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THE RISE OF AGRICULTURE AND THE RISE OF POPULATIONS PRIOR TO THE AGE OF DISCOVERY: A LITERATURE REVIEW

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Prologue in Heaven:

> The Lord directed Moses to "Take the sum of the Children of Israel," and that the count was supposed to include only males, "All that are able to go forth to war in Israel."
>
> Numbers, (1:1)

Prologue Elsewhere:

> "Satan stood up against Israel and provoked David to number Israel. . . And God was displeased with this thing; therefore He smote Israel."
>
> I Chronicles, (21:1, 7)

Let us enter the study of populations with fear and trepidation.

I - CULTIVATING THE GROUND

Where did agriculture first begin? When? What plants did man first learn to stick into the ground and in the place of his own choosing? Did he first learn to split the stalk of a plant, part the ground and try to regenerate the original plant? Or did he gather the seeds or the fruit, carry them to a place near his dwelling and plant them there? These are fascinating questions. It's not economics. Neither is it history; nothing remains written of this period. I'ts not anthropology because we're equally concerned with the plant as we are with the man. Indeed, it must be a synthesis of all of these areas of study.

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Early man decided to quit gathering stalks by hand and rather liked the idea of fashioning some instrument to bash the dry stalks away from the ground. Capital formation; the scythe; labor saving technology; rising to a higher level of civilization by becoming a tool maker and tool user--aren't these really the semantic tangle in which we're unhappily involved, sophisticated terminology for less than sophisticated concepts?

Let us go back and try, through various tools which will be described below, tools of analysis from widely varying fields of research, to discuss the question of where man invented agriculture, and most especially, attempt to deal with the question of whether there were separate centers of origin.

Indeed, what do we mean, "center of origin"? Do we mean a geographical area where man began to learn to cultivate, or do we mean the place where primitive man discovered the plant, domesticated it and from which it spread radially to other cultures and other groups of men? In the following discussion, we must be careful to distinguish between the two, for they are entirely separate questions.

Did man proceed from his primitive position as a hunter to that of sedentary agriculturalist by the path dictated by conventional wisdom, going from the stage of being a hunter, to that of collector and then to sedentary agriculturalist? Wasn't it possible he was a fisherman? Must we assume he was a denizen of the forest or the savanna? Did he learn to plant in forest clearings, or on river banks, or in the open plains and river bottoms?

When did populations begin to rise? Did the natural tendency for man to reproduce abundantly put an upward pressure on him to make technological innovations? Did the need to feed more and more people force

him to plant more and different things in the ground and husband his resources better? Or did the fact that he had learned a new technique and had mastered increased production allow his numbers to burgeon until the surplus was gone?

After his numbers began to increase, what caused them to fall back to a lower level? Was famine the great destroyer of large numbers of people, or were the really major downward shifts in population over time due to other causes?

In the following paper, we will not be able to touch adequately on many of these questions. Above all, we would prefer to leave many unanswered rather than surmise widely on flimsy or nonexistent evidence.

The major empirical sources of evidence are the following:

1. Prehistorical research. Here archaeological evidence, diggings from tombs and early temples, cave carvings and primitive art can be of significant help in determining when various levels of technique in agriculture had been attained, as well as what the principal crops were.
2. Linguistic evidence. The etymology of many words in present-day languages, especially those that can be seen not to have changed significantly in thousands of years, will be of considerable help.
3. Early historical writings. A surprising amount has been gleaned by some researchers in examining early Sanskritic, Buddhist, Chinese and Semitic language texts. Colonial writings, especially some recently translated materials from Spain, the Relaciones of colonial administrators, shed some light on what was found at the time of the arrival of European man in the Americas and in Asia. And of course, the early botanists, in particular

Darwin and Alphonse de Candolle, have much to add from their somewhat primitive researches.

4. Genetic evidence. This is by far the most interesting. The first to try to work with this evidence was Vavilov, the Russian geneticist in the 1920's and 1930's; many followed in his path, in particular C. O. Sauer, P. M. Zukovskij, Elisabeth Schiemann, and I. H. Burkill.

Vavilov's method consisted of plotting on a map the distribution of recognizable races of a given cultivated plant and finding that where the dots lie the thickest is the center of greatest genetic diversity and must therefore be the center of domestication, the plant having spread radially from that place by migrating man or by cultural interchange. As Burkill points out, this method can be faulted for taking all of its information from the plant and none from the cultivator, for as every phytogeographer is aware, mountains are richer in species than plains due to the crowding of microclimates so that the chances of survival of variants of both useful and useless plants is multiplied (11, p. 251).

The struggle to limit the jargon of the various fields involved is immense. In order to not allow words to get in the way, let us begin with a few simple definitions. The progress of stone ages was from Paleolithic (Old Stone Age) through the Mesolithic and into Neolithic (New Stone Age). The transition from Mesolithic to Neolithic can be seen in the example of the Natufian hunter-fishers who were camping near Jericho around 7800 B C (16, p. 81). The commencement of the Neolithic saw not only the perfection of stone implements in the form of reaping knives, polished axes and tanged lanceheads, but also of pottery, and can be roughly said to have begun in the sixth millennium B C. The progression in metal culture was basically as follows, Age of Copper, Bronze, and

lastly, Iron; the most important, of course, being Bronze. Societies in Western Asia were conversant with the casting of copper in the fifth millennium B.C. New techniques took sometimes thousands of years to spread to other naturally isolated cultures, so we are not being specific as to time by indicating that something took place during the Neolithic or during the Bronze Age. Instead only the level of culture is being correlated with agricultural progress.

II - THE AMERICAS

Agriculture arose in the Americas most probably in the hills of Southern Mexico or Central America. The crops domesticated there include what are presently among the world's most important food crops: corn, manioc, the potato, the sweet potato, the peanut, and the tomato. Early agriculturalists in the Americas, however, were not successful at domesticating many animals, finding it possible only to domesticate the llama, the alpaca, the muscovy duck and the common American turkey.

The above statements are of course open to question first as to their validity and proof (or what can reasonably pass as proof) must be furnished. But they are also startling as to conclusions that could be reached. Conventional wisdom dictates that every American school child know that the first American friendly Indians came and showed the pilgrims how to plant corn (more properly, maize) by putting a small piece of dead fish in the hole as fertilizer. What if there had been no maize? What if there had been no Indians inhabiting the narrow flat belt of land separating the Appalachian mountains from the ocean? Or in the case of the first Spanish adventurers in Central and South America, had there not been the riches of the Mayan and Incan civilizations to plunder, would the Spanish kingdom have ventured to invest so much in the expeditions

that opened the age of discovery? Vast historical importance must be placed on ascertaining what was the agricultural base for the various Indian civilizations with which the white man came into violent and explosive contact, beginning with such men as Cortes in his conquest of Mexico.

Trying to ascertain whether maize is really of American origin by following the linguistic approach, one immediately encounters difficulties. For the French name for maize is Blé de Turquie (Turkish wheat), and the Turks call it Egyptian corn and the Egyptians call it Syrian dourra (23, p. 389). In a study of this very confusing aspect by one of the early botanists to whom credit goes for an enormous amount of work, Alphonse de Candolle, we find the discovery that the name of Turkish wheat was first given to maize by botanists dating from no earlier than 1536, well after the Age of Discovery had begun (23, p. 389).

Duchesne, in his classic Traité du Mais, was convinced that since Spain held the kindgoms of Naples and of Sicily that it was entirely possible that maize could have been transmitted and sold by the Venetians through Greece, the islands of the Ionean Sea, Bosnia and Croatia and, "il a pu en resulter que, dans ces pays soumis aux Turcs, le mais ait été plante dans les temps les plus recules, et que les autres nations telle que les Allemands, les Francais et une partie des habitans de l'Italie ne surent donne d'autre nom que celui de Ble de Turquie." [it has been possible, that, in these lands controlled by the Turks, maize was planted early and the other nations such as the Germans, the French and a portion of the Italians could give it no other name than Turkish wheat.]

Of far more interest, however, linguistically is not this less-than-substantive discussion of the origin of modern European words, but, realizing that they all date from after the beginning of the Age of Discovery,

to trace in the Americas the prevalence of words of various language groups which have changed little, if any, in reference to maize.

In a linguistic study of all the major language groups of Central and South America, Birket-Smith found that two predominant categories of languages prevail, one which he called "Peruvian" (in that they seem to have their center of location in the ancient culture area of Peru and Bolivia) and the other "Columbian" which extended north from Colombia up through Southern Mexico and down along the entire Amazon Basin, along the coast of Brazil (9, p. 32). The direction of loans of the words not only for maize, but also for roasted maize cob, seems to have been from the Andean regions down to the Amazon peoples, which "proved not only the cultural superiority of the mountain peoples, but also the fact that to a very great extent it is the Andean words for roast maize cobs that are found in the lowlands. In other words, the primitive tribes learned to know corn as an article of food among the highly developed mountain peoples." (9, p. 29).

That maize was surely first domesticated in the Americas is born out by historical research into the journals of many of the first travelers. Had it been known in Europe, one would not expect such amazement at--and constant difficulty of describing--maize in the New World. In some rather newly uncovered materials, entitled the Relaciones (generally, answers by the Spanish adventurers to various questionnaires sent out by the Spanish government), in 1513, a Spanish inspector of mines, Gonzalo Fernandez de Ovieda y Valdes, wrote extensively describing the cob of maize as the "size of a man's thumb or thickness of a cavalry lance . . . it is higher than a man and looks like the cane of Spain." (30, p. 150). De Acosta visiting Peru came upon wide plantings of maize as did Cortes in Mexico. Thus by the time of the Age of Discovery it had been successfully diffused fairly well throughout the Americas and, more interestingly,

had already been successfully adapted to the complete changes in soils, climate, photoperiod and light intensity of each locality. Moreover, numerous uses had already been found and were described by the Relaciones: bread, maize gruel, maize beer (brewed and drunk after only fours days!) and extractive products such as cooking fat in Peru and even for sugar (30, p. 154).

Vavilov, following his genetic approach (which assumed that the primary regions were those where the greatest diversity of varietal characteristics of a given species were to be found) found that not only maize but upland cotton, the common bean, the small seeded Lima bean, and the annual pepper all originated in the area of Southern Mexico and Central America. The probability was great of having many of the domesticable plants found there simply because there are so many more species in Mexico and Central America--he gave 11,626--of monocotyledones and dicotyledones as contrasted with the whole of North America--for which he gave as 9,403 (68, p. 191).

Vavilov counts very heavily on the importance of this subtropical and tropical area as the accumulator of specific and varietal diversity (68, p. 193) and finds that the growth of the great civilizations of the Mayas, the Aztecs, the Zapotecs, and the Toltecs in the Americas is completely in accord with this.

The pioneering work of Vavilov was carried on by Mangelsdorf, who followed very closely the genetic arguments concerning maize, extended the studies and arrived at rather different conclusions. In tracing the relationship between maize and its wild relatives, teosinte and tripsacum, one finds maize's relation to these rather obscure, but it was found that in general teosinte from southern Guatemala showed the fewest chromosome similarities to maize, and the farther one went away, the closer grew their chromosome characteristics (44, p. 50).

If one looks for the center of the domestication of maize in those places where there is the greatest existing diversity, reasoning that in the distribution of any cultivated plant that only a proportionately small number of samples will be carried away as man moves, and that the region of the greatest diversity always remains the center, then one must conclude that the center of origin of maize is in the Andes (44, p. 242).

However, if one looks for the greatest diversity of related cousins, then the Andean region is ruled out, as teosinte and tripsacum are not even found there, and instead one turns to Guatemala, where teosinte has truly been found as a wild species, as compared to the tablelands of central southern Mexico, where in fact most of the wild cousins have been found after several generations of hybridization to have already previously been crossed with maize (44, p. 214).

An interesting sidelight is that maize probably would have become extinct had man not begun to cultivate it, for maize is particularly unable to either disperse or protect itself. It has "no tuft or wing to catch the wind and when the ear is not gathered by man, the grains fall still fixed in the receptacle and then rodents and other animals must destroy them in quantities and all the more that they are not sufficiently hard to pass intact through the digestive organs" (23, p. 395).

Finding the real center of domestication of maize is rather important, because if in fact it was domesticated in Central America, this would fall in line with Sauer's thesis that below a certain line which cuts the Americas in two somewhere north of Panama, agriculture began through asexual reproduction--i.e., man learned to plant by cuttings. But if the origin was in fact far to the south, somewhere in Peru or Colombia, then much of Sauer's reasoning would have to be discarded. So it behooves us to pause a moment and examine Sauer's argument. He found that remarkable similarities occur among the many crops which can be traced to

South America. Planting began by division and multiplication. All required good drainage, and where drainage was poor the cultivators built the mounds high to provide aeration (57, p. 45).

Among these crops were manioc, the sweet potato, the racacha (which is similar to parsnip), and several others of lesser importance. Also, Sauer found that although vegetative planting did not carry far to the north, it did extend to the tip of South America. Such a southward expansion must have taken a long time, given the tremendous differences between areas near the equator where daylight is almost always the same year round, and, say, 50° South latitude, where the day in the summer is almost 17 hours long and in the winter less than 8 and a half hours, and between the tropical red soils and laterites of equatorial South America and the brown steppe soils and the podzols that occur in the extreme southern part of South America (60; 39, p. 138).

Sauer found that north of his line through Central America the mode of agriculture becomes seed oriented, or in his terms "selection takes place by sexual progeny" (57, p. 62).

Sauer does not rule out the possibility of there being two hearths of domestication, but prefers to think of a northward movement into the area in which man not only domesticated maize, but also a whole family of beans and squashes, which, as he notes, were grown rather early together, forming a "symbiotic complex, without an equal elsewhere." (57, p. 64).

The beans and cucurbits in particular have their widest variation in Mexico, and, by contrast, most of the forms beans take in South America are genetically recessive, having been selected and transported.

Throughout the area we find a tremendous predominance of grain products, vegetables, fruits and grain alternatives, with very little evidence

of proteins or oils in the diet based upon the domesticated crops. M.K. Bennett, in a study of the diet of the Southeastern New England Indians by means of historical research, estimated that in about 1605, the diet of the Indians was approximately 65 percent grain products, 10 percent animal and bird carcasses, with only small proportions of other inputs (6, p. 392).

As we will attempt to discuss later, there is very probably a strong connection between the diet, the types of crops domesticated, and the pattern of domestication and diet imbalance in other parts of the world.

We must turn now to the question of the population which this early form of agriculture was able to support in the Americas. Obviously, statistics are not available. The earliest demographic studies available in South America are 1890 for Brazil, 1876 for Peru and 1900 for Bolivia, so we are faced with an attempt to regress backwards over long periods of time with a wide chance of deviation, or else to devise some other means of estimating populations. If we can find other means which would hold systematically and logically, then perhaps we have a basis for judgment; otherwise we are engaged in guessing games, the relative merit of which is questionable.

Of the early demographers, Carr-Saunders, in the late 1930's estimated that in 1650 the population of North America was about one million and that for Central and South America it was about 12 million (12, p. 30). His method of estimation was to divide the area into a number of geographical areas, then take the best available evidence of densities in each area to find the product. To be able to do this, Carr-Saunders evidently had to lean heavily on Humboldt's estimates of the population of Mexico in his early visit there in 1793 (12, p. 33).

M. K. Bennett attempted to correct Carr-Saunders data and then worked backward, his assumption being that until the advent of modern medicine it was not the birth rate that varied and changed the size of a population, but the death rate. Thus he reasoned that the arrival of the Europeans, with their entire range of yet to be experienced diseases, caused a marked decline in the population of the Americas from 1500 to 1600 (7, p. 9):

Year	Population in the Americas (millions)
1000 AD	13
1100	17
1200	23
1300	28
1400	30
1500	41
1600	15

J. D. Durand, in writing for the United Nations in 1965, tends to accept Carr-Saunders estimates for 1750 (and thereby for 1650) for the whole of the Americas to be about 13 million, divided one million in North America and 12 million in South America in 1750 (29, p. 21).

Colin Clark, attempting to synthesize all the data available from all of the various demographers, accepts in total Bennett's data for the period 1000 to 1500 AD, but also includes some new information as to what might have happened to population from the period AD 14 to 1000 AD, finding that in AD 14 approximately 3 million inhabitants could be found in all the Americas, and that this had swollen to 10 million by 800 AD. Much before the European arrived, man in the Americas had begun to lay down a sufficient base of agriculture, insuring himself against major catastrophes, most probably by storing or saving some edible foods, perhaps by the use of pottery, but also perhaps by leaving the crop in the ground

if it is not one that must be harvested immediately after maturity, as in the case of manioc (40, p. 101).

Suppose for a moment that we do not question the authenticity of the population figures, but accept them instead. In 14 AD, three million inhabitants; in 800 AD this had risen to 10 million; at the high point of about 1500 AD, a veritable boom to 41 million. Where were these sites of civilization? From whence came these folks?

In 1884, Grotius proposed that the Indians of the Americas north of the Isthmus of Panama descended from Norwegians! He based this largely on a word-association of suffixes that he considered too much to be accidental. The -land one finds in such words as Iceland, Greenland, and other Scandinavian names is remarkably similar to the -lan endings in words for groups of Indians such as Cimatlan, Cuatlan, Ocotlan, etc. Also, the Aztec origin words such as Teut for God, Waiert for lash and beke bore for him sufficient resemblance. These coupled with a variety of remarkably similar practices, such as circumcision in Yucatan, led to possible Old World connections--in the last case Grotius guessed a migration from Ethiopia (by what means he didn't seem to bother considering) (36, p. 120).

It is clear that man has been in the Americas a long time, although it is not immediately clear from whence he came. He had been here long enough, in fact, to develop 160 linguistic stocks or language families and more than 1,200 dialects, which is, interestingly enough, more than the remainder of the entire world, according to Kroeber (43, p. 5). Most authorities do assume that man came over the Bering Strait from Asia somewhere near the end of the Great Ice Age. Had he arrived as late as 10,000 years ago, he would have had to negotiate an approximately 56-mile stretch of water; but if he came much earlier, the level of the sea would have been down about 200 to 300 feet exposing a land bridge (43, p. 14). Moreover, remains have been found of man previous to Folsom man (one of the

earliest in the Americas) which had been placed at 9900 B.C. by C_{14} dating and these earliest remains have been reliably estimated to be 50,000 years old (70, p. 12).

By the time of the conquistadores, however, contact had been made fairly well with the rest of the world. The people who beat the Spaniards were the Chinese and the Phoenicians, at least according to Verrill. Verrill cites an account by a Chinese Buddhist Priest named Hoei-shin, who visited the Americas in 499 and wrote his descriptions in a document called the Fusang which was entered in the Yearbook of Annals (70, p. 16). Verrill's wife made the spectacular discovery moreover, of the Sumerian (Phoenician) characters on the Santa Rita frescoes in British Honduras. And interestingly enough, for the purpose of the current study, these script characters described agriculture in the far-off land from which the Plumed Serpent had come--the Plumed Serpent described himself as the son of the Sun, having traveled arcund the world and described tilled and irrigated lands and their crops, indicating these by glyphs of food crops where the stomach should be and by crossed lines at his back which showed that his home-land had drainage ditches. He is estimated by Verrill to have arrived in about 600 AD (70, p. 110).

By 1492, the Indian had adapted himself to eight different climates from arctic to tropic, from arid to humid, and from sea level to 14,000 feet. According to Albrecht Penck 25,000 years would hardly be enough to do this (43, p. 5). Physiologically this means massive changes in man, for we know the physiological systems of every function of the body are different at different altitudes. In a study done of present-day Andean man, it was found that the blood volume of an average man goes from 5.21 liters of Lima men near sea level, to 6.98 liters of blood for Morococha natives normally found at 14,000 feet, and of this change the majority is

not due to simple increase in the neutral liquid (plasma), but rather to changes in total volume of red cells (from 2.34 liters to 4.29 liters) and of total grams of hemoglobin (from 788 grams to 1464 grams) (40, p. 363).

So it becomes clear that man has been in the Americas a long time, arriving before agriculture was an established practice. He settled and grew in three basic areas: the Central Platueu of Mexico, the Yucatan peninsula, and the western slopes of the Andes not far from lake Titicaca. In central Mexico the Aztec empire was actually preceded by the Zapotecs, the Tehuanas, and the Toltecs, who extended as far north as present day Utah (70, p. 50). The word Astec means, interestingly enough, People of the Cranes which would indicate that their first site was on some marshy shore. When the Spaniards invaded the Aztec capital it was already a very imposing city, over 12 miles in circumference with more than 50,000 houses and more than a quarteroof a million people (70, p. 55). Further to the south, in what is now Yucatan, Guatemala and Honduras, grew the Mayan empire which is estimated to have been at its first zenith during the period from a few centuries B C to about 200 AD.

Probably most famous of the South American civilizations was the Incan, which surrounded lake Titicaca and extended the entire length of South America on the west side of the Andes. But they were preceded by a very ancient group who had first built the city of Tihuanaco on the border of Bolivia and who it may be surmised knew irrigation. Their city showed tremendous engineering feats; they were stone workers and had complete subterranean sewerage and drainage systems and sluice gates to control water coming into and out of the moat which completely surrounded their city. Tihuanaco was estimated to have been constructed somewhere around 10,000 or 9,000 B.C., which would, if true, make it the oldest city in the world (70, p. 209).

All of these civilizations of the Americas were to leave considerable ruins showing signs of extensive civilization; pottery, calendars, temples, moats, glyph-type writings, the whole works. Was it not then necessary to have agriculture, in fact an extensive sedentary base of agriculture, in order not to be concerned with the daily problem of survival and to allow sufficient allocation of time and energies to these other activities?

Meggars concluded that not only was a sufficient base necessary, but that when a highly developed culture such as the Mayas moved into a new area with lower agricultural potential, it appeared archaeologically at this well-developed state, only to fail to diffuse into adjacent areas, and to gradually decline (46, p. 811).

Altschuler took issue with this environmental determinism. Were one to agree that the agricultural environment was the limiting factor, the history of the Mayas would be neatly explained, especially their decline, which is often thought to have been the result of declines in productivity of the land, causing them to abandon not only their fields, but also their practice of sedentary agriculture, change to shifting (or swidden or milpa) cultivation and go into decline. Altschuler reasoned that social factors were probably more important (1, p. 184). Mayan agricultural practices by their very nature did not involve a high development of central control for their ordinary operation. Such administration as was needed was done more on a kingship basis. But as the class of priests grew and demanded an increasing surplus, they began to expropriate this surplus and it was the dwindling margin or surplus left as a reserve for the fickle future that led inevitably to social disorganization. Soil depletion alone was not a sufficient argument.

In fact it is not a certainty that swidden agriculture denotes a lesser ability to attain a high level of civilization and therefore of

population. Dumond in a comparative article of present-day swidden agriculture societies adduced evidence that yields per acre for swidden plots are considerably higher, thus producing at least the reserve necessary in order to undertake other activities (27, p. 302). Moreover, if sharp definitions of role in society existed in these three centers of Indian empires, it is possible to conceive of the town or temple dwellers as sedentary, constructing those monuments that have endured, and at the same time the rural agriculturalist as either a sedentary or shifting cultivator but still able to produce sufficient surpluses in order for the population to grow and expand to the levels earlier suggested by the time of the arrival of the European.

III - AFRICA

Vavilov, writing in 1926, concluded that there was one center of domestication of cultivated plants in Africa. This was in Abyssinia, presently known as Ethiopia (66, p. 242). Compared to the rest of the world, Abyssinia can be credited with a number of forms of hulled barley, violet grained wheat, several original races of peas, some peculiar races of oats and a number of lesser plants.

Vavilov decided that oats belonged to Abyssinia not on the basis of direct examination of genetic material or number of types, as was usually his criterion, but on an allied immunity, which is genetically inherited in these types of oats, to certain European smuts and rusts, and a marked sterility in crosses (66, p. 173).

As a corollary to this, Vavilov found that of the types of smut which live on sorghum, the majority have been found in Africa alone. Finding that the diversity of specialized parasites could equally be a strong indicator of the center of domestication, he was led to include sorghum in the group of plants being of African origin (66, p. 151).

Sauer, writing in 1952, in reviewing the work of Schiemann, concluded that Vavilov had erroneously attributed barley to Abyssinia, but went beyond Vavilov in also attributing the cow pea, the hyacinth bean, several lentils and sesame to that area (57, p. 77).

It can be noted from Sauer's and Vavilov's findings that all of the crops whose origin or domestication is thought to be Abyssinia are seeded plants, growing by sexual, not asexual reproduction.

Sauer, when confronted with the fact of a few unexplainable types of yams, was moved to allow a "subordinate center of vegetative domestication to forest Africa, centering somewhere behind the Guinea coast." (57, p.35). These two yams, the white and yellow Guinea yams, (Dioscorea rotundata and cayenensis) were the only forms which were reproduced asexually. Most other plants found in Africa, Sauer was content to say, arrived through a sea corridor along the coast of the Indian Ocean, having first been cultivated in Asia.

Burkill (11, p. 271) concluded that sorghum was ennobled in Africa in the humid equatorial areas (not Abyssinia) and spread from the Atlantic coast to the Indian Ocean, its northernmost point there being near Zanzibar. He, like Sauer, found that almost all other cultivated plants could be ascribed to having come over the Sabaen land (a sea lane used by traders from East Africa to India) with one interesting exception, the calabash gourd, which has little value as a food, but is most useful as a natural dipper. By the time of the Age of Discovery, the calabash already was to be found in the Americas as well as Africa. Admitting that there are fantastic theories of how it got distributed that widely, Burkill stated that his "own belief is that Nature made it common to the Guinea and Brazilian margins of the Atlantic and that it spread thence." (11, p. 271).

Africa seemed to have been peacefully assigned to a minor position by the botanists and geneticists and stayed that way until 1959 when a bold new hypothesis was set forth by G. P. Murdock. He credited the Mande peoples of West Africa, who near the headwaters of the Niger River in the extreme western part of the Sudan, with the invention of agriculture in Negro Africa (50, p. 67). His line of reasoning was largely linguistic and ethnographic. "We should expect the particular people who first advanced from a hunting and gathering economy to an agricultural one to have multiplied in number and to have expanded geographically at the expense of their more backward neighbors . . . this condition does not prevail in either the central or the eastern Sudan . . . our criteria are fully satisfied however in the western Sudan by the far flung Nigritic stock." (50, p. 67).

It is important to note that this was not the Guinea coast, alluded to by Sauer, but an entirely new area, previously undiscussed. A number of present-day important crops which Murdoch mentions are Fonio (Digitaria exilis), bulrush millit, sorghum, cowpeas, Bambara groundnut (similar to the American groundnut and widely distributed in Africa), okra, the fluted pumpkin, the watermelon, the tamarind fruit and kola among the edible plants; among those used for other purposes he includes cotton, saying that it was ennobled early, having been transmitted to India quite early, but not reaching Egypt until the sixth century BC. Murdoch then went on to indicate that the Sudanic civilization spread from west to east, displacing the indigenous Bushmanoid peoples, dividing into three groups which eventually occupied a vast area, stretching from Ethiopia south to the Great Rift valley. In particular, the people who occupied present-day Ethiopia were the ones who extended Sudanic cultivation, bringing under man's control eleusine, a finger millet, several new varieties of sorghum,

ensete (which is the Abyssinian banana), mustard, castor and coffee (50, p. 182).

In July, 1969, a conference was held by the School of Oriental and African Studies in London to try to explore these seemingly contradictory hypotheses. Roland Porteres noted that none of the previous writers had considered the very important difference in the species of rice found in Africa, compared with the rest of the world. In particular, Oryza Glaberrima is of West African origin in contrast to Oryza Sativa, which is definitely of Asian origin (52, p. 197). This west African origin he divided into two groupings, "Le foyer primaire de diversification varietale se trouve actuellement dans le Delta Central Nigerien. Les formes que l'on rencontre presentent exclusivement des caracteres genetiquement dominants: . . . la biogenie est d'ordre aquatique et toutes les formes sont dites 'flottantes' avant la possibilite d'allonger leur chaumes au fur et a mesure que la crue s'eleve" (52, p. 198), [the principal region of diversification lies actually in the central delta of Nigeria. The forms that one meets present exclusively dominant genetic characteristics . . . the boigenie is of aquatic order and all the forms are called 'floating' having the possibility of elongating their stalks with the rise in water level.]

In the dorsal mountains of Guinea, Porteres found another site of emancipation (sic) with the difference being that the character 'floating' disappeared, as well as did the characteristic of being 'sticky' (la caractere dextrinuex--riz gluant) (52, p. 198).

J. D. Clark contended that one must make a fundamental distinction when considering African origins--the distinction between the cereal crops and the non-cereal crops (wheat, barley, millets, sorghum, versus bananas, yams, oil plants and trees, pulses, etc.). Clark indicated that the vegetative reproduction stages in domesticating the latter group were a local

development of the area south of the Sahara, whereas seed-reproduction came from Southwest Asia somewhere during the fifth millenium BC (17, p. 123). Clark's means of analysis were largely archaeological. He found that the first attempts at agriculture took place near waterside sites and the fringes of forests and that incipient agriculture was much more spread during the period approximately 5000 to 2000 BC, covering much of the area of the present Sahara desert, which began to dry about 2000 BC (17, p. 215). Moving into the present era, Clark thought that the Great Rift valley acted as the funnel southward, the movement of agriculture he related directly to the southward spread of forms of pottery, so that agriculture reached into present-day Tanzania, South Africa, and Angola in the era from 300 to 1000 AD (17, p. 221).

Adding to the findings of Murdoch was W. R. Stanton in his investigations in the genetic differences in the present population of maize, cowpea and sorghums in Nigeria. He noted a peculiarity in the pattern of distribution of sorghum, that it was grown on the Plateau area, but instead, acha, or fonio grass had been retained, indicating in particular an autogenous development of fonio (61, p. 256). For both sorghum and cowpeas there "are recognizable Nigerian (and by extrapolation West African) races of cowpea which are markedly different in morphological, developmental and disease resistance characteristics from those of the rest of the world." (61, p. 256).

Most interesting though of Stanton's work was a review of the inquest undertaken by the West African Maize Research Unit which led to the working hypothesis of a dual entry of the maize plant into West Africa: the Spain-Venice-Turkey-Egypt route bringing in types of maize peculiar to the Caribbean, and the Brazil-Ghana-Benin route bringing in Brazilian maizes (61, p. 255).

The movement of maize through West Africa can be traced by the fact that maize cobs were used as tools for marking the surface of pots; culture stratum may be dated by relating it to the appearance of maize marked potsherds (61, p. 255). Unfortunately this study had not been conclusive yet, but more information should be looked for from Stanton.

Insufficient direct evidence remains to allow an estimate, even a rough one, of population at any time prior to the advent of European man. However, some estimates have been made by regressing present population figures backward. Due to the extreme lengths of time involved, it is felt that these extrapolations are less than valid. It is much more honest to say we simply don't know what the population of Africa was.

IV - THE MEDITERRANEAN AND PERSIA

Vavilov, writing in 1926, concluded that there were two definite centers of plant domestication that lie within the area of present consideration: the Mediterranean Center which embraced Northern Africa, Palestine, Syria, Greece, Italy, and Spain; the other was the general area of South Western Asia, including Afghanistan, Kashmir, Persia, Asia Minor and Transcaucasia (66, p. 242). The center for the domestication of the soft wheats he established as Persia and Southern Afghanistan, although a large number of established varieties have been found in Transcaucasia which Vavilov finds reasonable in light of the geographical and historical connections of Armenia, Georgia and Azerbaijan (66, p. 156).

The ancient spelt, Triticum spelta, which belongs with the soft wheats and is still found in small patches in Switzerland and Swabia (South Western Germany), left Vavilov somewhat confused as this species was not recorded by any of the members of his expeditions to the general area of Persia (66, p. 158).

On the other hand, the durum (hard) wheats, subject of a long study by A. Orlov using data of racial diversity again, must be traced to Northern Africa and the coasts of the Mediterranean, but not to the region of Mesopotamia, which was found to be comparatively poor in the diversity of durum wheats (66, p. 158).

These two major kinds of wheat had been grown widely since antiquity; De Candolle notes that ancient Egyptian monuments and Hebrew scriptures show the cultivation of wheat already established; a specimen found in a brick in the pyramid of Dashur, Egypt, was assigned a date of 3359 BC. But wheat was also grown in China around 2700 BC according to Bretschneider, who adds that communication between China and Western Asia commenced only in the Second century BC (23, p. 355). De Candolle found that Mesopotamia was highly probable as to being the center for the dispersal of the cultivation of wheat for several reasons: 1) it lies in the middle of the belt of cultivation that extended from the Canary Islands to China, and 2) historians over a twenty-three century period asserted wheat to be indigenous to the Euphrates valley (23, p. 358).

The other quite distinguishable forms of wheat that had been cultivated in ancient times were einkorn (triticum monococcum) and emmer (triticum dicoccum shrank). Einkorn is still found in the wild form from Kurdistan to Palestine to Greece and its area of origin seems to have been Asia Minor, probably the Crimea (66, p. 161). Emmer, although assumed by Vavilov to be of Abyssinian origin, was of Mesopotamian origin according to Burkill; it became the leading crop of Lower Egypt and the harvest month was named after it (11, p. 259).

Interesting new research has been done to ascertain whether in fact the various wheats arose independently, or whether in fact the natural weeds which grow around wheat fields played a monumental part in developing

the new wheats of agricultural man. In particular the families of weeds Agropyron (quack grasses) and Aegilops (a weed grass) have been studied by the Americans McFadden and Sears and their reconstruction leads one to believe that all of the Persian wheats, emmer, the bread wheats and spelts have come about by accidental hybridization by neolithic man who didn't know enough to weed his fields. For a short summary of their work, see Edgar Anderson (2, p. 59-64).

Barley, which occurs in two distinct forms, two rowed and six rowed, has wild parents which are to be found, the former in Palestine, Syria, Persia and Afghanistan, and the latter in Tibet. Burkill asks, "When were the parents taken into cultivation? The one or the other in time for the cultigen, Hordeum vulgare to have been made and spread before ca. 6000 BC by which time it had become a crop of the Nile Valley and Mesopotamia." (11, p. 258). Further studies by a Hindu-Kush expedition under the German Scheibe in 1935 uncovered many more natural and even weed six rowed barleys in Tibet and have helped elucidate the occurrence side by side of the two types in agriculture since the European Neolithic Age (58, p. 310).

The case of rye seems to further the thinking that many of our cultivated plants came about as a result of the intrusion of weeds into fields of other cereals. Zukovskij concluded that rye did not even come about as a plant until the Bronze Age and did so by mutation from perennial to annual type (73, p. 5). The earliest deposits of weed rye occurred in archaeological findings at Mitridat in the Kerc peninsula dating from the Third century AD.

De Candolle, researching through many of the historians' writings, could not find any Greek who described or mentioned rye; the first writer is during the Roman Empire: Pliny, who described rye being cultivated at Turin (23, p. 371).

In his later writings, after a series of critiques has been leveled against his earlier centers, Vavilov divided his former Old World groupings into approximately twenty smaller groups, distinctive not only for their geographical differentiation, but also their ecological differentiation, and found rye, in widely different forms, to belong to three of these--wild rye in the Armenian mountain group, giant forms of rye in the Azerbaijan foothill group and recessive gened ryes, especially susceptible to European fungus diseases, in the Pamir-Badakshan group located on the Soviet-Afghan border (69, p. 556).

Clearly then, we can see the difficulty in trying to arrive at one, two or even a finite number of centers of origin in the general area of the Mediterranean-Persia. However, a number of features can be ascertained. The main item in the diet was a small seeded cereal. And man not only was intimately involved in adapting and domesticating this cereal, but in fact involved in its creation by the practice of agriculture. This does not deny that Middle Eastern Man also domesticated pulses such as those listed by Burkill: the chick pea, the garden pea, the broad bean and the lentil (11, p. 259).

The diet of the Greeks and of the Romans has been the subject of an intense study, not only to ascertain at what period these newly formed Mediterranean-origin cultigens appeared, but also to see what other domesticated crops appeared that seem to have had their origin in either the Persian-Afghanistan area or even further in Asia. Sir William Thiselton-Dyer noted that the Greeks resorted to every possible native plant, and had an insipid herby diet, which required many condiments. The Greeks relied heavily on onions and cruciferae, while in Italy greens prevailed, such as mallows, nettles, purslane, alexanders, leeks, cabbages, sea kale, chicory, artichoke and, or course, the olive and the grape vine (11, p.267). These will be dealt with more extensively in the following chapter on Europe.

Burkill worked primarily with Vavilov's information on the geographical group centers of origin set forth in Figure 1 (11, p. 252).

Figure 1

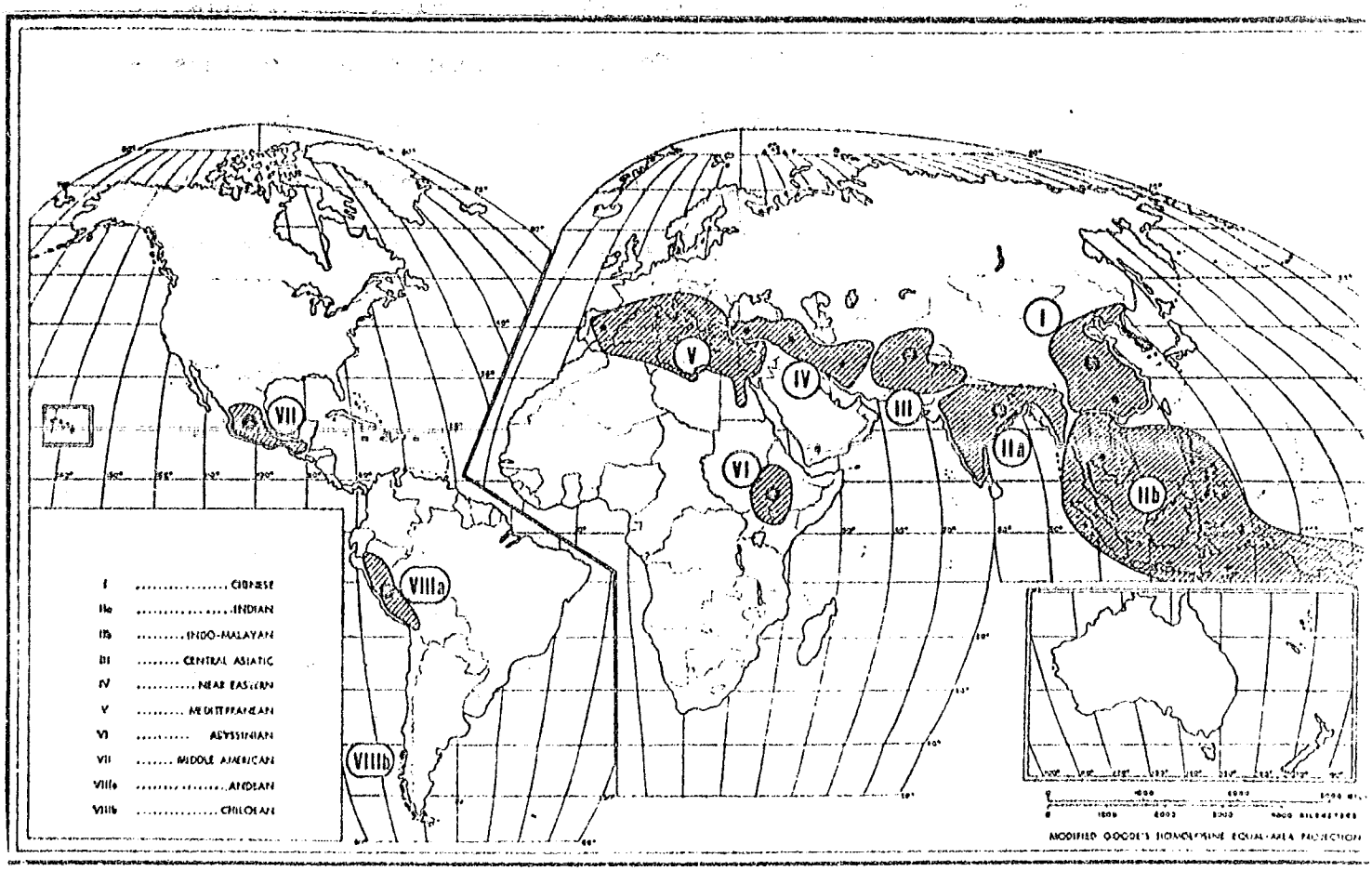


FIG. 1. World centers of origin of cultivated plants. [Redrawn from "The Origin, Variation, Immunity and Breeding of Cultivated Plants: Selected Writings of N. I. Vavilov," *Chronica Botanica*, XIII (1951), 22-23.]

A measure of the direction of spread of agriculture is necessary. Did agriculture spread from Persia westward to Mesopotamia? Did agriculture proceed from Mesopotamia toward Europe or the other direction? One clue to these questions is the development of the tools for cultivation of the small grained crops. The wild grasses, the predecessors of the domesticated wheats and barleys, could not be harvested by tools; instead beaters and baskets were needed in order not to shatter the grain and lose it in the field. Sickles were found earliest in proto-Neolithic and even earlier Mesolithic sites in the Mesopotamian valley (57, p. 81).

In Egypt the early reaper was a wooden bar into which flint flakes had been imbedded, whereas in Mesopotamia, the bar was of baked clay and curved with a curious alternative in a few archaeological sites, sickles made of terra-cotta, which is a very hard fire baked clay, making a most fragile, brittle tool. The earliest metal sickles recorded from Mesopotamia date from not earlier than 3000 BC (71, p. 227).

Agriculture not only developed very thoroughly and very extensively in the Middle East, but fortunately also was recorded in early writings. S. N. Kramer translating from Sumerian tablets found almost a "Farmer's Almanac of 1700 BC" which gave advice from a father to his son of the importance of the maintenance of irrigation works, the need for fences, the depth of seeding, the spacing of plants and recognition of some diseases of barley, as well as an admonition not to be lazy in the off season, but to fix and mend tools (71, p. 227).

Agriculture moved as the use of metal moved into the Mediterranean region. The progress westward of the two went hand in hand. Burkill's map (11, p. 266), shown here as Figure 2, indicates the time boundary (in years BC) of the spread of the use of metal and the planting of emmer.

Much more information exists, or at least more intelligent guesses can be made, concerning the size of the population of the area under consideration than for Africa or the Americas. Civilization, and with it population maxima, reached three peaks in ancient Egypt, the first during the Old Kingdom (ca. 2900-2550 BC), followed by the Middle Kingdom (ca. 2160-1780 BC), and climaxed during the New Kingdom or Empire (ca. 1580-1100 BC) (50, p. 101).

In ancient Egypt were cultivated not only barley and wheat, but also alfalfa, chick peas, clover, the garden pea, beets, onions, parsnip, radishes, artichokes, asparagus, cabbage, celery, endive, lettuce, the grape,

Figure 2

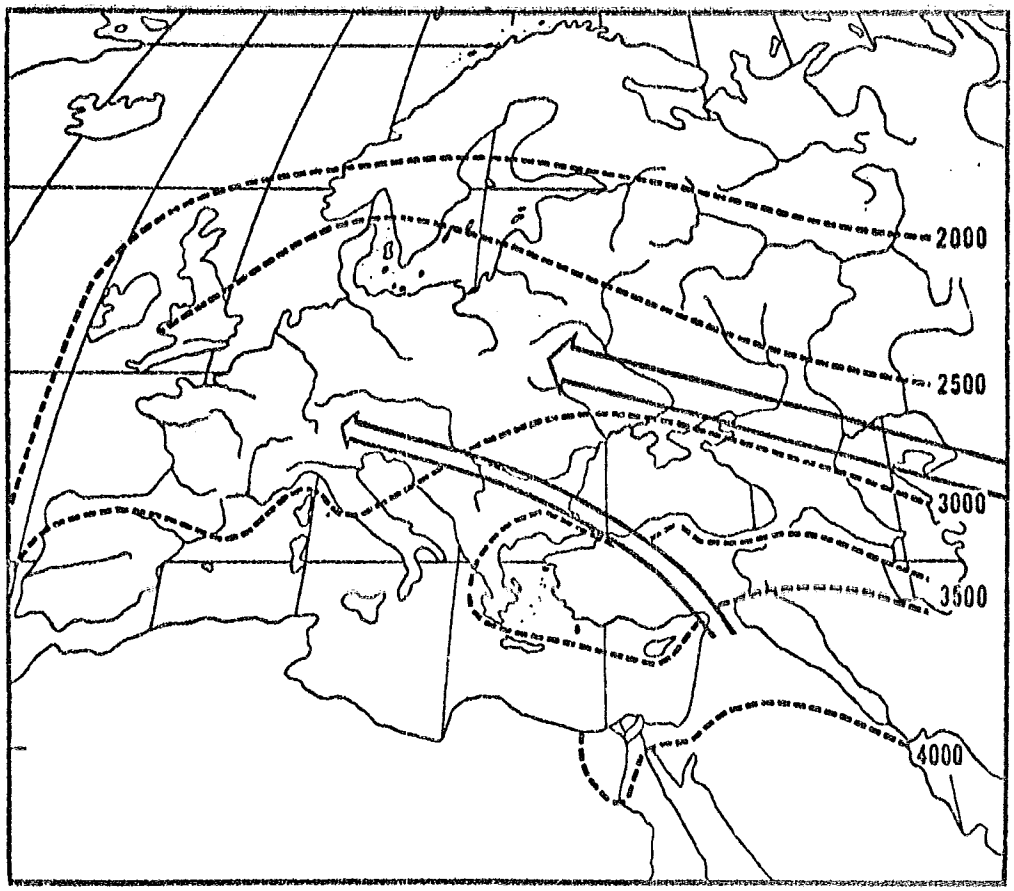


FIG. 2. Europe zoned in half-millenniums by the spread of metals, with one arrow to indicate the direction of the movement of round-headed migrants from Asia to central Europe, and a second arrow suggesting the diffusion of Emmer from Syria to central Europe. [The delimitation of the zones is derived from C. S. Coon's map of "Neolithic Movements and Chronology" in *The Races of Europe* (New York, 1939), 80-81.]

the cantaloupe, the date, the fig, many spices including dill, garlic, and leeks, olives, edible rape, and many animals, including cattle, chickens, goats, geese, horses, mallard ducks, pigs, pigeons, and sheep (50, p. 104).

Clearly this diversity of cultivated plants and animals could sustain a high level of population. Beloch's estimate of the population of Egypt in 14 AD of 5 million with a density of 179 persons per square kilometer could be revised upwards for times previous to the beginning of the present era (65, p. 9).

Usher reviews early estimates of population in other areas of the Middle East, finding that Persia was estimated to have had a population of fifty million at the time of Darius (around 490 BC--the battle of Marathon). But Usher himself tended to believe that full maturity of the population of Persia occurred later, either during the Selucid dynasty (311-129 BC) or the Sassanid dynasty (229-628 AD); and concluded, "we may assume then that while there have been fluctuations, there has been no real growth of population in this area since the early part of the Christian era" (65, p. 21).

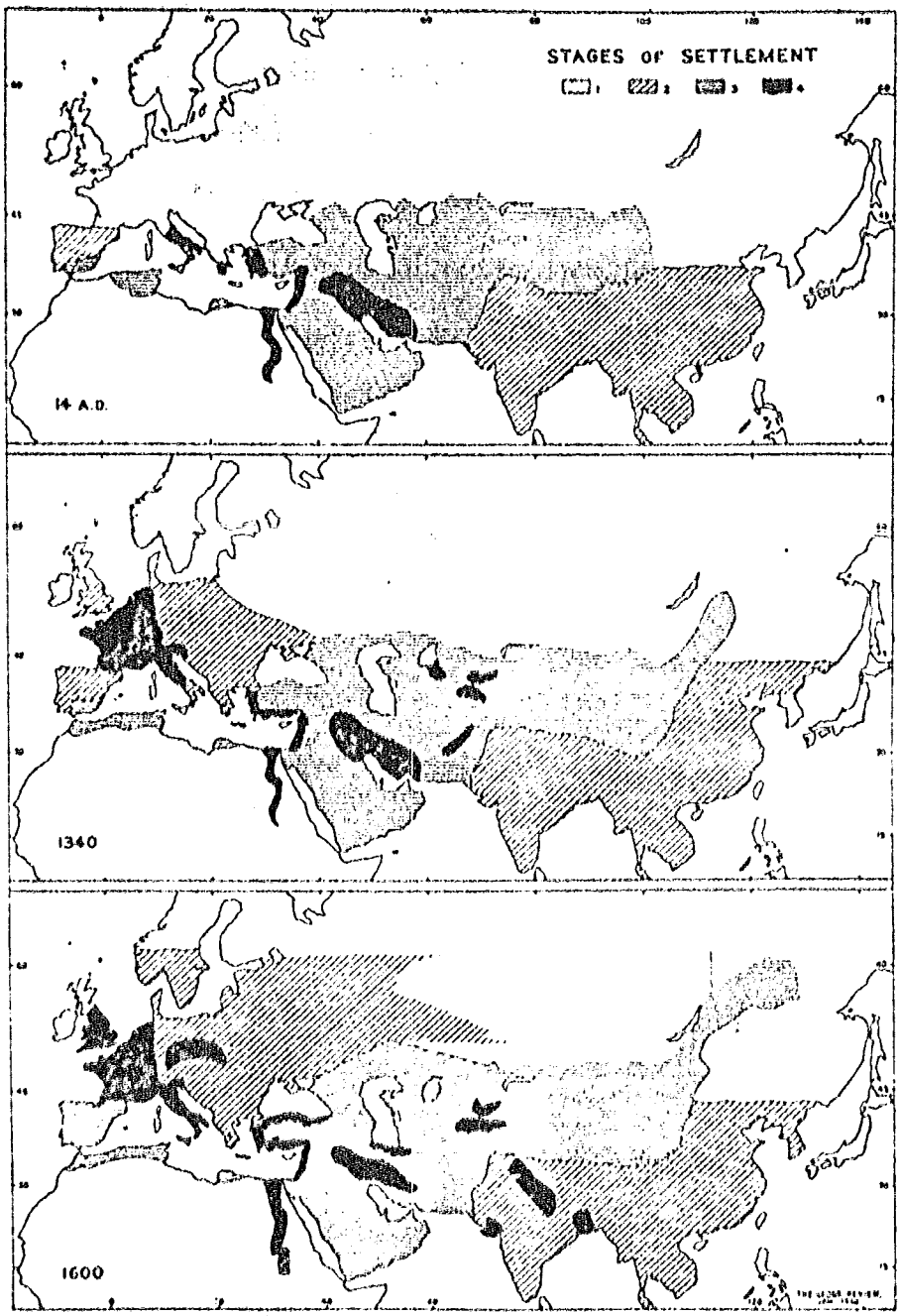
The entire territory of the Mediterranean-Middle East was the subject of population estimates at the death of Ceasar Augustus; Beloch gives the following results (65, p. 9):

Population of Roman Empire in 14 AD

Region or Roman Political Unit	Population (millions)	Density per km^2
European Mediterranean		
Italy	6.0	24
Sicily	0.6	23
Sardinia and Corsica	0.5	15
Greece	3.0	11
Spain	6.0	10
Asia		
Province of Asia	6.0	44
Rest of Asia Minor	7.0	17
Syria	6.0	55
Cyprus	0.5	52
Mediterranean Africa		
Egypt	5.0	179
Cyrenaica (present day Libya)	0.5	33
Africa (province) (present day Tunisia)	6.0	15

The growth and settlement of this region first by stages of settlement regarding maturity of civilization (by which level of agricultural and other skills was used as a general indicator) and then by attainment of high densities of population is indicated in Figure 3 (65, p. 25).

Figure 3



FIGS. 9 to 11.—Stages of settlement in Eurasia about the beginning of the Christian era, the mid-fourteenth century, and the beginning of the seventeenth century respectively. The numbers have reference: 1, frontier regions; 2, regions at intermediate stage of settlement; 3, maturely settled regions with low densities of population; 4, maturely settled regions with high densities of population.

V - EUROPE

Europe (from Spain to Sweden to Turkey) was not considered to be a primary source of origin of agriculture by either Sauer or Vavilov, except, as already noted, the Mediterranean region of present-day Greece and Turkey being the western extension of South West Asia, the site of the origin of the wheats and barleys. Hans Helbaek (1959) contended that rye and oats were introduced into Europe as weeds in the wheat field, rye coming from West Central Asia and oats probably from Eastern Europe, and that they had not been separated as different cultivated plants prior to their arrival in Europe (34, p. 371). Oats attained the status of a crop plant during the first millenium BC, and rye was brought into domestication only shortly before the birth of Christ. Helbaek did much of his investigation by means of analysis of pollen recovered from peat bogs during archaeological diggings, as well as the analysis of the contents of intestines of several neolithic corpses from different sites in Denmark.

What the agriculture of Europe was like before the westward movement of first Greek and later Roman civilization in terms of seeds and practices can be pieced together from various bits of data from diverse sources. We know, for instance, that one of the key words used to define slash-and-burn agriculture, swidden, is an old Anglo-Saxon word which has two by-forms, swithen and swivven coming from northern England (Northumberland, Yorkshire, Lancashire). Certainly the word must have described a local phenomenon. The original meaning was "burned clearing," or "to burn, sweal, or singe, as heather" (20, p. 457).

Tree bark was used as a food, presumably before the intrusion of Mediterranean cultures--the first reports in the Scandinavian countries

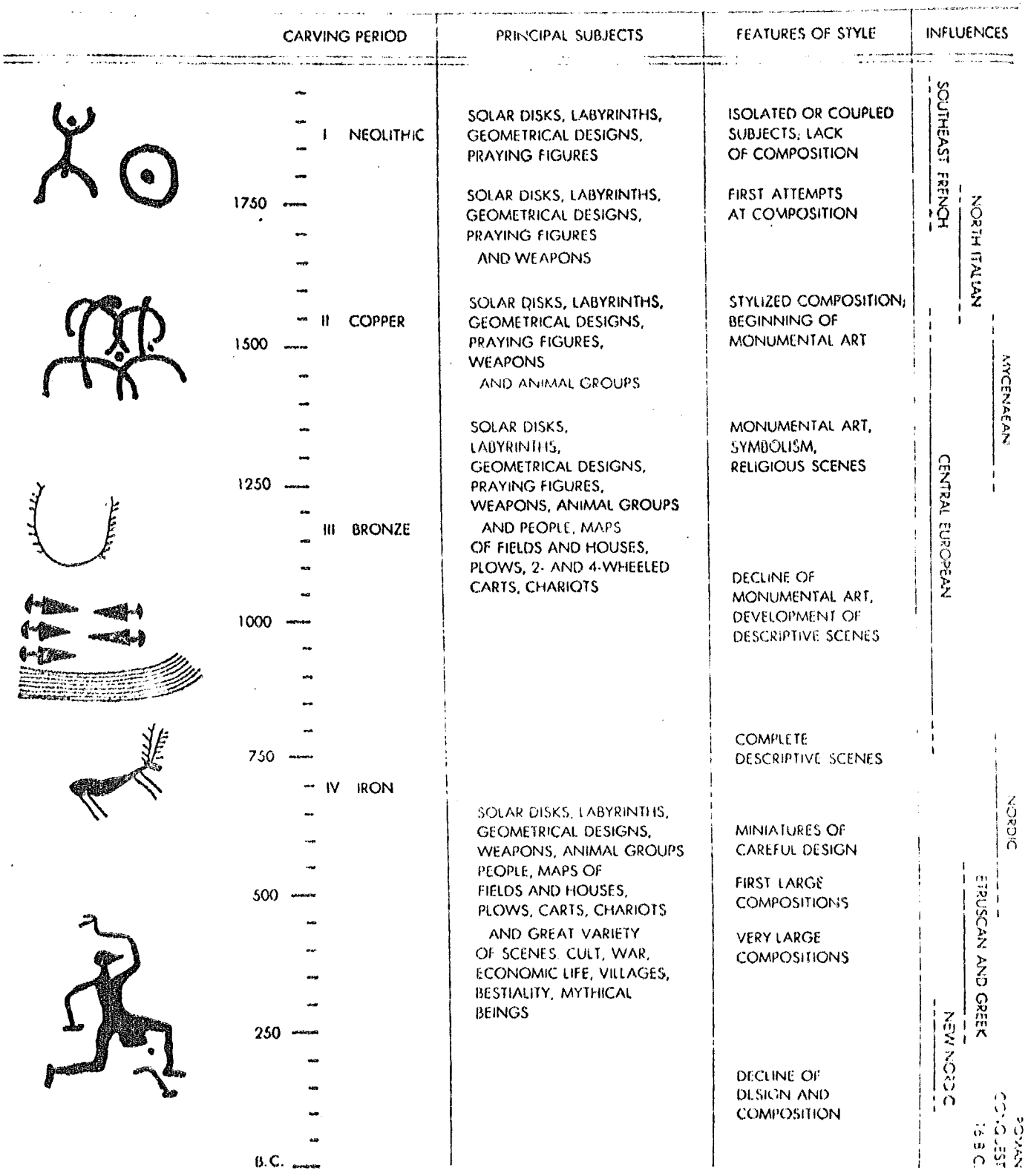
come from Plutarch, Polybius and Herodotus. The dried and crushed inner bark of certain trees, in particular the elm and pine, have been used for bread meal, despite the bad taste resulting from the difficulty of removing the resins (51, p. 301).

With the rise of the Roman Empire, and prior to its imperial expansion northward, trade began along direct north-south lines from Jutland (the mainland part of Denmark) to the Po valley of northern Italy, the main item of interest moving southward being amber, hardened resin. In fact an "Amber Road" has been postulated, passing directly through mountain passes of Switzerland and there coming into contact with several prehistoric cultures whose salient feature was their artistic ability--especially in vivid wall carvings. These prehistoric stone images reflected the level of culture of the area and have been the subject of intense investigation by Annati (1960). During the Bronze Age, the style of art broadened in range to include not only religious subjects but now also the artist added fields, plows and carts. This art can be dated by period rather successfully by noting the intrusion of Celtic themes from the north and Etruscan themes from the south. At least one Bronze Age carving shows a network of canals irrigating cultivated fields. The chronological chart (Figure 4) gives some indication of the level of agriculture depicted correlated with time (4, p. 58).

Local cultures of Northern Europeans gave way quickly to the much more systematic cultivation introduced by the Greeks and Romans in their expansion westward and northward. Changes in diet, changes in species of plants grown, changes in size of farm and tenure relations were quickly reflected throughout Europe. And so it is to the agriculture and food habits of the Greeks and Romans that we must return momentarily. It appears at first sight that the Greeks of Homeric times (very early Greece) were

Figure 4

Chronology of Camunian (Neolithic Switzerland) Art



CHRONOLOGY OF CAMUNIAN ART is charted here with tracings of carvings that illustrate changes in style. At top a male figure worships a solar disk; below it a wedding couple link arms; third is a composition with daggers; at bottom a monster gambols.

much more used to a meat diet than their successors--sheep, pigs and oxen were regularly devoured at even unimportant feasts and duly recorded by the early writers (31, p. 639). Fish is caught at the time of Homer only by those who can get nothing better to eat; bread is eaten with meat and barley meal is sprinkled over it; there is not much mention of vegetables.

In later Greece, however, farinaceous food is always regarded as the essential thing and what accompanied it (whether meat, cheese, fish or other vegetable) was always secondary. Barley made into a porridge was the most common food. Barley was first reduced to groats, then boiled together with water and olive oil. As the Greeks became vegetarians, they began to eat even the young shoots of wild plants (63, p. 63). Aristophanes even jested on the mother of Euripides being a greengrocer who palmed off an inferior thing (63, p. 63).

Marshall (1963) reviewed what is depicted as the level of agriculture in Rome from literary sources (45). The Romans placed an extremely high value on agriculture. In fact, many of the poets have come to be known as the pastoralists. In the second century BC Cato the elder wrote a treatise called De Agricultura. Later, Virgil's Georgics combined a sound knowledge of agriculture with an unrivaled poetic charm. In the early years of the empire, Columella wrote an elegant treatise on agriculture in 12 volumes, laying particular stress upon the value, to the farmer, of a thorough technical knowledge (45, p. 212).

Marshall made a broad distinction between two periods in Roman husbandry. The first was prior to 200 BC, the period of small holdings in which the small landed proprietor was the backbone of the state. Pliny notes that to be careless in the tillage of the land was an offense incurring the Censor's Ban.

In the second period, after 200 BC, there was a marked growth of large estates and the disappearance of the small proprietor. This was due evidently to the natural expansion of Rome. Since the millets could be grown more cheaply in Sicily and Africa and imported into Italy, there was an increase in the breeding of cattle and the cultivation of the vine which now became the most remunerative pursuits (45, p. 214). Cato, writing in the second century BC, noted that the vineyard was first in economic return, followed by the vegetable garden, the osiercopse (osier is a pliable willow used in making furniture and baskets), the olive plantation, the meadow yielding hay, the cornfield (here meaning small grain, not maize) and then wood and forest products for fuel (45, p. 214).

Conserving the soil had already become a matter of concern. Varro and Virgil noted that at first the "two-field system" was in effect (allowing the land to lie idle every second year) but as pressures built for more foodstuffs, the "three field system" supplanted the old (here the land lay fallow only every third year) (45, p. 215).

Population: For certain areas of Europe, much more intelligent estimates can be made than for other areas. It should first be noted that enumeration of population is very much a Judeao-Christian thing. The Lord directed Moses to "take the sum of the children of Israel" (Numbers, 1:1) and that the count was supposed to include only males "all that are able to go forth to war in Israel." It was for this reason that the fourth book of Moses is in fact called Numbers. However, Biblical treatment of the question is unfortunately not uniform. David also conceived of taking a census, but in this case, "Satan stood up against Israel and provoked David to number Israel . . . And God was displeased with this thing; therefore he smote Israel" (I Chronicles 21:1, 7).

The Athenians and the Romans took censuses for military reasons. Servius Tullius who ruled Rome from 578 to 534 BC is credited for having instituted census taking (64, p. 38). And later in medieval Europe, Charlemagne in his Breviary of 762 listed all males, as did Pepin the Short, King of the Franks in 758.

Taylor (1956) estimated that France has a population of from 4 to 5 million in the period before the Roman Empire, and at the height of the Empire (around 300 AD) the population had risen to about 12 to 15 million. His means of making these estimates was to use figures supplied by Raetzel which indicated approximately the population density that could be supported by various cultural levels (62, p. 44):

Type of Economy	Density Supportable
Pure collectional economy	3-6 persons per hundred square miles
Hunting and agriculture	0.5 to 2 persons per square mile
Pastoral economy	5 persons per square mile
Settled primitive agriculture	5-15 persons per square mile

With the disappearance of central government and the breakdown of many forms of social overhead capital such as roads, distribution systems and markets, the level of population sank back to approximately 6 to 8 million in France by the 8th century (62, p. 44).

Levasseur, working largely from detailed administrative records, gave the following estimates of population in France (35, p. 371):

1050 AD	7 million
1328 AD	20 to 22 million

For England, Taylor estimated that before the Roman conquest, the population was a little below 1 million; at the height of the Roman Empire, it had risen to about 4 to 5 million, and after the collapse of the Roman Empire, about 800 AD, it had sunk again to 1 million.

According to the Domesday book in 1086 and other sources of reasonable accuracy, the following can be considered to be good estimates during medieval times (62, p. 46):

Population in England	
1086 AD	1.8 million
1485 AD	2.7 million

The major factor influencing population levels from the end of the Roman Empire until the Renaissance was not, however, presence or lack of presence of centralized government coupled with a complex organization of society with food distribution systems subject to massive breakdown. Rather it was disease, the plague. The plague exists in two forms, bubonic and pneumonic, the former attacking the lymph glands causing them to swell and abscess and the latter being an invasion by baccilli into the respiratory organs encouraging the development of pneumonia. Both ravaged Europe. After the Ostragoths had conquered Rome and precipitated the decline of Roman civilization, the plague invaded in 532 AD coming from the east through Constantinople during the reign of Justinian I (59, p. 113). A large section of the European population was wiped out. Moreover the effect was complicated by a parellel outbreak of smallpox.

From 1315 to 1317 Europe again experienced one of its periodic devastating famines, but this time it was followed shortly, in 1348, by the Black Death--bubonic plague--which again came from Asia, moving first westward, then north into northern Europe and finally turning eastward again into Central Europe. Estimates of the casualties vary from 20 to 40 million. It is entirely possible that Europe lost between one fourth and one third of its entire population (59, p. 115).

The figures cited above, computed by Levasseur and others, point to remarkable increase in population from 1050 until the time of the Black

Death. Helleiner, writing in 1949, surmised what the population of three of the largest language groups would have been in 1650 had population continued growing at the rate experienced during medieval times (35, p. 372):

Country	Projected Population in 1650	Actual Population in 1650
England	13 million	5 million
France	60 million	20 million
Germany	36 million	20, 21 million

The difference was due entirely to the Black Death.

VI - ASIA

De Candolle concluded that the following plants were of Asian origin (23, p. 437):

a. Cultivated for their subterranean parts--the radish, taro, and the family of yams.

b. Cultivated for their stems or leaves--the Chinese cabbage, New Zealand spinach, and amaranth among the vegetables; for other uses, the following: tea, jute, indigo, cinnamon, sugar cane and the white mulberry.

c. Cultivated for their fruits--the citron or lemon, oranges, mandarins, the mangosteen, jujube, mangoes, apricots, peaches, rose apples, the cucumber, the melon, various gourds (the bottle gourd, towel gourd, the snake gourd, etc.) kaki, the date plum, bread fruit, jack fruit and the banana.

d. Cultivated for their seeds--the litchi, the longan, the rambutan, soy bean, notch-seeded buckwheat, Italian millet, and rice, as well as the following plants used for other purposes than as

food: herbaceous cotton, sesame, nutmeg, black pepper, long (chili) peppers, areca nut and cocoa nut.

In his earlier writings Vavilov was primarily concerned with the origins of the small grained crops and did not adequately consider greater Asia except to discuss briefly two basic centers of domestication, roughly South Western and South Eastern Asia. We have already considered Vavilov's South Western Asia in our discussion of Persia and the farther reaches of the Mediterranean. To South Eastern Asia Vavilov assigns hullless barley, millet, soy bean, many of the Cruciferae and "a series of endemic fruit trees" (66, p. 242).

In his work of 1927 Vavilov ammended his original list of centers of domestication to add an Asiatic island center comprising Japan, Java, and Sumatra, although he did not discuss either of the following points: what crops were domesticated there, and whether any link could be established between what happened in Japan and the rise and spread of agriculture throughout the Malay archipelago (the present writer suspects no connection) (67, p. 425).

Later Vavilov decided to redraw his maps and further partition Asia. See Figure 1.

Burkill, in reviewing the work of Vavilov, compartmentalized Asia in a slightly different manner, reasoning that not only must the natural barriers of mountain ranges and deserts be taken into account, but also defined limits of the invasion and movements of man, thus suggesting the geographical partitions given in Figure 5 (11, p. 255).

Fault must be found with this differential method of finding centers of gene diversity and concluding that these are centers of domestication: the fault is that of taking the whole of the evidence from plant and disregarding the cultivator. The two centers of China and the Malay archipelago can be seen to be distinct not only from India but from each

Figure 5

Compartments of Origination

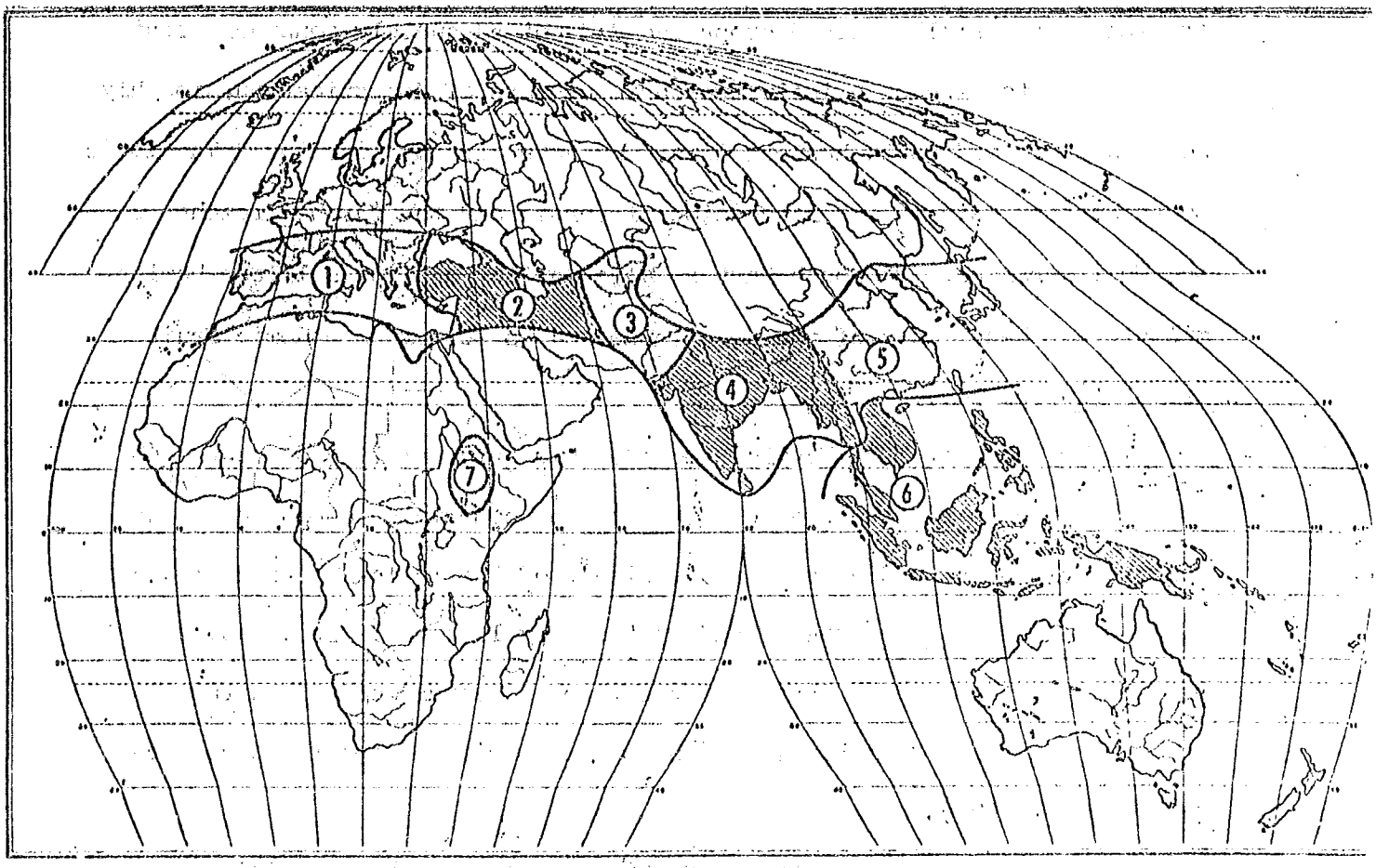


FIG. 3. Compartments of origination, being the political units named by Vavilov as holding his centers. [Base map courtesy of Goode's Map Serie

other by the relative importance of fruits and tree crops in the early stages of agriculture in China and Malaysia, and the complete distinction between the temperate and tropical tree crops domesticated. "Nothing proclaims the originality of Chinese agriculture more than their resort to silk as a fibre," stated Burkill, who later went on to add "the Chinese were fruit tree minded before the Latins . . . the earliest record of the cultivation of a Chinese fruit tree is Mencius' undoubtedly late mention of the mulberry in 'happy the peasant in possession of a few mulberry trees about his dwelling that he may clothe his parents in silk'; for Mencius died in 289 B.C." (11, p. 269).

Movements of other crops into China from other centers of domestication occurred very early, according to Sauer, (57, p. 33):

> South Chinese agriculture and that of Japan are advanced developments stemming from the original hearth to the south. Rice, bamboos, bananas, taro, persimmons and yams, brought originally from India or Indochina, were greatly remade and diversified by man in East Asia before we can speak of either Chinese or Japanese peoples. Rice for example, contrary to Chinese classical lore, is known from Neolithic settlements of North China . . . the planting culture, spreading from the South, set the dominant pattern northward beyond the Yangtze and across southern Japan.

In previous chapters we have discussed whether agriculture began with sexual or asexual reproduction of plants--planting of seeds (usually cereals) or of shoots or cuttings. Burkill found that the autochthonous development of agriculture in China was neither really with the cereals nor with the pulses but rather the greens. The originality of the development was consequential on the very unkind climate of the northern spring, at which time very cold and very dry winds sweep down from the cold pole in eastern Siberia and prevent the renewal of growth in the vegetation while an enduring grey dust storm shuts the sun out . . . The Chinese had taken to eating seedlings . . .the soya bean; others that they eat today include the broad bean, . . . seedlings of the labiate Perilla ocimoides, of the composite Aster indicus[1/] and of both species of Fagopyrum[2/]" (11, p. 268).

China was faced early with the problem of social organization and ownership of land because of the continuing problem of water. Chi Chao Ting in his work Key Economic Areas in Chinese History discussed the difference between north and south China in the early problems of irrigation. The most important cradle of early Chinese civilization is in the area embracing the provinces of Shansi, Honan, Southern Hopei, Western Shantung and Northern Kiangsu, rougly northern China, an area containing more loess than alluvium (14, p. 13). It is this continuous

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1/ The astor flower.

2/ Buckwheat.

semi-steppe, stretching from the sea to Turkestan, free from both forest and marsh and favorable to agriculture, that made early settlement and continuous diffusion of culture possible.

In South China, in the alluvial plains, there are authentic records showing that as early as the Earlier Han dynasty (206 BC to 25 AD) Chinese peasants knew the value of silt as a fertilizer. In about 95 BC after completion of the Po canal which conducts the silt-laden water of the Ching river to a large agricultural area in the heart of modern Shensi province, the peasants of the region sang in its praise (14, p. 16):

"A tan of Ching water contains much silt
It irrigates and it fertilizes
It makes your crop grow
It feeds millions in the country's capital."

In South China water control meant facing a two-fold problem, that of regulating water supply and also that of augmenting soil fertility. But here, as contrasted with North China, not only were inundation canals necessary, but also canals to drain the surplus water, especially from swampy areas and at times even lake bottoms for the cultivation of rice. At a time when many other cultures in the world were just beginning to settle and begin agriculture, the Chinese were moving into the field of public works. There are numerous accounts of public works for water control which Chi compiled into the following table (14, p. 35):

Major Irrigation Projects in History of China

Dynasty	Date	Total Irrigation Works Projects
Spring and Autumn	722-481 BC	6
Warring States	481-255 BC	8
Chin Dynasty	255-206 BC	1
Han Dynasty	206 BC - 221 AD	56
Three Kingdoms	221-265 AD	24
Tsin	265-420 AD	16

Legend has it that the very first public works engineer was the man Yu (somewhere between 1122-770 BC) who is cited in a famous story by Mencius, translated by James Legge (14, p. 48):

> In the time of Yao, when the world had not yet been perfectly reduced to order, the vast waters flowing out of their channels made a universal inundation. Vegetation was luxuriant, and birds and beasts swarmed, the various kinds of grain could not be grown . . .
>
> Yao raised Shun to office and measures to regulate the disorder were set forth. Shun committed to Yu the direction of the fire to be employed and Yu set fire to and consumed the forests and vegetation on the mountains and in the marshes so that the birds and beasts fled away to hide themselves.
>
> Yu separated the nine streams, cleared the courses of the Tsi and Ta and led them to the sea. He opened a vent for the Ju and Han and then regulated the course of the Hwai and Sze so that they all flow into the Chiang. When this was done it became possible for the people of the Middle Kingdom to cultivate the ground and get food for themselves.

The period of the Warring States (481-225 BC) witnessed a tremendous technical as well as social revolution that finally ushered China into the ensuing epoch, the semi-feudal period of its history. The beginning of the Iron Age, the use of oxen to pull the plough, the increasing application of animal fertilizer and the conseqeunt revolutionary growth in the productivity of labor in agriculture played havoc with the ancient communal land system and gradually brought about private land ownership. This can be dated by the beginning of the institution of a tax on each mau (about 1/8 acre) of land in 594 BC (14, p. 62). It no longer mattered whether land was "public" or "private" as in the previous tenure arrangement. All land became private. This cut the string which tied the feudal lords to the routine of production and freed them from concern over the harmful effects of protracted and large-scale forced labor on agricultural production. Thus the revolution in the land system created the conditions in China for large scale mobilization of forced labor and made possible the construction of large public works for water control.

India's neolithic technology, including agriculture and domesticated animals, dates from perhaps 7000 years ago (22, p. 23).

The two archaeological sites of Harappa and Mohenjo-Daro are well known to students of the subject, but unfortunately we are faced with an accomplished fact and there exist few clues as to either the genesis or the reasons for demise of these remarkable city states. Sir Leonard Woolley concludes that they are definitely not of Sumerian origin (71, p. 88). The inhabitants of these cities lived largely no doubt by agriculture; the specimens of wheat found resemble the common variety grown in the region today (22, p. 23). The civilization matured fully and then proceeded to stagnate; the buildings were destroyed by floods and rebuilt time after time. The people were gradually impoverished, a fact to which the upper levels of buildings gives eloquent witness. The final complete destruction came at the hands of the Aryan invaders around 1500 BC. The Aryans were both an agricultural and pastoral people who understood the principles of manuring and used the animal drawn plow.

Buddhistic literature indicates that between the 7th and 4th centuries BC the economy of Northern India was comparable to that of later Middle Ages in Europe: money and credit were everyday instruments (22, p. 24).

Merrill (1942), interested in a more recent period (that of the early spice trade between the Malaysian archipelago and early Europeans), was able to shed some light on the early movements of plants in South East Asia. The spices in which Europeans were interested were, of course, pepper, nutmeg, clove, and cinnamon; the various exotic fruits which were found by early explorers were the mangosteen, mango, rambutan, lansone, durian, banana, rose apple, malay apple, orange, lime, pomelo and the citron or lemon. A linguistic investigation interestingly enough shows that many of these plants derive their Malaysian term from a Sanskritic (early Indian) word. In particular, Merrill gave the following examples (48, p. 74):

English Word	Malaysian (here including words appearing in Malaya, Philippines or Indonesia)	Sanskritic
Basil	Telasih, Selasi	Tulasi, Tulashi
Pepper	Malisa, Marisano	Maricha
Safflower	Kachumba, Kasoba	Kasumbha
Cotton	Kapas, Gapas	Karpas
Pomegranate	Dalima, Talima	Delum
Ginger lily	Dansuli, Mandasoeli	Gandasuli
Watermelon	Karambodja, Kalambosa	Tarambuja

This would seem to be a clear indication of the movement of these plants from India (or in general, South Asia) into Southeast Asia. Sauer, on the other hand, proposes that the general region of Southeastern Asia is the cradle of earliest agriculture (57, p. 24). Moreover, he identifies this earliest center strongly with asexual plant reproduction; monsoon man gave continual attention to the individual plant and inattention to its sexual seeds. The list of such manmade cultigens stemming from this region is large, most important being the banana. The homes of the two major types of yams are thought to be the east side of the bay of Bengal and Indochina (11, p. 276). Moreover, most all of the palms have moved radially outward from this area, being greatly altered by man in the process. Rice, on the other hand, is thought to be a much later cultivated plant, coming most probably from India. It has even been suggested that "rice was originally a weed in taro fields; in weeding it was replanted elsewhere and a grain crop was produced, with partial retention of the vegetative planting habits" (57, p. 28).

Population in Asia

How to treat the growth of population in Asia and make a comparison of growth of civilization and level of agricultural technique is a problem.

For most of Asia we are confronted with no data (save a few guesses) with the exception of China. Here the problem is clearly one of far too much data, painstakingly collected and recorded and absolutely confusing. It is easiest to start with the other parts of Asia and come lastly to China, for which, thankfully, a tremendous amount of revision and appraisal has been done, in order to get some clear idea of what the population trends really were.

Kingsley Davis noted a source which gave an idea of what Alexander's army encountered when it invaded India in 327 BC. One small kingdom had 37 towns of over 5000 inhabitants (22, p. 24). Pran Nath estimated that around 300 BC the population of India was between 100 and 140 million (53, p. 268). If this information is accepted, and compared with an estimate of the population of the Indian subcontinent of 100 million in 1600 AD, an estimate of Moreland (1920) and confirmed by Chandrasekhar (1949) (53, p. 268), then one comes to the conclusion that the population must have declined rather than increased during this approximately two thousand year interval.

Pran Nath (the pen name of Pranantha Vidyalankara) made his estimate from a thorough investigation of Sanskritic, Buddhist, Greek and Hindu records dealing with war strength, administrative and feudal organization and population and the size of the individual cultivated estates (53, p. 268).

Until an investigator with different records or different means of investigation is able to give a better idea, his estimate will have to stand unchallenged.

The area of Asia which must be dealt with most seriously is Northeast Asia. Here finally we come to the area with the longest record of actual tabulations that can be called censuses. In an enumeration of about the

11th century BC, the population of China was recorded as 13,714,903. Or else it was 17,304,923 (28, p. 209). Clearly, as Durand, the analyst of these figures acknowledges, the transcriptions are garbled due to the extreme primitiveness of the writing system of the time, and lack of explanation of who was being counted. Another census, equally unreliable, in 680 BC showed a population of 11,841,923 or variants thereof. Taylor, in discussing the same data, concluded that an estimate of something of the order of 15 to 18 million could be accepted for the time of Confucius (ca. 500 BC) for an area covering 30% of modern China (62, p. 47). Much of the material appeared in the Wen-hien t'ung kao, the population records which have been successively worked over by deomgraphers such as Lao Kan, W. Eberhard and L. Giles. Lao and Eberhard assumed that they were tax lists, but Giles asserted that they recorded all individuals (8, p. 125). Bielenstein, on the other hand concluded that they are neither exclusively tax lists nor correct censuses (8, p. 156):

> Unfortunately most examinations of population history of China have been based directly on such collocations which have caused the authors to find enormous, in reality, non-existant variations. One must have a comically naive belief in the fighting parties bestiality and blood thirst to assert that An-Lu-Shan's rebellion in 755 AD should have reduced the population of China from 51.5 million to 17 million. In reality the dropping figures reveal the fact that the authorities preferred the simpler taxation registration immediately after the rebellions until the administration had been put in order again.

Below are given the comparative estimates from different sources, Durand being accepted by this writer as the most thorough and inclusive of all the sources available (28, p. 221; 8, p. 156; 15, p. 64):

Population in China
(millions)

Year	Durand		Bielenstein	Clark
	Empire Total	China Proper		
2 AD	74	71	57	
14 AD				73
105 AD	55	53		
140 AD	58	56	48	
156 AD	64	62		
350 AD				60
600 AD				54
606 AD	54	54		
609 AD			54	
705 AD	37	37		
732 AD			51.5	
755 AD	53	52		
800 AD				55
1000 AD	55			55
1100 AD	120			
1200 AD	125			123
14th Century	65			
1350 AD				62
1500 AD				100

In analyzing the above data, we must remember that each of these researchers has had the advantage of each other's data; this explains the high correlations. Two periods are of exceptional interest: around 705 AD and during the 14th century. Sacharoff, in the Imperial Russian Embassy to Hong Kong, in 1864 wrote that the major problem during the 7th and 8th centuries was religion, not famine (56, pp. 19-21):

> Unusually heavy rains in the year 682 occasioned a great famine and the price of food rose 100%. This was followed by a general epidemic which carried off a large number of the people. Still the population increased. Another obstacle to the increase of the population was the rapid spread of Buddhism, whose adherents, partly from a pious zeal and partly from an aversion to the crown service, entered the monasteries and nunneries. For the suppression of this evil, the government compelled (in AD 845) more than 265,000 persons of both sexes to enter the world again. Still the population would not increase. This was owing to home and foreign wars, to scarcity of food and bad administration. At the end of the Tang dynasty (in AD 907) the number of the population was three million less than at the beginning.

An interesting deterministic view, to say the least. The validity of Sacharoff's conclusions bears further investigation, which, unhappily is beyond the scope of this paper. China, during the other period of concern, the 14th century, is seen by Durand to have decreased in population due to the incessant fighting and bitter hardships which marked the last phase of Mongol rule, and especially the pandemic of bubonic plague which seems to have raged no less fiercely in China than in Europe (28, p. 233).

In Japan, census returns were taken from ancient times. Historical traditions frequently tell of partial censuses after 86 AD. In the era of recorded history, the Imperial order of 645 AD first provided for this task in a systematic manner and arranged to have the census taken every six years. However, most of the records were burned or destroyed after 30 years by government decree. Of all the surviving records (which as in the case of the Chinese statistics, show many conflicts) reasonable estimates were selected by Yoshikiyo Yokoyama and Togo Yoshida and appear in the following table (38, p. 3):

Population in Japan

Date	Population
823 AD	3,694,331
859-922 AD	3,762,000
990-1080 AD	4,416,650
1185-1333 AD	9,750,000
1572-1591 AD	18,000,000

An interesting comparison was made by James Murdoch to show that by 1580 Japan was actually much more heavily populated than many nations of Europe, a significant fact attesting to the high ability of agriculture to feed large numbers from a seemingly poor base (38, p. 5):

Population Comparisons by Country
(ca. 1580)

Country	Population
Japan	18,000,000
Domain of House of Austria	16,500,000
France	14,300,000
Spain	8,150,000
England	4,600,000

The rough conclusion can be drawn that Asia, the cradle of agriculture was able to sustain a rather high level of population very early. Not only the fact of agriculture (rather than hunting, fishing or food gathering) but also the social organization was important--the ability to move beyond simple agriculture into forms of relationships between men that allowed labor to be accumulated in large amounts for large productive projects such as irrigation canals. Not only the social organization but also the administrative ability coupled with some technical knowledge was important. But our knowledge of the interactions between level of civilization and level of development of agriculture allows only our elementary conclusions. Else would be conjecture.

VII - WORLD POPULATION: SUMMARY

A number of researchers have ventured to give their best estimates of population which are presented in the table below (7, p. 9; 15, p. 64; 25, p. 196; 37, p. 64; 53, p. 17):

Estimates of World Population From Several Sources
(millions)

Period	Bennett	Clark	Deevey	Huxley	Putnam
Lower Paleolithic	-	-	0.5	-	-
Middle-Upper Paleolithic	-	-	2.0	-	-
10,000 BC	-	-	-	-	1.0 (from 0.1 to 10)
8,000 BC	-	-	5.3	-	-
6,000 BC	-	-	-	20	-
1 AD	-	256	133.0	more than 100	275
700 AD	-	-	-	-	270
1000 AD	275	280	-	-	285
1200 AD	348	384	-	-	-
1340 AD	370	378	-	-	-
1400 AD	373	-	-	-	-
1450 AD	413	-	-	-	375
1500 AD	446	427	-	-	-

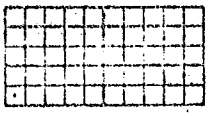
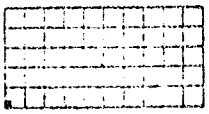
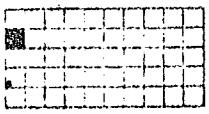
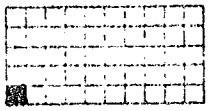
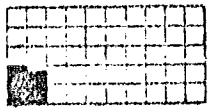
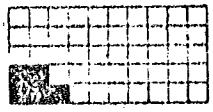
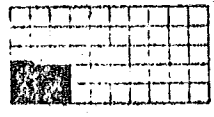
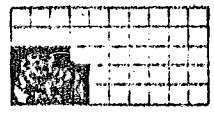
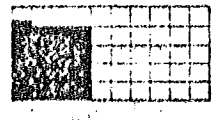
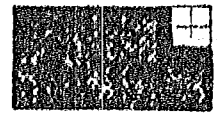
Most interesting are the various estimates of population density which have been made for various types of economies, for these give us some clear indications as to the increased levels of population that the advent of agriculture allowed. Taylor cites the figures of Ratzel for the following (62, p. 44):

Pure Collectional Economy	3-6 persons/100 square miles
Hunting and Agriculture	0.5-2 persons/square mile
Pastoral Economy	5 persons/square mile
Settled Primitive Agriculture	5-15 persons/square mile

These contrast with the Braidwood and Reed estimates for the archaeological sites in the Mid-east of 9.7 and 15.4 persons per square kilometer, which would be converted to 24.8 and 39.4 persons per square mile. And a further contrast can be made by extracting the assumed density per square kilometer from Deevey's chart (Figure 6) for the periods of 6000 to 2000

Figure 6

Cultural Stages Correlated with Area Populated and Population Density

YEARS AGO	CULTURAL STAGE	AREA POPULATED	ASSUMED DENSITY PER SQUARE KILOMETER	TOTAL POPULATION (MILLIONS)
1,000,000	LOWER PALEOLITHIC		 .00425	.125
300,000	MIDDLE PALEOLITHIC		 .012	1
25,000	UPPER PALEOLITHIC		 .04	3.34
10,000	MESOLITHIC		 .04	5.32
6,000	VILLAGE FARMING AND EARLY URBAN		 1.0 .04	86.5
2,000	VILLAGE FARMING AND URBAN		 1.0	133
310	FARMING AND INDUSTRIAL		 3.7	545
210	FARMING AND INDUSTRIAL		 4.9	728
160	FARMING AND INDUSTRIAL		 6.2	906
60	FARMING AND INDUSTRIAL		 11.0	1,610
10	FARMING AND INDUSTRIAL		 16.4	2,400
A.D. 2000	FARMING AND INDUSTRIAL		 46.0	6,270

years ago, during which time he assumed densities of 1.0 persons per square kilometer in the Old World and 0.4 persons per square kilometer in the New World, which convert to 2.6 persons per square mile and 1.1 persons per square kilometer (25, p. 196).

Clearly there is no resemblance between the figures. It seems probable that the discrepancy lies in the geographical area being considered, that is to say, whether land occupied or thought to have been controlled is the basis for the density figures, or else land actually utilized.

E. S. Deevey, in two articles (24; 25) attempted to synthesize the data into coherent patterns. Estimates of maximum possible population density were correlated by him with level of agricultural technique and are indicated in Figure 6 (25, p. 196).

From a biological point of view, agriculture allowed a larger level of population simply because of the more direct utilization of carbon which is combined into usable form by living matter. The following four levels of economy, hypothetical but plausible, will serve as examples (24, p. 106):

Primitive lake fishing culture: The lake itself produces about 300 grams of plant carbon per square meter per year. Tiny animals such as copepods utilize about 10% of that and larger fishes such as pickerels use about 10% of that, and man assimilates and uses about 10% of the carbon in the larger fishes. Net result: man uses about .03 grams produced per square meter.

More advanced ocean fishing culture: Here the chain of predation is likely go be shorter, according to Deevey, so that a more direct use of the carbon is made. Hypothetical result: man uses about .3 grams produced per square meter.

Hunting Culture: Here again the supply of plant carbon is the same, but it is eaten by insects as well as by other animals. The supply of catchable animals such as rabbits, therefore, utilizes only about 1 percent of the plant carbon, i.e. 3 grams.

Agricultural Society: Here plant production is about the same per square meter as in the cases considered above, but because the plants are directly utilized by the society, the human crop can consume about 30 grams per square meter.

In the above pages, we have considered the following evidence: early indications of level of techniques in agriculture, probable locations for the origin of domestication of plants, probable sites of the origin of agriculture, and to a small extent, the direction of movements of many major plants of interest before the transportation from continent to continent by the European during his Age of Discovery. We have attempted to correlate the rise of agriculture in each case, where possible, with rises in the level of population. It isohoped that new and fresh sources of information can be brought to bear upon this field of inquiry.

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