



Conservation in Pueblo Agriculture: II. Present-Day Flood Water Irrigation

Guy R. Stewart

The Scientific Monthly, Vol. 51, No. 4 (Oct., 1940), 329-340.

Stable URL:

<http://links.jstor.org/sici?sici=0096-3771%28194010%2951%3A4%3C329%3ACIPAIP%3E2.0.CO%3B2-C>

The Scientific Monthly is currently published by American Association for the Advancement of Science.

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/about/terms.html>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/journals/aaas.html>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

For more information on JSTOR contact jstor-info@umich.edu.

©2003 JSTOR

<http://www.jstor.org/>
Tue Nov 25 18:29:59 2003

CONSERVATION IN PUEBLO AGRICULTURE

II. PRESENT-DAY FLOOD WATER IRRIGATION

By Dr. GUY R. STEWART

SENIOR SOIL CONSERVATIONIST, SOIL CONSERVATION SERVICE, U. S. DEPARTMENT OF AGRICULTURE

THE life of the modern Hopi and Zuni tribes is full of interest for the student of primitive agricultural methods. These people, since their first contact with whites, have clung to their ancient life with a devotion which has preserved much of their early ceremonial existence. In the same way their system of planting corn and minor crop plants has been far less affected than have the Rio Grande Pueblos with Spanish and American agriculture. Valuable light can therefore be shed upon the relics of early ways of growing the traditional corn, beans and squash of the ancients by examining the agriculture of the Hopi and Zuni cultivators.

The Hopi villages lie at the southern end of the high upland known as Black Mesa. The agriculture of these communities forms an interesting example of the manner in which simple conservation practices have been developed to enable the cultivators to live in the midst of a rigorous environment. The elevation at the villages is approximately 6,000 feet, but the plateau rises to about 8,000 at its northern end. This higher elevation gives an appreciably greater rainfall upon the upper portions of the plateau than the 12.7 inches recorded over a ten-year period at Keams Canyon. This greater upland precipitation provides run-off in the main canyons coming out from the upper mesa emptying between the first, second and third mesas on which the eight villages are located. In addition, there is an important seepage of moisture along the mesa top, pro-

ducing valuable springs at various points below the upper mesa rim. This seepage also makes it possible to grow fruit trees, particularly peaches, at places along the upper mesa and on the sloping land adjacent to the uplands. The local run-off from the sides of the upper mesas is also caught in many places and supplies bean, squash and melon fields. This supplementary water is absolutely necessary for crop growth in view of summer temperatures from 95 to 98 degrees Fahrenheit, combined with strong, drying winds during the spring and fall periods.

The critical factor in the success of the Hopi corn crop is flood water run-off, which comes down the principal arroyos at irregular intervals after torrential rainfall descends upon the uplands. This flood flow fans out over the alluvial flats which lie to the south of the Hopi villages. During the growing season portions of the corn lands may receive run-off at three or four periods during June, July and August. In order that the flood water may be handled successfully, it is essential that the bed of the arroyo should be only slightly lower than that of the field on which it is to be diverted. The light dams of brush and earth which are thrown across the flood streams by the Hopi irrigators are a great aid in stopping gully cutting by preventing excessive deepening of the channel. If arroyos are unchecked so that cutting starts, a gully of twenty to thirty feet in depth may form in a few years, which lowers the flood water to a point where



—Stewart

BRIGHT ANGEL TRAIL OF THE GRAND CANYON
COTTON SEED HAVE BEEN FOUND IN SMALL RUINS ALONG THE LOWER PART OF THE TRAIL, INDICATING THAT THIS CROP WAS RAISED IN THE WARMER PART OF THE CANYON.

it can not be brought upon the land. Hence, regular use of flood water to spread it out and keep the arroyo beds filled with the sand and silt which the stream readily deposits is one of the important factors in successful flood-water farming.

Since the flood flow can not be controlled beyond diversion from the main stream, parts of fields at times may be washed out or other portions may be covered with a heavy deposition of silt and

The preparation of land for planting is relatively simple. It commences in late February and is completed during the spring months. Plowing has never been generally adopted among the Hopi, because of the danger of soil loss from wind erosion, during periods of high wind. In most cases the principal land preparation consists of digging out weeds and brush, either with the traditional wooden planting stick or wooden weed cutter, though some cultivators



TYPICAL FLOOD WATER FIELD ON THE FIRST MESA AT HOPI

—Stewart

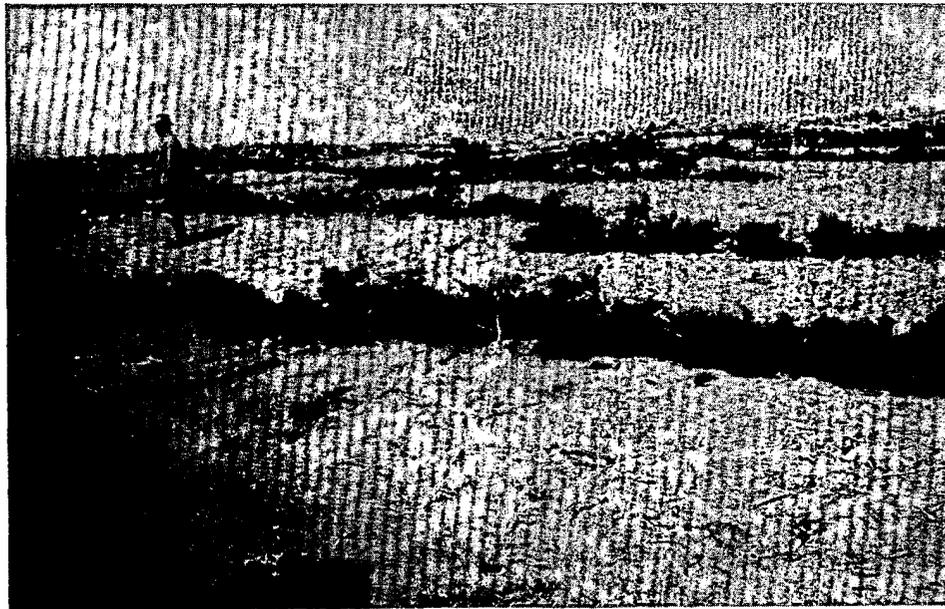
sand. This is one of the risks inherent in any such system of agriculture. It is minimized to a certain extent among the Hopi by the fact that a family may have a share in the clan lands inherited from mother to daughter, which will be located in more than one part of the flood plain. This arrangement of the land holdings also reduces the chance of crop loss from windstorms or from a heavy concentration of cutworms, which might occur before the family and friends could come out and pick them off.

have adopted steel hoes and spades. Part of the older Hopi, however, still feel that steel or iron tools may dry out the soil and make the planted seed likely to suffer from drouth and, therefore, use nothing but the older wooden tools. Each family group generally prepares its own land, the men doing the major portion of the work, but the women and older children may at times be seen working with them. At the same time that the fields are cleared, brush fences and windbreaks are rebuilt on the lighter

soils, and new windbreaks will be put in upon fields which have not been planted during the previous year. Any available type of brush or branches may be used, and the same material will be allowed to stay in the ground even after it is defoliated, so long as the branches give some protection against wind action. In the melon and bean fields the old roots will be removed as part of the land preparation, but in corn land the stumps from the previous crop are ordinarily

pan to form. On such plots the cultivators will often spade up the soil to a depth of 14 to 18 inches, breaking up the hardpan and incorporating any crop residues left on the surface.

The first planting of early corn is ordinarily put out in the terrace gardens in early May, depending upon the season. In most of the villages an official known as the Sun Watcher observes the point at which the sun rises along the southern horizon, and the Town Crier



—Stewart

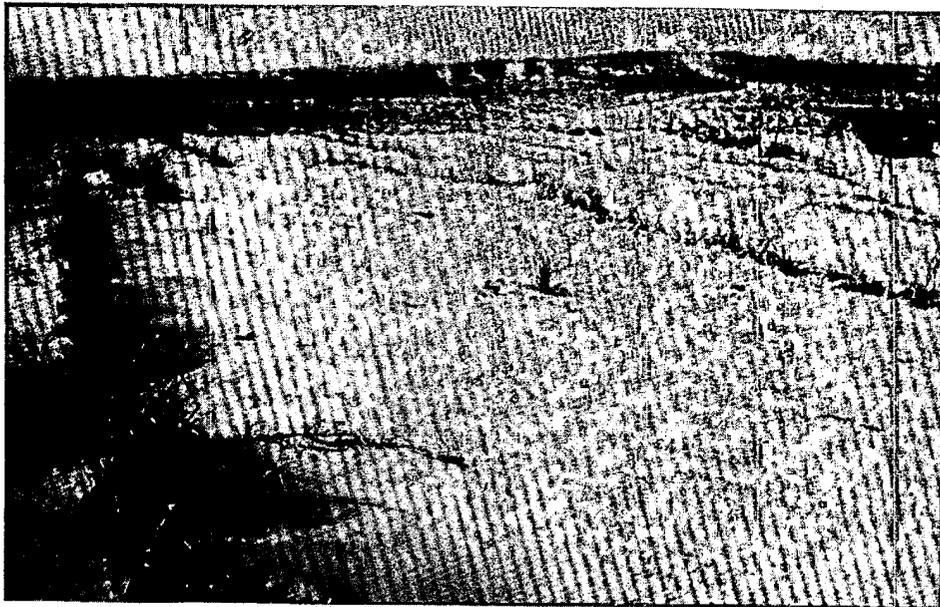
HOPI BRUSH CHECKS RECENTLY PUT IN TO CONTROL SOIL BLOWING

allowed to remain so that the new plantings will alternate with the old hills of corn. At the same time that the flood water lands are prepared for planting, the men whose families have terrace garden plots adjacent to one of the springs, work up the ground and prepare it for planting to chile peppers, onions and early sweet corn. The water of some of the springs is slightly saline, so that salts may accumulate in the upper soil and there may be a tendency for alkali hard-

will then announce that the time has come for planting early corn, watermelons and beans. The main planting of corn is not started until after the Town Crier announces that corn will be planted for the village Chief or Governor. This planting is a spontaneous tribute to their leader for his service in arranging ceremonials and advising in clan and village affairs. The organization of such a village planting party is partly wrapped up in mystical tradition



—Stewart
HOPI TERRACE GARDENS, NEAR THE WIPO SPRINGS, FIRST MESA
PHOTOGRAPHED WHEN THE LAND WAS BEING PREPARED FOR PLANTING.



—Stewart
HOPI BRUSH CHECKS PUT OUT IN SANDY LAND
DURING THE PREVIOUS YEAR AND NOW LARGELY DEFOLIATED. THESE THIN WINDBREAKS STILL GIVE
SOME PROTECTION FROM SOIL DRIFTING.



—Stewart
LARGE EARS OF CORN
 GROWN AT ZUNI, IN FLOOD WATER FIELD, ON RELATIVELY SMALL PLANT.

and is partly the result of long agricultural experience.

Upon the day set for planting, as the men start from their homes, the women of their family will observe an old Pueblo custom and dash a dipper or two of water over them, in order that the crop which they are to set out may not lack for rain water.

When the party of volunteer workers is gathered together, the men will first hold a short ceremonial smoke and breathe prayers for rain. Prayer sticks are next offered before a field shrine and a little corn meal is sprinkled in the six major directions—north, east, west, south, above and below. After these observances, the planters will start along one side of the field, spacing their planting about three to five paces distant from each other. The rows are located in be-

tween the rows of the preceding year and the hills alternated in distance in each adjacent row, so that no two hills are opposite each other, and all are set in new soil.

The planting technique that has been developed is simple and effective. The planter removes the surface soil with his foot and then digs a trough-like hole from twelve to sixteen inches deep. The damp subsoil which is reached at this depth is next loosened and from ten to twenty seed are dropped in the hole and covered with soil to a depth of eight to ten inches. This deep planting enables the plants to obtain the maximum advantage from the moisture present in the soil and allows them to develop a deep root system which can resist wind or the rush of excessive flood water. By the use of a large number of seed, a leafy clump of stalks is started which gives excellent protection to the central stalks when high winds blow at harvest time. These outer leaves may only be frayed remnants at harvest time, yet through their shelter the central stalks are able to grow and mature one or more large ears of corn which are set at the base of the stalk just at the level of the ground. The excess seed also gives sufficient plants so that a fair stand is likely to remain, even though mice or cutworms get into the field. It is often customary for foot races to be run by the planters at some time during their first day's work in a field. This is believed to be effective in starting the corn to growing rapidly.

After the planting is completed for the village Chief, other planting parties of friends and relatives are organized in each village, as only a few fields are planted at a time. The women of the family whose land is to be planted ordinarily provide a mid-day lunch for the workers and entertain them at a bountiful supper when they return home at

night. A great deal of pleasant social life in the villages is centered around these planting parties, while a similar exchange of labor and entertainment is a part of the work at the fall harvest of the corn crop.

As soon as the corn has sprouted, the soil about a hill is kept loose with a digging stick and weeds are removed with a weeding hoe. Some hills which are found to be badly whipped by the wind will be protected, when small, with circles of protecting stones and later with brush windbreaks. In many cases it can be noted that individual hills of corn are surrounded by low banks of earth to hold rain or flood water.

The Hopi cultivator gives his corn crop considerable attention during the early part of its growth. Weeds are cut with a hoe so as to conserve moisture during the time of its most rapid development. Portions of the field which fail to receive flood water from the first

storms are leveled off or roughly trenched to promote a more even flow of water if later rains come.

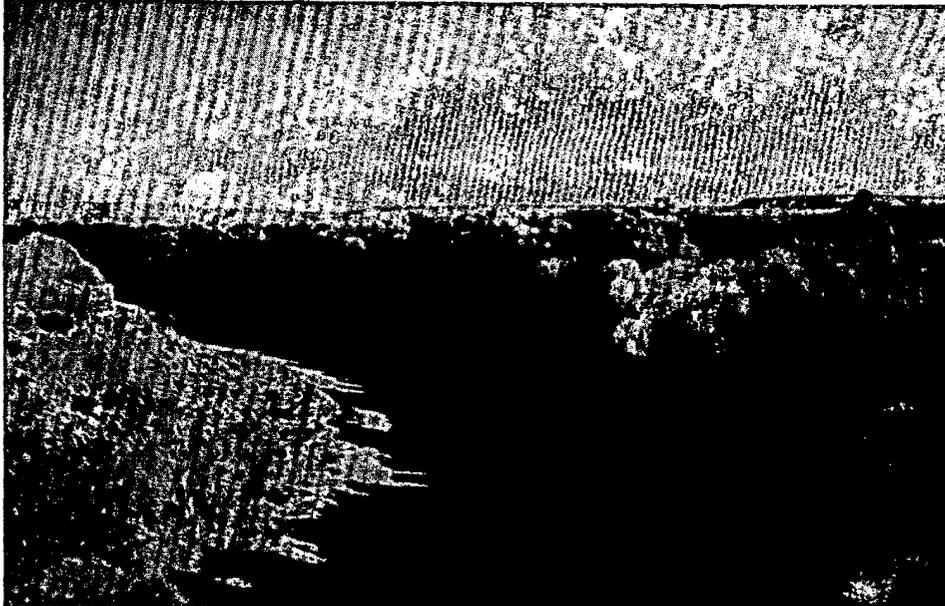
At Zuni, the corn crop is still raised on fields which receive flood water, even though irrigation has been made available for part of the village lands. The ditch-irrigated fields have been planted to wheat and alfalfa, while lands used for corn since traditional times still grow this crop with some modification of the old procedure which was originally very similar to that used in the Hopi villages.

The Zuni corn fields have always been surrounded with a high ridge of soil around the outer edge of the tract to aid in retaining flood water. Such a bordering ridge might be eighteen inches to two feet high and three feet or more wide at the base. This border was formerly raised by hand, but with the increase in plowing at Zuni, the ridge may now be thrown up with several rounds of a



ZUNI CORN FIELD SHOWING THE CUSTOMARY EARTH BORDER
THROWN UP TO RETAIN FLOOD WATER.

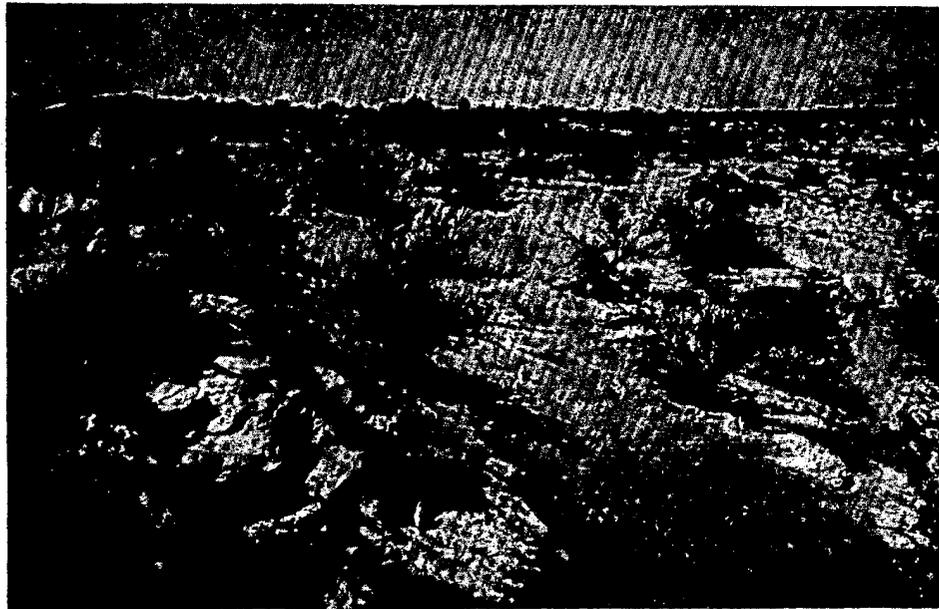
—Stewart



—Stewart

“BOSTON GULLY” NEAR ZUNI VILLAGE

FORMERLY THIS WAS A FLOOD WATER STREAM RUNNING THROUGH AN EXCELLENT CORN FIELD,
WHEN THE STREAM WAS STABILIZED BY PUEBLO IRRIGATION.



—Stewart

HOPI PEACH ORCHARDS, SECOND MESA, WATERED BY UNDERGROUND SEEPAGE

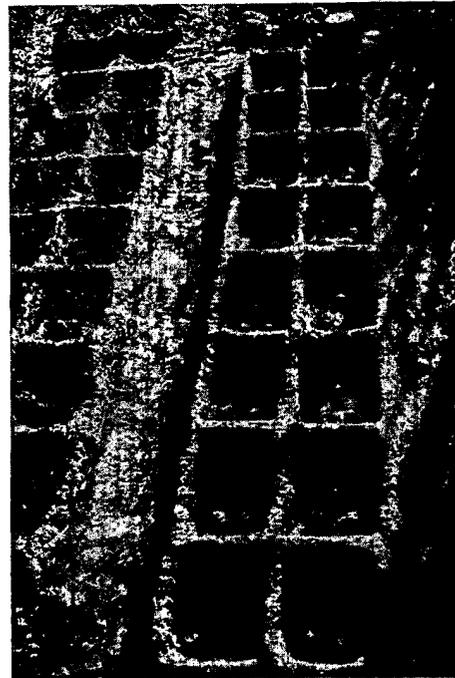
plow. Many of the Zuni streams furnishing flood water for patches of corn land have a less torrential flow than the arroyos coming out of Black Mesa near the Hopi villages. Consequently, the Zuni cultivator finds it easier to deflect the flood water out of the stream bed with a series of small brush-and-earth dams. At planting time a series of herringbone, radiating earth checks, extending out from the stream bank across the field, will have been thrown up. The brush and earth barriers across the stream itself deflect the water from the channel and spread it fairly even over the entire field with the help of the earth checks. The channel itself is kept up close to the level of the field so that this system of flood-water irrigation constitutes a wonderfully effective method of gully control. The more thoughtful Zuni recognize the value of these methods in preserving the land. On a visit to Zuni during the past summer the Governor of Zuni remarked to the writer: "Zuni farming always keeps the land good." Trouble at times may be experienced from excessively strong flow of water, washing out hills of corn, or too much sand may be deposited onto portions of a field, but spectacular gullying at least is prevented.

Not far from Zuni is a field which was farmed by Zuni cultivators for many years and was pointed out as an excellent corn field. About thirty-five years ago, in the realignment of the reservation boundaries, this field was placed outside the Zuni lands and went out of tribal control. The land was used for pasturage and flood-water irrigation ceased upon the area. Now the former flat stream has cut a deep channel, known as the Boston Gully, which is approximately seventy-five feet wide and twenty to thirty feet deep. It shows clearly that land under flood-water flow must be

wisely and continuously used if it is to be preserved.

A series of river gardens are found along the stream banks, both at Zuni and in the outlying villages. These gardens are largely tended by the women and produce crops of chile peppers, onions, beans, early corn and a fair variety of introduced vegetables which have been added to the Zuni diet in recent years.

At both the Hopi villages and at Zuni,



—Stewart

NEWLY PLANTED PLOT

ZUNI RIVER GARDENS, THE SEED IS PLACED IN A HANDFUL OF MOIST SOIL ON TOP OF THE GROUND.

the peach crop constitutes a valuable addition to the farming resources. Peaches were acquired at an early date, either directly from the Spaniards or from the mission fathers. In both places early observations of orchardists showed that there were areas adjacent to the mesas where seepage was present in the subsoil from underground run-off. The



A RIVER GARDEN AT ZUNI
IN WHICH CHILE, ONIONS, EARLY CORN AND VEGETABLES ARE RAISED BY THE WOMEN.

—Stewart



THE LARGE COMMUNITY VILLAGE OF PUEBLO BONITO, CHACO CAÑON
NEW MEXICO, WHOSE SIZE MAY HAVE CAUSED TROUBLE FROM OVERCROWDING IN PRE-SPANISH DAYS.

—Stewart

peach trees are raised from seed or cuttings and continue to produce for a long period of time. Many of the tops of the trees may pass their period of greatest productivity, but since few of the trees are on budded stock, shoots are allowed to come up from the base of the tree and after a time the new shoots become moderately productive once more. The peach trees are planted by individuals

abandoned villages. Several theories have been advanced for the complete disappearance of the Hokokam communities which formerly occupied the lower Gila and Salt River Valleys. The work of J. F. Breazeale, of the U. S. Department of Agriculture, and associated specialists at the University of Arizona has indicated that a compact, puddled, physical state of the soil may have resulted from



—Stewart

REMAINS OF AN ANCIENT VILLAGE IN NEW MEXICO
AZTEC, WHICH WAS OCCUPIED DURING SEVERAL EARLY PERIODS, HAD IRRIGATION DITCHES AND WELL-LAID-OUT FIELDS.

in common village or clan lands and belong to the person who sets out and tends the tree.

SUMMARY

Probably some of the readers of this article will be interested to inquire what the causes were which led to the abandonment of many of the early agricultural communities of the southwest. So far as can be learned there was no one single factor which caused a shift in population and in occupancy of the

the use of slightly saline irrigation water, without plowing or the incorporation of organic matter. This soil condition might finally have caused crop failures where no tool other than a wooden planting stick was used. Other students of this area have suggested a possible rise of the ground-water table, through the excessive use of flood water combined with slow drainage from the valleys. The sudden inroad of warlike enemies, during periods of food shortage in the surrounding country, with the loss of

many communities and the withdrawal of the survivors to the northern Pueblo country, is still another suggestion.

In the case of the northern Pueblos, there is good evidence that the great drouth of 1277 to 1299 caused the abandonment of the Mesa Verde villages. The other settlements at Cañon de Chelly and along the San Juan may have been given up either during periods of crop failure or as the result of wars and raids. In the case of the large communities, such as Aztec and Chaco Cañon, it is quite possible that some overcrowding with lack of sanitation, together with communicable diseases rising to epidemic conditions at times may have acted to depopulate them, combined with wars or crop failures.

There is no definite evidence of any great catastrophic change of climate throughout the region which would have wiped out agricultural plantings over a wide area, though undoubtedly local drouths, such as the serious occurrence at Mesa Verde, may have happened elsewhere.

We may, in fact, be justified in concluding that the system of agriculture based on flood-water irrigation developed through the Southwest was excellently adapted to a maintenance system of farming. The region, however, is one of rigorous extremes, and any one of a variety of unfavorable factors might intervene to throw the primitive cultivator out of balance with the environment from which he wrested a living.

WESTERN MIGRATION AS VIEWED IN 1855

EVER since Paleozoic times, therefore, the Oriental Continent—that is, Europe, Asia and Africa combined—has taken the lead in animal life. Through the Reptilian Age, Europe and Asia had species by thousands, while America was almost untenanted. In the later Mammalian Age, North America was yet in the shade, both in its Mammals and lower tribes; South America in still darker shadows; and Australia even deeper still. The earth's antipodes were like light and darkness in their zoological contrasts. And was there not in all this a prophetic indication, which had long been growing more and more distinct, that the Eastern Continent would be man's chosen birthplace? that the long series of living beings, which had been in slow progression through incalculable ages, would there at last attain its highest exaltation? that the stupendous system of nature would there be opened to its fullest expansion?

Another of our number has shown in eloquent language how the diversified features and productions of the Old World conspired to adapt it for the childhood and development of the race; and that, when beyond his pupilage, having accomplished his rescue from himself and the tyranny of forces around him, and broken

the elements into his service, he needed to emerge from the trammels of the schoolhouse in order to enjoy his fullest freedom of thought and action, and social union. Professor Guyot observes further that America, ever free, was the appointed land for this freedom and union—of which its open plains, and oneness of structure, were a fit emblem; and that, although long without signs of progress or hope in its future, this land is to be the centre of hope and light to the world.

In view of all these arrangements, man may well feel exalted. He is the last of the grand series. At his approach, the fierce tribes of the earth drew back, and the race dwindled to one fourth its bulk and ferocity,—the huge Mastodons, Lions, and Hyenas yielding place to other species, better fit to be his attendants, and more in harmony with the new creation.

Partaking of the Divine image, all nature pays him tribute; the universe is his field of study; an eternity his future. Surely it is a high eminence on which he stands.—*From address of James Dwight Dana (1813-1895), delivered as retiring president of the American Association for the Advancement of Science at its annual meeting in Providence, Rhode Island, in August, 1855.*