoric populations with an economy based partly on livestock herding. Such associations have been established at critical sites in the Atlas, the Hoggar and Tassili, in the Fezzan and in the Nile Valley. However, in dealing with an area as vast as the Sahara and a time range of at least three and possibly as much as six millennia, it would be simplistic to assume cultural or economic uniformity, let alone ethnic continuity through space or time.

Despite the difficulties of resolving the broad patterns of the Saharan Neolithic with the available information, the Saharan data does provide the first verified example of nomadic pastoralism. The origins of the cattle-nomads of the central and eastern Sahara and of the cattle-and-sheep nomads of the western Sahara remain obscure. The earliest manifestation of food producing in Egypt, the Sudan, Cyrenaica, and Tunisia are all younger than 5000 B.C., so that the Uan Muhuggiag date of 5590 B.C. and its association with domesticated animals must be held in question. Consequently, whatever their origin, the early pastoralists of the western and central Sahara are probably dated with some accuracy by seven radiocarbon dates between 3450 and 2730 B.C. (in terms of corrected, calendar ages, ca. 4500–3500 B.C.).

The basic economic traits of the Saharan pastoralists have been discussed by Rhotert (1952), Lhote (1959) and Clark (1967b). Subsistence was primarily based on cattle herds derived from local domestication of *Bos primigenius* (= *africanus*)—possibly somewhere in the Nile Valley. Lack of emphasis of the animals' udders in the pictorial art suggests that meat rather than milk was the major form of exploitation. Domesticated sheep replace cattle in

the Saharan Atlas, and an overlap of sheep and cattle-raising is indicated in the Tassili region. Much game was hunted, probably reflecting local fusion with autochthonous food-collecting groups. Possibly, although not necessarily, these cattle-nomads were the users of the occasional grinding stones reported from different parts of the Sahara. This may indicate that cereals were known locally, a point suggested also by the pollen from Meniet. The strong concentration of archeological sites in wadi valleys and at existing or former groundwater localities suggests that settlement was largely confined to areas with available water—both for human and for animal use. Caves were also occupied in some areas of the Tassili, Hoggar, and the Saharan Atlas.

No direct proof of nomadism is available for the Saharan cattle herders. However, significant cultural associations have been shown with nomadic Kushitic or Eastern Hamitic groups of the Red Sea coasts of Egypt, the Sudan, and Ethiopia (Rhotert 1952). The typical composite drawings of large cattle herds strongly suggest organized pastoralism. Also, the rapid dispersal of this culture through the Sahara may reflect a nomadic subsistence. With the erratic nature of the rainfall (even during the Holocene subpluvial) and the sporadic distribution of water and pasture, it is unlikely that permanent or semipermanent habitation *could* have been practiced in any one area. It seems necessary to assume that adequate water and fodder could only be guaranteed by periodic movements, possibly into the better watered highlands or to permanent water-holes during the dry season, to ephemeral pastures among the foothills and nearby alluvial plains during the episodic rains.

One may suspect that this very obvious case of adaptation of food production to an adverse environment had its origins in an agricultural community that gradually expanded or was displaced into marginal arid country where livestock raising was more economical than cereal agriculture. Or, these same people selectively acquired cultural traits from agricultural populations in nearby, better watered areas. At any rate, planting played a very small role in an economy based primarily on meat animals. This contrasts with the contemporary village farmers of the Near East and Europe, among whom subsistence was primarily based on cereals.

In retrospect, the diffusion of food-producing traits into the arid zone, and in particular into the Sahara, was a case of cultural or technological adaptation to a new environment. Yet this dispersal was only made possible by the temporary improvement

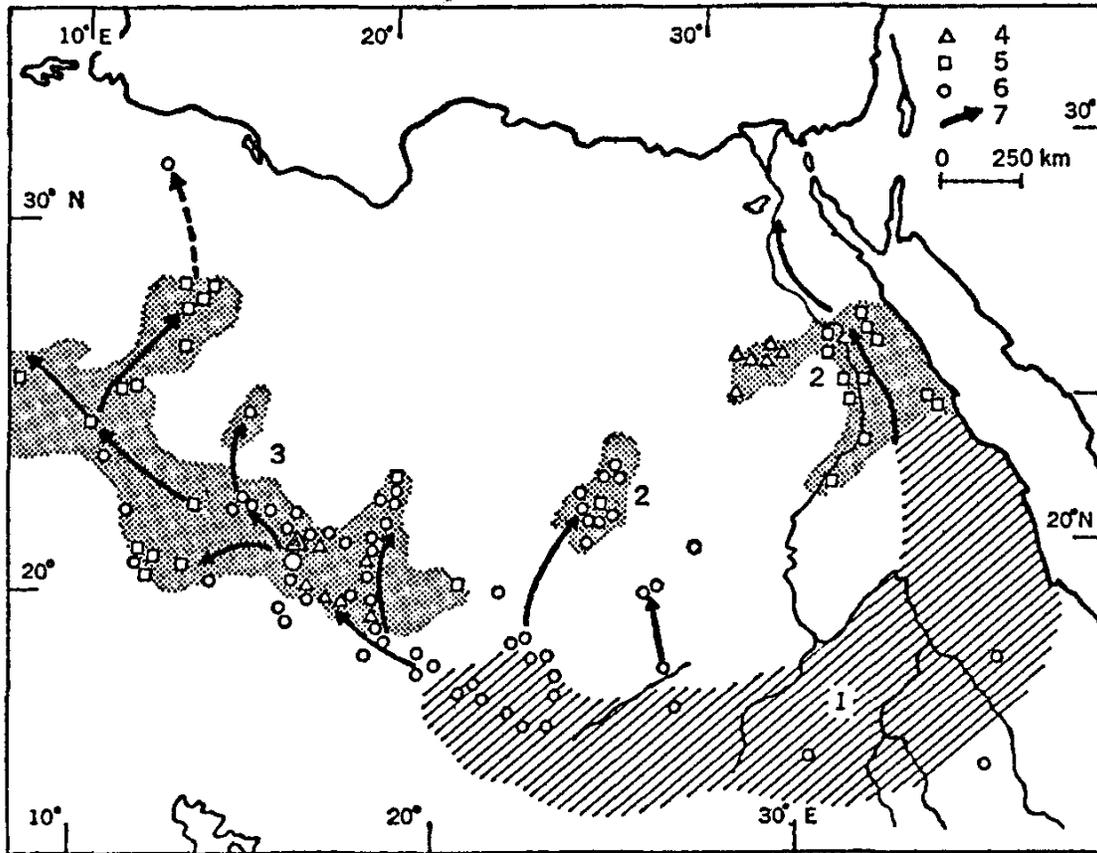


FIGURE 3 Hunters and cattle nomads in the Sahara *ca.* 5000–2000 B.C. 1, hypothetical cattle herding cultures *ca.* 4500 B.C.; 2, 3 domain of hunting groups *ca.* 4500 B.C.; 4, rock drawings of the hunters; 5, rock drawings of both hunters and cattle nomads; 6, rock drawings of cattle nomads; 7, expansion routes of cattle nomads in the fifth millennium (from Butzer 1958b).

of the environment and resource base of the Saharan highlands during the Holocene subpluvial. Not only did desiccation play no role whatever in agricultural dispersals after 5000 B.C., but instead the prevailing moister climate must have facilitated and perhaps motivated man's expansion over the world's greatest desert. In fact the spread of food-producing populations through the arid zone of the Old World followed close upon the migration of the Ethiopian faunas through the Sahara.

THE IMPACT OF FOOD PRODUCTION ON MAN-LAND RELATIONSHIPS

The impact of the new food-producing economies on the environment marks a rather significant change in man-land relationships. The

million years of Pleistocene time had witnessed a very gradual development of technology and economic patterns permitting existence of the human species under most environmental conditions. Man had also begun to modify the biological world, even if only on a local scale. Now, with the spread of ecologically potent farming communities across the Old World, transformation of the natural environment began to leave great scars in the landscape—the areal importance of which almost everywhere increased with time and the continuity of which was assured by the persistence of human populations at ever higher technological levels. The major aspects of geographical interest include (a) an explosion of population, made possible by an improved subsistence economy, (b) physical transformation of the environment, particularly through decimation of the native flora and fauna and their partial replacement by non-indigenous domesticated species, and (c) the creation of a cultural landscape.

Population is essentially controlled by available food. Rapid demographic expansion has ensued upon several major, technological improvements of the food supply: (1) after the first invention of tool-manufacture, (2) after the invention of agriculture, (3) with the intensification of agricultural production accompanying urbanization, and in more recent times, (4) with the industrial revolution. C. O. Sauer (1947) described the history of man as a succession of higher and higher levels, each one brought about by discovery of more food, either through occupation of new territory or through increase in food-producing skill. When the maximum possible population is reached, population must level off, either by gradual convergence of birth and death rates, or by draining off the surplus into daughter colonies.

The introduction of a subsistence based on farming and herding would provide a greater and more stable food supply. A much smaller economic area could provide sufficient food for much larger communities. Domestic animals could be used for meat at most times of the year, while the highly productive cereal crops could be stored for the whole year following the harvest. There was no longer any need to move when the local supply of wild plant foods or of game was exhausted. Starvation no longer ensued when biological cycles reduced the local game population. Above all, the food supply was far more reliable, both in the course of the seasons, as well as during the passing of the years, so maintaining a much higher population level. Of course, exceptionally cold winters, drought years,

crop and animal plagues, etc. would still exert a noticeable influence on the population curve. But man was becoming conspicuously less dependent on the vagaries of the environment.

Braidwood and Reed (1957) have discussed subsistence levels and modern ethnographic parallels, and suggested typical population densities of approximately 1 person per 100 sq. km. at the unspecialized Pleistocene food-gathering level, 5 per 100 sq. km. at the specialized late Pleistocene-early Holocene food-gathering level, 1000 per 100 sq. km. at the early agricultural level, and 2000 per 100 sq. km. at the early urban level. Obviously these are only meant to be orders of approximation, but the values help illustrate the degree of change involved.

The physical transformation of the natural environment was primarily the result of man's agricultural activities. Changes were originally confined to the biological sphere. The natural woodland or grassland vegetation was partly replaced by fields of wheat, barley, and vegetables. Such crops, originally native to a restricted area of western Asia, were to spread through most of the world, into lands where their very existence was often possible only through the caring hand of man. Species, which in natural competition shared minute ecological niches with countless other plants, now dominated acre upon acre of monocultures. Unconsciously agricultural or grazing activities favored certain local herbaceous plants by creating open spaces in woodlands, so increasing the importance of fire-tolerant plants in the course of slash-and-burn clearance. Similarly, new ecological niches were provided for a rash of new weed plants, whose original habitats and specific niches had been as insignificant as those of the cereals or vegetables.

The same can be said for the animal world. The wild fauna, with some exceptions, was decimated through a reduction of the natural habitat by cultivation, disturbance of breeding haunts, as well as improved hunting techniques by ever larger populations. Instead, the new farming populations tended select domesticated animals, thus enabling dispersal of certain species on a continental scale and causing drastic changes in the composition of the fauna. Certainly these qualitative and quantitative changes of flora and fauna required millennia, and the face of the earth was at first only altered locally. The cumulative effect over several millennia has, however, been significant and sometimes catastrophic.

The cultural landscape reflects intensive settlement with effective

transformation of the biological environment through agricultural land use. With the introduction of village farming into an area, cultivated fields and biologically altered grazing areas began to dot the landscape. Architectural skills had improved and shelter requirements were met by construction of houses, stables, and storage huts. Individual farmsteads coagulated to form villages dispersed over the countryside. With incipient urbanization these man-made structures increased in size, number, and importance as towns and cities, market places, roads, bridges, fences, and the like were added. Irrigation and drainage schemes were implemented in marginal environments. Forests were removed for land clearance and timber, and grasslands plowed up. These innovations were often followed by such unpleasant corollaries as soil deterioration and soil erosion.

Although the record of man's early transformation of the physical into a cultural landscape is poorly preserved in the Old World subtropics, the case of mid-latitude Europe is better understood. The significance of forest clearance and crop cultivation by village-farming communities was first recognized in Denmark from the pollen records of the Sub-boreal by Iversen (1949). The earliest appearance of cereal pollen was accompanied by a rapid increase or the appearance of weed colonists such as *Artemisia*, *Rumex*, *Plantago*, and chenopodiaceae, with a corresponding decrease in mixed oak forest. Such discontinuities were followed by temporary birch pollen maxima—common after forest fires—with subsequent increase of alder, hazel, and finally, oak. Evidence of burning is occasionally visible in the peat stratigraphy. Iversen explained these features through forest clearance by burning and felling, with subsequent livestock-grazing or crop-planting in the "opened" woodland. The fields were soon abandoned in the course of shifting cultivation, and so allowed to revert back to forest. Interestingly, open woodlands such as oak-birch forests on sandy soils showed little or no pollen discontinuity other than the presence of cereal and *Plantago* pollen. These show the existence of cultivation on plots available without recourse to intensive clearing.

This original picture of common, but not exclusive, slash-and-burn agriculture seems to be substantiated by the over-all archeological and palynological evidence in mid-latitude Europe (J. G. D. Clark 1945; Firbas 1949-52:Vol. I, p. 363 ff.). Fire was apparently not necessary in the more open landscapes. Tree-felling with stone axes was quite feasible, as recent experiments by Steensburg (1957)

showed. Bark-peeling or girdling of trees was probably also an effective clearance method, particularly after brush and lighter growth had been removed through burning. An interesting form of semi-agriculture preceded true agricultural colonization in Denmark (Iversen 1960, Troels-Smith 1960a). This Erteboelle culture may represent a contact culture, based largely upon stalled or tethered cattle. The animals were almost entirely fed with the foliage of elm, mistletoe, ivy, and ash. As a result there was a sharp reduction in elm pollen, formerly interpreted as a climatic change at the transition of the Atlantic to the Sub-boreal. A little wheat and barley was apparently grown, but there was no forest clearance worth speaking of. This example illustrates that the methods and significance of forest clearance by early agriculturists can hardly be generalized.

Prior to the first introduction of the ox-drawn plow from Mesopotamia into temperate Europe during the second half of the third millennium, soil preparation was made by hoe or digging stick. With such tools it is unlikely that most of the woodland soils yielded well for more than a year or two, requiring twenty or more years of fallow thereafter. Fertility must have been more enduring on the chernozemic soils, since recent plow agriculture without fertilization on the Ukrainian chernozems only required one fallow year in three. The exact nature of rapid soil depletion or yield reduction is complex, reflecting actual mineral depletion, rate of weed colonization, erosion resulting from soil structure changes, or humus destruction. The common symptom of sharply reduced yields probably results from a number of interacting factors.

Soil erosion was probably unimportant since cultivation was limited to the more productive lowland soils. Clearance and cultivation of hillsides was a late innovation in mid-latitude Europe. Deforestation or moderate grazing would not leave bare soil exposed for very long. Even in the Mediterranean region, in such an ancient land as the Lebanon, the commercial importance of lumber in historical times suggests that widespread deforestation was rather uncommon in prehistoric times. In fact Heichelheim (1956) and Darby (1956) emphasize that general deforestation and land deterioration even in the Mediterranean region fall largely within the two millennia of our own era. It would therefore seem that early agricultural land use did not yet provoke its more unpleasant side-effects such as accelerated runoff, seasonally accentuated stream discharge, soil erosion, gulying, and gradual loss of soil moisture

attendant upon the destruction or removal of humus. At any rate, both archeological and geological evidence to this effect is absent.

The preceding discussion of man-land relationships assumed that human populations automatically expand to the limit of resources available within a given technological framework. Such an assumption is of course questionable. Unfortunately the archeological data is inadequate for such evaluation of the underlying cultural patterns. Although less significant at the food-collecting level, efficiency of exploitation among technologically equivalent groups assumes considerable importance at the food-producing level. Was there a fundamental stability in the relationships of man to the exploitable resources of his habitat? Or, did local over-exploitation of resources already lead to temporary or semipermanent environmental crises? At the early agricultural level it would seem that a basic stability persisted, and with so much new land to occupy, it is possible that local overexploitation was still uncommon. But the problem remains to be investigated more thoroughly.