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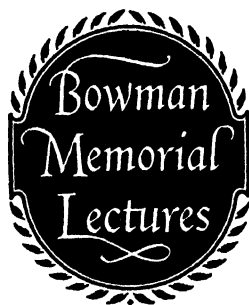
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*AGRICULTURAL ORIGINS
AND DISPERSALS*

BY

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Foreword

The Isaiah Bowman Memorial Fund was established by Mr. Archer M. Huntington as a permanent trust, the income to be used for such purposes as the Council of the Society may deem most fitting. At the meeting of the Council held on February 15, 1950, it was decided to apply the greater part to the institution of a series of lectures to be delivered at intervals by distinguished scholars on subjects to be chosen from the wide range of Dr. Bowman's interests.

The first of the series, "Geography, Justice, and Politics at the Paris Conference of 1919," given in 1951, by Charles Seymour, President Emeritus of Yale University, reflected Dr. Bowman's concern with political man and his world. The second series was given by Carl O. Sauer, Chairman of the Department of Geography, University of California, Berkeley, in the Harkness Theatre of Columbia University, New York City, on January 29 and 30 and February 1, 4, and 6, 1952. It reflects an aspect of Dr. Bowman's interest in pioneer man—in this instance, literally the pioneer of a new world. Not only in theme but in approach does it reveal the fresh, inquiring spirit of the pioneer. Such a lecture series as this primarily looks to the far horizons. As Professor Sauer himself expresses it: A senior scholar reviews the status of knowledge in a field of his major interest and sketches the frontiers on which he sees good prospects of new learning. He does not try to give a well-polished abstract of accepted learning, as much as a prospectus of that which is not securely within our grasp.

Contents

	PAGE
Foreword	iii
<i>Chapter I</i> Man—Ecologic Dominant	1
<i>Chapter II</i> Planters of the Old World and Their Household Animals	19
<i>Chapter III</i> The Planters of the New World	40
<i>Chapter IV</i> Seed and Harvest	62
<i>Chapter V</i> Herdsmen and Husbandmen	84
 <i>Plates</i>	 facing
I Old World Planting and Household Animals	26
II The Two Agricultural Systems of the New World	42
III Domestication and Dispersal of Seed Plants and Herd Animals in Southwest Asia and Northeast Africa	74
IV Hearths of Domestication. Limits of Agriculture and Milking About 1500 A.D.	84

I

Man—Ecologic Dominant

On Time as a Dimension of Geography

The focused curiosity that bears the name “geography” is or should be aware not only of the dependence of life on the physical environment, but also of the interdependence of living things in a common habitat, or of total ecology. The complete geographer must always be learning about the skills that men employ and about the objects, living and inanimate—total environment—to which such skills are applied. He is interested in discovering related and different patterns of living as they are found over the world—culture areas. These patterns have interest and meaning as we learn how they came into being. The geographer, therefore, properly is engaged in charting the distribution over the earth of the arts and artifacts of man, to learn whence they came and how they spread, what their contexts are in cultural and physical environments.

We are dealing in large part with observations of the present that originated in a past which does not come again, or which cannot be verified experimentally. We may, in fact, both as to nature and culture, be making reconstructions of past scenes and acts greatly different from what is now. We use the testimony of eye witnesses if we can find such, and also whatever circumstantial evidence that can be brought to bear on the reconstruction. Time, changing in tempo and usually non-recurrent as to mode, spreads a veil we can never fully lift. Yet, if we are trying to learn about the changing, man-inhabited world, human geography must take the risks of interpreting the meet-

ing of natural history and cultural history and that, perhaps, is as much of a definition as we need. Our problems have four dimensions and we cannot simplify them by, or as, academic abstractions.

I like that expression, the meeting of natural and cultural history, partly because I prefer natural history with its sense of real, non-duplicated time and place to ecology, and culture history for the same reason to sociology or social science. The things with which we are concerned are changing continuously and without end, and they take place, for good reason, not anywhere, but somewhere, that is in actual situations or places. That succession of events with which we deal is quite other than the conceptual models that are set up as regular, recurrent, or parallel stages and cycles. Such have been much liked by students both of plant and human ecology. Among geographers, William Morris Davis delayed somewhat our learning about the physical earth by his systems of attractive but unreal cycles of erosion, with their stages of youth, maturity, old age, and rejuvenation. Plant ecology also has been affected by Davisian views. Such concepts are sometimes, but improperly, called "evolutionistic." Actually, evolution operates by continuing variation and divergence. It does not return to a previous condition, and rarely rests. I shall—on several occasions—argue against parallel recurrence and for accumulating divergences.

Man alone ate of the fruit of the Tree of Knowledge and thereby began to acquire and transmit learning, or "culture." With each new skill he found in his surroundings more opportunity, or "resources," to fashion products of use to himself, to improve his well-being, and to increase his numbers. An environment can only be described in terms of the knowledge and preferences of the occupying persons: "natural resources"

are in fact cultural appraisals. Occasionally, a new idea arose in some group and became a skill and institution. Such innovation might bring out new possibilities of the homeland; it might also give competitive advantage over neighboring folk, and set in motion pressures eased by migration.

There is no general law of progress that all mankind follows; there are no general successions of learning, no stages of culture, through which all people tend to pass. There have been progressive cultures and others that show almost no signs of change. The latter are to be found in areas of high isolation; the former have been favored by the nature and location of their homelands. The parallel to biologic evolution is significant. Invention begins by small increments of insight, variant ideas that gain acceptance under a favorable cultural climate. Variation follows on variation and may build up into a significantly new way and view of life. Now and then, in a few and, I may repeat, physically favored areas some such center has burst forth into a great period of significant invention, from which ideas spread, and in part changed as they spread afield. These centers of major and sustained innovation were always few. In the history of man, unless I misread it greatly, diffusion of ideas from a few hearths has been the rule; independent, parallel invention the exception. The identification of such creative culture hearths is the topic of this discourse, in terms of the domination by man of other organisms.

As artificer of cultural change, man has become increasingly powerful in modifying the plant and animal world surrounding him. The history of mankind is a long and diverse series of steps by which he has achieved ecologic dominance. He has intervened, with and without design, to increase and decrease, to expel or exterminate and to introduce, to modify and even to originate organic entities. Largely he has prospered by dis-

turbing the natural order. Often, however, he overreaches himself and the new order he has introduced may end in disaster. As man became civilized he has grown more and more inclined to consider the earth as made for him to inherit, himself as the claimant of an anthropocentric order; he has come to believe in an ever-expanding system that places no limits upon himself other than his individual mortality. Often his capacity to know good from evil has been warped by the energy of his activities, his knowledge giving him powers which he has lacked the wisdom to control. Our own time has its prophets of progress unlimited in numerous social and physical scientists who speak of remaking the world. It may be proper, at this time of dizzy cultural change, to regard our past record as modifiers of the organic world.

A Personal Note

My own experiences have been almost wholly with the New World. By chance and choice I have turned away from commercialized areas and dominant civilizations to conservative and primitive areas. I have found pleasure in "backward" lands, where the demands of industry for materials and markets are little felt. In terms of the ever unsatisfied world economy these are the "underdeveloped areas" that are to be made over and thereby to lose their own ways and values. It is to these, thus far happily undisturbed places, that recollection turns, under whatever skies they lie, for a comparative reading of cultural processes and contexts elsewhere and of other times.

My first field season, of 1910, was in the Upper Illinois Valley. Some of these early observations raised questions that have come back elsewhere again and again to occupy my mind. The upland mantle of loess introduced me to the problems of Ice-Age climates. The prairies that extended across the uplands to the margins of the valleys posed the question of grassland

ecology. Indian fields and those of the pioneer whites, always situated within the woodlands, started an interest in the nature of primitive cultivation. What I wrote then about industrial location and such matters I have long since forgotten, but as to these three items, that valley of forty years ago is still green in my memory. They were the starting point from which trails have led in later years into different and distant parts.

The Primordial Habitat

As to the primordial home and nature of man we have a few clues. He is less specialized in his physiology than the apes; in particular he is able to eat a wide range of foods, suggesting that a great diversity was available to him. This wide feeding capacity predisposed him to experiment with different foodstuffs. Neither heavy forest nor open grassland was suited to his earliest state. A peculiarly long and helpless infancy argues against the view that our kind began as roving bands. His water needs are high and frequent, requiring certain cultural skills before he could penetrate lands of drought.

The earliest homes of our kind are to be sought in tempered climes, not heavily forested, places either on the outer margins of the tropics or elevated above the rain forests. Such mesothermal climates have opposed rainy and dry seasons, with growing and resting periods of vegetation, and with times of greater and less abundance of food. Our ancestors may therefore not have begun as improvident fellows, alternating between feast and famine. Storing food in times of plenty against a time of want may be an original human trait, as it is for many animals. The cradle of our race may well have lain in what would still seem to us pleasant places, of mild weather with alternating rainy and dry seasons, of varied woodland, shrub and herbs, a land of hills and valleys, of streams and springs, with alluvial reaches

and rock shelters in cliffs. Our place of origin was one of invitation to the well-being of our kind.¹

Ice-Age Climates and the Spread of Man

If we are now living in an interglacial stage, as seems likely, the whole documented span of human existence falls within the Ice Age. Never, in so far as we know, has the earth undergone more extreme and recurrent climatic changes. The old concept of Ice-Age weather based upon the simple equation of low temperatures and glaciation, rising temperatures and deglaciation, is now being replaced by an adequate dynamic interpretation.² When the general circulation of the atmosphere produced large north-south exchanges of air masses, ice caps formed in high latitudes through the poleward thrust of moist, mild air, along with greater cloud cover. At such times, pluvial conditions seem to have prevailed over some of the present arid lands. Sea level was generally lowered by several hundred feet by the locking up of water in ice caps. During the major deglaciations, the world climates may well have resembled our present pattern, with great winter cold in high latitudes, with wide deserts of drought, and with high sea levels. Man's occupation spread and ebbed with these physical changes, but not similarly the overall habitability of the earth.

The earliest known human records attest man's possession of fire. He could live in wintry lands, therefore, if he could supply himself with food. Very early in Pleistocene time, man was living widely over the Old World, inhabiting England, Morocco, South Africa, Java, and probably North China.³ The ice and snowbound lands of the far north, however, exacted skills beyond the attainments of primitive man. The tundras are still about the emptiest lands as to human population, and the subarctic lands of fir, spruce, and muskeg are still difficult.

The food resources of the far north are mainly aquatic and at the water margins, and may be cut off in winter. Only folk of quite advanced hunting, fishing, and storage skills can live there, specialists in survival in a most difficult environment. Primitive, artless man had no chances there.

Thereby we come to the entry of man into the New World. The conventional view allows him only a few thousand years over here; it developed in the '90's at a time when man (*Homo sapiens*) was considered as of late origin in the Old World, more or less near the end of the last glaciation. Human time has been expanded steadily for the Old World, but hardly revised at all for the New. An occasional geographer has protested as did Albrecht Penck in 1928 and George Carter in 1951.⁴

If man first came to America only ten or twenty thousand years ago, as tradition holds, northern Asia and North America, through which the passage took place, differed little in climate from the present, though there were larger ice masses. Really primitive folk could never have made the crossing as they could not make it now. I do not see that anything less than the specialized hunting, fishing, and cold-adaptive skills of such late comers as Eskimos and Athabaskans could have made human life possible across the far north. Yet both North and South America have held many tribes of very rudimentary arts, for whom there is no indication that they ever possessed such skills.

At much earlier times there were greatly different and genial climates in high latitudes. At times during the Pleistocene, important migrations took place of non-boreal animals, such as horses and camels going from the New World to the Old, elephants and bovines in the opposite direction. Among later immigrants from the Old World were mammoths and the

immediate ancestors of our bison and deer. All such dispersals were by land across the Bering Strait during a milder climate and lower sea level. The best time after the early Pleistocene for movement between the Old and New Worlds seems to have been during the Third (Illinoian) glaciation.⁵ Then the lands bordering the North Pacific were freely supplied with moist, warm air from the ocean to the south and, though mountain snows were breeding glaciers, the lowlands should have remained warmed and free from permanently frozen ground. With a dropping sea level that formed a land bridge at and south of Bering Strait, the streams, Alaskan and Siberian, flowing across the lowlands also cut down their valleys. The land was well drained; in place of ice and waterlogged plains rolling lowlands may have reached to the present Arctic coast. Instead of tundra and muskeg there were mixed woodlands including white birch, willow, alder, and poplar. Some of the streams may well have remained open in winter. At such time, man could make his entry into the New World as readily as did the other mammals which were not denizens of boreal climates. He had them to prey upon; he had plants that were useful and familiar, and wood aplenty for fire and shelter. Later, but perhaps well back in Wisconsin time the weather hardened, permafrost and tundra spread, flora and fauna were impoverished to Arctic levels.

Convention has chosen the most unlikely time for our first settlers. The optimal time, it has been suggested, of genial weather, varied biota, and low sea level would have been during the development of the Illinoian glaciation. Thus, about a third way back through the Ice Age the same invitation to pass at leisure through an easy gateway was available to animals, plants, and man. Well before this time man had become dis-

tributed to pretty far ends of Old World continents. No reason has been offered as to why he should not have gone where went bear, bison, and deer, and I see no reason why he should not have availed himself of the same favorable opportunity to colonize the New World.

Early Rate of Culture Growth

The remains of man have been traced back at least to the conventional beginning of the Pleistocene; his biologically inferred origins are much older. We still lack a proper yardstick for glacial time, but for the present may use the old estimate of a million years, this scale being quite satisfactory for plant and animal evolution, and also for the weathering and sculpture of the land that has taken place.

The preserved tools of Ice-Age man for a very long time were rude and of little diversity. Innovation and regional specialization became more marked in the second half of the Ice Age, and notable in the Upper Paleolithic of Europe, which occupied most of the fourth or last glacial stage. The explanation of the low rate of culture growth for most (nine-tenths or more?) of human time does not need to be sought in his physical evolution, since the old views of the lateness and separateness of *Homo sapiens* have broken down. It was not his brain that held ancient man back; it was the little he had to think about for so long. Ideas must build upon ideas and such accumulation and derivation, culture growth, that is, appears to have been very slow for a very long time. The distribution of nearly identical Paleolithic artifacts over very large areas also suggests that local centers of divergence—different kinds of ideas expressed in different practical applications—were rare. However, since the record is almost solely in worked stone, it

may be poorly representative; almost only the ideas that were expressed in one kind of durable but refractory material have been preserved.

Fire as a Culture Trait

Through all ages the use of fire has perhaps been the most important skill to which man has applied his mind. Fire gave to man, a diurnal creature, security by night from other predators. Hearth and home are still synonymous. About the fireside the last duties of the day are done, the events of the day reviewed and the morrow planned. The fireside was the beginning of social living, the place of communication and reflection.

Feeding the fire, man learned wood working, how to point a shaft, hollow out a vessel, and thus later to make a boat. Above all, fire provided ways of experimenting with food. Man digests raw starch and plant proteins poorly. Knowing how to cook, even the most primitive people have explored largely the food possibilities of roots, stems, buds, and fruits within their reach. Even food resources that require careful processing by heat or leaching, or both, in order not to make ill or to kill, have not been overlooked. These are the beginnings of scientific observation. Such knowledge is botany, by the precise identification of plant entities, and chemistry, by repeating properly the successful experiment.

Cooking by dry or moist heat long preceded boiling. Hearths on top of the ground and cooking pits dug into the ground are both very ancient, the former for roasting, baking, and broiling, the latter for pit steaming over a bed of coals. From Cape Cod to Chiloé the natives knew the "clambake," a complete meal by pit steaming of fish, flesh, greens, and tubers. In the island of Chiloé, for instance, a pit is dug in the sandy shore; over a bed of coals a layer of kelp is spread, then layers of shell-

fish, fish, potatoes (formerly oxalis tubers and lileaceous bulbs), leaves for cooked greens, and finally a cover of kelp. The result is a complete and savory meal. The Indians of the tip of Lower California, about as primitive as any in the Americas, roasted and baked tubers in ashes, parched and popped seeds in hot sand, and pit-steamed large quantities of turgid mescal (agave) flower-stalk buds. The basic techniques of cooking are immemorially older than pots, kettles, or even water-holding baskets.

Fuel always is in major demand. Through the ages man has moved more ton-miles of fuel than of any other commodity, whatever his cultural level. Where he lived on seacoasts and river banks his stock of driftwood might be replenished perennially. Elsewhere, man found in time that his fuel consumption exceeded the natural rate of supply, which was mainly dead stuff fallen to the ground. Also, he was, early, a user of bark and bast and thus came to know that a tree with its phloem destroyed, died. He acquired therefore the basic knowledge necessary for keeping up his wood supplies and also for clearing ground by deadening trees rather than by felling them. As professional camper, he chose his camp first by water, next by the available fuel.

Fire was much used in getting food, and some peoples learned how to set fires so as to improve plant reproduction along desired lines for the seasons ahead. I know of no American aborigines who did not set fires for hunting or collecting purposes at suitable seasons, if they lived where the vegetation was inflammable. Fires were set to smother small animals, to drive larger ones to a place convenient for the kill, to clear the ground for easier collecting of seeds, nuts, and acorns.⁶ Even the obtuse Tasmanians helped their food gathering by burning over the ground. A little-explored subject is the use of fire to

change the character of the vegetation deliberately, as to provide browse for deer or to stimulate the growth of freely seeding useful annuals. In not a few cases, fire became a deliberate instrument of land management by deliberate deformation of the plant association.

We need not think of ancestral man as living in vagrant bands, endlessly and unhappily drifting about. Rather, they were as sedentary as they could be and set up housekeeping at one spot for as long as they might. In terms of the economist, our kind has always aimed at minimizing assembly costs. The first principle of settlement geography is that the group chose its living site where water and shelter were at hand, and about which food, fuel, and other primary needs could be collected within a convenient radius. Relocation came when it was apparent that some other spot required less effort, as with seasonal changes in supplies. Consumer goods were brought to the hearth and processed there. Women were the keepers of the fire, and there prepared the food and cared for the children. They were the ones most loath to move, the home makers and accumulators of goods. The early hearths recovered by archeology are not casual camps, but fire places used so long and sites so significantly altered as to have withstood the obliterating effects of time. The normal primitive geographic pattern is that of a community, a biologic and social group, clustering about hearths at the points of least transport, holding a collecting territory for its exclusive use, and relocating itself as infrequently as necessary.

Fire as an Ecologic Agent

In Genesis it is said that man was given dominion over every living thing. From the first he asserted himself as ecologic dominant. He lived confidently, not in fear. At first a lesser

predator, he became chief among them, crowding back the animals that competed with him for food. Being omnivorous, he became numerous in areas of attraction; acquiring more skills he made more and more plants and animals dependent on his sufrage or favor.⁷

His greatest power to disturb the balance of nature lay in his employment of fire. He used it for certain ends, the effects went much farther. Collectors, hunters, tillers, and pastoral folk, set fires; civilized man alone is interested in suppressing them. The haze of Indian summer has the smell of smoke proper to it. The non-commercial landscapes of Latin America still are blurred toward the end of any dry season by a haze of smoke that lingers until the rains set in.

Burning is ineffective at the climatic extremes. Where the surface of the ground remains moist, litter does not ignite and fire cannot spread. However, many tropical forest floors become dry enough at times to be burnable. High latitudes may be protected by high ground moisture and low evaporation. Deserts have their plants too widely spaced and accumulate too little litter for burning. Semiarid lands of lower latitudes may be resistant to burning. The scrub savannas of western Mexico are well stocked with woody growth, especially with leguminous shrubs of small, divided leaves. These stay in leaf for several months, gradually defoliating during the dry season. The leaflets drop bit by bit and soon break up. There is no formation of a continuous litter and no chance for fire to run over the surface.

Little is known of the effectiveness of natural fires. Natural burning occurs with rainless lightning, or with light rain and thunderstorms following on a pronounced dry period. In our western mountains, especially at high elevations, lightning-set fires are common. Whether they affect the same spots suffi-

ciently often to maintain a fire-altered vegetation, I do not know; the subject invites study.

The great fires that we have come to fear are effects of our civilization. These are the crown fires of great depth and heat, notorious aftermaths of the pyres of slash left by lumbering. We also increase fire hazard by the very giving of fire protection which permits the indefinite accumulation of inflammable litter. Under the natural and primitive order, such holocausts, that leave a barren waste, even to the destruction of the organic soil, were not common. Rather, these were low ground fires burning lightly over the surface, searing the young growth to a height of a very few feet and consuming the dry trash but not affecting the actual soil.

All fires alter plant reproduction; the more so, the longer and more often they recur. Plants that are favored by burning have been called pyrophytes. The Berkeley, Calif., fire of 1923 gave an extreme test of survival. Most shrubs and trees were killed, with the exception of palms and dracaenas and some pines and redwoods. The former survived because, as woody monocotyledons, they were not dependent on external growth tissue. Thus palms, singly and in clumps, accent the fire-swept savannas of tropical lands as do the Cordylines the tussock plains of New Zealand. Redwoods, numerous pines, and some oaks are insulated by thick corky bark that burns poorly and conducts heat poorly. Some pine forests, as of our eastern and western yellow pines, may be in part the result of burning.

The long-lived trees and shrubs die out gradually under recurrent burning because their progeny is destroyed. The number of mature and maturing trees and shrubs grows less in time; the woods grow more and more open and toward the last are park lands, the last guard of mature trees, without issue. In the run of centuries, the slowly maturing woody plants that

reproduce by seed disappear, if fires are more frequent than the time needed for seedlings to outgrow the fire-sensitive stage. More and more the vegetation shifts to plants that reproduce from protected rootstocks and underground stems and to the freely-seeding annuals and plurannuals. The plant cover may become entirely herbaceous.⁸

Grassland Climax

The young science of ecology has undertaken to study the associations of organisms, initially as belonging together by their physiologic requirements or their joint adaptation to a particular physical environment. Systems of classification arose that identified plant and animal complexes with climate. Thus there arose the concept of the "ecologic climax," currently defined as "the final or stable type of plant community reached in a particular climate." A postulate tends to displace reality. Climatic regions are cartographic abstractions, useful as elementary teaching devices to give some first notions of weather contrasts over the earth. "Final or stable" communities are quite exceptional in nature: weather, soils, and surfaces are continually changing; new organisms are immigrating or forming, old ones may be giving way. Change is the order of nature: climax assumes the end of change.

Since there are many grasslands about the world, such associations have been inferred to represent a grassland climax, that is, to be stable and the result of particular climates. The theme song became that every single grassland must have a climate for its own. When I had ecologic instruction with the admirable Cowles at Chicago, I was at first persuaded. More and more I had to admit that I was unable to find the coincidence of grassland and limiting values of moisture. Why should heavy-rooted woody plants be excluded from certain areas and

these surrendered to the exclusive occupation by herbs and grasses? Thus I began to surmise that the plant ecologists had construed away the role of animals and especially of man.

I grew up in the timbered upland peninsula formed by the junction of the Missouri and Mississippi rivers. The prairie began a few miles to the north and extended far into Iowa. The broad rolling uplands were prairie, whatever their age and origin, the stream-cut slopes below them were timbered; river and creek valleys and flanking ridges were tree covered, be they formed in bed rock or on deep loess mantle. From grandparents I heard of the early days when people dared not build their houses beyond the shelter of the wooded slopes, until the plow stopped the autumnal prairie fires. In later field work in Illinois, in the Ozarks, in Kentucky, I met parallel conditions of vegetation limits coincident with break in relief. I gave up the search for climatic explanation of the humid prairies.

The Far West, of subhumid and semiarid climates, showed again the same relation of grassland to topography. The grassy valley basins of California, bordered by oak parks of senescent, non-reproducing trees,⁹ the high plains of Arizona, New Mexico, Chihuahua, and Durango all are or had been grasslands lapped against rough, woody country lying above or below the plains. In the Latin-American vernacular, *monte* (mountain) has come to mean brush or woodland. Last, I became acquainted with tropical savannas in Central and South America, plains often studded with tall palms, with gallery forests along the valleys and with woody growth wherever there is broken terrain. Parts are semiarid, parts get as much rain as any part of the Mississippi Valley. Cattle grazers still keep up the aboriginal burning practice.

Such, in brief, has been the sum of my experience: Grasslands occupy plains; woody growth dominates rough terrain.

It does not follow, of course, that plains must be grassy, though grasslands and pine woods do characterize a lot of them. Fires sweep most freely over smooth surfaces, spreading before the wind until they are stopped at the brink of valleys cut below, or die out in hill and mountain lands that rise above them.

Grasslands shrink where protected from fire. The woods margin may advance by shading out the grasses. Animals and wind carry seeds, some of which grow where accidental openings occur in the herbaceous cover, and these accidents do happen. In the Kentucky Barrens or Pennyroyal¹⁰ a gently undulating limestone upland of high fertility is surrounded by stream-cut terrain, the latter, at settlement, a forest of mixed hardwoods, the former a grassland, whence its name, Barrens. The Pennyroyal a century ago was noted by the gifted geologist David Dale Owen as having self-seeded woodlots in former grassland. These were enclosures fenced off to serve as stock pens. Owen attributed the grassland to fires, as by Indian burning, the woodlots to protection by white farmers. Aided by grazing stock, there has been under way lately an explosive advance of leguminous scrub, mesquite, catclaw, huisache, over former grasslands in northern Mexico and the Southwest. On the Staked Plains of Texas there has been wide invasion by dwarf white oak brush, on the southern Colorado Plateau of sagebrush.

In the natural course a maximum depth of plant growth tends to develop on any site. Between ceiling and floor a maximal diversity of organisms is accommodated to the full utilization of moisture, light, minerals, and organic food. Grasslands are living zones greatly reduced in depth, above and below the ground; they are simplified morphologically, and usually reduced as to diversity. They are an impoverished assemblage, not a fully developed organic household or community.

Continued Deformation by Man

In very many parts of the world, Old and New, man has been on hand for so long and in such numbers that great deformation of the vegetation has resulted. We can then hardly speak of a natural balance without him, since man has been exerting sustained and selective pressures. Except at the climatic extremes, there may be no such thing as undisturbed or natural vegetation.

Man, nurtured in the woodlands, has been of old the enemy of trees. He has exploited them, destroyed them, rarely favored them. His simplest skills were adequate to overcome the tree, for which he needed no ax, only the immemorial arts of setting fire and stripping bark. In the wood and brush lands in which most of mankind has lived over most of its span, the woody cover was progressively thinned and the ground more and more fully exposed to sun and air. Sun-requiring herbaceous plants increased at the expense of shade-tolerant ones. As Professor Ames pointed out¹¹ our crop plants are heliophile, and he thought of the parental forms of our economic annuals as evolving along with man. Man also was an agent of plant evolution by carrying plants to new places, along his paths, to his dooryard, on the refuse heap. New variations arose by such carriage, both as hybrids and mutants, adapted to the new situations. About him, plants that tolerated the man-made environment and served his ends became dominant. Quantitative and qualitative changes in plant life were initiated by man's mastery of fire; they grew with every increase in his numbers and of his economy.

Planters of the Old World and Their Household Animals

Antecedents of Domestication

It took man so very long to get around to the invention of agriculture that we may well doubt that the idea came easily or that it came from hunger, as is often supposed. Archeology has traced Neolithic farming back in the Near East for seven to eight thousand years, a late date in the history of the human race. These earliest Neolithic farmers were far removed in time and place, as I shall argue, from the origins of agriculture. Their crops, animals, and in part even their houses were not very different from those now existing in the same areas; one is inclined to say that they were nearer to the contemporary than to the original agriculture, the beginnings of which may well lie several times seven thousand years in the past.

It may be noted that the earliest Neolithic farmers lived at the time when the sea had risen to about its present level, that is, when a rough balance had been struck between ice formation and ice melt. I have previously made the inference that world weather was then not greatly different from the present. Before this time, that is, during the last deglaciation, the major part of the basic inventions of agriculture must have been made.

There is little dissent from the view that agricultural arts were first developed in the Old World and such origin is here accepted. The place and manner of their beginnings are the

topic next under consideration, a central and classical question in anthropogeography. Geographers together with biologists in the past have contributed evidence on the nature and origins of agriculture. Combined with the findings of archeology, a more adequate interpretation is now gradually taking form. The classical view, carried down from Roman authors, that mankind progresses on a general sequence of stages, beginning as collectors through hunting and pastoral nomadism to agriculture, is still current in serious writing. Humboldt made the first breach in this position by pointing out that the New World had advanced agricultures but no pastoral nomads. Ritter was impressed by the few favored foci in which progressive cultures arose and from which crops spread. Moriz Wagner originated a corollary to Darwin by the thesis that biologic variation arose through migration into a new environment. Ratzel formulated the principle of diffusion as dominant over parallel invention. Hahn based animal domestication on non-economic grounds. The anthropogeographers have been maligned as environmentalists; actually they have been least guilty of proposals that similar environments develop similar ways, and have been most critical of parallel inventions and of general succession of stages of culture.

My own observations on primitive agriculture have been gathered in various parts of the New World. I have used these as aids in thinking comparatively about what I have been able to read about the Old World. The evidence gathered from workers in various parts and different disciplines seems to me to indicate a revised interpretation as to how agriculture arose. This presentation will serve its purpose if it is an incentive to further examination of the problem. First, certain basic premises:

- 1) Agriculture did not originate from a growing or chronic

shortage of food. People living in the shadow of famine do not have the means or time to undertake the slow and leisurely experimental steps out of which a better and different food supply is to develop in a somewhat distant future. Famine foods, and there are a number that are so-called, seem to have little relation to the plants ennobled by cultivation. The improvement of plants by selection for better utility to man was accomplished only by a people who lived at a comfortable margin above the level of want. The saying that necessity is the mother of invention largely is not true. The needy and miserable societies are not inventive, for they lack the leisure for reflection, experimentation, and discussion.

2) The hearths of domestication are to be sought in areas of marked diversity of plants or animals, where there were varied and good raw materials to experiment with, or in other words, where there was a large reservoir of genes to be sorted out and recombined. This implies well-diversified terrain and perhaps also variety of climate.

3) Primitive cultivators could not establish themselves in large river valleys subject to lengthy floods and requiring protective dams, drainage, or irrigation. I was bothered by the thesis of the potamic origin of agriculture in the great valleys of the Near East until I had assurance from Vavilov, in a visit of a quarter of a century ago, that all the investigations of his group pointed to origins in hill and mountain lands.

4) Agriculture began in wooded lands. Primitive cultivators could readily open spaces for planting by deadening trees; they could not dig in sod or eradicate vigorous stoloniferous grasses. Indian farming, except for the most advanced cultures, remained woodland farming. Years ago I objected to the then general European view that the loess lands were the lands of Neolithic agriculture because they were grassy. I proposed that

they were colonized by early farmers because they were mesophytic woodlands, easily dug and productive.¹ Lately, some European scholars have shifted to the view that farming began in woodlands.²

5) The inventors of agriculture had previously acquired special skills in other directions that predisposed them to agricultural experiments. Of all peoples those most given to hunting were least apt to incline toward domestication and breeding of plants, or, I think, of animals. There are suggestions in Paleolithic archeology that not the workers of flakes and shapers of blades, that is, the hunters, but the ax users, interpreted as woodland dwellers, were remote ancestors of the agriculturists.

6) Above all, the founders of agriculture were sedentary folk. I have already said that groups move as little as their needs of food, water, fuel, and shelter require. Mobility as a dominant character goes with specialized hunting economies or with life in meager environments. Growing crops require constant attention. I have never seen primitive plantings that are not closely watched over until the crop is secured. A planted clearing anywhere is a feast set for all manner of wild creatures that fly, walk, and crawl to come in and raid fruits, leaves, and roots. What is food for man is feast for beasts. And, therefore, by day and night some one must drive off the unbidden wild guests. Planting a field and then leaving it until the harvest would mean loss of harvest.³

The Progenitors

After the Upper Paleolithic hunters of big game in Europe, the Aurignacian, Solutrean, and Magdalenian folk, and before the early Neolithic farmers of the Near East and Europe, an intervening culture is being recovered by archeology. This

Mesolithic period differed largely from the preceding hunting ways, has been identified especially along the Mediterranean and in Atlantic Europe, and seems to have been immigrant into Europe from Asia and Africa. It used, and perhaps introduced the bow and arrow; it employed fishing gear, fishhooks and lines, nets and sinkers, boats and paddles, none of them known earlier; it had a new style of ax and adz, with chisel edge; toward the last there was crude pottery; especially, it brought the dog, unknown for the preceding hunters, but characteristic of Mesolithic settlements.

The main interests of this culture were not in hunting by land, but in living by sea, stream, and lake, depending on fishing and water-side hunting and collecting. These habits and the time of its coming are probably responsible for the meagerness of Mesolithic record. At that time, because the ice caps were melting away, sea levels were rising markedly, and hence rivers were filling their valley floors so that only chance locations not buried beneath sea or alluvium may be found. The known settlements may have derived from major cultural changes that took place far to the East as a western, marginal extension, a simplified frontier, frontiers being likely to carry a reduced and simplified form of the culture from which they spring. I lay weight especially on the appearance of the dog and the fishing arts. Europe, until late historic time, appears to have been always a far peninsula of the Old World, receiving belated and reduced ideas from east or south.

The progenitors of the earliest agriculturists I have sought in some well-situated, progressive fishing folk living in a mild climate along fresh waters. Fresh water is postulated rather than salt because seaside vegetation has contributed little and late to the making of crop plants. For sedentary living there must have been available a long season or year-round staple resource in

fish and other aquatic life. Clustering of groups in permanent villages was made possible at sites continually advantageous for fishing, such as stream junctions, lake outlets, rapids. Waterways served as lines of communication with other villages and so for the exchange and growth of ideas. Waterfowl, riparian mammals, waterside plants gave diversity to food. Basts and fibers were used to make nets and lines and suitable woods were at hand for boats and paddles.

There seems to be a connection between fiber preparation and the taking of fish by use of plant extracts to stun or kill them. These stupefying substances, in Spanish *barbasco*, commonly are alkaloids, they often lather freely, and are likely to be taken from plants also used for cordage, making bark cloth, and as detergents. The latter uses may have come first, and through them, the discovery that fish were stunned when certain plants were macerated or retted in water, without affecting the food quality of the fish. In the Old World, this barbasco trait is most elaborated in Southeast Asia, whence it radiates outward through the Pacific Islands, westward through the Mediterranean to Atlantic Europe and southwestward through forest Africa. The procedure is sufficiently characteristic and complex that it may have a common origin. This curious way of fishing is apparently older than, and may be a forerunner of, agriculture.⁴

The Cradle of Agriculture

As the cradle of earliest agriculture, I have proposed South-eastern Asia. It meets the requirements of high physical and organic diversity, of mild climate with reversed monsoons giving abundant rainy and dry periods, of many waters inviting to fishing, of location at the hub of the Old World for communication by water or by land. No other area is equally well situ-

ated or equally well furnished for the rise of a fishing-farming culture. I shall attempt to show that farming culture in origin is tied to fishing in this area, that the earliest and most literally domestic animals originated here, and that this is the world's major center of planting techniques and of amelioration of plants by vegetative reproduction. I accept the familiar premise that man learned to plant before he grew crops by seeding.

Planting and Plant Selection

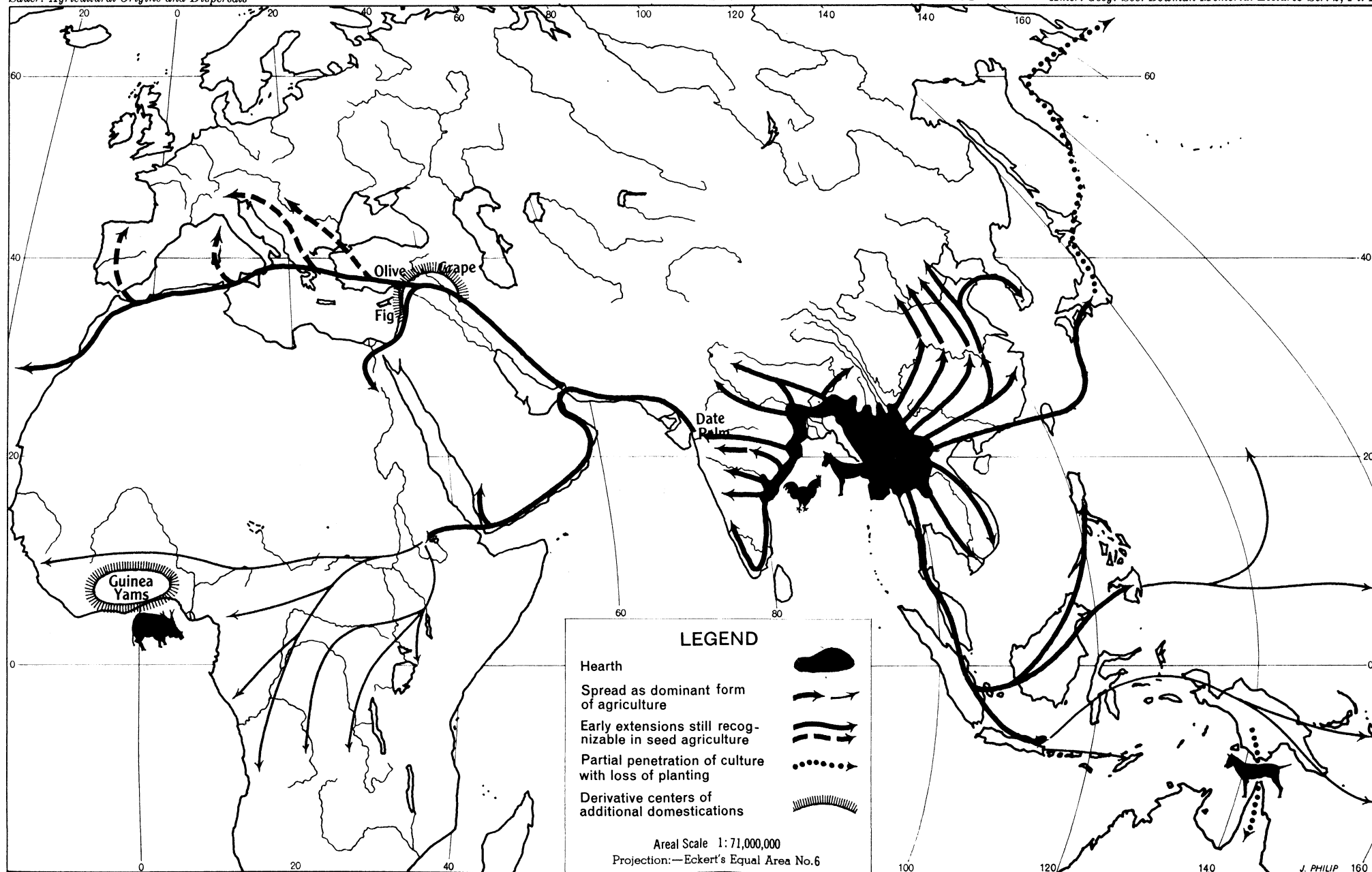
The creative curiosity of man in the monsoon lands has operated strongly with asexual plant reproduction. Multiplication and selection is from clones. A piece of a plant is set into the ground to make a new plant. This may be by an offset or sprout from the parent, by dividing a root stock, by a stem cutting, or by a piece of underground stem or tuber. An individual plant is divided and multiplied indefinitely. The thing grown is identical reconstitution of parent rather than variant progeny. Selection begins by choosing the individual plant to be divided in order to make a number of plants that are like the parent. Selection proceeds by observing and preserving desirable individual variation, as in propagating an attractive chance root or bud sport, or by noting an accidental self-sown hybrid that is then divided for planting. In the long course of time, this continuous attention to the individual plant, and inattention to its sexual seeds, has given rise to an extraordinary lot of forms that are completely dependent on man for their existence. Seeds being of no interest, many such cultivated plants have lost the capacity to bear viable seeds, some as sterile polyploids, some in other ways. This culture operates by a very specific and sustained idea of reproduction; break the continuity of this operation and the plant may be lost.

The list of such man-made plants, or cultigens, is large, with

eastern India in first place as to origin. Botanically, it includes especially many and important monocotyledons: Southeast Asia is the original home of the bananas. Genetic studies lately have resolved the variations in the Asiatic bananas with the result that the old distinction between bananas and plantains must be abandoned. One cultigen line derives directly from *Musa balbisiana*, native from Behar up to the Himalayas, another from the Malayan *M. acuminata*, the third main line involves hybrids between the two.⁵ The domesticated forms of the ginger family, such as turmeric, appear to be mainly Indian. Aroids, cultivated for root or stem, including especially the taro, which is probably Indian, form a major food source especially out through the island world. For the home of the greater yam (*Dioscorea alata*) Burkill favors the east side of the Bay of Bengal, for *D. esculenta*, Indochina.⁶ A half-dozen species of cultivated yams, some of them carried to the farthest Pacific Islands, throw important light on cultural radiation from the Southeast Asiatic mainland. Certain palms, especially the sago palm, pandans, bamboos, and sugar cane, have been widely carried out of India and Indochina and greatly altered by man. Dicotyledons have yielded shrubs, vines, and trees, greatly changed by immeasurably long vegetative selection, such as the leguminous derris cultivated for fish poison and insecticide, the several breadfruits, the citrus fruits, and persimmons (ebony family). The majority of the plants that have been thus made over by man are at home in well-drained alluvial lands, a few are river swamp plants, and some are aquatic.

The basic cultivated food plants of monsoon Asia do not constitute a balanced diet. They are sources of carbohydrates, mainly of starch, but also of sugar. Plant fats and oils are very minor, and vegetable proteins mostly lacking. The people who made the asexual crop plants had no need to develop a bal-

OLD WORLD PLANTING AND HOUSEHOLD ANIMALS



anced vegetarian diet, for they got their fats and proteins from animal food, originally fish and shell fish. The great preponderance and diversity of carbohydrate cultigens sustains the thesis that this was a fishing culture before it became a planting one. Other strong traits of this culture are the attention to the growing of spices—Southeast Asia included the spice lands of early commerce—and the emphasis on the coloring of food, person, and clothing, especially yellow or red (as by turmeric), with ceremonial significance attached thereto as life-giving, from birth through marriage to funerary offering.

These food plants may serve other purposes, especially as sources of fiber. Perhaps we have here another suggestion as to why fishermen began the cultivation and alteration of plants. Fiber, food, and ceremonial color may come from the same plant. *Cordyline fruticosa*, or *terminalis*, in such joint use among Malaysians and Polynesians, is apparently of ancient introduction. Some of the pandans or screw pines have been widely carried by man and greatly selected by cutting propagation for matting, cordage, fruit, and scent. Breadfruits also have been a major source of barkcloth and of yellow dyes. It may well be that among the earliest domesticates were multi-purpose plants set out around fishing villages to provide starch food, substances for toughening nets and lines and making them water resistant, drugs, and poisons. Food production was one and perhaps not the most important reason for bringing plants under cultivation.

Plants that are grown from seed may be germinated before they are set out. Rice and coconut are familiar examples. Neither is considered to belong to the oldest planting culture. Rice probably originated in India; the place of origin of the coconut is still debated. Rice is the only cereal I know which is still a perennial, though in cultivation it is treated as an annual.

The custom of starting it in a seed bed and later setting the individual plants out cannot be explained entirely by the necessities of paddy cultivation and it is not so restricted. It has been suggested that rice was originally a weed in taro fields⁷; in weeding it was replanted elsewhere and a grain crop was produced, with partial retention of the vegetative planting habits. There is no necessity of starting coconuts in a seed bed and transplanting them later. Both customs suggest partial retention of the older idea of plant reproduction.

Plants of different kinds, growth habits, and uses were assembled in the same cultivated patches, not fields but simple gardens. The ground was dug with a planting stick, that later became spade or fork; the loosened ground often being mounded and the plants given added aeration and food by the heaping up of top soil.

Social Organization

In this culture the men built the boats and fished; the women had domain over the tilled land and the homes. Women were cooks and cultivators, domestics and domesticators. These societies were largely developed and organized by their women. It was through them, it is inferred, that descent was reckoned and membership in the household determined. Matrilineal and matriarchal societies arose. The *Kulturkreis* school seems to have a valid generalization in equating its "Old Planter" complex with matrilineal societies, and in linking to them multifamily houses, large, rectangular, gabled structures, providing living and storage space for the extended household, and often built on platforms set on posts.

Household Animals

The animals domesticated in Southeast Asia—dog, pig, fowl, duck, and goose—are all animals of the household, in contrast

to the herd animals originating in Southwest Asia. As with the plants, the domestication may be attributed to the care and arts of the women who managed the household.

The dog is generally given place as the oldest domesticated animal, the eldest companion of man. There is no basis, however, for the story that as camp follower of hunters, he gradually joined the camp and became their hunting companion. This attractive myth is a projection into the past from modern European romantic views. Hahn long ago pointed out that hunting dogs are late specializations among certain peoples of advanced culture. Really primitive peoples do not hunt with dogs, though these may trot along with a hunting party. The great hunters of the Upper Paleolithic had no dogs. It has been noted that these appear archeologically first with Mesolithic folk, who were not much engaged in hunting, at least not on the land.

The Swiss zoologist Studer began a series of studies in the comparative anatomy of the dog and its relatives, which have been extended by others, especially in later years by Dahr of Sweden.⁸ These make a strong case for the monophyletic origin of the dog. The conclusion is that the dog, in several ways less specialized than the wolves, cannot be derived from the latter, as on grounds of comparative anatomy man cannot be derived from the apes. Objections were raised to the conclusions of Studer since he postulated an unknown ancestor. Since then, however, remains of a wild dog have been described from the Early or Middle Pleistocene Chou-k'ou-tien caves near Peking, also of a recently extinct wild dog of the Tengger Mountains in Java. The feral pariah dogs and the Australian dingo are accepted as approximate models of the primitive dog. Dahr has reduced the so-called archeologic species of European dogs to breeds selected as domestic variants from a single ancestry, and considers that much later occasional wolf blood was introduced

by Arctic hunters, as by Samoyed and Eskimo. The dog is considered therefore as originating from a wild dog, native to Southeastern Asia, living in forested monsoon lands, perhaps resembling the fox in food and social habits.

When Europeans set out to discover the seas of the world, they found the tropical villages of both Indies overrun with pets. Sailors returned, bearing monkeys, parrots, guinea pigs; soon there were pet shops and zoos to entertain the homefolks. Raising and training pets is still characteristic of both Indies. As I know it, the animals are always taken as young as possible. Men bring in fledglings from their nest, infant mammals are taken from the den or saved on killing the mother. I have had guides size up a young captive and then hit it over the head as too old to tame. Wildness develops rapidly in the young; only the helpless infants, wholly dependent on foster parent, form the strong attachment to the household in which they are raised. The feeding and training of the young captives is by women. The animals share roof and food of the family, are playmates of the children, and become part of the household. A comfortable surplus of food and permanent dwellings is presupposed, for the purpose is not economic at all. This is an important cultural bent, giving varied esthetic satisfaction; it merits study as to cultural context.

Infant mammals require milk. Until there were domestic mammals, the only nurse-mother available was woman. There are still tribes in tropical America and in Southeast Asia among whom women suckle pups, pigs, kids. By such means, the dog was actually adopted into the human family and into a specific family, within which the children were his kin. Under these circumstances, the dog may acquire a personal name and on death be mourned as any other member of the family. Somewhere, at some time, these ties became so strong as to result in

domestication and the propagation of a stock that lost connection with the wild kin. It seems also that a good while ago the wild dog had become rare and this may have helped the absorption of the tame dog into human communities. In Southeastern Asia, the simpler peoples hold the dog in familiar and reputable status. It is here that the myths of a dog as tribal ancestor are most commonly found.¹⁰ Even among the Chinese there is an elaborate legend of the marriage of an ever-faithful dog to a princess, with noble issue. Our western myths of Beauty and the Beast may have some similar origin.

In the Old Planting culture the dog, as a prized and respected creature, came to be an object of sacrifice, and of ceremonial consumption by the participants. As familial and religious connotations became blurred, the dog became a food item, especially at feasts. Because the dog held a position of high respect in this culture, it readily became an object of antipathy in neighbor cultures of other ceremonial and religious orientations. These latter rejected the animal as despised and unclean. It was, however, early disseminated into far parts of the world, farther it seems than any other parts of the culture from which it stemmed. In being handed on to peoples of other habits, the dog lost its status as member of the family circle, but became an utility animal, as watchdog, for hunting, for draft, for wool.

The wild pig of the Southeast Asiatic mainland, *Sus vittatus*, is unquestioned as ancestor of the domestic pig of that part of the world. The wild form is replaced by *Sus cristatus*, which has not been domesticated, in the formerly continental islands of Sumatra, Java, and Borneo. The *vittatus* species lives in jungle forests, likes to root in the village plantings, and does not avoid human settlements as does the European wild boar. The domestic pig too has become a member of the household and its domestication may have been by the same route as that of the

dog. The spread of Hinduism and Islam has pretty well wiped out ceremonial uses, which persist, however, elsewhere.

Our domestic fowl stem from the jungle fowl of the less wet margins of the Bay of Bengal. The wild fowl weigh only around two pounds, lay settings of four to seven eggs, are shy, elusive, and keep away from settled areas. No economic motive is involved in their domestication: their egg laying and meat producing qualities were developed elsewhere and at later times. In Malaysia and India, their traditional use is for cock-fighting and this has resulted in selection for big bodies and broad breasts. Another ceremonial selection is shown by black color, including black skins and black bones, blackness still having magic and medicinal values. Our poultry fanciers maintain this originally ceremonial breed of Silkies, genetically weird, economically almost useless, but spread of old through eastern Asia.

All domestic ducks, except the New World Muscovy, are bred from the wild mallard. Little is known of their history but their diversity and importance in China, and in part also in India, are suggestive of antiquity.

Dispersal of Domestic Plants and Animals into the Pacific

The ancient complex of plants and household animals was dispersed far and early in all directions except northward, where cold blocked the way. The islands of the Pacific, as they were colonized by man, were stocked by introductions from the Asiatic mainland, ultimately as far as Hawaii and Easter Island. Be the cultures Melanesian, Polynesian, or Micronesian, the domesticates rarely are of island origin, but came from the Southeast Asiatic planting hearth. A number of plants, lost or largely lost to cultivation to the west, have been

kept or have survived ferally in some of the islands, such as the primitive seed-bearing bananas, uncertainly named *Musa fehi*, pandans, certain inferior yams, and lesser aroids. That a planting culture got into the island world at a fairly remote time is suggested by diversification of races of some cultigens, as of the common breadfruit.

It is curious that the pig was not taken to New Zealand, while it got to other far extremities of Oceania. East of the Wallace line, all the pigs appear to be of *vittatus stock*, though the wild pigs of the island west of that line are of *cristatus stock*. The so-called wild pigs of Timor and New Guinea therefore are considered to be only feral. Beyond the limits of Islam, the pig is of major importance to man, as much so ceremonially as for food. That the dog reached Australia may possibly be due to a slight penetration of higher culture; the failure of sedentary folk to establish themselves in Australia whereas they found and occupied the smallest atolls in the wide ocean remains unexplained and cannot be ascribed to physical barriers.

Into China and Japan

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. Planting methods were elaborated into the most sophisticated garden culture of the world. Warm climate plants were selected for shorter seasons and cold resistance and new domesticates were added from northern natives. Among those native plants vegetatively selected were the sedge *Eleo-*

charis tuberosa, the yam *Dioscorea batatas*, *Sagittaria*, and some of the citrus fruits. In the numerous Neolithic villages of the loess lands, large quantities of pig bones have been recovered.⁹ The planting culture, spreading from the south, set the dominant pattern northward beyond the Yangtze and across southern Japan; of the household animals the pig and dog, at least, were carried well to the north.

Into Africa

In tropical Africa, agriculture is by planting, usually by women using either hoe or planting stick. The general configuration of life is remarkably similar to Southeast Asia, and the basic items are introduced from the East. The statement applies only to the forest people, not to those of the Sudan, nor to most of East Africa. The forest negroes have no great variety of cultivated plants. The great staple before the coming of European ships was plantains and bananas. A section of the genus *Musa* is native to Africa, but it does not enter into the parentage of the cultivated bananas and plantains, which are derived from India and possibly beyond and probably were brought around the northern margin of the Indian Ocean. Taro was similarly and also anciently introduced. The greater yam (*Dioscorea alata*) may have come late out of India, carried perhaps by Malays or Arabs. The wide presence of *Dioscorea bulbifera*, with cultivated races differing in Africa from those of the East, and of *Tacca pinnatifida* (called both Fiji and African arrowroot) need further examination. So may that of the tuberous *Coleus*, which Vavilov assigns to Southeast Asia, but which is more probably African. Scientifically, tropical Africa is still the Dark Continent. Two cultured yams are certainly of African origin, the white and yellow Guinea yams (*Dioscorea rotundata* and *cayenensis*, the latter misnamed as

from the New World). Only a subordinate center of vegetative domestication can be credited to forest Africa, centering somewhere behind the Guinea Coast.

Of domestic animals, the dog and fowl have been widely distributed in Africa and what little is known of their races suggests ancient introduction. Both were found at the first white contacts with the pygmies and the Niam-Niam. There are some curious bits of information that may have bearing on the antiquity of African-Indian contacts. Strange negro fowl of black feathers, meat, and bones were described from Mozambique in 1635,¹¹ and there are hints of black fowl in negro ceremonies that need inquiry, as to breed as well as ritual. The pig has been reported only from the borders of Ethiopia, especially from the ancient land of Sennar between the Atbara and the White Nile, where there are surviving pre-Hamitic peoples and cultures. Some of these raise pigs and here there are also wild pigs, which, however, are only a feral form of the Southeast Asiatic *Sus vittatus*. The inference is that the pig was introduced from the East into eastern Africa, perhaps over the same route by which bananas, taro, and chickens were brought, but that it disappeared with the spread of Hamitic dominance or was lost in Abyssinia by the Semitic conquest. The Abyssinian Christian Church, it may be noted, bans the eating of pork. Europeans have found pigs difficult to keep in equatorial Africa because of tsetse-carried trypanosomes. The natives of West Africa have a partly domesticated bush pig of different genus (*Potamochoerus*), from Guinea down to Angola. It is possible, therefore, that the Asiatic household pig met a barrier in the African forest and that a partial substitution has been made by a similar native animal.

Tropical Africa did not get its planting culture out of India by way of the Fertile Crescent. The bananas, for instance,

could not take the northern route. The passage westward can hardly have been in any other manner than by skirting the Indian Ocean. Along it there was no winter cold and the arid stretches were broken at intervals by alluvial strips watered from highlands. The southern rim of Arabia, from the Straits of Hormuz to those of Bab el Mandeb, along the coasts of Oman, Hadhramaut, and Yemen, may be a great lost corridor of mankind. Coon has called attention to survivals of primitive human stocks here, small elf-like roundheads in the Yemen coast, in Hadhramaut Veddoid and negrito types as well as Mediterranean racial elements.¹² Schweinfurth found taro so naturalistically distributed in Yemen that he considered it a native plant. The door into Africa south of the Sahara was the Abyssinian highland and its foothills, inviting for primitive agriculture; the Sennar country was the last step on the route west into the tropical forest lands and the Sudan. This corridor between East Asia and Africa was used repeatedly in agricultural dispersals; it still awaits closer exploration. The carriage of plantains over this route presents no special difficulties. Although plantains produce fruit only with a good supply of moisture, they can withstand long dry seasons. Also, the root stocks can be thoroughly dried out and left exposed for months before replanting. In some places it is customary to expose the planting stock to long drying.

Into the Mediterranean

Parts of the Old Planter culture reached the Atlantic by way of the Mediterranean. The presence of the dog through the Mesolithic of Europe has been mentioned. The name of the Canary Islands is thought to refer to the dog-keeping and eating habits of the natives. Pig remains are common in early archeologic sites of the Near East and westward, as in Egypt at

Faiyum and Merimde, in Palestine at Gezer. Menghin,¹³ in fact, has set up a swine-breeder culture at the threshold of the Neolithic, wide spread across southern Asia and southern Europe. He maps it on the basis of association of pig bones with certain artifacts, in particular with a sausage-shaped, chisel-edge celt or ax of greenstone. Domestic pig remains have been described from the first sedentary horizon at Anau and from the Lake-Dweller villages of the Alpine forest lands. In both cases, these have been determined as turbarry pig, a form of the Southeast Asiatic *Sus vittatus*. Modern swine breeds in conservative peasant communities of the Grisons in the Alps and in Transcaucasia are assigned to the same stock. The wild pig of Sardinia has been placed as a *vittatus* form and hence would be of human introduction.¹⁴ Professor Gordon Ferris of Stanford tells me that the lice of our domestic pigs are not those of the European wild boar but of the *Sus vittatus*. All of which seems to add up to the conclusion that the domestic pig was passed on from India across the Mediterranean to western Europe, that such is the basic stock of our common swine, with subsequent incrossing of some boar blood. I know of no evidence of independent pig domestication in Europe or in western Asia.

There are numerous indications that the pig belongs in the substrata of Mediterranean culture history. The Egyptian god of evil, Set, was identified with the pig, but he also was considered eldest of the gods and suffered the degradation that happens to elder gods when later divinities gain adherence. Where vestiges of pre-Indo-European culture remain in the Mediterranean, the pig is likely to have a place of prestige. The Arcadians, ancient mountaineers of the Peloponnesus and in part pre-Dorian, were known as swineherds and acorn eaters. The greatest and oldest of the Greek mysteries, the Eleusinian, used the pig alone as cult animal. The place of the ritual oc-

cupied a pre-Greek cult site of high antiquity. Sir James Frazer in "The Golden Bough" shows the close association of Demeter-Persephone with the pig, suggesting that she may have taken the form of the animal, and that Demeter is a Greek version of the more ancient Great Mother. When Xenophon celebrated the approaching return to his homeland, he made burnt offering of swine, according to the custom of his country, which was Athens. Among the Romans, pork (*porcina* or *suilla*) was the preferred flesh, and the customary main dish at feasts. It was a common sacrifice, especially to the household gods, the lares, the familiar spirits that were older than the high gods. The ancient Iberians, pre-Indo-Europeans, were swineherds and esteemers of pork, as their partial descendants, the Spanish and Portuguese, still are. Far out on the last island of the Canaries, Ferro, lived the most primitive of the diverse natives of the Islands. They held in veneration the pig, according to one of the earliest accounts, "conscious that a demon appeared to them in such form."¹⁵ These are samples of evidence of a pre-Indo-European, pre-Semitic pig culture and pig cult, which persisted in the West in spite of the coming of later gods and still later of Christianity, but which the spread of Semitic and Hamitic ways wiped out in the Near East and Africa.

Finally, across the Mediterranean, increasing in strength westward, the privileged position of woman is to be noted. The mother, and especially the grandmother, has authority over the family throughout Hispanic and Portuguese areas. The Basques are not only matrilineal, they have pretty much a matriarchal society, and the Basques are the clearest survivors of folk who came before the children of Shem, Ham, and Japhet spread their ways over the ancient world.

The plants of the Farther East either did not pass westward as did other elements of the Old Planter life, or they were

dropped in favor of seed plants. The chufa, *Cyperus esculentus*, which is of old culture in the Iberian Peninsula, may be an exception. However, the Mediterranean agriculture relies on vegetative reproduction and selection in its own manner, and these ways are ancient. The two principal areas of horticultural skills are southern China and the old Mediterranean, with similarities in techniques, and both may well owe their original stimulus to ideas out of India. Among the oldest cultigens of the Mediterranean are the date palm, the olive, and the fig, all of them reproduced by cutting. The date palm either stems from a lost ancestor in the Near East or from the wild *Phoenix sylvestris* of western India. The olive and fig are first known from the eastern end of the Mediterranean and may have originated there (or in southern Arabia?). The alteration from wild ancestor into the cultured form in each of the three is great and would seem to require a formidable length of time. The immemorial manner of reproducing these plants rests on pretty refined horticultural practices of no casual origin. Yet, in so far as known, they are part of the oldest Mediterranean agriculture. The grape, out of mountain valleys of the Caucasus-Turkish-Iranian border lands, is also grown by cuttings; but it is thought to be later, principally because wine in Greece is younger than other alcoholic drinks. The difficult and tedious procedure of creating and reproducing the olive tree and of making olive oil is more readily derived from the disciplined planting arts first fashioned in India than from any other source. Also, only in that one corner of the Mediterranean facing the ancient East do we find the origin of cultigens according to the eastern model.

III

The Planters of the New World

Again, a Tropical Hearth

The lower latitudes of the New World hold an agricultural complex that resembles closely the one across the Pacific and may be the source out of which the farming ways of the New World were fashioned. It is a planting culture, especially well developed all about the Caribbean both as to mainland and islands, and it dominates most of South America. Even now, a line drawn through the Florida Straits into the Gulf of Honduras and then winding southward through Central America to the Pacific Coast in Costa Rica (Pl. II) approximates a separation between a northern and southern pattern of aboriginal farming. Between West Indies and United States mainland the separation is sharp, in Central America transitional. The Antillean farmers at the coming of the Europeans were Arawak and Carib, who had brought their ways from the southern *tierra firme* of the Caribbean. In Central America, the Caribbean side was occupied by natives of Chibchan affinities, living in the manner of their kinsmen in Colombia. The native stocks may long since have disappeared or have become blended into mestizo populations, but the plants and animals that are grown today and the habits of rural life still carry many qualities of ancient ways and days. This tropical culture is based strongly on the idea of vegetative reproduction.

Its origins are to be sought not in tropical rain forests, but in areas of alternate rainy and dry seasons. The seasonal rhythm

about much of the Caribbean is not very different from that of the monsoon lands of Southeast Asia. In particular, to the south of the Caribbean Sea lie lands of very diverse climates, ranging from near deserts on the shores of Venezuela to the rain forests of the Andean montaña, both on the Pacific and in the interior, and to the Alpine páramos of the higher mountain chains. Between these extremes lie numerous intermediate climatic areas attractive to agriculture. The splitting of the Andes into a number of sierras and basins abutting against the Caribbean Sea brings rain shadow conditions to one position, rain increase to another. Ranges of sedimentary rock, of crystalline and metamorphic rocks, volcanoes of ash, cinder, and lava flows have resulted in extreme range of soils. To this high diversity of climate, terrain, and soils is joined a most varied flora expressed in patterns of distribution that led Humboldt to one of the earliest formulations of biogeography. Here the life forms that originated in the southern continent meet the immigrants from the north which moved down through the Central American land bridge and also others of Middle American origin. We know little of degrees of kinship between wild and cultivated forms for the New World, but the genera to which the vegetative cultigens belong are clustered about the Caribbean as nowhere else.

Northwestern South America is also at the human crossroads of the New World, both by land and sea. It has many waterways of streams and along sheltered coasts, with a lot of aquatic and riparian life useful to man, both animal and plant. It has many sheltered basins of fertile land, within which people could live well and increase and shape their own cultures with the proper balance of self-containedness and outside contact. Environmentally this was the land of greatest invitation for

riparian folk to become sedentary and to begin the experiments of domestication, the likeliest spot in the New World for agricultural origins.

Archeologically the area is still mainly unexplored. We know that metallurgy used most advanced techniques here, that a strange high civilization both of mountain and lowland had passed its peak before the coming of the white man, in particular in Colombia. It may not be accidental that the two greater historical areas of native high culture, the Peruvian and the Mexican-Guatemalan, lie near the opposite margins of the Caribbean *tierra firme*.

Ethnic traits have many resemblances to Indonesia. The natives were admirable boatmen and made dug-out canoes and pirogues of various and excellent designs. They were skilled net fishermen and used barbasco cunningly. Some of them were adept at preparing arrow and dart poisons that caused sensible losses to the Spaniards. They colored food and painted themselves with the fruit of the Bixa, whence, perhaps, the origin of the name red Indians. They made fermented drinks by chewing and used masticatories. The Spaniards found natives living in multifamily rectangular houses, many of them built on platforms set on posts (whence the name Venezuela) and not restricted to flood plains. Villages were surrounded by *palenques*, stockades through which the invaders had to hew their entry. The name cannibal is derived from the name Carib, and the Spaniards wrote gruesome accounts of the eating of human flesh, especially in western Colombia. Cannibalism is one of the less attractive traits that accompanies cognate planting cultures, both in Southeast Asia and Africa.

And, although the Spaniards were not aware of it, this was the first acquaintance of Europeans with an undisturbed matrilineal society. From Española to Colombia they met ruling

queens and princesses. The Spaniards were titillated and shocked by what they considered licentiousness and worse, the unfamiliar mores of a society in which the males did not make the rules. The pattern of behavior was so different from their own, that, as civilized people, they unhesitatingly condemned it and proceeded to break it down. Out of these confident ignorances they built the myth of the Amazons, in which there was some truth.

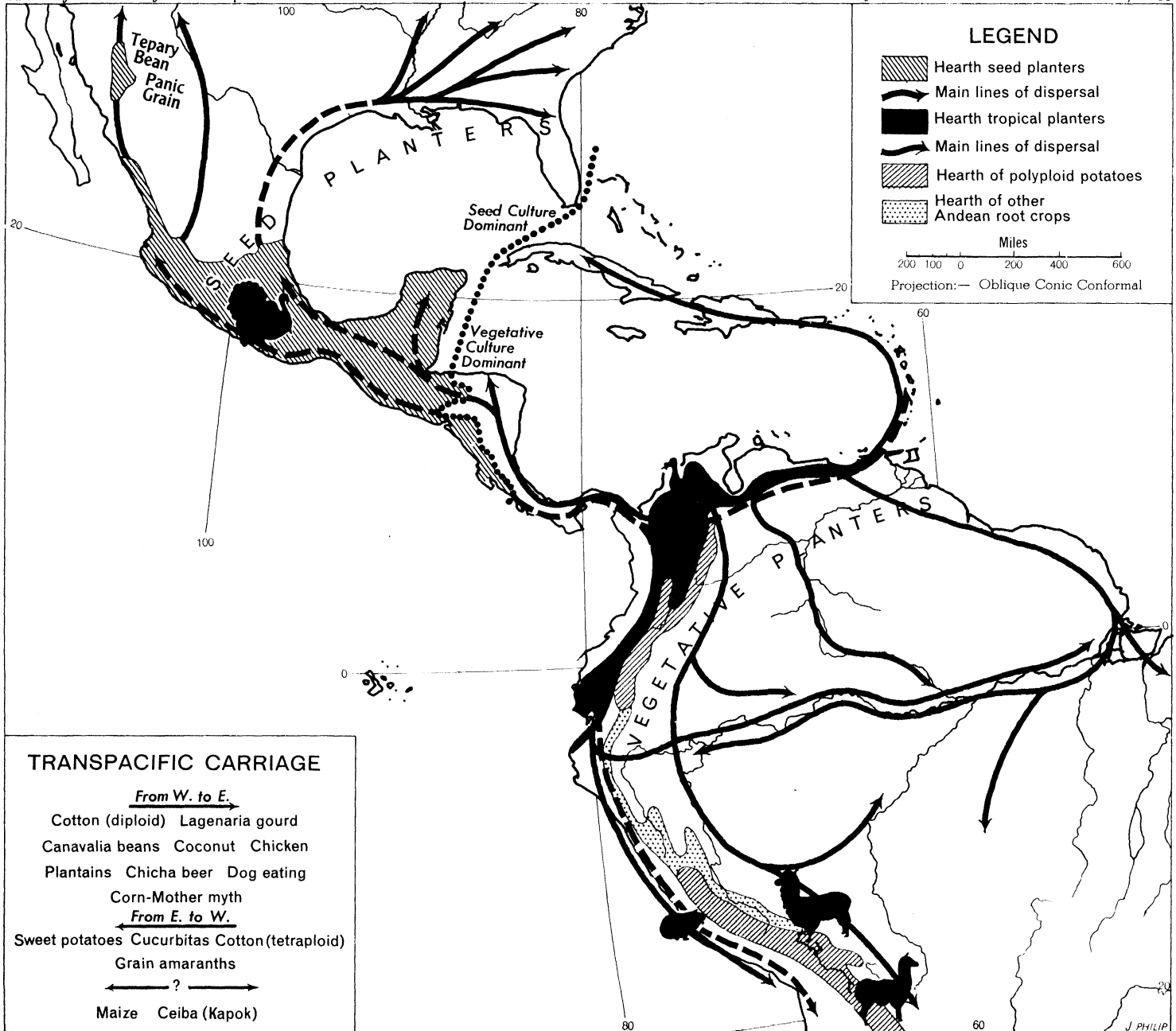
I like the combination of nature and culture in northwestern South America for locating here the first hearth of agriculture and so am disposed against seeking its origin or plural origins in higher latitudes. A single New World center is unproved (I once wrote in the opposite sense)¹ but it seems to me that there is a case for one basic hearth, and that case I shall try to present as an invitation to inquiry.

Brazil has often been designated as one of the centers of origin, in part, because a number of cultivated plants and their wild relatives were first described from southern Brazil and the La Plata Basin by nineteenth-century European naturalists. In land forms, soils, and climates, Brazil, like the eastern United States, is designed in large patterns, with gradual transitions, and hence it is a land of reduced floristic diversity as compared to the Caribbean lands. Culturally, it lies at the farther end of the New World. It is mainly a reservoir of primitive populations pressed into a dead end by more advanced cultures or untouched by innovations arrived at elsewhere. Numerous agriculturally attractive areas were inhabited by folk of simple collecting and hunting habits. The principal agriculturists belong to the Tupi-Guaraní family and are late arrivals in the south. Their earlier home appears to have been about the lower Amazon where they had been in contact especially with the Carib peoples; the culture they brought with them is

THE TWO AGRICULTURAL SYSTEMS OF THE NEW WORLD

Sauer: Agricultural Origins and Dispersals

Amer. Geog. Soc. Bowman Memorial Lectures Ser. 2, Pl. II



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hardly more than Caribbean. East of the Andes, Arawak tribes carried northern ways and plants by far flung colonies to the interfluves of Amazon and La Plata. South of the Amazon archeologic finds of sedentary populations, at least to date, are very meager.

The peanut is usually credited to Brazil because of related wild forms. It was never more than a subordinate crop anywhere and being a protein food, would not be expected to be one of the first domesticates in a planting culture. There are two principal lines to cultivated peanuts,² the one aboriginally better known, distributed from the Peruvian coast north to Mexico and, in so far as I am aware, unknown to the east of the Andes. It is fairly old in Peruvian archeology. Until further studies are made, the identification of the home of the cultivated peanut is uncertain.

The pineapple is also commonly said to be of Brazilian origin. Again, we have a minor cultivated plant. So-called wild pineapples have been reported from Brazil (earliest) to Venezuela and Colombia. Like most of the terrestrial Bromeliads, the plant is xerophytic and has numerous suitable habitats about the Caribbean. It was here that the Spaniards found the fruit most cultivated and most selected, and it was from here that appreciation of this king of fruits, as described by Oviedo and other early reporters, was spread. Its place of origin also remains uncertain.

Agriculture on the desert west coast of South America and in the higher Andes is probably derivative from elsewhere because the environment demanded advanced skills such as irrigation. Tello thought of the hearth as in the Amazon basin, but this tropical forest land seems unsuited both as to plants and culture. The port of entry for Peruvian agriculture I should place to the north, with some secondary later domestica-

tion moving up from northwestern Argentina (Diaguaita culture). The vegetative cultigens of Central America appear to be assignable to Colombia, and its annuals to the North. Agriculture seems to have been introduced into the West Indies by the spread of the Arawak from the South American mainland. And thus I come back to the northwestern part of the southern continent as combining more favorable factors than any other area.

Tropical Plants and Tillage

Here again, planting is done by setting out cuttings, usually in mounds or ridges of top soil thrown up by spade-like tools. Selection was by division and multiplication of attractively varying clones. In contrast to the Old World there are no wetland domesticated plants. All thrive best with good drainage. Where drainage was poor the cultivators built the mounds high to provide aeration.

All the important food plants are grown for starch and sugar. Vegetable proteins and fats were as much neglected as across the Pacific. First among the starch products was manioc (*Manihot utilissima*), or yuca as it is called through most of Spanish America, the name having been picked up from the Arawak of the West Indies. Wissler thought it so important that he named the tropical Indian economy from it. It is widely grown in tropical forest lands on well-drained sites, but its home is not in the rain forest. The starch which it stores in its tubers enables the plant to make a quick start when the rains begin, and to sustain long dry seasons. Its native climate is that of the savanna with a rainless season longer than the rainy one. The yuca is extraordinarily drought resistant and for that reason has been so successfully introduced into Africa between the forest and the desert. I have seen it flourishing in Peru in soil so dry that cotton and grapes, both drought tolerant, were wilt-

ing. The plant, incidentally, looks somewhat like the castor bean to which it is related; its woody stalks are important as fuel. Reproduction by cutting has been carried on for so long that it has lost almost completely the ability to set seed. There are very many races, largely unstudied; the wild parent is remote and uncertain. It is certainly an ancient cultigen, bred to rank in yield with the bananas of the Old World. I should guess an origin in the Venezuela savannas, a tropical climate with marked dry season.

The bitter, or poisonous varieties of yuca have been distributed in Atlantic drainage basins from Cuba to southern Brazil; they were unknown in Central America, most of Colombia, and in the Pacific Coast of South America. In the montaña at the eastern base of the Andes they are likely to be absent among the more archaic folk, and present among tribes that have moved up the Amazon from the east, especially those of Tupi and Carib affiliations. The manner of preparation follows a fairly standard pattern of grating, pressing, and washing to remove the hydrocyanic acid, followed by baking into the admirable and long-keeping flat bread, called *cazabi* (cassava). The sweet varieties appear to be grown wherever bitter manioc is, but their cultivation extends much farther, into extratropical latitudes and altitudes. Sweet manioc is mainly boiled or baked, without grating, and rarely is the staple food that the bitter forms commonly are.

The sweet potato (*Ipomoea batatas*) is perhaps next in importance and extent of distribution. Its natural habitat also is one of opposed rainy and dry seasons, but it would seem to belong to a land of less drought than the manioc. The plants commonly flower in low latitudes, but very rarely seed. The general mode of propagation is as with us. Along the Pacific the sweet potato was grown beyond the limits of yuca cultivation, both

north and south. In interior South America Arawakan peoples seem to have favored its cultivation. Selection developed both sweet and starchy races, the latter giving the larger yields and hence perhaps of greater aboriginal use. The rapid and catastrophic collapse of Indian populations about the Caribbean by the Spanish conquest resulted in the loss of numerous varieties. Oviedo noted in 1526 that by that time some of the best kinds that he had known no longer existed. The Spaniards were not at all interested in the starchy kinds, but continued the cultivation of sweet races.

The peach palm, or pejibae (*Bactris utilis*, syn. *Guilielma*) is widely distributed through the warm lands of Colombia, into lower Central America, and south through the Amazonian montaña. It is grown from root sprouts. In many cases the fruits have only vestigial seeds. I do not know that it has been found truly wild; the so-called wild stands are perhaps only persistent groves about former settlements. The fruits are boiled or baked and have a chestnut flavor; food yield is high.

The New World aroid that takes the place of the taro, *Xanthosoma* (*yautia* or *malanga*), belongs in the main to the Atlantic tropics. It is still important in Puerto Rico and Haiti and in the northeastern mainland of South America. The lone New World cultivated yam (*Dioscorea trifida*) also has an Atlantic localization, especially in the Guianas and the West Indies. In the Caribbean also are the excellent but low-yielding American arrowroots, *maranta* and *allouia* (*Maranta arundinacea* and *Calathea allouia*) relict cultigens that may have given way to plants of greater productivity.

The racacha (*Arracacia xanthorrhiza*), a parsnip-like plant of high starch content, is much grown at temperate altitudes in the tropics, mainly in Colombia and southward through Peru in the mild inter-Andean valleys. All of these plants are repro-

duced by some practice of cutting, appropriate to the particular habit; all have been selected over long periods for their yield of starch and sugar so that wild ancestors are lost or unknown.

The planters of the American tropics were about as sophisticated as those of monsoon Asia in the use of toxic substances. Curare is used in modern medicine. In northwestern South America the arborescent daturas, known in our gardens as angel's trumpets, furnished narcotic drinks for initiation ceremonies which, according to dosage, bring visions, frenzy, stupor, or coma. These shrubs perhaps are known only as cultivated forms. Coca chewing and cultivation were pretty general through the south side of the Caribbean as well as in the Peruvian Andes. Tobacco may have been used first as a ceremonial drink, next in chewing and snuff, and perhaps last, by smoking. The elder cultivated species is inferred to be *Nicotiana rustica*, which was grown from Chile to Quebec, and seems to have originated as a hybrid on the Peru-Ecuador border. The milder and to us more acceptable species, our commercial tobacco (*Nicotiana tabacum*), is also a hybrid of two wild species, formed apparently at the edge of the tropical forest in or near interior Bolivia. The tobaccos and cocas are grown from seed, but in carefully prepared seed beds, from which they are planted out into the fields. A similar transplanting practice has been noted before in Southeastern Asia. There are several cultivated barbascoas out of different families. The most famous one, *Lonchocarpus nicou*, a commercial source of rotenone insecticide, has been so fashioned to dependence on man that until recently it was thought to be incapable of flowering.

Animal Food

The only native, truly domesticated animal is the Muscovy duck, which has nothing to do with Moscow or with musk. The

name may have come from the Muisca Indians of central Colombia. It is a tropical tree-nesting bird that pretty well avoids human habitations. The domestic forms still extend from the Araucanian villages of Chile to the northern limits of high culture in lowland Mexico. They were known to the Spaniards as *patos caseros*, house ducks, which they still are, their swimming and flying habits almost lost.

The lands about the Caribbean were also the center of a peculiar dog raising, a special breed of low slung dog being kept, often in pens, and fattened on plant food. The Spaniards, pressed a bit by hunger, found them delicious; the eating dog was one of the first casualties of the white conquest. In western Colombia there was semi-domestication of the pig-like collared peccary, which ranges from Texas to the Argentine, suggesting a parallel to the bush pig in western Africa.

In addition to fish, the tropical planters had available to them a remarkable wealth of aquatic and waterside animals—turtles, manati, water fowl, tapir, and the many hystricomorph rodents peculiar to this part of the world. The last are creatures of delicate flesh, ranging from the hundred and fifty pound capybara and the large pacas, to the little hutias and caviés. Some of these are now on the point of extinction, some became extinct before the coming of the white man, apparently due to overhunting.³ The abundance and diversity of easily secured animal food and the absence of ceremonial motives for domestication may be a sufficient answer for the failure to domesticate more animals.

Planting in Non-Tropical Lands

Northward, vegetative planting was not carried far. It did not even reach the Tropic of Cancer despite the fact that the plants could have been grown far beyond. Southward it was spread to the farthest limits of agriculture, in the island of

Chiloé where the antarcticward limit of agriculture still rests. I like the idea that the highlanders learned the planting arts from the tropical lowlanders and that little by little, partly by selection, partly by substitution of other plants, the skills were spread from north to south into lands of cold, longer days and shorter summers.

Some of the tropical tubers, sweet potato and racacha in particular, do well in temperate altitudes, to six thousand feet or more. My postulated tropical planters, therefore, should have had no difficulty in settling valleys that reached well up into the Andes. For the next stage in the farming colonization of the Andes, that of the cool temperate zone, new crops had to be found. Among root crops, certain potatoes appear attractive possibilities to bridge the gap between *tierra templada* and *tierra fria*. A number of the simpler (diploid) cultivated species of potatoes which genetically are considered as early in the history of the elaboration of the cultivated potato complex, belong into these intermediate and mild climatic levels. Three of these have been identified for Colombia and Ecuador, and others from Peru and Bolivia, some of these latter out of intermediate, some out of high elevations. Of special interest is the papa amarilla, *Solanum goniocalyx*, still widely grown for its excellent quality and taste, planted in temperate levels.

In the first farming settlement of the cold country I should place emphasis on the second-rate tuber crops—oca, ulluco, and ñu. The first is a cultigen *Oxalis*, the second of the *Basella* family of which we have the Madeira or mignonette vine in our gardens, and the last is what is popularly called a nasturtium (*Tropaeolum*). They are inferior in food value and in yield to potatoes, but are maintained in cultivation by highland Indians from Colombia to Peru and are grown in the same fields as potatoes. There are numerous races of each, and all three are

man-made species, remote from any wild kin. It is difficult to believe that people who had passably satisfactory potatoes to hand would have given attention to transforming such wild plants into root crops which provided nothing that was not better provided by potatoes. On the other hand, if the minor tubers were developed first, they might retain a place in Indian cooking because of traditional dishes and old taste preferences. Wherever there are highland Indian communities these tubers still are much used; white people do not care for them.

The tubers of oca and añu are quite acrid and are commonly soaked before cooking. They are further improved if they are frozen, thawed, and washed repeatedly. The dried tubers thus prepared are called chuñu; they can be stored indefinitely and are easily transported. Today, chuñu processing is applied mostly to potatoes and the dry tubers are a major item of trade between the people living within the frost zone and those below. The process was perhaps first invented for the bitter tubers to make them more palatable and preserve them and later extended to the potatoes of the cold lands.

The history of the potato is better known than that of most plants, thanks in particular to the Russian and English potato expeditions into Latin America. The Russian group began the investigations, the English, under J. G. Hawkes of Cambridge, carried it forward, assembling impressive evidence of genetic connections, especially with the wild potato, and revising strongly the Russian interpretations.⁴ Out of the genetically simpler (diploid) forms more vigorous, better-yielding polyploid forms have been made, especially the great tetraploid species complex of the high Andes of Peru and Bolivia, but also of Colombia, usually called *Solanum andigenum*. These and other high-yielding hybrids mainly enabled the denser agricultural settlement of the cold lands to altitudes above those of

root crops elsewhere in the world. In time, *andigenum* potatoes were carried south to Chilean extratropical lowlands. This involved, with each move southward, selection for maturing under longer days. Chilean races, markedly of long-day habit, chiefly made possible the introduction of the potato into successful cultivation in northern Europe and thereby the agricultural revolution of the past centuries. It is to Hawkes that we owe the knowledge of the Andean derivation of the Chilean potatoes; he has finally disposed of the thesis that Chile was an independent center based on local wild forms.

Animal Domesticates

The Andean cultures domesticated llama, alpaca, and guinea pig. Of these, the guinea pig is perhaps the oldest. Professor Castle has made a good case for its domestication in the area of Arequipa, which lies close to the southern limit of the genus.⁵ Such domestication close to the margin of natural range, where the animal was not abundant, has been noted for other animals. Genetic selection of the guinea pig has been especially for fecundity, size, and color patterns. The alteration from the wild form is great and indicates considerable age. The animal spends its life within the house, fed entirely by man. It has both ceremonial significance and food value. Mummified remains are common in desert burying grounds in north Chile. Professor Stirton informs me that the bones are abundant in archeologic sites around the savanna of Bogota. The guinea pig appears to have been well spread around the Caribbean. Early Spanish reports seem to refer to this household animal in the Antilles and Yucatan; and the English name is thought to be a corruption of Guiana.

The older center of llama breeding seems to have lain in the

border country of Peru and the northwestern Argentine; for the alpaca, in the high mountains of the Peru-Bolivian border. All three of these animals, therefore, may have been domesticated within the territory that Richard Latcham ascribes to the ancient Atacameño people.⁶

Food Balance in the Andes

The peoples of the central Andes impress me as not having had a balanced diet. It certainly was, and in part is, distressingly low in proteins and particularly in fats. The Spanish improved the diet by introducing *habas* (*Vicia faba*) and field peas. The one native legume of the cold lands was the great seeded lupine *tarhui* (*Lupinus mutabilis*), an Andean cultigen, still fairly largely grown. It is pretty poor food and requires days of soaking before it can be eaten. Some of the potatoes have a fair protein content, such as the golden fleshed *S. gonio-calyx*. Maize and quinoa also helped somewhat to make up protein deficiency. Maize, however, is less grown and much less efficiently used than in North America. The llama was no ordinary food; how largely the guinea pig was eaten is uncertain.

The highlands are miserably poor in fish, game, and fuel. Gilmore suggests extermination by hunting to explain the occurrence of several extinct animals found in archeological sites near Cuzco.⁷ Guanaco and vicuña have disappeared from the larger part of their earlier range. These items indicate that man got seriously out of ecologic balance in highland Peru and Bolivia, that he overhunted animals as he overcut wood for fuel. The highlands once may not have been as bleak as they are now. The steady expansion of the Inca state may have been in part due to the need of more and better food for the protein- and fat-starved central highland.

Independent Invention or Diffusion

The general hypothesis that has been presented is that both tropical Asian and Andean planting cultures are environmentally divergent developments of one basic, dominant, and persistent way of growing and improving plants.

Not alone the vegetative manner of planting, but the overall configuration of customs and skills are much like monsoon Asia. And thus we come to the question as to common or independent origin. Did we have in the low latitudes of both hemispheres a generally similar solution of the opportunities present in the environment by parallel inventions? Or did the Planters of the New World in some degree derive their institutions and skills from the other side of the Pacific? Proof of the first thesis would show a remarkable 'psychic unity of mankind' and power of environmental influences, similar environments giving rise to similar societies. This view can be established only by showing that there was no communication of planting peoples on the Asiatic side with the New World tropics; the opposite view requires evidence that there was such contact. The adherents of parallel invention have the advantage of representing what is considered the more respectable and conservative position. This rests not on evidence, but on authority: good scholars have frowned on the idea of such contacts. On the other hand, others, including geographers from Humboldt and Ratzel to Sapper, have thought that there was such diffusion of culture from the Old World to the New. The geographers, who by profession are students of the environment, seem to have least faith in the power of the environment to engender similar ideas in man. Also, perhaps we geographers find it easier to think of the earth as a continuous surface, for certain conveniences in map making represented as an eastern and western hemisphere.

That the Asiatic planting and fishing culture was expansive is shown by its spread across the islands of the Pacific and its penetration of tropical Africa, of the Mediterranean, and of western Europe. A diffusion about the northern margin of the Pacific should have presented no greater difficulties. Beyond Japan lie coasts and streams greatly inviting to skilled boatmen and fishermen. Here are the finest waters of the world for anadromous fish, such as salmon and sturgeon, the best crabbing grounds, and here were large numbers of sea-inhabiting mammals readily taken along shore, such as the Steller sea cow and the walrus. Inland seas and island chains provided sheltered harbors and facilitated water travel. Over most of the route growing timber or driftwood was available in abundance for boats and gear, for fuel and houses. It would seem strange that people who were adept boatmen and skilled fishermen and hunters on and by the water, should have held back from entering such coasts. They may well have continued to colonize northward from Japan, but have given up planting in the coasts of low summer warmth.

Numerous resemblances in customs between the Indians of our Northwest coast and peoples of Indonesia are familiar. In Kamchatka, the Alaskan Peninsula, Kodiak, and on the coast of British Columbia, there were matrilineal societies, living in multifamily houses with notions of property, prestige, and art forms which are about what might be left of Southeast Asiatic culture from which an adverse environment had eliminated certain possibilities, in particular agriculture.

As to archeology, we may have in the New World some equivalent of the European Mesolithic. Our earlier folk did not have the dog, bow, or arrow; when these were brought in, simple polished axes also appear, again mostly made of greenstone. This greenstone preference, which impressed Menghin

across the breadth of Eurasia, may not be coincidental for America.

The burden of denying passage to boat people having the skills mentioned would seem to me to rest on those who object to such diffusion into the New World. The passage may have been made at great leisure or it may have been made rapidly, by groups that leap-frogged from one fishing cove or stream mouth to another, to see what lay beyond. A few generations may have sufficed for a passage about the northern margin of the Pacific Ocean, during the spread of Mesolithic cultures.

It is reasonable in that case to consider that traditions of former planting practices might have survived, that a re-emergence of planting took place when the immigrants got to favorable latitudes, since the general cultural context remained pretty well intact. It is not beyond possibility that some plants were carried through, and this possibility needs to be studied. We have in North America a number of curiously distributed plants, commonly associated with man, of which we do not know the origin or whether they are identical with Old World forms. These include the sweet flag (*Acorus calamus*), the esculent *Cyperus*, *Trapa natans* (water chestnut), the Nelumbium lotus, and the *Sagittaria sagittifolia* of China and our Pacific Coast, known to the Columbia Basin Indians as *wapatoo*. Some of these plants are reproduced from underground parts, some have seeds of extreme viability; mostly their distributions are not such that animal or water transport seems likely.

Later there is varied and good evidence of transpacific carriage of plants in low latitudes, for which human agency alone appears competent. Again, there has been reluctance to get and to weigh the available evidence. The biological evidence is the most critical, since the same organism cannot be claimed to

have originated repeatedly in distant parts of the world. Those opposed argue for post-Columbian introduction or accidental drift across the great Pacific by current and storm. Such explanations may strain the credible far more than do native boatmen who were able to venture into the open ocean. The post-Columbian explanations require extremely rapid handing on of the introduced thing over a very large area to accommodate the historically known presences.

Famous theses of this sort are: (1) the assumed carriage of the American sweet potato by Spanish vessels from Peru to the other side of the Pacific, and along with it the name "kumara," supposed to be Peruvian; (2) the presence of maize as an important Chinese crop of the second half of the sixteenth century as handed on in a few decades from Spain through the Mediterranean and southern Asia into China; (3) the bringing of bananas from Africa by Spaniards and Portuguese, as illustrated by the distribution of the supposedly European name *plátano* among the Indian tribes; and (4) the first introduction of the chicken into the New World by the Portuguese and Spaniards. Each of these constructions can be shown to be based on errors that invalidate them. I should like to present briefly the case of the chicken.

In 1922 Erland Nordenskiöld published a memoir on the spread of certain culture elements through South America.⁸ One of the elements that he discussed was the domestic fowl. The known historical record begins with Magellan's party which secured supplies of fowls in 1519 from Indians on the coast of southern Brazil. Hence, so Nordenskiöld thinks, they were introduced by Cabral in the discovery of Brazil in 1500 or by someone else shortly thereafter. No document mentions anything of the sort, though the journals of Cabral's voyage are quite detailed. The Cabral landing took place a thousand miles

to the north of the Magellan incident. In 1526 Cabot's men not only got hundreds of fowls in the coastal villages of South Brazil but sent for additional supplies to a distance of forty leagues inland. Later explorers of the interior from Paraguay to the Orinoco commonly found chickens being kept in Indian villages never before visited by whites. "Domestic fowls were evidently taken inland by Indian traders to far-off places long before these were explored by whites." Nordenskiöld elaborates this statement by lengthy and careful documentation. The name of the Inca Atahualpa is accepted by him as the Quechua word for domestic fowl; he traces the distribution of this name and other native names from the Araucanians to Amazonian tribes. "Not a single tribe living in an area bordering on the old territory of the Inca Empire calls the fowl *gallina* or *gallo* or uses any name traceable to Spanish." Doggedly Nordenskiöld worked out an enormous distribution of the fowl through remotest agricultural South America before Spanish contact, documenting it with the distribution of native names, ceremonial uses of the fowl, and selection for white plumage, as a remarkable example of explosive rapidity of diffusion. He did not concern himself with the question as to how chickens could have multiplied so rapidly as to have been spread over hundreds of thousands of square miles in a very few years, nor about the probable rate of acceptance of a strange new animal, including ceremonial acceptance, into a wide range of native societies. That the chicken could have been brought only by white men was a premise that it never occurred to him to question.

Ten years ago I went on a field trip in Chile with a Chilean zoologist. We were served boiled blue and olive green eggs at an inn. I was surprised at seeing them and he was surprised that we had no eggs of such colors. I then learned that the

Indians, that is, Araucanians, like to raise a breed of chickens that lays such eggs and that white folks do not care for such fowl or their eggs. We saw them in Araucanian village after village, obviously cross-bred with ordinary races. My education in the blue- or green-egg fowl continued at the hands of Don Ricardo Latcham in Santiago who, I found, knew a lot about the question and had written in the same year as Nordenskiöld another study on the chicken in the New World.⁹ Using much the same documentation, he had come up with the opposite conclusion, that the Indian chicken was of a quite different breed from any European ones, that it had been introduced long before European contacts, and that it survived as the Araucanian fowl. Don Ricardo seemed to me to have the best of the argument. Few people seem to know this study of his, nor has this fine scholar and gentleman ever had full recognition outside of his adopted country for the range and depth of his insight into native cultures. To him belongs the credit for discovering the pre-Columbian chicken of the New World.

On returning home, I found that the blue-egg chicken was a *cause célèbre* in poultry genetics. Professor Punnett of the animal genetics laboratory at Cambridge had established this color factor as a dominant gene.¹⁰ It is unknown in the Old World. Such dominant mutations arise very rarely under domestication, being ordinarily primitive genes of remote origin. The Cambridge experiments were made from Chilean stock. An Englishman resident in Costa Rica supplied Punnett with a further note of "original" chickens laying green eggs; this was among mountain Indians of Costa Rica, a small outlier of Chibchan culture surviving in mountain fastnesses. Thus, from the southernmost extremity of the New World vegetative planters to their northern limit there existed and in part still exists a greatly aberrant form of chicken, the like of which is

unknown elsewhere. The Europeans could not have brought it, for they did not have it. Its economic qualities are inferior to European breeds and it survives vestigially as a marker of vanishing Indian cultures. Hybrid origin (which Latham surmised) appears impossible for the New World has no nearly related fowl other than the turkey. A miraculous post-Spanish mutation can be ruled out; this is an Indian fowl, Indian cultures were in retreat and breaking down by Spanish conquest, and Chilean and Costa Rican Indians were not in contact with each other.

To the mystery of the chicken in the New World Dr. J. P. Harrison of our National Archives, adds a further item from the journal of T. A. Dornin, *U.S.S. Brandywine*, May 30, 1828, Païta, Peru: "The poultry here have black combs and black feathers, have also black meat, except a small white streak on their breasts—the bones are black, which is unfavorable in appearance only, for they are the sweetest and tenderest here. Prejudice is powerful, some of our mess would not eat them." This internal blackness has been noted for Asia and Africa as a quality of a ceremonial breed preserved in the ornamental Silkies. The source is apparently from Southeast Asia; an introduction by way of Europe is unlikely.

The transpacific carriage of cotton, the true gourd, sweet potato, and coconut appears proven, I should say, even for the coconut as due to the deliberate action of man. The case for the plantains, some eating bananas excepted, first proposed by Humboldt and supported by Sapper, is equally good, but has not been presented. There are several dozen plants, cultigens, intimately associated with man on both sides of the Pacific, that need critical investigation. Such plant remains in the pre-ceramic archeology of the coast of Peru show that times earlier than the Polynesian settlement of oceanic islands are

involved.¹¹ Other culture elements that show up especially in Northwestern South America, such as chicha fermentation by chewing, masticatories with lime, the blow gun, perhaps the “edible dog,” etc., may be inferred as introduced across the Pacific.

The principal aboriginal marine ports of entry may have been about the Peruvian–Ecuadorean border and their use lie as far back as the beginning of dynastic time in the Near East. Of significance, for instance, is the place of origin of the tetraploid cottons of the New World, originating out of Old World cottons and a Peruvian wild *Gossypium* (probably *G. raimondii*).¹² The crossings were in both directions; they did not introduce the planting system of the New World but they reinforced and enriched it with new items.

IV

Seed and Harvest

Seed Planting of Aboriginal North America

North of the Chibchan lands of Central America and the West Indies, the aboriginal mode of agriculture becomes quite different. Planting by cuttings is replaced by seed planting; selection takes place by sexual progeny, not by division. The northerners were seed farmers, making annual harvest and storage of matured seed, and selecting next year's seed stock from the pick of the harvest. With few exceptions the plants grown are annuals or became annuals by cultivation. I referred in the preceding lecture to this change in manner of plant reproduction as outlined fairly well as a hinge line, the contact of two great culture areas historically, differing also in other ways than by their agricultural practices (Pl. II). The Lenca of Honduras are of northern affinities, as are their neighbors the Mayan and Nahuatl peoples, and as were also the vanished Otomangue and Subtiaba groups of the Pacific Coast.

Northward into Mexico, the dry seasons grow more marked and the highlands experience some winter cold, but environmental change is insufficient to explain the cultural change. In the coastal lowlands, root crops were grown well to the north of the hinge line, but remained subordinate to seed crops. In the Nahuatl languages (of Mexico and south) the crop plants out of the south may have descriptive names indicating belated acquisitions, such as the name for manioc, *huauhcamote*, "the woody plant with tubers." The cultivation of

root crops stopped well short of the northern limits of Mexican high culture. No climatic barrier excluded the sweet potato from northern Mexico or the United States. By contrast, when it got into the hands of the Polynesians, races were bred that succeeded in the South Island of New Zealand, in latitude and climate similar to that of Vancouver. The folk north from Central America just were not strongly interested in the vegetative plants available to them from the south.

Nor did the north lack suitable wild plants to be grown and ameliorated by vegetative reproduction. There are wild *Solanums* in number in the highlands of Mexico and our Southwest that bear tasty and nourishing potatoes. Some of these by their genetic constitution and desirable qualities are of interest to our potato breeders. Wild *Solanum* species grow as volunteers in fields on the Central Mexican volcanoes. They are dug and eaten, occasionally are sold in the markets, but are not cultivated. In our Southwest, *Solanum fendleri*, the Navajo potato of sweet flavor and frost proof, is a wild food source that might have been an important addition to Indian agriculture, but the Pueblo farming tribes did nothing with it. In central and southern Mexico, various wild tubers, commonly called *camotes del cerro*, are dug and used as food, even sold by sidewalk venders in large cities, but remain uncultivated. The Indians of our eastern woodlands dug sweet tubers in quantity, such as the groundnut *Apios americana*, but they appear to have planted only seed crops; so too with the Jerusalem artichoke, which is not an artichoke and has nothing to do with Jerusalem. This tuberous sunflower is a persistent weed of cultivated ground and was common in Indian fields in Canada and the eastern United States, where it was a food item of some importance. Like the wild potatoes on the Mexican volcanoes,

it multiplies well under disturbance by digging and this appears to have been the means of its increase and spread. Its actual selection in cultivation came at European hands.

The Maize-Beans-Squash Complex

The dominant plants of North American agriculture were maize, beans, and squashes or pumpkins. These formed a symbiotic complex, without an equal elsewhere. The corn plants grow tall and have first claim on sunlight and moisture. The beans climb up the corn stalks for their share of light; their roots support colonies of nitrogen-fixing bacteria. The squashes or pumpkins grow mainly prone on the ground and complete the ground cover. In lands of short growing season, all three may be planted together at the same time, the corn then being of early maturing kinds. In lands of long season, the corn was planted first, the other two later in the hills of corn. With few exceptions, all three were grown together. By long cultivation varieties of all were selected, able to grow to the farthest climatic limits of Indian agriculture. Civilized man has not extended the limits of any of them and has introduced only a few crops that succeed under more extreme climates. Maize, beans, and squash were grown on the lower St. Lawrence and by the Mandans on the upper Missouri. They are grown in *milpas* on the Mexican volcanoes to the highest patches of available soil. Forms were successfully selected for growing on the margins of the deserts of Sonora and Arizona where there is only an occasional summer thunderstorm. The Hopi, living in a land of little and late rain, of short summers and cold nights, depend on them and by them have maintained themselves and their fine and gentle culture, our civilization lacking the skills to match theirs for this harsh environment.

Maize is a species complex, the enormous diversity of which

is being uncovered by geneticists, mainly by study of Indian varieties. Only a small part of this genetic wealth is preserved in our commercial corns, which have been developed for rich soils and yield of grain, in part, as has been found lately, to the detriment of food value other than carbohydrates. Our main interest in corn is as feed for livestock; native attention has been given to it as a staple of human food. The corn on Mexican or Guatemalan hillsides that may seem a sorry plant to the visitor from the United States, is likely to be very properly suited to the native diet and the local soils and weather. The experiences of very many generations of corn growers are not to be set aside lightly by the simple and short-range interests of commerce. It is not accidental that a single native village may maintain more kinds of maize than the Corn Belt ever heard of, each having a special and proper place in the household and the field economy.

There are at least four quite distinct cultigen species of beans. One, *Phaseolus coccineus*, the scarlet runner bean, still is a perennial, used not only for its oil-rich beans but for its starchy, thickened root. Its cultivation extended at least from the Pueblo Indians of our Southwest to Ecuador and is greatest in the high country of southern Mexico, for it is mainly a cold country crop. The common kidney, navy, or frijol bean (*P. vulgaris*) has been most diversified and most widely spread; it is usually the dominant bean in the temperate areas, but there are important races to the limits of New World farming. The lima and sieva beans (*P. lunatus*) have their center of diversity in Central America, extend far south in South America, are approximately absent in Mexico, and reappear among the Pueblo and eastern-woodland Indians of the United States. Their distribution presents unsolved problems of dispersal.¹ The tepary (*P. acutifolius*, var.) is the Indian bean of Sonora

and adjacent Arizona as well as the lower Colorado Valley; it is specialized beyond all others for least moisture and most heat requirements. The aboriginal farmers perfected beans suited to virtually all climates and soils, of high protein and oil content, and so superior to the pulses of the Old World that they soon became important additions to Old World gardens from western Europe to China and Japan.

Problems in the Distribution of Cucurbita

The genus of *Cucurbita* in its wild species is restricted to the New World. Wild variety is probably greatest in Mexico. Of the five cultigens, one, *C. ficifolia*, stands apart; in the appearance of plant and fruit it resembles a watermelon, and it is the only perennial cultigen in the genus. Its origin is assigned to the highlands of Mexico and Central America, where it is the only squash cultivated in the higher and colder fields. It is used a little as a green vegetable, somewhat for its seeds, and also for making a lightly fermented drink with the addition of sugar or honey. At present it is also grown as food for hogs, but otherwise is little thought of. In the Andean Highlands, it has very much greater importance in Indian food but has been thought to be a Spanish introduction into South America. No native name is known for it in South America, and one of the common names is a modification of the Mexican name, *tzilacayote*. Since this cucurbit is quite below the white man's notice, it is not apparent why Spaniards should have carried it into the southern continent. Lately it has been discovered in large quantity in the oldest archeologic levels of Peruvian coast agriculture, before pottery was made and before corn or true beans were grown there.² It is, therefore, the oldest cultivated squash known and it is archeologically known from a climate in which it is now absent. Its primitive qualities thus seem to mean, not

that it is late and a marginal substitute where better squashes will not grow, but that it was early and was dropped from cultivation, except in cold areas, when better squashes were developed. Its historical position is reversed by these unexpected archeologic finds, and they reopen the question of the time of its appearance in the Old World. *C. ficifolia* was first described botanically from India where a different form, growing in a quite different climate, has long been known as the Malabar gourd. It is also known as the Siam gourd. A century ago some yaks from the borders of Tibet were shipped via Shanghai to France. Because it was thought that they needed accustomed food, a large quantity of this squash was brought down with them for the ocean voyage. Some were left over on arrival in France, the fruits having extraordinarily long-keeping qualities.³ This plant of ancient American cultivation and of no economic use to the white man needs looking into as to its Asiatic forms and distribution. When such a study is made, the Asiatic forms of *C. pepo* and *moschata* which have perplexed botanists from Linné to Vavilov need also to be re-examined.

The other four cultivated squashes may form one cognate group, originally centered on the south half of Mexico. Our common field pumpkin, *C. pepo*, is dominant in the cool highlands of Mexico where it is a staple food. Diversity is low in Mexico and increases into the United States, especially east of the Mississippi, where it was carried as far as maize and the common bean. The great squash of the temperate lands of Mexico and Central America is *C. moschata*, which was carried about the Caribbean and to the coastal oases of Peru, where it met *C. maxima*. The purely South American *C. maxima*, grown from Chile across to southern Brazil, may have an ancestor in a wild gourd of the La Plata drainage, *C. andreana*, or *andreana* may be only "a weedy by-product or non-horti-

cultural form of *C. maxima*." However, since *andreana* "seems to be more closely allied to the perennial species, *C. ficifolia*," the latter, introduced from North America long ago, may be involved in the ancestry of the South American squash complex.⁴ *C. moschata* may also be involved. Whitaker and Bohn⁵ have shown that it will cross with *pepo* and also with *maxima*, but that these latter two can be crossed only with difficulty. At present it looks as though *moschata* were the central and fundamental species, domesticated from some wild Mexican *Cucurbita*, all of which, as far as known, are perennial, with woody turnip-shaped roots. A *moschata* cross with another wild *Cucurbita* may have given rise to the pepos, near or beyond the United States border. The fifth species, ineptly named *C. mixta*, has been least studied. It is most easily recognized by a greatly swollen, corky peduncle, often bigger than a man's fist. It is now limited in distribution mainly to the hot lowlands of northwest Mexico and is the common squash of Sonora. Prehistorically it was grown on the southern Colorado Plateau, of brief, cool summers; it included a race that was used as water jugs by the cliff dwellers.

Wild *Cucurbita* and, even more so, those of the related North American genus *Apodanthera* are still collected and sold in Mexican markets for their seeds, edible on roasting. That the *Apodantheras* were not made into cultivated plants may be due simply to the fact that their range is mostly beyond the northern limits of the earlier agriculture. Here and there a cultivated form of thin-fleshed *moschata*, is still grown only for its seed. Throughout Mexico, squash seeds are carefully saved for food; indeed, to many Mexicans the seeds are quite as important as the flesh. The original domestication was for the seed. The wild kinds, in so far as I know them, are fleshless. Any mutation toward fleshiness was probably disadvantageous

in natural reproduction. In the course of time cultivated variants were selected for their starchy and sugary flesh, and large forms developed. In many native and mestizo communities of Mexico and Central America, the large fruited races are about as important as corn or root crops as a source of carbohydrates; the seeds also are a principal source of protein and oil, hence in those countries the squashes are a principal staple food.

Multiple Use of Seed Plants

Everywhere the squashes have multiple and continuing uses and thereby illustrate an important characteristic of New World seed plants. The squashes have separate male and female flowers and this distinction has been well noted by the natives. Most of the male flowers are picked and used in stews, soups, and salads, enriching the diet with carotin. The young fruits are thinned from time to time to serve as green cooked vegetables; proper thinning secures maximum size for the fruits that are left to mature. The mature squashes are stored for consumption during the dry or winter season and may last until the next crop is in. Where a dry season is absent, they may be sliced and dried. The squash is likely to have, therefore, a year-round place of importance as carbohydrate food. The seeds are carefully taken out and dried. Roasted, they are either eaten out of hand or ground and mixed into meal or sauces. Hard-rinded forms may be scraped out and used as gourds for storage; the United States Indians also grew inedible gourd forms of *pepo*, used by ourselves in former days as darn-ing eggs and now grown as ornamentals.

Other major New World seed plants are similarly used at various stages of their growth, as greens, for their inflorescence, for immature fruits, and finally when matured. This is true of corn, the beans, amaranths, and chenopods. They are alike

vegetables and seed crops. Something may be taken out of the field at most times during the period of growth and thus they are distinguished from the Old World seed culture, in which the plants mainly are left untouched until the harvest. In large measure, harvesting is of single matured plants, not of the common maturity of a field. Also, there is no hurry about harvesting unless it is to save from damage by animal depredation. A lot of our native crops like corn and squash can await the convenience of the farmer. Harvest time has a less conspicuous position in the agricultural calendar of the New World than in the Old; harvest festivals are less important.

Planting Practice and Seed Selection

The native seed farmers of the New World still are in effect planters. Unless they have learned to plow, there is no overall preparation of a field, but selected spots are dug up, worked over, and heaped into mounds or hills. Each mound is planted with a number of things. The seeds are stuck into the ground, usually one by one; so many grains of corn according to the kind, so many beans, so many squash seeds, and perhaps some of something else. Selection of next year's seed stock is by individual plant. Individual ears of corn, entire seed heads of amaranth and chenopod are selected and hung up for the next season's planting.

By individual selection of seeds, the New World beans have acquired a large diversity of seed size, form, and color, which the mass-selected Old World *Phaseoli* lack. Both groups started with quite small seeds; but even our least teparies have been selected into seed sizes greater than those of any Oriental beans and many of the limas are giants. For ages our Americans have been playing around with size, color and shape of beans by sorting out the individuals that attract them; and they still do

such hand sorting. The attention to individual plant qualities may well be linked to the planting of cuttings of attractive individuals.

Origin as Attractive Weeds

The ancestors of most New World seed plants appear to have been attractive weeds. They were not tenacious intruders that the cultivator had difficulty in getting rid of, nor are they such as grow on trodden ground. They were gentle, well-behaved weeds that liked the sunshine, loose earth, and plant food of the tilled spaces, and had no great root system. Such volunteers, usable by man, were first tolerated, then protected, and finally planted. The tomato is in part still in the stage of becoming a cultivated plant. In many places in Mexico and Central America the little cherry tomato is the common form; it is not planted, but protected. It, in turn, derives from wild, inutile tomatoes of northwestern South America.

I infer that other plants were grown before seed plants became the object of cultivation. Plantings of root crops provided room for self-sown plants. It appears that these volunteers which became cultigens are distributed especially around the farther margins of vegetative planting. Chile, at the southern limit of agriculture, has at least two native seed plants, the oil plant *Madia sativa* which is a tarweed, and *Bromus mango*, a weedy grass used as a minor cereal. In the northern periphery of the root crops a similar substitution on a much greater scale took place with amaranth, chenopod, squashes, and beans. It may be as simple as this: where climatic advantage shifted from the root plant to the seed plant, the attention of the cultivator shifted from the former to the latter. Instead of selecting root variants to meet the local situation, he began to select the attractive weeds.

Major New World Hearth of Seed Plants

I incline to the northwestern extremity of vegetative planting, that is, the Mexican–Central American border, as the hearth of the principal seed plants. In wild kindred, the squashes, beans, amaranths, chenopods, sunflowers, capsicums are best represented here. Their cultural diversity is also greatest here. Small-seeded and wild-colored races in particular are likely to be found in Mexico and northern Central America. The lima bean gets its name from Peru, but all the beans of Peru and most of those of South America are genetically recessive forms, of maximum seed size and of domestic colorations. The archeologic beans of Peru are scarcely distinguishable from present day commercial varieties. The earliest farmers there had no true beans; when these appeared, they were of highly-bred types. They were therefore brought in from elsewhere, long after domestic amelioration. Seed planting is distributed through most parts of South America. Seed plants are, however, usually subordinate to vegetative plants in the economy; their kitchen uses are fewer and simpler than in the North. Fewer kinds of squashes and beans are grown. Maize is considered by some specialists as of South American origin; yet there it is rarely the staple food, rather is it prized as a green vegetable, ears in the milk stage being much used, a low-efficiency use compared to the dominant Mexican use as *nixtamal*, wet ground hominy. In some South American areas aboriginal maize production was mainly for the making of chicha beer, again inferior to the Mexican malting. The argument of the origin of this mysterious monster continues among the specialists and we shall await its outcome. It seems to me too improbable a plant to belong to the start of the seed domestication complex. I prefer the view that it took place later and became substituted for the grain ama-

ranths and chenopods, which from present evidence came out of the North.

The Turkey

The lone contribution of the American seed planters to animal domestication is the turkey. The wild form does not occur south of the Isthmus of Tehuantepec and the domestication took place in Oaxaca or some place nearby.⁶ Other attractive birds, some gallinaceous, readily tamable and often kept tamed, were not domesticated. Among them are the handsome ocellated turkey of Central America, the curassows, and the whistling tree ducks, often kept as a sort of watch animal. The turkey of the Pueblo Indians I think was kept rather than domesticated.

Seeding Marginal to Planting in the Old World

In the Old World, at least three centers of seed domestication may be identified, all on the margins of the Old Planting lands. One lay in North China, including the loess lands, beyond the cold limits of the subtropical vegetative crops. A second began in western India ("India," throughout, is used in the traditional sense) and extended to the eastern Mediterranean, involving passage from summer rain to winter rain country. The third was in Ethiopia where the Abyssinian highlands adjoin the Sudan. In all three, vegetative reproduction was made difficult, annual seed growing facilitated by climate. The thesis that in climates marginal for vegetative planting, attractive volunteer seed plants became objects of use and of cultivation may also be applied to these three areas. In each, a cultivated assemblage took form that included starchy seeds, seeds rich in protein, and those yielding vegetable oils. These areas no longer depended on fish and other water or stream-side

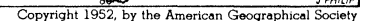
animals, but acquired plants suited for balanced vegetarian diet. The Neolithic domestic pig continued to be important in North China, as it anciently was in the lands west from India and in the Ethiopian center. (The three centers are shown on Plate III.)

In each, the basic complex includes grasses cultivated for grain, legumes for protein and fat, and usually some additional oil and perhaps fiber plants. The plants that became the cultigens either were annuals to begin with, or were converted by selection into annuals. Much less so than in the New World were uses established for immature plants; a harvest season marked the high point of the year.

The basic grains were millets, a botanically meaningless but economically valid term. A millet is any small and many-seeded grass grown for its seed as human food. They were attractive for the multitude of seeds a plant produced, not for their size. Selection seems to have paid little attention to increasing seed size, but rather the size of the seed head. Grasses with many branched seed heads or panicles were sought after, such as the sorghums or those that set numerous seeds all about the spike, such as fox-tailed millet. The so-called great millets of travelers' accounts are mostly sorghums, the lesser millets may be of various grass tribes, but are in many cases some panic grass. In many countries of Asia and Europe a particular millet has a special odor of antiquity as traditional food, in folk lore, or as an early beer grain.

I do not consider the sites of early seed agriculture to have been grassy plains in the Old World any more than in the New. I accept the view of Vavilov that cultivation started in small valleys and their adjacent slopes, in mixed and varied vegetation. This is a rude departure from the cherished view that the earliest seed farmers avoided wooded and brushy land and

Amer. Geog. Soc. Bowman Memorial Lectures Ser. 2, Pl. III



settled in grasslands. As I said before, I inferred earliest settlement on loess because it was well drained, fertile and wooded and the soil was easy to dig (p. 21). The removal of tree trunks and brush did not become necessary until plowing demanded well-cleared areas, free from obstruction to the making of furrows.

During Neolithic time the surface was loosened by primitive spade or hoe, more often a pick than a transverse blade. Since small seeded things were grown, there was not the need of deep working that root crops required. The seed planters of the Old World seem not to have carried over the habit of hilling the ground which was continued in the New World. The small seeds needed to be only lightly covered; complete tillage of a field and broadcasting or drilling came probably with the later use of the plow. In the Sudan the ground is still, in places, loosened with a pick-like hoe, a hole dibbled with the big toe, a few seeds dropped and covered by a swipe of the foot, a good early model of seeding. Further cultivation was mainly by pulling weeds. Harvest required no special tools; the ripe seed heads were broken off or pulled, as is still done in parts of India and Africa.

North China

Bishop reported *Panicum miliaceum* from the Neolithic of North China. He says that "in the early writings this is the chief cereal mentioned, and it is the only one to possess a religious significance—itself a sign of great antiquity."⁷ Vavilov and his associates assign to North China the origin of this ancient cultigen, a matter of considerable interest since it was also grown by the lake dwellers of the Alps. To China too, they confirm the origin of the foxtail millet (*Panicum italicum* or *Setaria italica*) which also was early in European cultivation,

and either to China or Japan the barnyard millet (*Echinochloa* or *Panicum frumentaceum*). Thus the genetic evidence is that from this far source the panic millets were carried at an early time to India and the Mediterranean. They are ancient beer grains in Asia; as Bishop pointed out, fermentation was started by chewing, as with the vegetative planters to the south. This practice has a continuous Asiatic distribution and was diffused from a southern center.

North China produced the soy bean, a long-day plant which we are only now breeding to succeed in lower latitudes. This photoperiodism may have blocked its spread in the past; at any rate, it did not get carried as did most cultivated plants of high merit. Soya protein is equivalent to animal proteins for human food and said to be unequalled in this respect. It is also unequaled as a vegetable oil source. Two minor beans bridge the climatic gap between the great soya of the north and the beans originating in India. These are the adzuki (*Phaseolus angularis*) and the velvet bean (*Mucuna hassjoo*), the latter ameliorated from a genus marked by irritant and stinging pod hairs.

Ethiopia

At the other end of the Old Planting area a seed center took shape long ago in Ethiopia. Here, along the passageway by which taro and banana, hog and fowl were brought to Africa, a greatly different seed domestication had its home, from the temperate mountain valleys of Abyssinia to the hot Sudan and Saharan margins. It remained for Vavilov and his co-workers to discover in Ethiopia one of the world's greatest and oldest centers of domestic seed plants.

The home of the sorghums is Africa, the cultivated forms stemming from the general area of Ethiopia. The one exception is Johnson grass, now known to be a polyploid deriva-

tive weed and not ancestral to any of the cultivated sorghums. The great millet, the durras, and sweet sorghums were fashioned here, and from here stem the large number of secondary sorghum races of India, and the kaoliangs of North China. The pearl millet, or bajra of India (*Pennisetum spicatum*) is placed here, as are teff (*Eragrostis abyssinica*), and, probably, the African millet or Indian ragi (*Eleusine coracana*). Nowhere else in the world were so many or such valuable millets developed, a fact of major significance for the age of seed agriculture here.

Vavilov goes much further: "According to the number of its botanical varieties of wheat, Abyssinia occupies first place. In fact, botanical, physiological, and genetic studies indicate that the wheats of Abyssinia should actually be divided into separate botanical species. This is also the center of origin of cultivated barley. Nowhere else does there exist in nature such a diversity of forms and genes of barley." ⁸ I should interpret this to mean that barley, according to Vavilov, was originally domesticated here, and that certain local wild wheat grasses entered into the complex series that we call wheat, but that other areas to the north and east had an earlier role in the making of the wheats. Elisabeth Schiemann, in a recent publication, disagrees in a number of important conclusions with Vavilov. She assigns the origin of barley to eastern Asia (Tibetan-Chinese borderlands?); her new material suggests that this cereal may have been developed in the cold mountain borders either of China or India. ⁹

To the pulses the area contributed the cow pea (*Vigna sinensis*), the hyacinth bean (*Dolichos*), and an anciently divergent lot of lentils (the Abyssinian forms are partially sterile with Asiatic ones). Sesame is originally a North African plant, and the gene center of the cultivated forms is here. The

list of Ethiopian contributions to the food plants of Old World agriculture is imposing.

Lately, a group of British cotton geneticists have overhauled thoroughly the previously badly confused picture of the genus *Gossypium* and related malvaceous plants.¹⁰ Some of their findings have upset the earlier views of the New World cottons; another result, unnoticed by culture historians, upsets the Asiatic domestication of cotton. Only cultivated, man-made cottons they say are lintbearing. All wild species of *Gossypium* are lintless; any mutation toward lint is unsuited to survive in nature. The domestication of *Gossypium* seems to have commenced, therefore, before it filled its bolls with fiber and must have been for some other end, possibly for its oil-bearing seeds or fibrous stalks. The new view derives the cultivated Asiatic cottons not from an Asiatic wild species, but from the African arid-border *Gossypium anomalum*, thus opening a vista into a remote time when a *Gossypium* was first taken under the care of man in Africa for some unknown purpose, and later, presumably in Asia, was made into a seed fiber plant.

Archeology has never pointed a finger at Ethiopia as a cradle of civilization, but this and other biologic evidence does so, and very strongly.

West from India

West of the rainy monsoon lands of India rice and the root crops are replaced by annual seed crops, including protein and oil sources. Western India is not credited with many early cereal grasses, except for such minor ones as Koda millet (*Paspalum*), jungle rice (*Echinochloa colonum*), and Samai millet (*Panicum miliare*). It is a poor lot; something seems to be missing or lost. Some of the great west-of-India crops are African, such as the sorghums; wheat came from farther west.

Barley is certainly of ancient cultivation in India, and the Schiemann argument may place its origin nearby, probably to the northeast. Possibly these superior plants replaced earlier natives; that their Indian age is high is supported by their local diversification, as Vavilov pointed out. The rest of the list is better. Here are assigned four out of the five cultigen *Phaseolus* beans of the Old World, which moved also into China but not westward. Western India is the home of the chick-pea or garbanzo (*Cicer*), of old cultivation also in the Mediterranean. Here too is thought to be the first home of the widely wandered true gourd (*Lagenaria*), of the dish-cloth gourd (*Luffa*), the cucumber, eggplant, radish, lettuce, and hemp.

West of the Indus and north thereof, the rainfall still comes mainly in summer, but the season of rain is shorter and there is marked winter cold. Northwest India, Kashmir, Afghanistan, and eastern Persia are continental-climate extensions of the trans-Indus country. Additional important legumes were domesticated here: lentils, true peas, grass peas, and later this was the place of origin of the polyploid bread wheats.

Still farther west, beyond the deserts of central Persia, the lands of winter rainfall begin in the highlands of western Persia. This eastern end of Mediterranean climates is linked to cis- and trans-Indus lands in its crop plants. The legumes are almost wholly of more eastern origins, but, to the west, they appear in advanced, especially in larger-seeded, races.

The primitive wheats, alone among important crop plants, seem to have their roots in the eastern margins of the Mediterranean. The most primitive (diploid) cultivated wheat, einkorn (*Triticum monococcum*) is thought to stem from the highland borders of Asia Minor. Better wheat became available to Neolithic farmers in tetraploid cultigens, especially emmer (*T. dicoccum*), for which origin has been placed in Syria and

Palestine. (Schiemann again partially dissents, placing the home of emmer in the mountain borders of Anatolia, Transcaucasia, or western Persia.) It continued to be the great wheat of the Mediterranean through most of Roman time. The small-seeded so-called ancient bread wheats of the Near East are still unsolved, but McFadden has advanced an argument that these were actually a tetraploid species, similar to or identical with Persian wheat, and that bread wheat (*T. vulgare*), a hexaploid, came much later, developed in the Afghan-Indian border. At any rate, the Near East did have a leading part in the fashioning of wheat culture, but got most of the rest of its plants out of the East.¹¹

The significance of wheat and also of barley in the early civilizations has perhaps been overestimated, possibly because they belong to our own system. That the Mediterranean lands and the Near East made more use of wheats than did others, is true. Why they did so is clear to me only in so far as these were winter crops. The millets began, and are mainly grown in lands of summer rain. Barley also is more largely spring than fall sown, though there are old races of winter barley. The winter-rain country of the Near East got from the Middle East such climatically adaptable crops as the chick pea, the field and garden peas, lentils, and Brassicas; but there may have been a climatic dilemma as to grains.

There were at the eastern end of the Mediterranean and farther east local wild *Triticums* and other grasses that cross to some extent with wheats, and some of these became improved at the hand of man. I do not think that these spindling plants of few seeds were very attractive, but they may have been the best available. Nor do I think that there were waving fields of wild wheats, waiting to be reaped by the sickle. Rather

the ancestral cereal grains would seem to have grown intermingled with a lot of different plants. Sickles, of sharp-edged stones set in wood, are an ancient tool of the Near East and, I think, have been correctly interpreted as a grass-cutting tool. They appear not only in the proto-Neolithic site at Tell Has-suna (Mesopotamia) but in the late Mesolithic Natufian.¹² I doubt, however, that they were used in the reaping of wild grass seeds. It is the nature of wild grasses, and especially of the wheat kindred, for the mature axis or rachis to be brittle and shatter, scattering its seeds to the ground. One of the principal changes by domestication has been the selection for non-shattering quality. Primitive harvesting of grass seeds is by seed beaters and baskets. A sickle, and especially a stone sickle would have lost the seed. The presence of the sickle is an argument for already domesticated grain.

*The Pattern of Spread of Seed Agriculture
in the Old World*

It seems to me that the patterns of distribution of the seed annuals make some sense as to the manner of their dispersal. There are at least three hearths of seed plants, all forming strategically placed salients along climatic margins of the Old Planting area. All, I take it, began as gradual shifts of attention from cuttings to seeds, where environment became less favorable to root crops than to annual seed crops. This is again the thesis of the attractive volunteers. At the northeast, one complex of economic annuals took form in the loess country of China and perhaps in the mountain margins of inner China. A second was at the Ethiopian gateway to Africa. The third was in three segments: trans-Indus, cis-Indus, and the Near East, the last involving a shift from summer-rain to winter-rain

crops. By their plant complexes, Ethiopia and China appear older than the central salient, and in the latter the Near East as later than the two sides of the Indus.

The dispersal of seed plants outlines certain far-reaching early lines of communication that may lie greatly beyond any times disclosed by the spade of the archeologist. The Indian-South Arabian-Abyssinian route of the Old Planting culture functioned again in the spread of seed agriculture and became extended in the opposite direction, through Upper Burma and Szechwan into the loess lands of North China. Along this line moved, from Africa, the sorghums, sesame, cowpeas, and the primordial cotton. The Chinese classical tradition is that sorghum came out of India within the Christian era. The botanical argument on the kaoliang races is to the contrary. Archeologically, Andersson has shown the Neolithic presence of rice culture in China¹³ and Bishop has reported Neolithic kaoliang. Along this great way between Abyssinia and Shensi the seed annuals have left a trace of early civilization, inviting exploration (Pl. III).

The panic millets, if correctly credited to North China, indicate an early route diverging westward in India to pass into the Mediterranean and ultimately to the Iberian and Celtic peoples of the Atlantic.

The seed crops show a curious failure to disperse from Abyssinia down the Nile to Lower Egypt and into the Mediterranean. The sorghums, one of the most valuable lot of man-made plants, seem never to have taken hold to any extent in Lower Egypt or beyond. Pliny said that they were introduced in his lifetime from India. The Egyptians did not use cotton, which came west belatedly and slowly from India after Alexander's invasion. According to Burkill, the ancient African sesame reached Egypt about 1300 B. C. and, again, probably via India

and Mesopotamia. The Abyssinian durum wheats seem not to have reached the Mediterranean until after Roman days. The block between Ethiopia and the Mediterranean was in part only climatic, between summer and winter growth seasons, gradually overcome by irrigation and the breeding of winter races. This is, however, obviously an inadequate explanation; an undisclosed cultural break is inferred that again invites study.

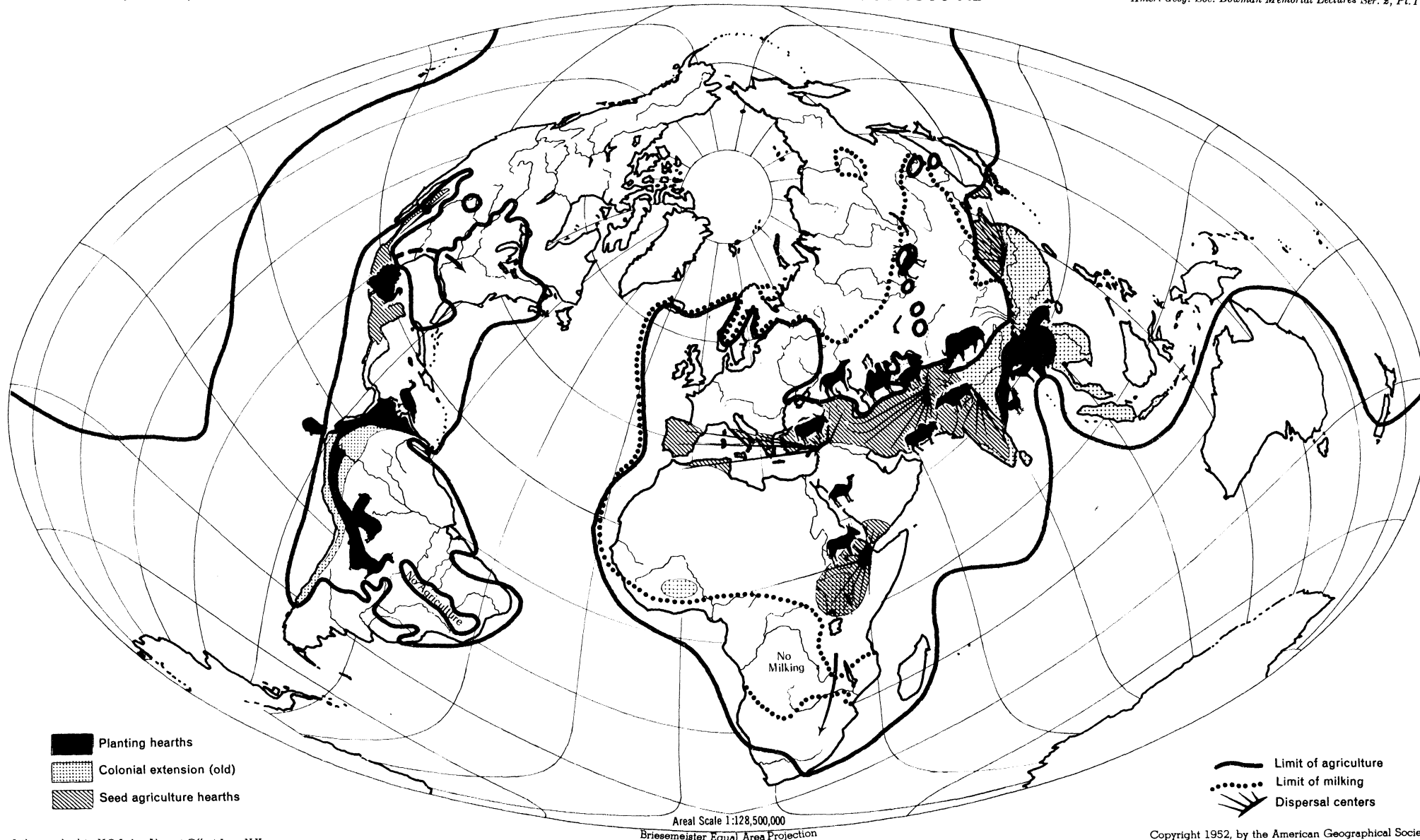
Herdsman and Husbandmen

Herd Animals Belong with Seed Agriculture

The household animals I have associated with vegetative planting in origin; the herd animals belong with seed farming. The only exception is the reindeer, living in margins of the Arctic beyond the lands possible to cultivation. The notion that nomads domesticated herd animals stems from the age-old fancy that hunters became pastoralists and finally farmers, that hunters were the animal domesticators and that collectors learned how to grow plants. I know no evidence for such views, nor for the assumption underlying both, that growing scarcity of food gave the impetus to domestication. The dependence of the nomadic pastoralist on agricultural communities is well known and general, and his way of life is derived from the sedentary farmer.

The great thesis of the geographer Eduard Hahn needs some revision, but it has stood up remarkably for a half century. He started to write an economic geography and to map distributions of economic systems, but in order to explain geographic differences in gainful activities he found himself turning more and more to past conditions and so to the quest of agricultural origins. The query that really opened up to him the whole question of domestication was how, where, and why the milking of animals was begun. Having satisfied himself that pastoralism came out of agriculture and was practiced by people who lived on the margins of agriculture, he came to the con-

HEARTHTHS OF DOMESTICATION LIMITS OF AGRICULTURE AND MILKING ABOUT 1500 AD



clusion that the herd animals were originally part of an early (he actually thought the earliest) seed agriculture, which arose in one particular region (he thought Mesopotamia). His views of place and time must be somewhat changed in the light of later evidence, but the domestication of herd animals by sedentary folk who were seed farmers and who arose out of one common way of life is still most acceptable, culturally and biologically.

The hearth of domestication of herd animals lies in Southwest Asia. To the myth of the wolf that became a dog by joining the campfire of hunters and the one that hungry collectors began to sow and thus originated the noble grains, we may add the fancy that enclosure of game animals by hunters was the means by which our herd animals came to be.

The bones of cattle, sheep, and goats are found with early village sites of seed farmers, dated as about seven thousand years old, and ranging from the base of the Cilician Mountains to the basin of Persepolis in south-central Persia.¹ Tell Hassuna in upper Mesopotamia and Tepe Sialk in central Persia, are among the oldest known. These records of the life and arts of ancient seed farmers and stock raisers exhibit conditions far removed from the beginnings of domestication, perhaps more different from their beginnings than they are from modern village life in the same parts. No more than for the crops has the archeologist discovered the beginnings of animal domestications, nor the order in which they appeared. For such reconstruction we must turn to the distribution of the wild forms, to bits of genetic evidence, all too few as yet about the descent of the domestic forms, and to folkways and folklore in different societies.

To confine bands of adult wild and lusty animals until they became domestic herd animals was not within the power of any

early folk. The building of enclosures which could not be leaped or breached was hardly possible, nor was taming by starving into acceptance of food and obedience to man. Taming of the wild again may be thought of as beginning by infant capture, nursing by a foster mother, and raising the young in close association with man. I should start the procedure therefore in much the same manner as among the tropical planters, by fully sedentary folk, in this case seed farmers, who had no want of food and were not interested in the captured young as future roasts, but for entertainment or ceremonial. Pigs as well as dogs were already widely distributed, I have inferred as acquired from the planting cultures of the East. The pig, it should be remembered, was generally raised all across Southwest Asia and farther west until it became despised in the rise of newer religions. If any domestic mammals were already present, lactation of captured infant stock was simplified. A plausible reconstruction is thus: man returning from the hills with a kid or lamb, woman rearing it, and children growing up with the young animal and leading it out to browse. In such a gentle captivity, breeding might occur and thus domestication begin. In any case, hungry and errant hunters were not the ones who thought of domestication or could practice it.

Milking Common to Herd Animals

All the domestic herd animals are milked or have been thus used in the past. Milking may, therefore, have been both part of the process and purpose of their domestication. The wild forms of such animals are not more desirable sources of milk, either as to quality or amount, than a lot of other herbivores, accessible to man but never domesticated. Early in Hahn's study of economic geography he found that milking had a con-

tinuous distribution which could not be explained by climate, pasture, or anything else in the environment. Beyond this milking line there were people who had an aversion to milk and its products. In other words, here Hahn inferred a non-environmental culture trait that originated in one center and spread thence until stopped by other cultures that would have nothing to do with it. The original center, he judged correctly, lay in Southwest Asia. It was unknown in America, nor did the natives of the New World care for the strange practice when it was brought by the Europeans.

In the Old World, milking is not practiced in two agricultural areas, the Far East and the Pacific islands in Asia and the tropical forests of Africa.² Some of the animals milked elsewhere are kept in numbers and of old both in the Orient and inner Africa. The explanation that the Chinese do not use milk because they got cattle and goats before milking was invented is an assumption unsupported by any evidence. I think it more likely that the Orientals and central Africans accepted some domesticated herd animals, but did not take on the habit of milking because it was strange to their ways and they did not like it. We know that the Orient remained in communication with Southwest Asia and that there was continuing transfer of ideas that were congenial. The cultures that rejected milking were the two ancient planting cultures, and the basis of rejection is probably only antipathy.

That milking began for economic ends is, I think, also unlikely. At the beginning of domestication, the animals secreted milk enough only for their young, or very little more. That small children might on occasion share milk of goat or ewe with the animal young is hardly a sufficient basis for starting a milking economy.

Ceremonial Basis of Domestication

In the domestication of the herd animals, religious ideas, concerned with the origin of life, are deeply involved. Hahn came to the conclusion, and thereby gave offense to some of his colleagues, that these animals were desired and used by man first for ceremonial purposes, in particular in connection with fertility cults. In the lands from India to the Mediterranean there is a substratum of primordial religions, pre-Indo-European and pre-Semitic earth gods, spirits of wood and water of pantheistic or animistic nature. There was especially about the eastern end of the Mediterranean from very olden times a cult of the Magna Mater, or Earth Goddess, who became Ishtar, Astarte, Demeter or some other goddess of later religions. These seem to have walked the earth for a long while before they became heavenly deities. In their earlier forms they had in themselves the power of procreation; as virgin goddesses they brought fertility to field and flock. The Eleusinian mysteries, celebrating Demeter, seem to have had no sexuality, certainly nothing of religious orgies. The principle of fertility was in the female, the male was irrelevant or subordinate.

Later, the Great Mother seems to have become a moon goddess, and also the religions became heterosexual and acquired ceremonies that were orgiastic. Fertility rituals became dramatically realistic and obsessive. And then the time of the paternal, dominant gods had arrived. Finally sex was exorcised by the rise of monotheism and theology based on ethics. I am apologetic about this extreme simplification of one of the most difficult questions in our cultural backgrounds. It is, however, also one of the most important ones and Hahn was right in seeing ceremonial bases in the keeping of herd animals.³ The materialism of our time assumes that consciously direct economic motives are the mainspring of human inventiveness.

This projection of ourselves into a remote past may greatly misinterpret motives, ends, and means.

An elder maternal society does underlie the high cultures of the ancient West. In it we may expect to find the beginnings of milking domestication. Again, the Canaries give a glimpse of what may have been. According to the old accounts, the people were matrilineally organized, and had, in the terms of the chroniclers, queens, high priestesses, and prophetesses. Milk and butter appear to have been the only offerings made in their ceremonies.⁴

By the time religion and society were paternally reorganized in the lands of the old western civilization sacrificial killing of animals had become high ceremony. The offerings were of domestic animals with preference as to kind by particular divinities. Hahn saw in these cult associations of god and animal the main cause of domestication. The sacrifice was partaken of by priests, the elite, and perhaps the commoners. Sacred uses became profane as old meanings and reverences became blurred and the meats of cult festivals became the food of those who could afford it. The originally sacred animal became homely and utilitarian, not the other way around.

We incline to overstress slaughtered meat in the diet of the early husbandmen. Proteins and fats rather were mainly from plant sources. "Esau was a cunning hunter, a man of the field; and Isaac loved Esau, because he did eat of his venison." Yet when Esau returned hungry, he sold his birthright for "bread and pottage of lentiles." The order of importance may have been thus: pulses first, game next, and slaughtered meat last. There were many kinds of game; the hunt even in times of high civilization continued to be a major source of meat. It was often and for a long time cheaper to get meat by hunting than by raising it. I doubt that we produce more meat today on

ranges than wild game would yield from the same land. Beef in particular never seems to have been an ordinary meat anywhere in the Near East or the Mediterranean.

Domestication as to Kind

The kinds of animals that were domesticated are curious and meaningful. There was high diversity of game animals in the Levant and its borderlands: antelopes and gazelles in the plains; wild cattle, bison, and buffalo in forest, brush, and grassland; deer of various kinds and habits; goats and sheep in rocky and mountainous lands; camels in deserts; horses and asses in continuous distribution from the Cape of Good Hope north to the Siberian taiga. Of this multitude only a very few were domesticated, though the ancient sculptures and paintings abound in hunting scenes of diverse sorts and also tell of the keeping of numerous kinds tamed.

The selection was not based on propinquity to man, nor on sharing his habitat. It was not based on declining abundance, for most of the domestication took place near the margins of the natural range occupied by the species. It was not based on docility: antelopes, gazelles, and deer, easily tamed and much kept for diversion, provided no domesticate except the reindeer. This animal of the cold north seems to be a belated substitute added when pastoralism spread into the margins of the Arctic.⁵ Rather, one might say that animals were chosen for domestication that were not easy to take, which were not common, and which were difficult to make gentle—the wild mountain goats and sheep that avoid the vicinity of man, the formidable wild cattle and buffalo. Hunting the urus (*Bos primigenius*) was a sport of major hazard and elaborate organization to the time of their extinction in the seventeenth century of our era. Yet this is the ancestor of our domestic cattle. The

feared wild cattle of India, the gaur, are no more dangerous than was the urus. The Old World bison, a very near relative of our American bison, never had such a reputation for ferocity. It occupied a very great range that extended well into the lands of ancient civilization. It was desirable for meat, hide and wool, but no domestication was undertaken; the failure to do so was not due to its nature, habitat, or economic suitability.

The eleven domesticates are: the common cattle, zebu, water buffalo, yak, goat, sheep, reindeer, dromedary, Bactrian camel, horse, and ass, all now or once milch animals. Except the reindeer, all are first known from ancient seed-agricultural centers and their wild ranges are in or marginal to such areas. The coincidence of the west Asiatic centers of seed domestication and of herd animals is such that they appear as complementary features of one cultural complex (Pl. III).

Goats and Sheep

The goat may possibly begin the series of herd domestications. It has been distributed all the way across Eurasia and to the south end of Africa, penetrating both the non-milking cultures of the Far East and of tropical Africa quite generally. Among African forest folk it is often the most important domestic animal, especially a dwarf race which has been thought to be akin to the turbary Neolithic goat of Swiss lake dwellers. There are very many domestic races in the Old World and they have not been well studied. It is probable that the blood of several wild species has been introduced into the domestic forms, but the main descent is traced from the southwest Asiatic bezoar goat (*Capra aegagrus*), a mountain animal ranging west of the Indus to the Caucasus. Adametz thought the earliest pictorial representations in the Near East to be a domestic version of the screw horned *C. falconeri*, native to the western Hima-

layas, Afghanistan, and east Bukhara, and known to be fully fertile in crosses with the house goat.⁶ First choice as to place of origin therefore goes to the cis-Indus country (Area B of the seed hearths). The wild forms live in the mountains well above, but at no great distance from the ancient agricultural valleys.

Culturally there are a number of suggestions of high antiquity. The goat is both herd and household animal and is found among people who have none of the other herd animals, but who keep pigs and fowls. It is sacrificed, but usually as second choice to sheep. Goat gods, such as Pan, and the ritual scapegoat, may be traits of degradation such as elder gods and elder rites have often suffered.

Sheep were domesticated in the same general area as the goat, the chief parent being considered *Ovis vignei*. Adametz ties an early domestic form with horizontal spiral horns to a variety of *O. vignei* living from the Salt Range of the Punjab to Baluchistan, emphasizing "the outstanding role which these parts of Asia played, in part as centers of origin, in part as staging areas of domestic animals and peoples in the early history of mankind, moving from East to West." Independently, therefore, the seed plants of Area B and sheep and goats have been assigned to the same area as to domestic hearths, from which they passed into the Near East and beyond. Fat tails and woolly fleeces were later developments of domestication. In Ethiopia parallel selection formed races of goats and sheep so much alike as to confuse travellers and lead to stories of crosses between the two.

The Ass

The ass was the lone contribution of Africa to the domesticated animals. An equally attractive lot of wild asses, half asses, and zebras held contiguous ranges from extreme southern Africa across the Near East and Turkestan into north-central

Asia, but only one form, the wild ass of Nubia, was domesticated. Its origin is, therefore, in association with that of the great group of economic annuals formed in the same area, Ethiopia. It is the original pack animal of the old civilizations and probably the earliest riding animal. Its breeding was not directed, as it readily could have been, toward the development of draft power. The use of its milk is now mostly restricted to cosmetics, medicine, and magic.

Cattle

The original ceremonial domestication of cattle was proposed by Hahn to much academic headshaking. In brief, they were, in his view, the originally sacred animals in the moon cult, their horns symbolizing the crescent moon. Milking and castration were fertility rituals. Sacred oxen first drew the ceremonial cart and pulled the plow, a phallic symbol for the insemination of the receptive earth. Cattle, cart, plow, broadcasting, and drilling all began as ceremonies of a rising fertility cult of the Near East in which the officiants were males, and henceforth the care of the cattle, the hand at the plow, the sower, was male. The husbandman thereafter takes over the agricultural operations, the women retire to the house and to garden work. Paternal societies are formed, with priests and kings, politics and states, aristocracies and subjects. The male hierarchies prevailed where cattle, plowed fields, and wagons became dominant institutions. The thesis was repugnant to materialistic rationalism. It also offended because it placed sex at the center of esoteric religious matters. It remains a great contribution, still acceptable in large part.

The ancestral wild stock is one species complex, *Bos primigenius* in the west, from Atlantic Europe into western Asia, *Bos namadicus* in India. These wild cattle, among the strong-

est and most savage of game animals, held their own against all predators, and there seems to be no record of their being broken or tamed as adults. Both domestic types appear near the beginning of the archeological record of agriculture, common cattle in upper Mesopotamia at Tell Hassuna, the zebu at Rana Ghundai I in north Baluchistan. At such early time this part of the world was permeated by the Great-Mother cult, followed later by the moon goddess. The earliest ceremonial carts were drawn by oxen; there is even an early figurine in which a goddess sits on a throne on an ox-drawn sled.⁷ Priests officiated at ceremonial plowing, of phallic symbolism. Cattle were the plow animals exclusively for a long time; their economic use for milk was less than of other animals and production for beef was never important in the older lands. Milking and meat raising became dominant on later peripheries, in northern Europe and east Africa.

The Camels

Camels were on the verge of extinction when they became domesticated. No wild dromedaries have ever been known, and prevailing zoologic opinion considers the living "wild" two-humped camels of Chinese Turkestan as feral. The dromedary is linked with Semitic peoples and an Arabian domestication is commonly assumed. There are a few early Egyptian representations, none, it is said, being known after the First Dynasty until the time of the Ptolemies.⁸ This early Egyptian knowledge suggests a center in western Arabia, where quite early agricultural settlements may be inferred, though such have not been proven. The spread of the dromedary was late and then rather rapid when states and trade required a transport animal for desert crossings. For the Bactrian camel, no other locality is indicated than the one that gives the name. A separate domestication is

inferred because crosses with the dromedary are sterile. Such hybrids were fairly common in Asia Minor in classical times, where it is thought also that the breeding of mules originated. Neither dromedary nor Bactrian need be assigned to nomad origin. Bactria is a farming land more ancient than the probable time of camel domestication. So too, it is surmised, is Yemen, and probably Hejaz; there are botanical indications that point that way.

The Horse

The horse has been well studied by comparative zoology and is referred to tarpan ancestry.⁹ This wild horse, extinct only a few decades ago, ranged the south Russian steppes to the Caucasus. Crossings of tarpan stock and the heavier forest breeds of western Europe may have produced the big-boned draft horses. Lately we have learned that the domestic horse was known to the ancient civilizations in the third millenium B. C., as at Harappa on the Indus, Rana Ghundai in Baluchistan, in the second phase of Sialk in Persia, early Anau, and pre-dynastic Mesopotamia.¹⁰ It may be inferred that horses in small numbers were carried southeastward from the margins of the Caucasus a thousand years before the animal became important in the ancient civilizations. This time is notably earlier than anything known about Indo-European peoples. Some unknown people, probably sedentary farmers, I should say, at the northern base of the Caucasus, effected the domestication.

Historically the horse is associated mainly with the Indo-European migrations, martial bands that poured across Anatolia into the Fertile Crescent, through Media into India, and out of the Russian plains into the Mediterranean peninsulas and western Europe. With the horse came the war chariot and the cavalryman, new forms of war and conquest, military

aristocracy. To Indo-Europeans it was the animal of prestige, the sacred animal above all others, the high sacrifice, the flesh of solemn festivals. To the nomads of interior Asia it became the provider of fermented milk, kumiss. To our ancestors it was a source of meat, though much less so than were beeves. Christianity stamped out the eating of horseflesh among our people since it was a main link to pagan ways.

Restatement of Culture Periods

The naming of the great cultural time divisions by stone and metal stresses minor attainments of man. Restatement changes the emphasis thus:

The Neolithic opens with well-established agriculture, and a rather full complement of the crops and animals still basic to the Old World. The great, long, and tedious job of domestication was done before then. For western civilization the common center was a series of mountain-margined basins from the Indus Valley west to the Levant.

At the end of the Neolithic, plow agriculture becomes dominant and powerful states develop. As a rough marker we may use a time around 3000 B. C. when dynasties appear. In this change, the supremacy of the male becomes established and new religions arise; the moon goddess becomes subordinate to the Sun God, her crescent ultimately the symbol of Allah.

Around a thousand years later the great historic peoples take the center of the stage, first Semites, then Hamites and Indo-Europeans. Their ancestors may have lived on the fringes of the older, unnamed agriculturists, perhaps as hunters and collectors who gradually learned the arts of tillage and stockraising. Their contributions are in political organization and the setting up of codes of law, in war and conquest, in cities and

commerce, and in time as makers of theologies and philosophies, the usual stuff of history.

Separation of Herdsmen from Husbandmen

The separation of herdsman from husbandman came about insensibly and imperfectly. "Abel was a keeper of sheep, but Cain was a tiller of the ground," and both were of one family. Beyond the tilled lands of the villagers lay the open range where herds grazed or browsed in hills and mountains and on plains too dry to farm. In the off season, the fallow fields provided additional grazing. Feed from browse was important, probably more so than grass. As the numbers of people and stock increased, herdsmen and herd moved farther and farther away from the villages and became more permanently detached from the settled lands. This about describes the roots of pastoral nomadism. As with village Arab and Bedouin, sedentary folk and mobile tent dwellers are mostly one people. In Inner Asia, earlier hunting peoples took on herd animals from other kinds of folk to the south, but still there is some dependence of herdsman on farmer for grain. The original and absolute pastoralists can scarcely be said to exist or ever to have existed; they derive from a farming culture in which livestock was an original element.

Hamitic and Indo-European migrations were largely driven by a strong bent toward herding. The former, stemming out of a common background with the Semites, moved across north and east Africa, bearers of a cattle culture in which the beasts were — and are — prized far beyond their economic utility. Hamitic cattle lords spread over the native hoe-tilling peoples in a sort of symbiosis in which the privileged group were masters of the cattle, the peasant mass grew the field crops. The

Aryan invasion of India had similar aristocratic quality. In Europe successive Indo-European waves overran and mingled with the older sedentary cultivators. The latter are still partially recognizable in "Mediterranean" racial stocks in the south and west and Alpines in the central mountains and hill lands. Some of the Indo-European bands came by way of Asia Minor, others by way of the Russian plains, all with their herds of cattle and horses.

North European Husbandry

Our forebears, drifting west and north, got into lands of shorter and cooler summers and of mixed forests or woodlands. The farther they went the more did climate restrict their habits. By the time they settled on the Baltic and North Sea lowlands, they were stockmen, not cultivators. Studies of pollen that drifted into bogs have enabled a pretty accurate reconstruction of vegetation.¹¹ The earliest clearing of land was not for sown fields but for pastures and meadows; the newly-immigrated plants were only pasture weeds. Somewhat later, the first grains appear, wheat and barley; still later, rye and oats. The pollen record is checked by seed impressions in pots-herds of known age.¹²

Rye and, in part, oats are wild grasses at home in western Asia, mingling in fields with wheat and barley but only as weeds. Primitive methods of harvest and winnowing did not separate weed seed from grain and so the ryes and oats marched along with the wheat and barley in their westward travels. Meanwhile, a partial domestication had taken place quite by chance, for the strains of rye and oats that remained intermingled with the cultivated grains were those that had become non-shattering, matured at the same time as the cultivated plants, had similar grain and stalk sizes, and hence became part

of the harvested crop. As the growing of cereals spread into lands of colder and wetter summers and acid soils, barley and in particular wheat did less and less well, the volunteer rye and oats relatively better and in the end these became the cultivated crops and the north Atlantic lands came to depend on them for human cereal.

Thus arose a distinctive farming system north of the Alps and west of the Russian steppes. This was a balanced, mixed farming, primarily an animal husbandry. Milk products were most important and, with dairying, the calf crop increased the meat supply. Clearing of new ground was primarily to gain more pasture and meadow. The limiting factor always was the amount of feed that could be grown for the animals, the grazing available during open weather, the hay that could be stored against winter. This economy produced the barn for hay and the stable for stock. Field crops took second place to hay crop. Rye had increased importance because, being fall sown, it provided some winter pasture. Fertility was maintained because the stable manure was returned to the fields. Long continued pasturing and mowing selected an association of forage plants that prospered under the bite of cattle and cut of scythe in a closed ecologic cycle, as Gradmann liked to point out. Man took from the ground no more than he returned; he did not lose topsoil by overcultivation nor was it lost to winter rains. Production was not at a high level, nor was the life of the husbandman easy, but man lived durably on the land and could expect his descendants to do so.

Such were the systems of culture across northwestern Europe for two to three thousand years, systems not seriously modified until the eighteenth century. Then, with the introduction of the potato, the development of stock beets and field turnips, and the cultivation of clovers, the new agricultural revolu-

tion arose and, in part, prepared the way for the industrial revolution.

The Problem of Desiccation

In lands of uncertain or markedly seasonal rainfall the tenure of man has often been insecure. The ruins of settled communities are strewn across the heart of the Old World from the Tarim Basin of Inner Asia to Mauritania on the Atlantic shore of Africa. The land has become desolate where fields long were tilled and flocks and herds grazed. Within the dry lands and all about them human occupation has broken down from time to time over a long period and there has been progressive shrinkage of the habitable land. Neolithic settlements are found where no later villages were built; Roman colonies thrived where now are only occasional herdsmen; medieval settlements failed in their turn.

Thus it has become customary to speak of the 'desiccation' of the heart of the Old World as an ancient and continuing process. The Sahara in particular is said to be extending year by year. One school of thought asserts long continued climatic deterioration. Ellsworth Huntington, who had taken part in the exploration of the ruins of Anau, devoted much of his life to the thesis that the dry climates are growing drier and more extensive. Many archeologists, especially British, accept increasing aridity as a principal cause of failure of settlements. On the other hand it may not be necessary to postulate a change in the mechanism of atmospheric circulation to account for the human failures, but to explain these by the action of man.

It seems to me there has been misconstruction of various data. It has been too freely assumed that loss of vegetation and fauna must be the result of climatic change. Climatic data from northern Europe have been misapplied to distant and different

situations. Especially is this true of the so-called "climatic optimum." About the Baltic and North Sea bog studies have shown a series of vegetational changes, rather closely identified as to time. For a period when certain plants, such as ivy, mistletoe, and oak grew farther north than at present the term "climatic optimum" was introduced to express some increase in length or warmth of summer. This phrase has been picked up by students of the ancient Near East and applied there incautiously. No one has explained how the factor of summer temperature in Scandinavia becomes a matter of moisture in the Near East. A misunderstood phrase has beguiled and bemused.

The early and long recurrent failures of settlements have happened in areas subject to marked variability of rainfall. In good years they have enough water; in others they suffer. The margins of the dry lands have always been hazardous to man. His own numbers and those of his flocks increase to full use of optimal weather conditions; a run of dry years brings overgrazing, depletion of the more palatable plants, baring of surface to wash and wind. Man tries as long as he can to counter the natural checks on population that tend to restore ecologic balance. The result is that after a time of weather stress the land does not recover its former ability to grow useful plant cover and to absorb moisture. In our short occupation of our dry West, we have ample experience of ecologic deterioration, as by successive drops in range capacity through a series of droughts. These man-made pressures have existed in the Old World a hundred times as long as with us. Maintenance of human and animal numbers as close to normal or optimal moisture conditions as possible brings recurrent and increasing imbalance and surface attrition, which may resemble the effects of increased aridity.

There are significant contrasts in surface and vegetation be-

tween our dry lands and those of the Old World. Ours, except the most extreme, are fairly well vegetated and carry a richly diverse flora. The Sonoran desert, meteorologically quite similar to the western Sahara, is an impressive display of bloom in spring and early summer, with abundant insect, bird, and rodent life, mule deer, antelope, mountain sheep—a rewarding collecting ground for the naturalist. It has no lifeless spaces, in contrast to the wastes of climatically similar areas in the Old World.

We have no great expanses of moving sand or rock-surfaced hammadas. Aside from the Peruvian desert, where the sand dunes are mainly derivative from sea beaches, our dune belts, as along the lower Colorado and in Chihuahua, are Pleistocene relics of pluvial periods when former lakes and stream floods provided sand in beaches and bars. Despite the greater aridity of the present these dunes have become fixed by vegetation except where they are disturbed by man. If climatic change is responsible for the “desiccation” of the Old World, similar effects should be equally apparent in the New World. I have been more than a casual student of our dry areas for years and in different parts, and I know of no such late modification of climates.

The difference between the deserts and their margins in the Old and the New Worlds may be explained by the different histories of occupation by man. The Old World lands were lived in much longer by more people and by people who turned flocks and herds out to graze and browse. The people of the New World had neither herd animals nor plow. Not only Spanish exploring parties but United States military and railroad surveys in our Southwest provide evidence that less than a century of grazing and plowing has greatly modified and reduced the vegetation, precariously balanced in ecologic tension

zones of frequent droughts. The Old World also has, especially in the eastern half of the Mediterranean and the Near East, a great deal of limestone country, attractive for cultivation and productive of good forage, but vulnerable to erosion as limestone lands are, because soil is likely to be underlain at shallow depth by solid rock. The bare limestone ribs of Mother Earth whiten the slopes of many of the uplands of the ancient civilizations where once lay good fields and fat pastures. I should attach first importance therefore to the cumulative effects of soil erosion, through thousands of years. Across the heart of the Old World neither herdsman nor plowman was able to maintain a lasting position for himself in an environment of recurrent droughts. The land became more and more bared to wash and wind. Man has been long in retreat before the growing desert he has helped to make. The desert continues to grow, not because of progressive deterioration of climate but because of continuing attrition of cover and surface.

We are at the end of this summary review of what man has done with the plants and animals at his disposal. His mastery over the organic world began with his employment of and experiments with fire. Sedentary fishing peoples perhaps commenced the cultivation of plants and became the first domesticators of plants and animals. The earliest plant selection was by vegetative reproduction and the early domestic animals were part of the household. Later came plant selection by seed reproduction and the keeping of flocks by seed farmers. I have thought to link these inventions in series, possibly beginning from a common center, and to follow their dispersals and divergences. If this be exaggeration of the processes of diffusion of learning, the proposed thesis may be taken as an invitation to

study the various lines of evidence as to the growth of the agricultural arts.

Our civilization still rests, and will continue to rest, on the discoveries made by peoples for the most part unknown to history. Historic man has added no plant or animal of major importance to the domesticated forms on which he depends. He has learned lately to explain a good part of the mechanisms of selection, but the arts thereof are immemorial and represent an achievement that merits our respect and attention. We remain a part of the organic world, and as we intervene more and more decisively to change the balance and nature of life, we have also more need to know, by retrospective study, the responsibilities and hazards of our present and our prospects as lords of creation.

GENERAL REFERENCES AND NOTES

The following selected general references, listed by topic, are given for the reader who may be interested in knowing some of my major guides. Our geographers have little awareness of the great handbooks relevant to their work: here are some of them. References to specific points in the text follow under chapter headings.

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NOTE ON THE MAPS

The maps are attempts to reconstruct the hearths of domestication and the routes by which the ideas and objects of agriculture were spread. Maps are likely to carry even more assurance of knowledge than do texts; the reader is warned that Plates I to IV attempt only to set forth what is, as of present knowledge, reasonable interpretation. They are work sheets to be revised as better knowledge comes to hand of the evolution of man's plants and animals, of their remains recovered in archeology, of

their implications in different cultures, of the climates, shore lines, and land surfaces of the prehistoric human past. The earliest design on which they are based is Vavilov's map of World Centers of Origin of Cultivated Plants (*op. cit.*, pp. 23-24), revised by Darlington and Janaki (first end piece of Chromosome Atlas). In the present set of maps, additional plant data have been used, domestic animals related to plant domestication, and inferences made as to cultural dispersals.

The maps were drawn by John Philip of the American Geographical Society's cartographic staff. Plate II uses the bipolar conformal conic projection designed by O. M. Miller (see *Geogr. Rev.*, Vol. 31, 1941), Plate IV, the equal area projection designed by William Briesemeister for the Society's "Atlas of Distribution of Diseases."

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