

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 101, NUMBER 3

ENVIRONMENT AND NATIVE SUBSISTENCE
ECONOMIES IN THE CENTRAL
GREAT PLAINS

(WITH FIVE PLATES)

BY

WALDO R. WEDEL

Assistant Curator, Division of Archeology
U. S. National Museum



(PUBLICATION 3639)

CITY OF WASHINGTON
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During the past 10 years an increasing interest has been manifested in the relations of man to environment in the Great Plains. Widespread droughts, spectacular dust storms, and recurrent crop failures are driving home again a fact which had been largely forgotten during the preceding prosperous decades—namely, that the climatic fluctuations to which the region is subject can be of sufficient magnitude to render man's occupation precarious. Numerous farms have been abandoned, and there is a rather general belief that much of the land is wholly unsuited to agriculture. Students of ecology and geography, recalling similar happenings in the past, have been insisting again that a long-range program of land utilization in place of the present haphazard methods would make possible the recovery of much of the supposedly worthless area.

It is not my intention here to suggest a cure for the economic problems arising from the conditions just noted, but rather to examine certain pertinent facts brought out by recent archeological investigations. We know now that long before white explorers ventured into the Great Plains, the region had been exploited in different ways by various native peoples. There is a growing belief that some of these aboriginal groups may have had to cope with adverse climatic conditions similar to those faced by man here today. The evidence is still fragmentary and scattered, because the area involved is enormous and the workers are few. Still, it may be worth while to indicate the directions in which the available data appear to lead.

For present purposes the central Great Plains comprise the area included in the States of Kansas and Nebraska. We shall review briefly the environmental setting as a background for an outline of the historic and prehistoric native subsistence economies. This will be

followed by a consideration of the possible significance of certain inferred climatic variations upon past human populations.¹

ENVIRONMENTAL FACTORS

To the casual observer traveling across Nebraska and Kansas along the main thoroughfares, the region exhibits a rather wearisome uniformity. In broadest outline it is a land of low relief, few trees, and little rainfall—of sun and wind and grass. A closer regard for the details of topography, native flora and fauna, and other aspects of the environment will show, however, that there are a number of natural variations (see Shelford, 1926, and Fenneman, 1928) which bear on man's utilization of the land.

The western portion of the area is a part of the High Plains province (fig. 1)—the remnant of a great outwash plain which in Tertiary times reached from the mountains into eastern Nebraska and Kansas. The High Plains are characterized by broad, monotonously flat upland areas which, toward the north, tend to become uneven or gently rolling. Rivers heading in the Rocky Mountains, such as the Arkansas and Platte, flow eastward across this belt in wide, flat-floored valleys. Lesser streams rising within the High Plains occupy shallow, open valleys which in places give way to picturesque rock-walled canyons. Where the secondary valleys have been cut through the unconsolidated Tertiary silts, sands, and gravels into the impervious underlying formations permanent springs occur. These give rise to perennial creeks flowing in verdant valleys which contrast strikingly with the surrounding uplands and which, since time immemorial, have provided ideal camp and village locations for primitive man (pl. 3). Where not under cultivation, the uplands are dominated by buffalo and grama grasses, with yucca, cactus, and sagebrush locally abundant. In the valleys there are groves of hackberry, cottonwood, and willow, with some elm and ash. Thickets of wild plum, elderberry, and other edible native plants are scattered along the ravines and stream valleys. Juniper grows along the valley rims, and in parts of Nebraska there are stands of western yellow pine. Native fauna included notably such animals as the bison, antelope, mule deer,

¹For helpful information and stimulating suggestions as this study developed, I am particularly indebted to Dr. C. E. Leighty, J. S. Cole, and O. R. Mathews, agronomists at the Division of Dry Land Agriculture, Bureau of Plant Industry, U. S. Department of Agriculture; and to Harry E. Weakly, junior agronomist at the North Platte Experimental Substation of the College of Agriculture, University of Nebraska.

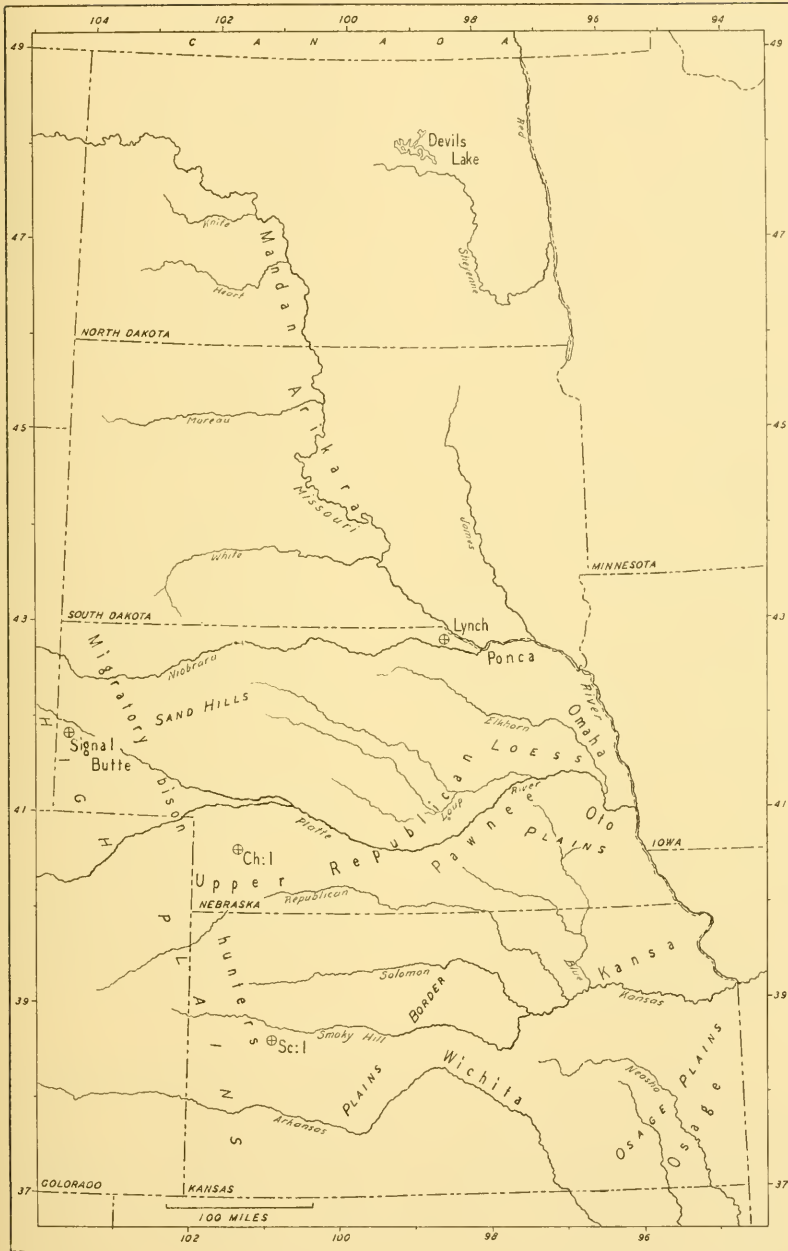


FIG. 1.—Map of the central Great Plains and upper Missouri Valley, showing physiographic divisions, tribal groups, and archeological sites considered in the present paper.

prairie dog, coyote, black-footed ferret, jack rabbit, badger, and smaller forms, and game birds such as prairie chicken and grouse.

East of the High Plains there is a marked change in the terrain. North of the Platte River in Nebraska are the Sandhills, a rough, hilly area dotted with ponds, lakes, marshes, and hay flats. The hills are in reality sand dunes which are held fast by a cover of bunchgrass interspersed with yucca and cactus. Trees are scarce except in the vicinity of ranch buildings. There are few streams, but those which head in the region, notably the several forks and upper tributaries of the Loup, carry an abundance of excellent water throughout the year. They head in shallow, grassy swales which soon give way to deep canyons lined with deciduous timber, plum thickets, and other vegetation.² Wild rice grew in some of the shallow lakes and was an important native food item (Gilmore, 1919, p. 67). Beaver, muskrat, deer, and smaller mammals inhabit the valleys; coyotes and jack rabbits abound; and great numbers of waterfowl still have their nesting grounds about the lake margins. Like the High Plains, the Sandhills are a region of low rainfall. Since the soil is loose and sandy and tends to blow readily when the sod is removed, large-scale agriculture is impracticable and cattle raising is the principal activity today.

South of the Republican River, in north-central Kansas, the eastern front of the High Plains has been dissected by stream erosion to produce the so-called Plains Border. This is a belt of high plateaus and prominent east-facing escarpments cut through by the deep, broad valleys of the Smoky Hill, Saline, Solomon, and their tributaries. Buttes and ridges are a conspicuous feature of the landscape. The fertile river valleys are fringed with forests of oak, elm, ash, walnut, cottonwood, and other hardwoods, and bluestem and bunchgrasses formerly clothed the upland areas. Native fauna included all the larger forms found on the High Plains together with numerous other species more typical of areas to the east.

² In 1895 Bessey (1896) observed that relict stands of western yellow pine were to be found in the canyons along the Niobrara River as far east as Holt County, along the North Platte and Lodgepole Rivers to Lincoln County, in widely isolated canyons in Valley, Custer, Greeley, and other Counties in central Nebraska, and along the Republican to the vicinity of Franklin. These localities lie for the most part west of the 99th meridian. Hussong (1896) also calls attention to the fact that "yellow pine grew formerly in and along the canyons south of the Republican River in Franklin County . . ." Early settlers cut the larger trees for fuel and posts, and transplanted the smaller ones to gardens and lawns. Bessey held that these distributions were best explained "by supposing that the central region was once wholly or in part covered with forests."

East of the Sandhills and Plains Border provinces the Great Plains give way to what was formerly a bluestem and prairie-grass region. In eastern Nebraska the Loess Plains present a flat to rolling or hilly terrain. A thick mantle of loess extends from the Missouri Valley westward to the Sandhills and, as a narrower band, between the Platte and Republican Valleys to the High Plains in southwestern Nebraska (pl. 4, fig. 1). To the southeast it merges into the unglaciated gently rolling Osage Plains lying south of Kansas River. Throughout all this region, the streams run in broad, bluff-lined, often terraced, valleys. Fine stands of burr oak, elm, walnut, hickory, sycamore, and other hardwoods skirt the streams. Edible plants include the wild grape, plum, chokecherry, mulberry, and a number of tuber-bearing forms (see Gilmore, 1919). Other items which unquestionably figured in aboriginal economy were the Osage orange or bois d'arc, papaw, pecan, and persimmon, all found in eastern and southeastern Kansas. Bison, elk, antelope, and deer found unlimited pasturage in the valleys and on the deeply grassed uplands. Wolves, coyotes, badgers, and rabbits were plentiful; along the streams were beaver, bear, otter, raccoon, cougar, opossum, wildcat, fox squirrels, and a host of lesser forms. Most of these followed the wooded valleys westward far into the plains. Permanent streams are, or were, the rule, and fine springs formerly abounded on the larger as well as on many of the lesser watercourses. Precipitation, except in the west, is ample for agricultural needs, and the soils everywhere are deep, rich, and easily worked. Today this is the most densely populated and the finest agricultural land in the central Great Plains.

The Loess Plains are flanked by a narrow strip of rugged hills on the east where short, deeply incised creeks and narrow, heavily timbered ravines empty directly into the Missouri River. Broadleaf forests and dense thickets were formerly dominant, and the district abounded with game and other wild-food resources. Historical accounts indicate that the lofty bluffs fronting on the Missouri were bare of trees during the early nineteenth century, but the valleys must always have been well wooded.

From the standpoint of agriculture, whether modern or aboriginal, probably the most important factor in utilization of the Great Plains by man is climate (Kincer, 1923, and Climatic summary of the United States, sections 38-41). The region as a whole is characterized by warm summers with abundant sunshine; by winters that are cold and dry; and by considerable windiness throughout the year. In the central portion, as we have defined it, there is a frost-free growing

season of 150-200 days, sufficient to mature most cereals and vegetable crops. Precipitation decreases markedly from an annual total of about 40 inches in southeastern Kansas to 15 or 18 inches in western Kansas and Nebraska. Because of the dry winters, the moisture stored in the soil is generally scanty; hence crops depend chiefly on the rainfall during the growing season. In this respect, the average annual precipitation shows a favorable distribution, since about 70 percent or more falls between April and September.

As Smith (1925, p. 413) has pointed out, "averages do not tell the whole story. Averages rarely happen. The freaks of the season decide man's chances . . ." In the Great Plains, the minimum precipitation required for successful agriculture by ordinary methods is somewhere between 15 and 20 inches annually. This means that over much of the region, particularly west of the 98th or 99th meridian, the yearly average is very close to the minimum required for successful crop growth, and hence that the year to year variation is of very great importance. A decrease in rainfall of only a few inches, particularly if continued for several years, may result in a major disaster for the grain farmer.³ Furthermore, long-time weather records show that in the western Great Plains "there is less than the normal amount of rainfall in more than half the years." Farming except by specialized methods is rendered still more precarious by the fact that there may be several seasons of deficient moisture. These fluctuations are of variable duration, do not come in regular succession, and cannot be forecast with any accuracy.

The character of the summer rains must also be considered. In large part, they come as thunderstorms, often of great violence and short duration. Downpours of 3 to 6 inches within a 24-hour period have been recorded at many points, this sometimes exceeding in amount the normal precipitation for the month in which it occurs. The rains may come with such force that the ground surface is puddled, so that most of the water runs off before it can be absorbed

³The delicate balance between yearly rainfall and crop yields in this western area has been strikingly demonstrated by Cole (1938). From weather and crop records for 14 stations in western Nebraska, Wyoming, North and South Dakota, and Montana, he has determined the mean precipitation and mean average yield of spring wheat over periods varying in length from 10 to 28 years. With an average precipitation of just under 15 inches, the average wheat yield was slightly over 15 bushels per acre. When average precipitation fell 20 percent to 12 inches, wheat yield dropped nearly 50 percent to a trifle over 8 bushels. A further lowering of precipitation to 50 percent of normal thus resulted not in a half crop but in no crop at all. No comparable statistics are available on rainfall and corn growth in this region, but a similar correlation may be suspected.

by the soil. These storms, furthermore, are mostly local, with short, erratic courses that may leave one small area drenched while surrounding sections receive little or no moisture. Similar local differences are reflected in the annual precipitation records from time to time. Thus, in 1875 and again in 1901-3 inclusive at Dodge City, Kans., annual precipitation was from 50 to 90 percent of normal (average, 19.9 inches); but during the same years at Hays, 85 miles to the north, there was an excess of moisture ranging from 5 to nearly 50 percent (average, 21.28 inches).

Droughty conditions in summer are often attended by prolonged periods of high temperatures. Southerly winds predominate; being warm, they have a drying effect, and their high velocity favors rapid evaporation. Particularly destructive are the so-called "hot winds" which may accompany shade temperatures of 100° to 110°. They have been likened to a blast from a hot furnace, and frequently cause much damage to crops and serious discomfort to animal life. Immense havoc may be wrought in a few hours if these winds occur at critical stages of crop development, and when they continue for several days man and beast alike suffer intensely and widespread crop failures result. Many farmers insist that these hot winds can kill the corn crop even when through subirrigation or otherwise the soil is moist enough to meet the normal requirements of the growing plants. I am not certain, however, that this view has general acceptance among impartial observers.

HISTORIC SUBSISTENCE ECONOMIES

The 99th meridian, lying somewhat east of the line of 20-inch annual precipitation, may be regarded as the approximate dividing line between the Great Plains on the west and the true prairies or prairie plains on the east. It will serve also as the line of demarkation between two strikingly divergent native subsistence economies in the central Great Plains during the nineteenth century. To the east, where soil and especially climatic conditions are today recognized as most favorable for farming, the native economy was based on horticulture with hunting secondary. West of this line, where bitter experience has since shown the white settler that agriculture is likely to be a highly uncertain venture, hunting was of primary importance.

The principal natural game resources of the High Plains have already been noted. What they may have lacked in variety was more than offset by the abundance of certain species. During the nineteenth century the High Plains and the Plains Border immediately to the

east were preeminently the range of the great bison herds. Parasitic on these were several Siouan, Algonquian, and Shoshonean Indian tribes whom we may term the migratory bison hunters (fig. 1). North of the Platte were the Dakota bands; farther south was the habitat of the Cheyenne, Arapaho, Comanche, and Kiowa. Throughout the spring, summer, and early fall organized bands of these Indians hung about the flanks of the herds, subsisting chiefly on the flesh of the bison and drying large quantities of meat for winter use. In winter the roving village units usually returned to certain sheltered spots which because of water, wood, and forage for horses were used year after year. Large herds of horses were to be seen at every camp. The portable skin tipi was universally used (pl. 1). Skin working was highly developed; otherwise, implements, utensils, and industries were limited to essentials which could be moved easily and conveniently on horseback from camp to camp. Surplus foods were stored in skin containers. Agriculture was nonexistent, as was the potter's art. The gathering of quantities of wild fruits, nuts, berries, and starchy roots and tubers supplemented the chase (Carlson and Jones, 1940); maize was obtained by trade or theft from settled horticultural tribes. An elaborate militaristic system had been built up, and much of the time not occupied in food getting was given over to warfare and horse stealing. These peoples recognized no definite tribal boundaries, and the distances traveled by them during their annual hunting trips and in raiding forays frequently totaled many hundreds of miles.

East of the 99th meridian, since the coming of the white man, have dwelt chiefly Siouan- and Caddoan-speaking tribes. Eastern Kansas was held by the Osage, northeastern Kansas by the Kansa, eastern Nebraska by the Oto, Missouri, Omaha, and Ponca. Farther to the west, on the Loup, Platte, and Republican Rivers, stood the villages of the Pawnee, a confederacy of Caddoan tribes whose nearest kindred linguistically were the Arikara in South Dakota. At the dawn of the contact period, the Wichita are believed to have had a group of settlements in central Kansas in the vicinity of the great bend of the Arkansas. These were abandoned during the eighteenth century for other lands farther south. The rest of the tribes enumerated remained in their respective locations until reservation days a century or so later.

All these tribes dwelt in large fixed villages situated near streams where wood, permanent water, and arable ground were to be had. Habitations were circular earth-covered or grass-thatched lodges (pl. 2). Subsistence was based primarily on the cultivation of maize, beans, and squash, to which were added a long list of wild berries,

fruits, and tubers (Gilmore, 1913, and 1919). The latter included wild plum, hackberry, chokecherry, sand cherry, wild potato (*Ipomoea pandurata*), ground bean (*Apios tuberosa*), the pomme blanche (*Psoralea esculenta*), and others. Of considerable importance, too, especially after acquisition of the horse about 1700, were the products of the chase. Bison were the principal game animal, and to obtain them one or two well-organized hunting trips were made annually into the western plains. The Omaha and Ponca hunted north of the Platte into the Sandhills; the Pawnee went either up the Platte and Republican Valleys, or else shared with the Kansa and Osages the Plains Border and adjacent regions in central Kansas. At such times the entire population of the villages excepting the very young, the senile, and the decrepit moved en masse, dwelling in portable skin tipis and hauling their impedimenta on horseback or by travois, and living in general like the migratory bison hunters. At the temporarily deserted villages, the possessions which could not be carried along were concealed in underground pits. Under aboriginal conditions all these groups made pottery, and possessed in addition well-developed industries in stone, bone, horn, shell, and other materials. Whereas the temporary campsites of the migratory bison hunters today show little evidence of occupancy beyond hearth areas and possibly a few stone implements and animal bones, the abandoned house sites, cache pits, and accumulated refuse deposits of the village dwellers usually yield a rich harvest for the archeologist.

Fundamentally, the native agriculture of the Great Plains was of southeastern type, with tillage mostly or entirely by the hoe. The old type of hoe consisting of a bison shoulder blade lashed to a bent or forked stick survived until very late times, being used side by side with iron tools supplied by the traders. The fields—more accurately described as gardens—were small, ranging in size from $\frac{1}{4}$ to 3 or 4 acres. No attempt was made to break out the tough sod of the uplands. In the valley bottoms, the plantings were confined to little patches of loose alluvial soil scattered along the creek banks or lying at the mouth of a ravine. Because such spots were usually limited in number, the women often found it necessary to travel from 5 to 10 miles to and from their gardens. Corn, beans, and squash were the principal crops, but sunflowers, tobacco, and watermelons were also grown (Gilmore, 1913, p. 322). Women did all the planting and cultivating. Fertilizers were unknown and there is no evidence that irrigation was attempted. It is not definitely known whether the Indians of the central Great Plains had developed special deep-rooted, early-maturing, or drought-

resistant varieties of corn, as had the Mandans of the upper Missouri (cf. Will, 1922), but it is quite possible that in the course of years some selection of this sort had taken place.

The fields were ordinarily hoed only once or twice. After the second hoeing, in June, the entire population of the village set out on the summer hunt, returning in September to harvest the crops. Surplus corn was boiled, cut from the cob, and dried, and then stored in underground caches. These caches, when emptied of foodstuffs or when rendered unfit for further use by spoilage of their contents, were abandoned, often to be refilled with refuse. Such pits are a common feature of every village site so far excavated in the central Great Plains where horticulture is evidenced. In the early historic villages of the Pawnee along the Loup and at the contemporary Wichita (?) sites in central Kansas, these caches are often 6 feet deep, and they have been known to attain a depth and a diameter of 10 feet or even more. At later sites, particularly in those dating after 1800, caches seldom reach these dimensions. It is not yet clear whether this decrease in size reflects smaller crops due to a slackening interest in farming and a correspondingly greater reliance on hunting or is attributable to some other factor.

The Pawnee and Omaha used an upright wooden mortar with pestle for grinding corn; their protohistoric contemporaries in central Kansas used the flat or hollowed stone mealing slab with muller.

ARCHEOLOGICAL CONSIDERATIONS

As systematic archeology adds perspective to our picture of native life in the central Great Plains, it becomes increasingly clear that the two fundamental economic patterns outlined above, or variants thereof, have long been present locally, but that man's emphasis has shifted back and forth from one to the other. As Kroeber (1939, pp. 76-79) has indicated, ". . . the historic Plains [horse] culture was a late high-pressure center of culture in a region which previously had been rather conspicuously low-pressure." He is undoubtedly correct, too, when he observes further that in the prehistoric period, prior to the sixteenth century, the plains were a cultural margin. By comparison with the eastern Woodlands and the Southeast, where advanced mound-building civilizations once flourished, the region west of the Missouri is characterized by antiquities of quite unspectacular nature. Temple mounds, for example, are nonexistent; and the practice of raising tumuli over the dead, which serves to emphasize the highly elaborated burial cults of the east, extends only a little way into the

prairie plains of eastern Kansas and Nebraska and is not indicated at all for the plains proper.

The admittedly marginal nature of the semisedentary village cultures in historic times, together with the nomadic mode of life followed by the "typical" plains tribes farther west, has tended to obscure certain facts relating to the earlier agrarian peoples in the area. Kroeber (op. cit.) states that "It is scarcely controllable that the western plains were wholly uninhabited before the horse was available. Agricultural groups from east and west probably strayed in now and then and tried to farm. Small groups could make a living by combining bison and river bottom hunting with berry and root-gathering . . ." Archeology shows that primitive maize growers from the east had indeed penetrated far beyond the western margin of the prairie plains and had established themselves along many of the stream valleys in the High Plains. Their settlements were much smaller—and far more numerous—than those of such historic village tribes as the Pawnee. It is hardly accurate to speak of these prehistoric groups as mere "strays," for they came and spread in sufficiently leisurely fashion to scatter their remains along almost every arable stream valley with reasonably sure water as far west as the Colorado line. The diffuse nature of this early occupancy is in striking contrast to that of historic times when such tribes as the Pawnee dwelt in a very few large compactly built towns within a few miles of one another.⁴

Strong (1935) was the first to point out clearly that in the light of archeology the limitations of environment in the Great Plains were not so severe as many have been led to believe. In the long-range view, the droughts, excessive temperatures, and searing winds, which have played havoc with the present-day farmer and his commercial ventures, are comparatively transient if recurrent phenomena. Under normal climatic conditions the region is less hostile. Some degree of success, at least, must have attended the efforts of the native peoples who, content with a subsistence agriculture, ventured to try their hand at wresting a living from the soil of the short-grass plains.

As an example we may cite the recent discovery of pottery-bearing sites yielding definite proof of native farming activities in Chase

⁴ The Pawnee after 1800 were variously credited with 5,000 to 12,000 persons. I suspect that if these were redistributed among the older sites, many of the latter would be decidedly underpopulated. Even granting that not all the small prehistoric sites were inhabited synchronously, I am of the opinion that there may at times have been about as many Indian farmers in prehistoric Nebraska as there were during the nineteenth century. A very considerable proportion of these, moreover, lived in the High Plains area.

County, Nebr. (see fig. 1, Ch: 1), and in Scott County, Kans. (fig. 1, Sc: 1).⁵ These sites lie near the 101st meridian, 300 miles or more west of the Missouri, and well within the dry High Plains province (pl. 3). Both have yielded charred corn, together with bone hoes made from the scapula of the bison. At the Scott County site (pl. 3, fig. 1), where certain puebloan influences suggest the possibility of irrigation, the remains of squashes or gourds were also found. The great abundance of animal bones, as well as the very limited positive evidence of fixed habitations, leads to the belief that hunting probably ranked first in the food economy, with horticulture perhaps a side line. There is no reason to suppose that the inhabitants of these sites were related to the Pawnee or to any of the other Caddoan or Siouan village tribes of the eastern plains, or that they were directly ancestral to the Dakota, Cheyenne, and Arapaho who roamed the same area in the late eighteenth and nineteenth centuries. Scant amounts of iron trade materials indicate an early historic or protohistoric dating. The sites have been assigned to the Dismal River culture; it is possible that they will eventually be attributable to some of the semihorticultural Apache communities which according to seventeenth- and eighteenth-century Spanish documents formerly lived in the bison plains. At present they represent the westernmost points at which maize specimens have been reported archeologically in the central Great Plains.

In an earlier period, before any European influences had yet reached the area, horticultural peoples of another sort dominated the central Great Plains. Most widely distributed and best known are those who left the remains comprising the Upper Republican culture (Strong, 1935, pp. 69-124, 245-250, 275-278; Wedel, 1935, and 1940b, pp. 310-312; Champe, 1936). These remains occur throughout the Loess Plains to the edge of the Sandhills and south to the Smoky Hill-Kansas River drainage, with a westward extension far up the Republican (pl. 4, fig. 1) and Platte basins.⁶ They consist of innumerable small village sites situated near former springs or other permanent water on the flood-free terraces which characteristically border many

⁵ Wedel, 1940a; unpublished field notes by A. T. Hill, Lincoln, Nebr.

⁶ It is interesting to note that in terms of present-day agricultural regions, the village sites of these prehistoric agrarian peoples are most plentiful in those portions of Nebraska and northern Kansas which are assigned to the Corn Belt (see O. E. Baker's map in *Atlas of the Historical Geography of the United States*, pl. 142A). Their range also includes adjacent districts in northern Kansas now given over to hard winter wheat. From surface finds of pottery, it appears that they may have inhabited the present corn-wheat zone in northeastern Colorado.

of the creek valleys. The villages included from a half dozen to two or three dozen rectangular pit houses scattered over several acres of ground. Unlike the historic Pawnee villages, these earlier communities were apparently unfortified. Cache pits are present in all these sites; they seldom exceed 3 or 4 feet in greatest depth and diameter, and thus average much smaller than those of the early historic Pawnee. In them are found charred maize, beans, animal bones, pottery, stone and bone artifacts, and other evidences of human industry. Universally present is the bone hoe. Charred corn, cobs, and beans have been found in these sites as far west as Medicine Creek in Frontier County, Nebr. Typical pottery, together with evidence of earth-lodge remains, occurs still farther west in Chase County, and excavation will probably show that the occupants of these villages also practiced farming. Inferentially, this must have been on a small scale and by methods closely similar to those described above for the Pawnee and their neighbors. The hoe, and also the crops evidenced through archeology, all have historic counterparts. Since the prehistoric villages were much smaller, it can be assumed that sufficient arable ground was available in the bottom lands close at hand. The horse was unknown, but since the villages were scattered widely over much of the choicest bison range it is probable that ample supplies of meat could be obtained by foot hunters whenever desired. At any rate, the bone refuse in their sites shows that the Upper Republican peoples relied probably more on the bison than on any other single species for meat.

A somewhat variant contemporaneous manifestation along the Missouri River bluffs has been termed the Nebraska culture. Here, too, are found rectangular earth lodges, cache pits, pottery, and other evidences of a settled horticultural mode of life. Animal bones indicate that white-tailed deer, elk, and smaller mammals figured much more heavily in the native diet than did the presumably more distant and less easily obtainable bison. In this respect the nonequestrian prehistoric inhabitants of the immediate valley of the Missouri differed from the historic Siouan tribes who, mounted, could and did travel hundreds of miles westward in quest of the bison.

Underlying the widespread Upper Republican and contemporaneous manifestations are other pottery-bearing horizons. Remains designated as Woodland are found in small obscurely situated sites which have so far received scant notice from archeologists. In the ravines of eastern Nebraska they occur as artifact-bearing occupational strata exposed in newly cut banks, with an overburden that varies from 6 to 25 feet or more (pl. 5, fig. 1). Farther west, as in the High Plains

of Lane County, Kans., and elsewhere, similar strata are often overlain by wind-blown soils. It is still uncertain whether these overlying materials represent short cycles of abnormally heavy precipitation (in the east) or of excessively dry, windy conditions (in the west), or are due to slower but long-continued erosional processes. The extent to which the Woodland groups depended on cultivated crops is also a question since the sole evidences yet reported of horticulture—at the Walker Gilmore Site in Cass County, Nebr.—involve only the squash and gourd (Strong, 1935, p. 193).

Apparently contemporaneous with the Woodland sites are others along the Missouri in northeastern Kansas and nearby Missouri, which show a close similarity in several respects to the Hopewellian remains of the Mississippi-Ohio drainage. Evidence of horticulture is generally wanting throughout the Hopewellian horizon in the eastern United States, but it has been postulated that such an economic basis would have been necessary to so highly developed a civilization (Setzler, 1940, p. 262). At any rate, the only Hopewellian-like village site so far investigated seriously on the Missouri yielded direct proof of horticulture in the form of charred maize and beans (Wedel, 1938, p. 101). The bone hoe is absent, probably having been replaced by implements of stone or other material. To what extent the local economy was based on gardening is not clear, but cache pits possibly for storage of domestic crops were relatively plentiful. These yielded considerable quantities of deer and raccoon bones, but almost none of the bison. Since this complex does not appear to have penetrated very far west beyond the Missouri it is of minor interest so far as primitive horticulture in the Great Plains is concerned.

The prehistoric potters and farmers of the central Great Plains are thought to have moved into the region from a general easterly direction. If the Woodland peoples practiced horticulture, as we know the later Upper Republican groups did, then at least two principal waves of immigration by native farming economies are indicated. How long the interval separating these two is we do not know; there is no clear proof that the Upper Republican developed directly out of the Woodland, though some contact between the two is indicated (cf. Wedel, 1940b, p. 346). Both groups spread westward into the High Plains, nearly or quite to the present Colorado line. There is no way of telling whether either found the western plains uninhabited. It is abundantly clear that hunting economies had occupied much of the region at a far earlier time, as shown by the presence of Folsom, Yuma, and other ancient nonagricultural remains. Since hunting tribes again

controlled the area in historic times, it can be inferred that occupation by native subsistence economies based on maize constituted a relatively brief interlude which was preceded and followed by very much longer periods of occupancy by nomadic or seminomadic bison hunters.

The first Spanish explorers to visit the western plains in the sixteenth century found them occupied by nomadic Indians who had "no other settlement or location than comes from traveling around with the cows." In terms of modern linguistic groups, these are thought to have been Athabascans, probably Apache or Lipanan (Harrington, 1940, p. 510). Just when they arrived is not clear, but by 1541 the little farming communities over most of the Upper Republican area had evidently been given up. At any rate, there is no mention in the narratives of the Coronado or subsequent expeditions of anything corresponding to the Upper Republican village sites as these have been defined by archeology. The first permanent settlements seen by the sixteenth-century Spaniards in what is now central Kansas were large, some of them estimated to number 200 houses (Winship, 1896). The houses were of straw, and the natives are described as having corn, beans, and melons. All of this is reminiscent of the large protohistoric villages found in Rice and McPherson Counties, Kans. Insofar as it concerns fixed villages of horticultural peoples it also calls to mind the great fortified towns of the protohistoric Pawnee on the Loup River in Nebraska—possibly the Harahey of Coronado's chronicles (see Lesser and Weltfish, 1932, p. 12). Farther west, according to these explorers, were only migratory hunters whose mode of life was essentially the same as that of the historic hunters except for innovations taken over by the latter from white men. The cause or causes for the observed abandonment of the western plains by native farming peoples in late prehistoric times is one of the problems now confronting plains archeologists.

DROUGHTS AND PREHISTORY

Van Royen (1937, p. 637) has remarked that "there is little doubt in the minds of students of weather and climate that wide borderland areas between humid and arid regions will always be subject to recurrent droughts of varying duration and intensity, such as those experienced in historical times. Also, before the dawn of recorded history droughts occurred, some of which were brief, others evidently very long." The Great Plains constitute just such a borderland zone, with arid regions on the west and southwest and humid regions to the east. We may turn, therefore, to a consideration of certain phenomena

which suggest drought conditions during the prehistoric occupancy of the central Great Plains, keeping in mind particularly their possible effects on the native horticultural peoples.

Two sites in Nebraska are of especial interest in this respect. They are Signal Butte in the North Platte Valley near the Wyoming line, and the Lynch Site on lower Ponca Creek in Boyd County about 12 miles from the South Dakota border. Archeological remains at Signal Butte and their geologic context have already been detailed elsewhere (Strong, 1935, p. 224-239). Briefly, they consist of three prehistoric levels of human occupancy separated from one another by layers of wind-deposited loess from 18 to 24 inches thick. The topmost cultural horizon includes pottery of Upper Republican and Dismal River types, and may be no more than 300 to 500 years old. The middle and lower strata, yielding no pottery, are believed to represent much older hunting cultures. The occupational strata consist in part of humus, and presumably indicate periods of increased humidity. The intervening sterile layers are attributed to dry, windy periods. Van Royen suggests that "one or both of the sterile strata on Signal Butte may correspond to a long dry period from three to four thousand years ago or that they may be even older." Strong's estimate is more generous, with 8,000 to 10,000 years given as the possible time which has elapsed since level I (the lowest) was inhabited.

At Lynch (Van Royen, 1937, p. 638), the archeological remains cover a considerable area on the bluffs just north of Ponca Creek. As revealed in excavations by the University of Nebraska, their most striking feature is the presence of "a thick dark stratum, which near the ends of the [University test] trenches was found to lie about a foot beneath the surface and which was covered near the center by eight feet of sand. . . ." These sands, according to Van Royen, are wind-deposited, and were derived from the water-laid Pleistocene sands on the high terrace north and northwest of the areas of accumulation. The topsoil to a depth of 12 to 18 inches has been colored gray by plant matter and still supports a fair stand of grass. Wind activity here today is not great enough to produce dunes or sand drifts except where the grass cover has been killed off by cultivation or by overgrazing. The gray topsoil is too deep to be accounted for by the few decades which have elapsed since introduction of the plow in the district, and "since the culture stratum does not show any influence of the white man" it is suggested that the period of pronounced sand movement antedates the coming of Europeans. The observed conditions would imply a prolonged period of lower

rainfall and destruction of the grasses, followed by increased wind action on the denuded ground surface.

The question of dating even approximately the Indian occupation at Lynch, and through this the drought which must have followed it closely, hinges very largely on accurate identification of the archeological materials in the dark stratum. A detailed report on these has not yet appeared, but certain generalizations can be ventured on the basis of sherds collected on the surface during several visits I made before and at the time of the excavations (Wedel, 1940b, p. 317; see also Van Royen, 1937, p. 647). The sandy overburden has blown extensively wherever modern cultivation is under way, this being especially true on fields a few hundred yards east of the diggings. On the denuded village surface there were abundant remains, and hearths could be found only a few inches below the plowed topsoil. A collection of several hundred potsherds including numerous rim pieces, as well as many end scrapers, projectile points, and other chipped forms indicated an interesting mixture of types. One group of sherds exhibited features characteristic of the Upper Republican horizon; others, including a few rim pieces with handles, were reminiscent of Nebraska culture remains. A third group, in which shell tempering was noted, included incised or trailed decoration, rims, and handles resembling in most particulars the Oneota wares of the upper Mississippi and Missouri Valleys. A few sherds bore parallel ridges on their exterior surfaces, apparently produced by the same paddling technique used so widely by the Pawnee, Mandan, Arikara, and other tribes in protohistoric and historic times.

The Upper Republican and Nebraska culture manifestations throughout the central Great Plains have been extensively worked, and in no case has iron, glass, or other evidence of contact with white men been noted. On the other hand, Oneota village sites in Iowa, Missouri, and Kansas have yielded small amounts of such material. All the available evidence indicates that in the Missouri Valley and westward, the Oneota remains are late. Some of the sites may antedate slightly the arrival locally of white men, but the strikingly uniform character of the remains over most of the area occupied would indicate that they were not spread over a very long period of time.

It is not clear whether all the several pottery types noted at Lynch occur together or whether there was a stratified succession of wares. It is possible that a late phase of the Upper Republican survived here for a time alongside an unclassified peripheral variant of the Oneota

manifestation. In any case, the fact that pottery with definite Oneota affinities underlies the sand deposits is strong evidence that the latter were laid down within the last three to five centuries.

Much less striking than the sand accumulations at the Lynch site or the stratified remains at Signal Butte is the occurrence at many sites in the central Great Plains of a soil cover equally suggestive of dry, windy conditions. In a great many localities soil profiles have been partially obliterated by modern agricultural activities, but here and there in stream terraces can still be seen evidences of a dark humus zone buried under 10 to 30 inches of fine light-gray loess, without doubt wind-laid. That this old humus zone was at one time an inhabited surface is indicated by archeological observations. In the Republican drainage of southern Nebraska, as for example, on Medicine and Lost Creeks, Upper Republican pit-house sites have been found excavated into the humus line, with potsherds, bones, and similar village refuse littering the same level (Wedel, 1934, pp. 149, 152, 154; Strong, 1935, p. 76). That these houses were not dug from the present surface is shown by the presence of culturally sterile wind-blown materials which extend evenly and uninterruptedly across the old house basins and over the adjoining detritus-strewn humus zone. The present surface of this soil cover is usually flat with no suggestion of dunes or drifts. The material itself is finer than that at Lynch, and superficially resembles rather closely the sterile layers separating culture horizons at Signal Butte.

Upper Republican village sites blanketed in this fashion occur throughout the Republican River basin in southern Nebraska from Frontier, or possibly Hayes, County eastward at least to Webster County. I have observed a similar though thinner unbroken covering on Upper Republican sites in the lower valley of the North Loup River (pl. 4, fig. 2). Since widely scattered sites are thus involved the factors responsible must have been of more than local magnitude. At the same time, it must be pointed out that other Upper Republican sites in the Loup drainage are marked by shallow surface depressions, indicating either that less soil was deposited over them or else that the houses and caches were dug through the covering material and are thus later. The villages occupied by the Pawnee on the lower Loup and Platte Rivers seem never to have been thus buried, and the old lodge circles were always clearly visible before their obliteration by the plow. Still farther east, along the Missouri, the Nebraska culture sites which are believed to have been occupied synchronously with some of the Upper Republican villages, charac-

teristically show deep, well-marked house pits where they are not under cultivation.

It has already been noted that Woodland sherds and stone artifacts have been found in western Kansas and in Nebraska in similar buried humus strata. Wherever Upper Republican and Woodland remains occur on the same location, the latter are always at the bottom. For example, near Healy, in Lane County, Kans., Upper Republican village remains (pl. 5, fig. 2, stratum A) occur just below the wind-eroded surface of several small terraces. Below, and separated by a few inches to nearly 2 feet of sterile gray soil (pl. 5, fig. 2, stratum D), is a dark-gray stratum yielding hearths and Woodland artifacts (pl. 5, fig. 2, stratum B).⁷ The number of known similar occurrences in the Republican, Loup, and other more northerly river valleys is increasing.

Insofar as they relate to prehistoric man, the dust deposits of the Republican Valley and adjacent areas, as just described, have not been closely studied by physiographers or geologists. It should be noted that the repeated dust storms of the past decade accompanying droughts which wiped out the corn crop in many localities have not produced comparable formations in the Republican and Loup Valleys, though elsewhere deep drifts and dunes have been formed where fences, hedges, and other obstructions tend to break the wind. It is not certain that these deposits result from a single short, intense drought such as that evidenced at Lynch. It has been suggested to me that they can more reasonably be interpreted as a gradual accumulation over a period of many years. At the same time, the fact that the dust covers a dark humus stratum which often contains archeological remains would seem to indicate that a period of fairly rapid deposition followed a more humid interval which lasted long enough to produce a vegetative cover and to become the home of sedentary farming peoples. In other words, I see no reason why the different strata cannot be viewed as evidence of climatic fluctuations analogous to those inferred from the findings at Signal Butte.

Carefully controlled studies in the past decade have made it possible to arrange the major archeological horizons of the central Great Plains in sequential order (see summary in Wedel, 1940b). Where evidences of severe drought, or of prolonged periods of subnormal precipitation and consequent increased soil deposition, are definitely linked with these horizons it may be possible to determine the ap-

⁷ What is possibly a third occupation zone here is indicated as stratum C in plate 5, figure 2; from it came only broken animal bones and fire-cracked stones, hence the horizon remains unidentified.

proximate time involved. At Signal Butte, as already indicated, the dry periods have been tentatively assigned an antiquity of several millenia. At Lynch, on the other hand, the archeological evidence points toward a very much more recent drought—one that might have occurred as late as the sixteenth or seventeenth century.⁸ The dust blanket on the Upper Republican sites in southern Nebraska must have begun to accumulate at least 400 years ago, since there is evidence that the Pawnee were living in large villages in eastern Nebraska in Coronado's time (1541) but none whatever that contemporary horticultural earth-lodge-using peoples lived in the western plains.

The estimates of age here given are inferential, and rest on archeological and historical data. At present they cannot be checked by precise methods such as dendrochronology offers in the Southwest. However, as already indicated, red cedar (*Juniperus virginiana*) is widely distributed throughout the High Plains, and there is good evidence that western yellow pine grew scatteringly eastward to the 99th meridian as late as the nineteenth century. Moreover, it should be borne in mind that charred pine and juniper have been found in

⁸ M. E. Kirby, of the U. S. Engineers office at Omaha, Nebr., has called my attention to relevant data by Upham (1895, p. 594) concerning fluctuations in the surface levels of certain glacial lakes in North Dakota. Devils Lake and nearby Stump Lake in the northeastern part of the State present highly irregular outlines and are believed to occupy the valley of a preglacial river which has been elsewhere buried with drift. In historic times Devils Lake reached its highest level about 1830. At about the same time occurred record high-water levels in Red River and in the Great Lakes. Thus, 1830 would appear to represent the high stage in a period of heavy precipitation. The shore line of Devils Lake at that time is indicated by a line of heavy timber. Between this and the recent shore line Upham noted a stand of smaller trees which in 1889 showed a maximum of 57 annual growth rings. During the 1830 high stage the waters flowed into Stump Lake a few miles to the southeast, but the latter never attained the same level as Devils Lake owing to evaporation. The early postglacial outlet of Stump Lake into the Sheyenne River was dry during the 1830 high water, as shown by a stand of large timber growing across the channel. This timber corresponds to that marking the 1830 water line in Devils Lake.

At present, in the bed of Stump Lake, North and South Washington Lakes, and Lake Coc, all situated near Devils Lake, there are old stumps of trees which grew when the lakes were dry some time before the 1830 rise. Many of these have been uprooted and used for fuel. Some of the stumps on the lake bed showed as many as 115 annual rings, indicating well over a century of deficient rainfall. It is not known just when the protracted period of desiccation here indicated came to an end, but it must have been long before 1830, since many years of heavy rainfall would be required to refill the lakes. Upham suggests that the drought represented here may have coincided with the arid conditions in the Great Basin which are supposed to have dried up Pyramid, Winnemucca, and other lakes in Nevada about 300 years ago.

Upper Republican pit houses (Wedel, 1935, p. 170); that the former distribution of pine and the present occurrence of juniper overlap the known range of the prehistoric Upper Republican horizon; and that much of the area of overlap in the western plains has a low rainfall which is apparently directly reflected in tree growth. Working on wood specimens from historic log structures and from old stumps in gully fills in Lincoln County, Nebr., Weakly (1940) reports a continuous tree-ring sequence reaching back to about A. D. 1480. The buried material is said to have given "very readable ring sequences," but absolute dates have not yet been assigned. All this raises the hope that continued research, combining dendrochronology with archeology, will soon produce exact tree-ring datings for some of the late prehistoric and protohistoric culture horizons in the western plains, and also establish the time of some of the associated drought evidences in the same region.

In another paper (Wedel, 1940b, p. 329), I have suggested the possibility that abandonment of the western plains by sedentary horticultural peoples in late prehistoric times may have been due in part to inability to cope with drought conditions. This view has been questioned by ecologists with whom I have discussed the point. Their contention is that the small gardens of the Indians, unlike the present-day farms, would have been situated only in sheltered bottom-land pockets where there was maximum protection against hot winds and where natural drainage conditions would have provided subirrigation. Moreover, the practice of storing one to several years' supply of corn against the contingency of crop failure would have carried them through droughts such as those of the historic period. In this connection a perusal of the reports of the various Indian agents in the Kansas and Nebraska territories is instructive.

The effects of the droughts of 1860, 1870, and 1893-96, in terms of large-scale populational movements out of the plains by white settlers, have been frequently recounted.⁹ Their effects on the native and transplanted Indian populations, however, seem to have gotten little attention. According to the report of the Commissioner of Indian Affairs for 1860, the Pawnee (pp. 94-95) "had about 800 acres of corn, pumpkins, beans, etc.; but owing to the extreme drought in this section of the country, and improvident farming, their crop is very light." Among the Oto and Missouri (*ibid.*, pp. 96, 97) a highly favorable spring was followed by three rainless months, with "a constant burning sun and scorching wind, the result of which is the

⁹ Summarized in Clements and Chaney, 1937, p. 41.

entire loss of their crops. . . ." Even the grass was burned up, so that neither the Indians nor the agency were able to lay up their usual reserve of hay for the winter. Along the Nemaha, the Sac and Fox (*ibid.*, p. 99) fared a little better, with the prospect of half a corn crop and considerable hay. The Kickapoo (*ibid.*, p. 101) in northeastern Kansas who had just been presented with oxen, plows, and other farm machinery, were giving up their farms consisting of "8 to 10 acres of soft turfless ground among the girdled trees skirting the narrow borders of the creeks" and were venturing out into the prairies. For them, 1860 brought the worst drought of their 30-year sojourn west of the Missouri, and a complete crop failure. The Pottawotamie (*ibid.*, p. 41), the Sac, Fox, and Ottawa (*ibid.*, p. 111), the Kansa (*ibid.*, p. 113) together with the Kaskaskia, Peoria, and other tribes on the Osage River in eastern Kansas were equally hard hit. Total or partial crop failures are also reported for the Choctaw, Cherokee, Chickasaw, Quapaw, and Wichita (*ibid.*, pp. 114-123) far to the south in the Indian Territory. According to the agents, the alternatives confronting the natives everywhere throughout this vast region were starvation, government aid, or recourse to the plundering of such of their white neighbors as were receiving relief from the government or from friends in the east.

A decade later, in 1870, drought struck again, but this time it affected the Indians over a much smaller area. At the Whetstone Agency, Dakota Territory, the crops were destroyed by a 2-month drought in June and July. At the Santee Agency, in northeastern Nebraska, 370 acres of corn were a total loss. The agent for the Ponca wrote that "Had it not been for the very long and severe drought, they would have realized a yield of at least 14,000 bushels. On the first of July their crops looked well, and I was of the opinion that the bottom lands would not be affected by the drought; on the contrary, the whole was an entire failure. . . . This tribe is now bordering on starvation." In southern Nebraska, of the Oto it is said that "On the bottom lands a few will probably succeed in harvesting light crops of corn; but I fear those . . . on the upland . . . will experience an almost entire failure of their crops. . . ." Throughout northeastern Kansas the tribes generally seem to have fared very well. Weather records show that Leavenworth, Kans., enjoyed an excess precipitation of nearly 25 percent in 1870, which suggests that the reservation Indians hereabouts may have been out of the main drought area.³⁰

³⁰ References to insect pests are rare in these reports. In 1870, however, the agent for the Yancton Sioux suggested (p. 212) the advisability of removing

Prior to 1860, data on drought conditions in the central Great Plains are scarce. We may note, however, that in 1848 the Council Bluffs Agency reported that "The government has purchased the past season for the Pawnees between 1700 and 1800 bushels of corn, to keep them from suffering. . . . They are still in a miserable condition; their crops this season have almost been an entire failure, owing to the drought. Their corn in the Platte bottoms was literally burned up; . . . they will suffer, unless they make an unusual good hunt this winter."

The distressing conditions set forth in these reports are a significant commentary on the reactions of Plains Indian farming communities to drought. It can be objected that at this late date the old cultural patterns of such tribes as the Pawnee, Omaha, Oto, and Ponca were swiftly falling apart. Their horticultural economy was only a part-time interest, and probably but a dim reflection of what it evidently had been a hundred or two hundred years before. Moreover, tribes like the Kickapoo, Sac, Fox, Ottawa, and others, were originally residents of more easterly drought-free areas who had been moved onto reservations west of the Missouri so recently that there was insufficient time or incentive to make the necessary adjustments to a changed environment. All this is true. But it is also true that the area inhabited at this time represents the best corn-growing section in the central Great Plains, climatically and otherwise. It must be remembered, too, that there was no contemporary Indian agriculture beyond the 99th meridian in the High Plains, and the above observations contain about the only extant data concerning such activity under pronounced drought conditions beyond the Missouri.

The recorded droughts of the nineteenth century, despite their occasionally calamitous effects, were relatively short-lived affairs. Most of them meant only a year or two of subnormal precipitation; in no case has there been, since the coming of white settlers, as much as a decade of continuous drought and unbroken crop failure. For this reason, it is impossible to say how long or how intense a period of drought would be needed to kill off the sod cover to the point where large-scale soil movements could take place. Clements (1938, p. 202) states that "even a thin cover of vegetation controls the wind so

these Indians from "a climate where crops are so uncertain, owing to the scarcity of rain and the ravages of the grasshopper. . . ." He says further that ". . . in five years of the last ten the crops were totally destroyed by the drought and grasshopper, and in one year of the ten there was about half a crop . . ."

effectively that soil-drift and deposition during the past must have been limited to bare areas such as ocean-strands and river-banks. During the historical period, dust storms have come only from soils exposed by man in the course of settlement." The second statement, at least, may need revision, since terrific sand and dust storms apparently rivaling in intensity those of recent years were experienced by McCoy and his surveying party in northern Kansas 200 miles west of the Missouri as early as 1830 (McCoy, 1840, pp. 408-409). The material which overlies Upper Republican sites can hardly have been due to man's work, since it unquestionably antedates the era of modern agriculture and could never have been an aftermath of the small-scale horticulture practiced by the people whose remains it covers.

In his discussion of the Lynch site, Van Royen (1937, pp. 645, 648) expresses doubt that 20 to 25 years of drought would have been sufficient to destroy the local sod cover and inaugurate wind erosion leading to the topographic changes there noted. On the other hand, many farmers in the western plains maintain that 5 years may be enough to kill the grass and start serious soil movements, even where no overgrazing has taken place. On this point, agricultural experts with whom I have talked corroborate the observations of the farmers. In light of these latter statements it would be interesting to know just how long the droughts suggested by the archeological record may have lasted. A possible clue lies in the tree-ring studies already mentioned.

Weakly (1940) has called attention to the presence of aeolian deposits in canyons in the vicinity of North Platte, Nebr., beneath which red-cedar stumps are buried. Annual rings on these stumps "indicate a period of over 30 years with deficient moisture. Apparently this drought period contributed very largely to the death of these trees." Presumably, the fill overlying these stumps is a result of wind action on the surrounding uplands after these had been partially or largely denuded of their sod cover. The drought conditions manifested here have not yet been dated. They have significant implications, however, for they suggest that prolonged droughts comparable to those held responsible for extensive ethnic disturbances in the Southwest in 1276-1299, and again in 1573-1593 (Douglass, 1935, p. 48), might well have occurred in the Great Plains, though not necessarily concurrent.

In addition to this as yet undated major drought, Weakly believes his tree-ring data prove the occurrence of a number of shorter periods of deficient rainfall. Some of these "would have been very

severe even on the present population of this section and . . . would have been a major catastrophe to a population of aboriginal farmers. Several of the drouths were of sufficient severity to very largely depopulate the plains even now. . . ." (Letter of March 7, 1941.) In this same letter, Weakly informs me that the major dated drought periods previous to 1700 are as follows:¹¹ 1439-54 (15 years), 1459-68 (9 years), 1539-64 (26 years), 1587-1605 (except for 1594-96). I am inclined to suspect that if Weakly's chronology has been extended beyond question to the early part of the fifteenth century, he may be on the threshold of an exact dating for some of the Upper Republican village sites in western Nebraska.

We have already indicated that the western portions of the Upper Republican habitat have a low irregular rainfall which borders on the minimum required for successful farming. It can be assumed that these peoples farmed intensively and that they were far-sighted enough to lay by seed corn and food against a year or two of crop shortage. At the same time it may be doubted that their harvests were ever on the scale of those normally enjoyed by the later Pawnee and other horticultural peoples farther east. In light of the difficulties experienced by Indians in the eastern plains during the brief droughts of 1860 and 1870, I am led to believe that when hot, searing winds and droughty summers visited the aboriginal farmers throughout the western Great Plains, crop failures and some measure of destitution were their lot in prehistoric days as well. Dry years may also have given rise to insect plagues, as they do today, further complicating the native economy. The delicate balance between annual precipitation and crop yield has been noted elsewhere in this paper. If drought conditions recurred for several successive years, or if there was a drop of several inches in the average annual precipitation over a period of 10 or 20 years or more, perhaps with springs and watercourses drying up, there would have been no choice for the natives other than that of abandoning their villages and removing eastward to better-watered and more dependable regions. A sedentary mode of life such as that indicated for the Upper Republican peoples, involving relatively permanent earth-lodge villages, would have been impossible when climatic or other factors prevented the cultivation of maize. All this leads me to suggest again that the early horticultural peoples of the Upper Republican communities may have been forced out of their habitat in western Kansas and Nebraska, probably toward the east, in large part by a long-continued

¹¹A manuscript detailing the results of Mr. Weakly's tree-ring studies is awaiting publication by the U. S. Department of Agriculture.

period of subnormal rainfall, the outstanding physiographic aftermath of which is seen in the dust which today covers many of their ancient living sites.¹²

¹²The relation between the prehistoric Upper Republican peoples and the historic Pawnee is still a puzzle. There is nothing in Pawnee traditions to suggest that this group was a late arrival west of the Missouri, and it is generally believed that they were firmly established in or very near their historic locale at the time of Coronado's march into the plains. Strong (1935, p. 277) has suggested that the Pawnee may have been the lineal descendants of the Upper Republican peoples. This is based on a number of resemblances involving basic house types, pottery, and the general semisedentary horticultural mode of life. Persistent search has so far failed to produce a single site in Nebraska which could be regarded as intermediate between the Upper Republican horizon and the earliest protohistoric village remains attributable to the Pawnee. On the contrary, the small, open, undefended villages, prevailingly rectangular pit houses, cord-roughened pottery, and communal ossuary burials of the Upper Republican peoples are consistently in contrast to the large, defensively situated, fortified towns, invariably circular earth lodges, corrugated paddle pottery, and individual flesh interments of the Pawnee. The much sought "clear unbroken line of ceramic and other development" foreseen by Strong is not yet at hand, nor can we say how long the gap in the proposed sequence is. The data on physical anthropology, which may well be crucial in this connection, are either nonexistent or unpublished.

Recent excavations (Wedel, 1941) in Rice County, Kans., have shown that small but consistent amounts of Upper Republican-like cord-roughened pottery occur here, along with puebloan sherds of ca. 1525-1650, at village sites tentatively ascribed to the Wichita. There is also some evidence of ossuary burial. Strong (1940, p. 382) has recently proposed that the Arzberger site near Pierre, S. Dak., represents "a late prehistoric horizon, basically Upper Republican, but in process of development into the more specialized and later protohistoric Pawnee (to the south) and Arikara (in the north)." As I have indicated in this paper, there is also a strong possibility that a late phase of the Upper Republican culture survived into virtually protohistoric times in northeastern Nebraska, as shown by the pottery remains at Lynch. In other words, traits which may be regarded as of Upper Republican derivation appear to have survived later in the eastern plains and in South Dakota and Kansas than in the Upper Republican-Pawnee region in Nebraska. One wonders, therefore, whether the postulated development from a prehistoric into a historic entity, or entities, may not have taken place outside the Nebraska area, with the Pawnee on the Loup and Platte Rivers representing a backwash. According to their traditions, the Pawnee entered Nebraska from the east and south rather than from the north, which might explain certain ceramic (as for example, the cloistered rims) and other elements in their material culture which have an easterly rather than Upper Republican flavor. This is admittedly a thorny problem and one which cannot be certainly answered with the information now at hand. As a working hypothesis, however, it may be well to bear in mind the possibility that the threads running from the Upper Republican to the Pawnee, if they exist, may have to be traced out of Nebraska and then back at a somewhat later period, which, in any case, should precede 1541.

As has been pointed out elsewhere, the occurrence of dust-covered humus strata containing human debris is more frequent in the central Great Plains than has commonly been supposed. Moreover, to the best of my knowledge this does not involve the remains of such historic tribes as the Pawnee and their Siouan contemporaries whose villages and campsites seem always to have been situated on the present ground surface. If the similarity between Signal Butte and other later stratified or "buried" sites can be taken as evidence of like climatic fluctuations, then it would appear that the record of man's activities in the western plains is linked with the periodic development of stable humus zones between which there are dry-weather dust deposits. Thus, in the archeological record we have Signal Butte I and Signal Butte II, each succeeded by periods of undetermined duration during which dust was being laid down. Later came pottery-making groups: First the Woodland, then the patently horticultural Upper Republican, each followed by periods of increased deposition. There is at present no way of determining accurately the length of time required for the development of these now-buried humus zones on which prehistoric farming peoples once carried on their everyday activities over much of the central and western Great Plains. It seems to me, however, that these intervals must have been of some length since the human occupancy spread westward about as far as climatic factors would permit corn growing. In any event, if the repeated interludes of deposition were indeed the aftermath of decreasing rainfall and increasing wind activity, as contrasted to the more humid periods which produced the humus layers, we may visualize the farming Indians as having ventured far out into the Great Plains during favorable times only to withdraw when droughts set in.

CONCLUSION

It need not be assumed from the findings of archeology that any major climatic change or permanent desiccation has taken place in the central Great Plains within the span of time represented by the various aboriginal pottery-making groups formerly resident there—or, as a guess, within the past 8 or 10 centuries. In all likelihood, however, shorter or longer periods of deficient rainfall have occurred repeatedly in prehistoric as in historic times. Some of these periods were probably of sufficient duration or intensity to depopulate the western plains for a time. The occupation of the region by migratory hunters since at least 1541 may well be due to the accidents of history as much as to any unfavorable climatic trends. That

is to say, it is conceivable that had the hunters first seen by Coronado's party not received horses and firearms from the whites, maize-growing peoples might again have extended their occupation westward beyond the 99th meridian. In view of the still sketchy nature of our information on plains prehistory, it is impossible at this time to evaluate fully the respective importance of environment and of historical accident on the alignment of native economies in the region. Nevertheless, it begins to look as though alternate settlement and abandonment was true of primitive man's occupation of the western plains just as it has characterized the subsequent white man's tenure where large-scale government aid was not forthcoming during periods of adverse climatic conditions.

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TYPICAL SCENE IN A PLAINS INDIAN HUNTING CAMP OF THE
NINETEENTH CENTURY

Photograph by S. J. Morrow, probably made in the upper
Missouri Valley about 1870.



EARTH-LODGE VILLAGE OF THE PAWNEE, A TYPICAL SEMIHORTICULTURAL TRIBE OF THE EASTERN PLAINS, ON THE LOUP RIVER, NEAR GENOA, NEBR.

Photograph by W. H. Jackson, 1871.



1. BEAVER CREEK VALLEY IN SCOTT COUNTY, KANS.

The even skyline, scattered trees, and short grass are characteristic of the High Plains. A Pueblo ruin and other protohistoric Indian remains lie at the center of the view.



2. VIEW IN THE VALLEY OF STINKING WATER CREEK, CHASE COUNTY, NEBR.

The remains of a protohistoric village of hunting and farming Indians occupy the flat immediately across the stream.



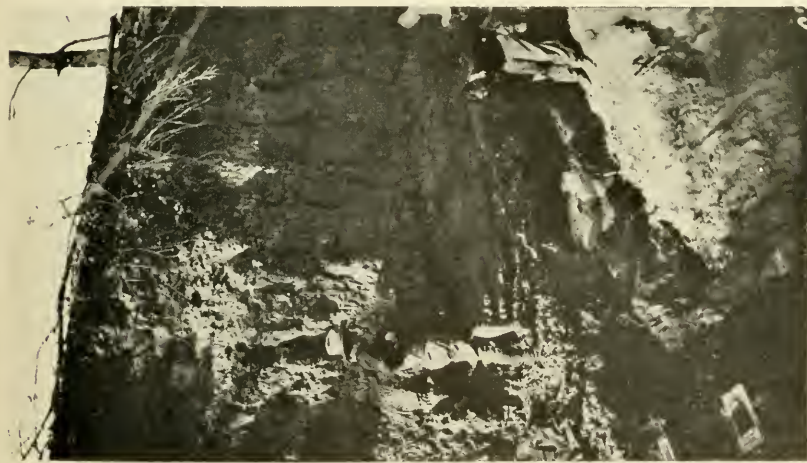
1. VIEW IN THE REPUBLICAN VALLEY, FRANKLIN COUNTY, NEBR.

The Dooley site, type station for the prehistoric Upper Republican culture, lies on Lost Creek, just to the left of the loess bluffs.

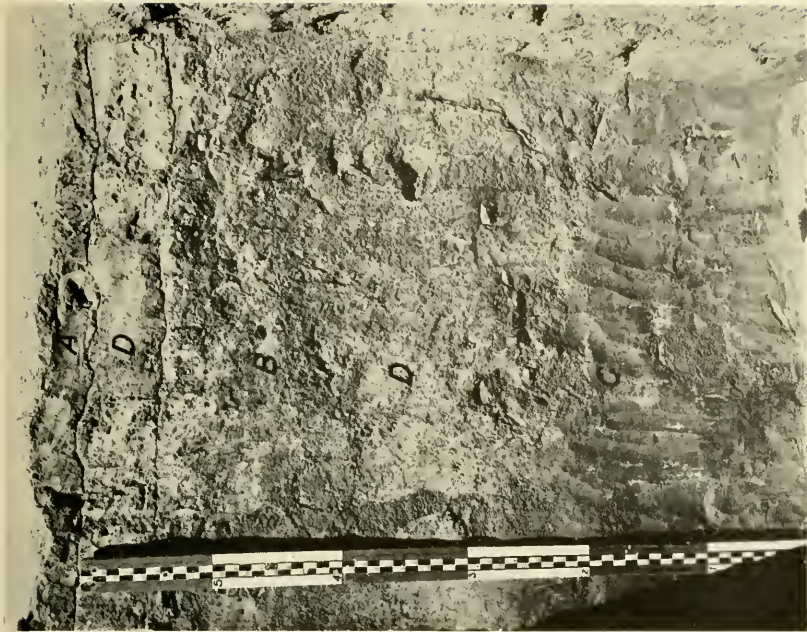


2. STRATIFIED SITE ON DAVIS CREEK, NEAR COTESFIELD, NEBR.

Twelve-inch dust mantle (A) overlying dark gray humus stratum (B) containing potsherds and other remains of Upper Republican type.



1. DEEPLY BURIED HEARTHES AT WALKER GILMORE SITE (WOODLAND), CASS COUNTY, NEBR.



2. STRATIFIED SITE ON SALT CREEK, LANE COUNTY, KANS.

See page 19 for explanation.