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EXPLORATIONS AND FIELD-WORK OF THE  
SMITHSONIAN INSTITUTION  
IN 1915



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## EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1915

The Smithsonian Institution every year initiates or cooperates with other institutions in numerous expeditions to various parts of the world in the interest of theoretical and practical science. Accounts of the principal expeditions engaged in during the year 1915 are presented herein chiefly in the words of the investigators themselves, while those of more than routine importance are signed with the names of the writers. The various lines of research include geology, zoology, botany, anthropology, physics, and astrophysics.

Of the several branches of the Institution, only the United States National Museum, the Bureau of American Ethnology, and the Astrophysical Observatory are mentioned in this account as having engaged in field-work. The National Museum has no specific funds for this purpose, but whenever possible embraces opportunities to take part in natural history investigations and to add to its collections and exhibition series. Researches in American ethnology consist largely of field-work among the Indian tribes, detailed accounts of which will be found in the annual reports of the Bureau. The Astrophysical Observatory undertakes expeditions here and abroad for the purpose of observations in connection with its regular work of studying the physical properties of the sun and their effects on the earth.

The results of these explorations and field-work have been to increase scientific knowledge and to yield valuable material for the collections and study series of the National Museum and the Bureau of American Ethnology. The Institution is forced every year to forego numerous opportunities to participate in other expeditions owing to its limited means.

### GEOLOGICAL EXPLORATIONS IN THE ROCKY MOUNTAINS

In continuation of previous work in the Rocky Mountain region, Dr. Charles D. Walcott, Secretary of the Smithsonian Institution, was engaged in field investigation in the Yellowstone Park area, and from there north into the Belt Mountains east of Helena, Montana. The work in the Yellowstone Park was carried on with two objects in view :

First: To determine, if possible, the extent to which the lower forms of algæ and possibly bacteria contributed, through their activities, to the deposition from the geyser and hot-spring waters of the contained carbonate of lime and silica.



FIG. 1.—Riverside Geyser in eruption, Upper Geyser Basin. Water falls into Firehole River. Photograph by Mary Vaux Walcott.

Second: The securing for the National Museum, of a series of geyser and hot-spring deposits, also silicified wood from the petrified forests and certain types of volcanic rocks.





FIG. 2.—Camp in meadows near Apollinaris Spring, close to main road traversed by a thousand tourists daily. The bears made frequent visits, two grizzlies, two black, and one brown bear calling in an afternoon. Photograph by Walcott.



FIG. 3.—Lone Star Geyser in action. Siliceous matter in hot waters deposited to form very beautiful cone, standing on large mass of evenly bedded siliceous deposits. Photograph by Walcott.

During the investigations and collecting, numerous photographs, some of which are here reproduced, were taken by Dr. and Mrs. Walcott, of geysers and hot springs, and of deposits made from the waters through evaporation and organic agencies.

The collections were brought in to the various camps on pack



FIG. 4.—Nearer view of cone of Lone Star Geyser, showing outer appearance of deposit. Photograph by Walcott.

horses and buckboard, and subsequently packed for shipment at Fort Yellowstone and Yellowstone. Material assistance was afforded by the cooperation of the Acting Superintendent of the Park, Col. L. M. Brett, U. S. Army, and officers of the United States Engineer Corps who are in charge of the maintenance and development of the park roads and trails.

Upwards of five tons of specimens were collected and shipped to the National Museum. This collection permits of the preparation of a special Yellowstone Park exhibit of great beauty and interest.<sup>1</sup>



FIG. 5.—Liberty Cap at Mammoth Hot Springs. A dead geyser cone slowly being destroyed through action of rain, frost, and changing temperatures. Profile on right-hand face of cone suggests spirit of dead geyser. Photograph by Walcott.

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<sup>1</sup> In his work through the Park, Dr. Walcott was assisted by Mrs. Walcott and Messrs. Sidney and Stuart Walcott, and Charles D. Flaherty.



FIG. 6.—White Dome Geyser, near Great Fountain, in eruption with hot waters cascading down its sides. This dome is in midst of broad plain, and owes its prominence to gradual deposit of siliceous matter largely by evaporation. Photograph by Walcott.



FIG. 7.—Ruins of Grotto Geyser, with two centers of eruption, Upper Geyser Basin. Photograph by Walcott.





FIG. 8.—Platform of thin-bedded sinter deposits beneath giant geyser cone, Grotto Geyser of Upper Geyser Basin. Photograph by Walcott.



FIG. 9.—Mouth of Great Fountain Geyser showing water at rest just before a great eruption, as seen in Fig. 10. Photograph by Walcott. Alternate wetting and drying of area about the geyser results in deposition of salica in beautiful forms all about its basin.



FIG. 10. Great Fountain Geyser in eruption with arrows of water shooting 150 feet above mouth shown in Fig. 9. Photograph by Walcott.



FIG. 11. Looking down into throat of small geyser near Firehole River in Upper Geyser Basin. A type of siliceous deposit relatively rare. Photograph by Walcott.



FIG. 12.—Small geyser and hot spring on bank of Firehole River, showing geyser and hot-spring deposit side by side. Small vents on side of spring erupt quite frequently. Photograph by Walcott.

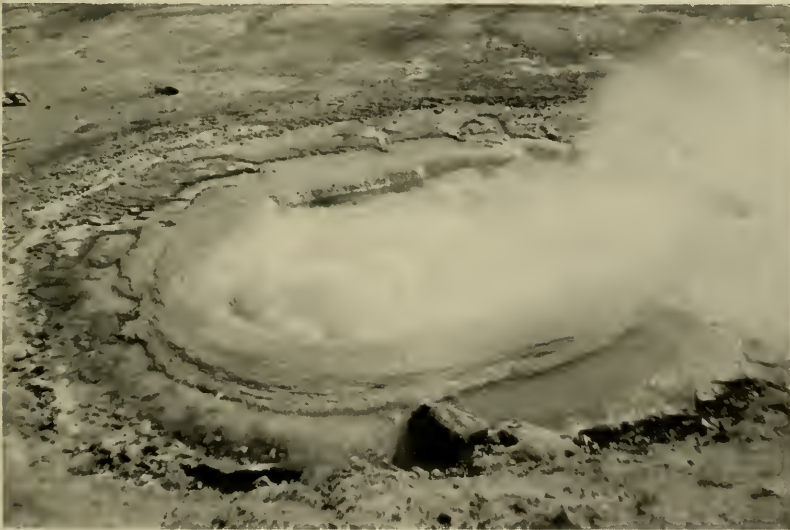


FIG. 13.—Sulphur Mountain Geyser boiling, prior to small eruption. Coloring in mouth and throat of geyser varies from rich cream above to deep red and buff below. Minor details of siliceous deposit about area flooded by hot siliceous water are most beautiful. Photograph by Walcott.





FIG. 14.—Panoramic view of Norris Geyser Basin, with several small geysers in eruption. Many fine specimens were secured for National Museum from this area. Photograph by Walcott.





FIG. 15.—Sidney and Stuart Walcott cutting out specimen near the Growler, Norris Geyser Basin. They were driven back many times before the hot rock was finally secured. Photograph by Walcott.



FIG. 16.—Algal growth in cool pond where there was no mineral matter in solution to be deposited. Photograph by Walcott.

It was found that algal growth was everywhere present when the temperature of the waters was from  $70^{\circ}$  to not much above  $180^{\circ}$  Fahrenheit, and that this growth had a marked effect upon the



FIG. 17.—Three of the Seven Sisters Hot Springs above Black Warrior Geyser, one mile northeast of Great Fountain Geyser. These springs, although very beautiful and each of a different color, are rarely visited by tourists, and the same is true of most of the Great Fountain group. Photograph by Walcott.

amount and character of both calcareous and siliceous deposits. Some of these are shown in the accompanying illustrations.



FIG. 18.—One of the Three Sisters Springs filled with boiling hot water, through which bubbles of steam are rising. Photograph by Walcott.



FIG. 19.—Great Sulfosel Hot Spring, about one mile northeast of Great Fountain Geyser, elevation 7,300 feet. The main opening of the spring has a temperature of  $201.2^{\circ}$  F. ( $93^{\circ}$  to  $94^{\circ}$  C.). Water cools toward run-off in foreground, to  $172.4^{\circ}$  F. ( $78^{\circ}$  C.). Siliceous deposits about this spring extend as cornices out over edges. Algal growth abundant in water at  $134.6^{\circ}$  F. ( $57^{\circ}$  C.). Fine specimens were collected for National Museum. Photograph by Walcott.



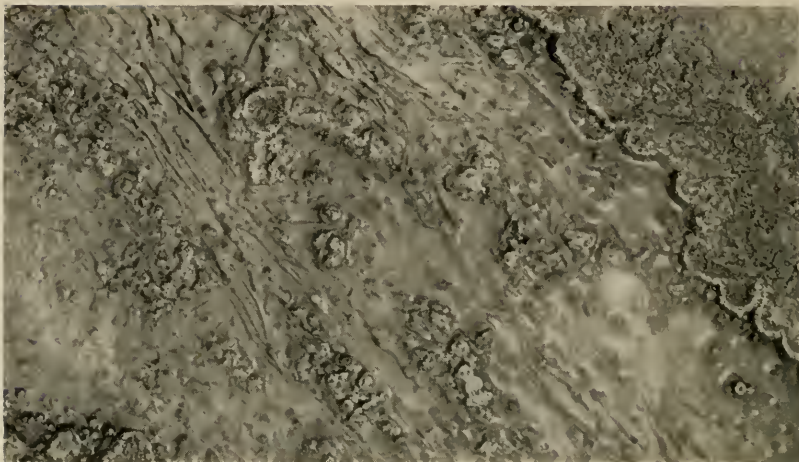


FIG. 20.—Illustration of algal growth in rapidly moving hot water in run-off from hot spring shown by Fig. 19. White siliceous deposit is made over and through algal growth, latter being gradually replaced and changed from soft gelatinous, spongy mass to hard siliceous permanent deposit. Photograph by Walcott.

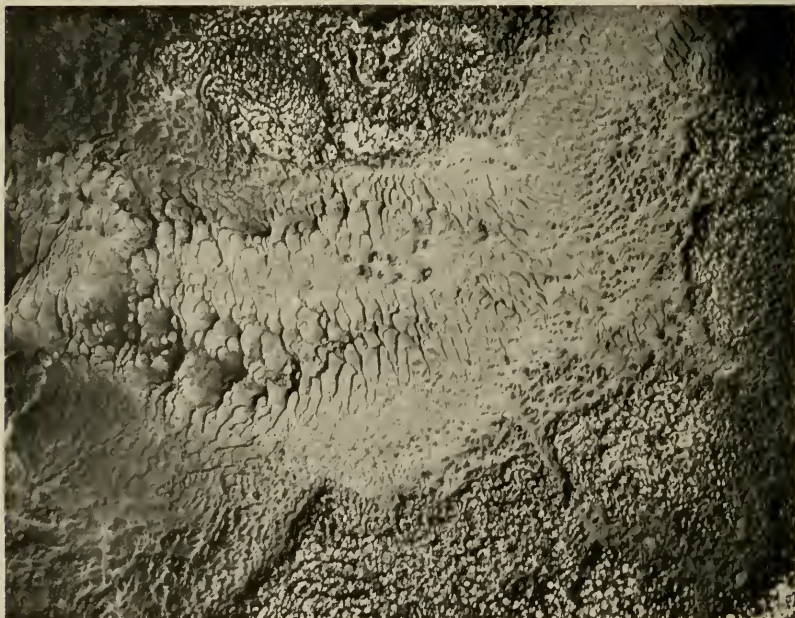


FIG. 21.—Cream-colored siliceous deposit in run-off from Artemisia Geyser, Upper Geyser Basin. Photograph taken looking down through the water. Photograph by Walcott.

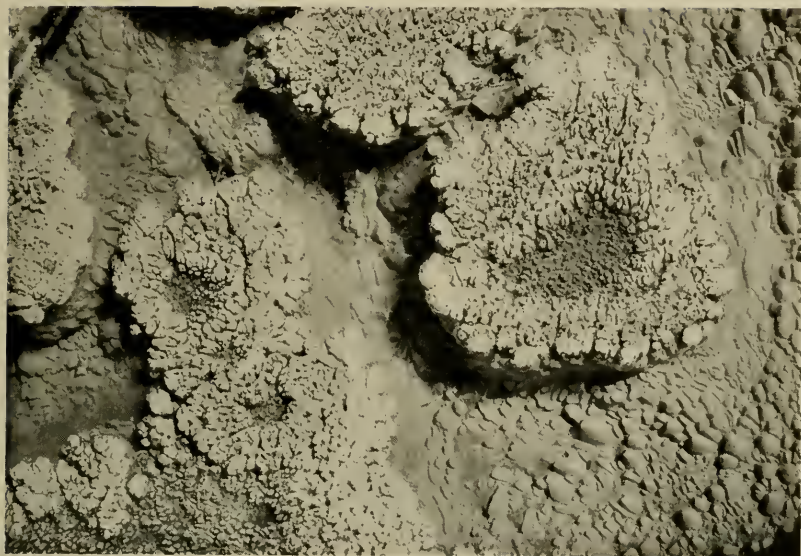


FIG. 22.—Beautiful light cream-colored siliceous deposit in run-off from Artemisia Geyser, about one-eighth natural size. Photographed looking down into the hot water. The pebbly looking bottom is from 6 to 8 inches beneath surface, and is formed by the deposit in very much the same manner as the ripple deposits in Fig. 21. Photograph by Walcott.



FIG. 23.—Yellowstone Canyon below Tower Falls Creek, showing two beautiful bands of columnar basalt interbedded in the early basic breccia formed of fragments of pyroxene-andesite, hornblende-andesite, and basalt associated with basic lava flow. Photograph by Walcott.





FIG. 24.—Beautiful "Tower Falls," short distance above canyon of Yellowstone River, in northeastern section of the Park. Photograph by Walcott.

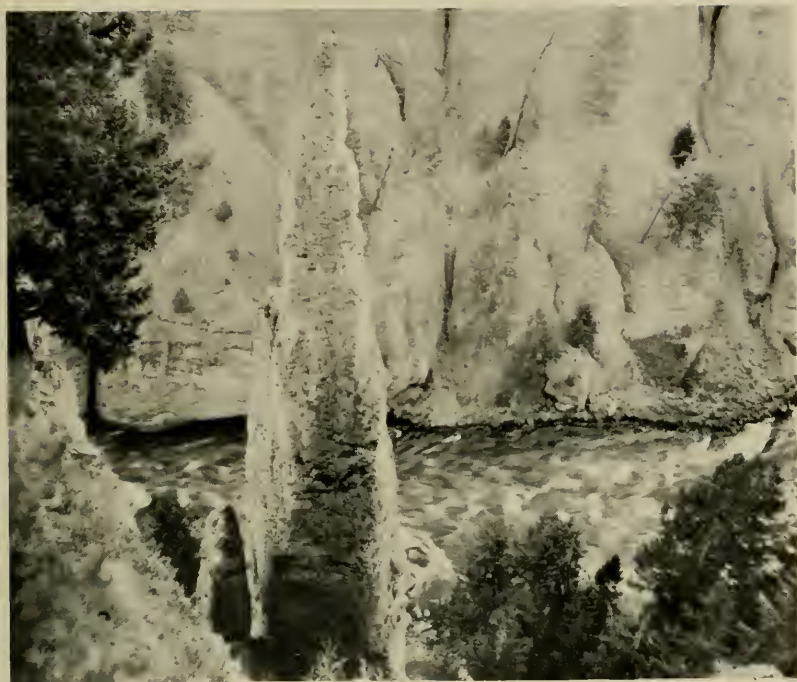


FIG. 25.—Great Needle in Yellowstone Canyon, a half mile below Tower Falls, shown by Fig. 24. Picture taken by hanging camera in limb of a tree about 300 feet above top of Needle. Needle probably 400 to 600 feet in height. Photograph by Walcott.



FIG. 26.—Obsidian Cliff, Norris Geyser Basin, showing columnar structure in obsidian and massive-bedded rhyolite above. This cliff is one of the interesting geological phenomena of the Park. Photograph by Walcott.





FIG. 27.—Boulder of volcanic breccia rolled down from the cliffs shown in Fig. 28. Fragments forming the breccia include pyroxene-andesite, hornblende-pyroxene-andesite, and basalt. Photograph by Walcott.



After completing the investigation of the geyser and hot-spring deposits, a trip was made to the Fossil Forest in the northeastern section of the Park, in the Lamar River Valley. Large collections were made of silicified wood and various minerals; one of the latter being a remarkable and beautiful form of calcite rosettes (figs. 29, 30, 31, 32).



FIG. 28.—Looking across Lamar River from the north to fossil forest ridge 2,500 feet above the valley. Ridge formed of great thickness of volcanic breccia deposited in great layers at intervals sufficient to permit of growth of coniferous forests. Stumps of fossil trees were measured 9 feet in diameter, 6 feet above their roots. Seven successive forests that had been destroyed by volcanic deposits were seen in the cliffs shown in this view. Walcott camp in the foreground. Photograph by Walcott.

Dr. Wherry, assistant curator, division of mineralogy and petrology, U. S. National Museum, describes the calcite rosettes as follows:

The remarkable character of these specimens is illustrated by the photographs of four of them shown in figures 29, 30, 31, and 32. They consist of

close groups of thick tabular rhombohedrons of calcite, the faces of which are deeply curved into saddle-shape forms, a structure frequently found in the mineral dolomite, but comparatively rare in calcite. That the latter mineral is represented, however, was proved by qualitative chemical tests, which showed only traces of magnesium, and by measurement of the index of refraction  $\omega$ , which was found to be 1.660, essentially that of calcite.



FIG. 29.—A calcite rosette collected by Mrs. Walcott and B. Stuart Walcott high up on the cliffs shown in Fig. 28. Photograph by Mr. T. W. Smillie, U. S. National Museum.

The fundamental crystallographic form toward which all of the crystals tend is the negative rhombohedron,  $01\bar{1}2$ . One specimen, which is shown in figure 32, approaches this form quite definitely. The angle between two adjacent faces of this crystal close to their intersection, measured with the contact goniometer, is about  $46^\circ$ , while the theoretical angle is  $45^\circ 3'$ . No other faces

have been noted on the specimens, although cleavage planes, beveling the edges of the surface form, are visible here and there. The faces of the negative rhombohedron are not smooth nor simple, but are built up of a series of innumerable smaller faces, belonging to individuals in approximate parallel position, though with enough divergence to cause the curvature of the faces; while at the thin edges of the crystals the individuals are still more distinctly



FIG. 30.—Calcite rosette showing somewhat different structure from that of Fig. 29. Dr. Edgar T. Wherry, of the United States National Museum, explains their origin as due to starting of crystallization at numerous closely crowded points, the crystals being perhaps at the start quite parallel, but as they grew crowding one another out of parallelism, although not enough to prevent approximately equal growth of every individual. He states that this type of crystallization of the mineral calcite is comparatively rare. Photograph by Mr. T. W. Smillie, U. S. National Museum.

separated, so that the effect is that of superposed layers of curved sheets, resembling the petals of the rose to such an extent that the first word to describe them which suggests itself is "rosette."



That this curvature is not merely a superficial phenomenon, due to the development of vicinal planes, as is often the case in curved crystal faces, is shown by the fact that the cleavage faces are also curved, their relative position with respect to the surface faces being always retained, no matter where they are developed. The composite character exhibited by the external faces is also shown by these cleavages, which proves that the curvature of the crystals is only apparent, and is not due to actual deformation by pressure. This is borne out by microscopic examination, for the cleavage flakes show between



FIG. 31.—Calcite rosette, varying in form from Figs. 29 and 30. Photograph by Mr. T. W. Smillie, U. S. National Museum.

crossed nicols quite uniform extinction, without a trace of the wavy darkening characteristic of crystals which have been distorted by pressure.

The origin of these specimens is to be explained, then, as due to the starting of crystallization at numerous closely crowded points, the crystals being perhaps at the start quite parallel, but as they grew crowding one another out of parallelism, although not enough to prevent approximately equal growth of every individual. The resulting groups form unusually fine display specimens, all the more interesting because of the comparative rarity of this type of crystallization in the mineral calcite.



FIG. 32.—Calcite rosette with fundamental crystal form preserved. Photograph by Mr. T. W. Smillie, U. S. National Museum.



FIG. 33.—Distant view of bison grazing on the gently sloping bottom of Lamar River Valley in northeastern section of Park: 220 bulls, cows, and calves were counted in this herd. Photograph by Walcott.



FIG. 34.—Nearer view of some of the bison shown in the distance in Fig. 33.  
Photograph by Walcott.



FIG. 35.—Kodak snapshot of two bison bulls and a cow in herd shown in Fig. 34. By remaining on horseback it is possible to get quite near to some of the animals. Photograph by Mary Vaux Walcott.





FIG. 36.—View near the mouth of Squaw Creek, West Gallatin River Canyon. The rocks in the immediate foreground on the right are of pre-Cambrian age, those in the cliffs at the base of Castle Mountain are of Cambrian age, the cliffs just below the summit of Devonian age, and those forming the castle on the summit, of Carboniferous age, the entire section embracing over 3,000 feet of bedded limestone. Photograph by Walcott.



FIG. 37.—Rural delivery station, Deep Creek Canyon, Belt Mountains, 16 miles east of Townsend, Montana, where we received a promptly delivered daily mail. Photograph by Walcott.



FIG. 38.—Wood road in one of upper canyon valleys of Belt Mountains. Forest Ranger Orrin C. Bradeen coming in from patrol. Photograph by Walcott.



FIG. 39.—Summits of the Big Belt Mountains, with Mount Baldy capped by September snow. In foreground wheat harvest on dry farming slopes. Photograph by Walcott.



The camp site in the Lamar Valley was one of unusual interest and beauty (fig. 28). The high hills to the south show the rock cliffs containing silicified wood, calcite rosettes, and beautiful specimens of chalcedony. A little way from the camp the party met with a large herd of bison grazing freely in the broad open valley, also herds of elk, bands of antelope, a few black bear, and an occasional wolf.



FIG. 40.—Wheat farms on slopes farther from mountains shown in Fig. 39, where there is a commingling of dry farming and irrigation. Richness of the soil is indicated by shocks of wheat.

On leaving the Park, after 675 miles of travel with the camp outfit, the party proceeded down the West Gallatin River Canyon, stopping to examine the section of Cambrian rocks at the mouth of Squaw Creek (fig. 36). The next permanent camp was made in Deep Creek Canyon, 17 miles east of Townsend, Montana, where the extensive pre-Cambrian sections of the Big Belt Mountains are beautifully shown. About two tons of pre-Cambrian specimens were collected in this vicinity, before the storms of late September closed the season's field-work.

## THE INDIANA MASTODON

Each year the Museum receives reports of many finds of mastodon and mammoth remains, especially from different localities in those States bordering on the Great Lakes. These "finds," which come for the most part from swamp deposits of the Pleistocene, usually consist of a few isolated bones or teeth, but they give evidence of the great abundance of these larger creatures which roamed over this continent during the geological age just preceding the present. Compared, however, with the great number of remains found, complete skeletons are rare. This is due in large part to the fact that by far the greater number of the finds are made by men of no



FIG. 41.—Ditch where Indiana mastodon was found. The long iron rod was used in probing in the swamp for the remains. Photograph by Gidley.

experience in collecting and usually little or no knowledge of what they are finding. The National Museum is therefore fortunate in the recent acquisition of a fine, nearly complete adult male mastodon skeleton from a swamp deposit in northwestern Indiana.

This specimen was donated to the National Museum by Mr. W. D. Pattison of Winamac, Indiana, and Captain H. H. Pattison, U. S. Army, on whose farm, about 15 miles northwest of Winamac, it was found.

A part of the skull, four limb bones, a few ribs and vertebrae, were unearthed by a dredge crew while excavating a drainage canal on the Pattison farm in the spring of 1914 (see fig. 41). On learning of the discovery, Mr. Pattison took immediate steps to preserve these bones, but before he could prevent it a few of them were carried

away as curiosities by people of the vicinity. These were, however, for the most part recovered. Mr. Pattison, recognizing the value for public exhibition of such a specimen if properly handled, and judging correctly that the greater part of the skeleton might be secured by an experienced collector, very generously packed and shipped the bones then in his possession to the National Museum, at the same time extending an invitation to the Smithsonian Institution to send an expedition to his farm to recover, if possible, the remaining parts of the skeleton. A small appropriation was set aside for this purpose, and the first expedition to the Pattison farm, under the direction of J. W. Gidley of the National Museum, was undertaken in June, 1915. This resulted in securing the lower jaws, most of the remaining vertebræ and ribs, parts of the pelvis, and a few more limb and foot bones. The undertaking was too extensive for the funds then available, and Mr. Gidley was obliged to return to Washington before the search was completed. Most of the bones secured on this trip were found in working over the material thrown out by the steam shovel on either side of the ditch at the time the dredging was done.

In October a second appropriation was made available, and Mr. Gidley again visited the locality of the find, this time completing the work which resulted in securing from the undisturbed deposit at the bottom of the ditch the last of the missing sections of the vertebral column, several more foot bones, and other important fragments.

At this time it was necessary to sink a coffer-dam across the ditch, which is about 20 feet wide, and at this place contains about six feet of water and mud before coming to a hard sand bottom. Mr. Gidley thus was enabled to study the formation and make an accurate estimate of the conditions of deposition of the skeleton.

On assembling in the laboratory the bones of this skeleton received from all sources, it has been found that, with comparatively little artificial restoration, a much more than usually fine and complete specimen of the American mastodon can be assembled. This is now being mounted and will soon be placed on exhibition as one of the striking features of the Fossil Vertebrate Hall.

#### PALEONTOLOGICAL AND STRATIGRAPHIC STUDIES IN THE PALEOZOIC ROCKS

Dr. E. O. Ulrich, associate in paleontology in the U. S. National Museum, was occupied for several months during the field season of 1915, under the auspices of the U. S. Geological Survey, in a study of the Lower Paleozoic deposits of the Mississippi Valley. He

was engaged chiefly in seeking evidence respecting the boundary line between the Cambrian and Ozarkian systems. For this purpose many of the outcrops of these rocks were visited, but the most important evidence was found in the Upper Mississippi Valley and in Missouri where the Upper Cambrian rocks are particularly well displayed, and the succeeding deposits of the Ozarkian system are more commonly fossiliferous than elsewhere. The relative abundance of fossils in these areas permitted the actual boundary between the two systems to be accurately determined after considerable study. This boundary, when determined, was found to coincide with the uneven plane (see fig. 42) formed at the junction of the deposits



FIG. 42.—Contact between Cambrian (Jordan sandstone) and Ozarkian (Oneota dolomite) two miles south of Boscobel, Wisconsin. The undulating line of unconformity is distinctly visible. Photograph by Ulrich.

laid down by the retreating Cambrian sea and by those formed by the return of the waters in the succeeding Ozarkian time. During the progress of these stratigraphic studies numerous collections of fossils were secured for the Museum series, and incidentally the investigations resulted in the proper placement of many fossils whose stratigraphic position had hitherto been uncertain.

In the latter part of the season Dr. Ulrich worked out the field relations of some insufficiently located collections of Paleozoic fossils made in southwest Virginia at various times in the past. The most important result of these investigations is the proof that a large coral



fauna, exceedingly like that which marks the horizon of the Onondaga limestone throughout the extent of this well known and widely distributed Middle Devonian formation, had already invaded the continental basins as far as southwest Virginia during the closing stages of the preceding Lower Devonian. This instance of recurring fossil faunas is regarded as one of the most important of the many similar instances that have been established through the field studies of Dr. Ulrich during the past 25 years. All have served in correcting erroneous correlations of formations that had arisen through the confusion of earlier or later appearances of faunas with the one recognized in the standardized sequence of stratigraphic units.

Mr. R. D. Mesler, under the supervision of Dr. Ulrich, spent the summer of 1915 in making collections of Ordovician and Silurian fossils from formations and localities in the Appalachian and Mississippi Valleys which had hitherto been little represented in the Museum collections. A large number of fossils resulted from his trip, particularly from the Middle Ordovician rocks of east Tennessee, which will form the basis of a future monograph on the paleontology of that region.

#### EXPLORATIONS IN SIBERIA

Through the liberality of a friend the Museum was enabled to send Mr. B. Alexander with the Koren Expedition to the Kolyma River region of northern Siberia. The expedition left Seattle, Washington, about June 1, 1914, and returned a year from the following September. The immediate purpose of the trip was to obtain remains of large extinct animals, particularly of the mammoth for which the region is noted. The results were not all that were hoped for, but a considerable quantity of material was obtained, though no complete skeleton.

The following report, with photographs taken by his party, was submitted by Mr. Alexander at the conclusion of his field-work:

In May, 1914, the Smithsonian Institution appointed me as a collector, with instructions "to obtain geological, mineralogical, and paleontological specimens" for the Institution, and particularly "to secure remains of the Siberian mammoth" in the Kolyma Valley, northeastern Siberia. For this purpose I was attached to a trading company which left Seattle in a small power schooner June 24, 1914, arriving at Nizhni Kolymsk on August 26.

Nizhni Kolymsk is the oldest and outermost permanent Russian settlement in the Yakutsk government, northeastern Siberia. The village now consists of about 26 inhabited log houses and one Russian orthodox church, and is located near the 69th degree of northern latitude, a short distance above the mouth of the Kolyma and just inside the Arctic tree limit.

The Kolyma is the most easterly of the great rivers of northern Siberia, and is here about three versts (two miles) [a verst is 0.621 mile] wide. It heads in the Stanovoi Mountains and approaches the Alaskan Yukon in length, drainage, and volume.

The town site is situated near the lower end of a narrow, low island surrounded by two arms of the Kolyma River and about 100 versts long. Near the upper end of this island the Omolon empties into the Kolyma from the right. Opposite Nizhni Kolymsk and but a few versts apart, the two Anyui rivers—Big and Little—flow into the Kolyma, likewise from the right.

These three rivers are the most important tributaries and head also in the Stanovoi Mountains. But while the mountain passes beyond the sources of the Kolyma and Omolon lead to tributaries of the Sea of Okhotsk, the headwaters of the two Anyui connect with those of the Anadyr.



FIG. 43.—Little Anyui River. First elevated silt bank, showing detail; going up-river, September, 1914.

As there remained only a few weeks of open weather before the beginning of winter, I concluded the nearest field for promising research would be the two Anyui rivers. Accordingly I started upon my first exploring trip on September 3 in the schooner's dory, accompanied by three members of the party who intended to do some hunting and photographing.

We entered the Little Anyui and explored this river for a distance of approximately 150 versts from the mouth upward. For about the first 100 versts the ascent was quite easy and made by rowing. After that tracking had to be resorted to almost exclusively, the current of the river increasing rapidly almost at once.

For the lower 100 versts the river flows—after the manner of many sub-Arctic rivers in Alaska and Canada—through a low tundra, covered with dense willow thickets and puny larches, the east forelopers of the great Siberian taiga that stretches from the Urals to the Pacific. The river course forms enormous bends swinging alternately from the right to the left. The

current cuts away the unconsolidated alluvium of the outer bands (here generally from 10 to 20 feet high), depositing the material removed in the shape of extensive bars on the inner curves below.

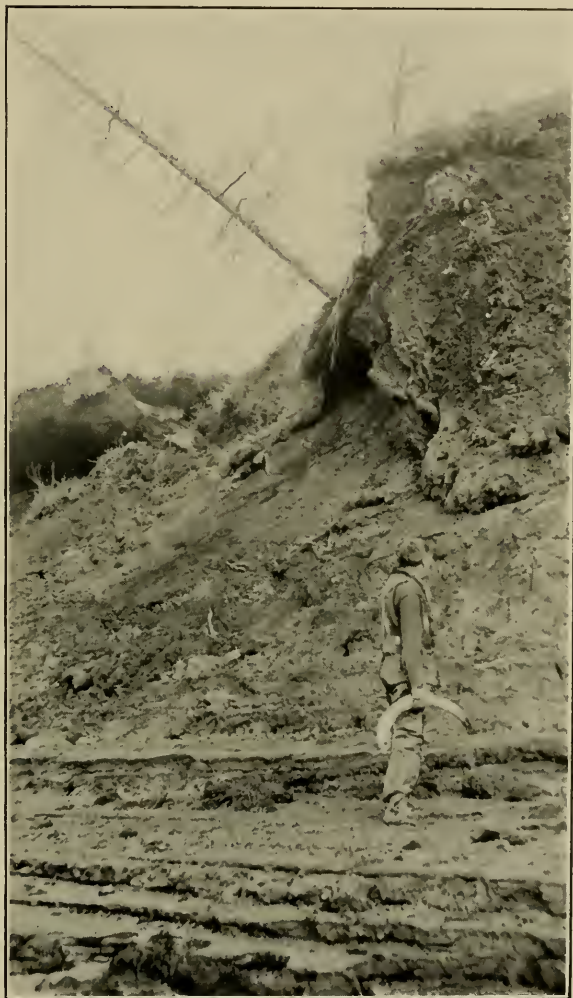


FIG. 44.—Little Anyui River. Third-elevated silt bank, showing detail near center. Up-river trip, September, 1914.

These bars are generally quite boggy on the water's edge and mostly covered with driftwood piles and a rich verdure of equisetum—now swiftly dying or already dead—upon which the numberless swarms of wild geese have been fattening that are now gathering together to return to the South.

The driftwood is composed not only of the larches of the lower river, but also frequently of birches and poplars that thrive along the upper river reaches.

Many decaying cabins, long since deserted, prove that at some former time a comparatively numerous population lived along the river banks.

On the steep higher banks, thawed by the sun and undermined by the current, frequently large outer slabs slide into the stream, carrying with them willows and larches that grew upon the meager upper crust. Under the remaining overhanging drapery of tenacious moss and lichen, thin, peaty layers alternating with clear ice and frozen silt may be observed.

Approximately 100 versts above the mouth of the Little Anyui the first elevated silt beds—so characteristic of the fossil deposits along the Yukon—were observed on the right bank reaching a height of about 100 feet and



FIG. 45.—Little Anyui River. Third elevated silt bank, looking up-stream from lower end. Up-river trip, September, 1914.

extending for three versts along the whole outside curve of the river. During the next 50 versts five more similar silt ridges came into view along the outside bends of the river front.

The second one was on the left bank, about 80 feet high and fronting the river for about 100 yards.

The third elevated silt bank was once more on the right bank of the river, from 100 to 150 feet high and occupying, as did the first, the whole length of the outer river bend, this time about four versts long.

The fourth and fifth ridges (both on the right river bank) were only about each 300 yards long and reached a height of approximately 80 feet.

The sixth (and last) ridge observed was on the left bank of the Little Anyui River, extended for about 300 yards and reached a height of approximately 80 feet.

The fifth and sixth high silt banks, separated from the main branch of the river by shallow sloughs, exhibited no recent slides, were largely overgrown by vegetation, and yielded practically no fossils, which the lower four silt ridges did abundantly.



Among the fossils collected, the remains of wolverine, bison, deer, and mammoth were easily recognized on the spot.

All these fossils found were carried to convenient shelves on the base of the silt bluffs and marked by stakes driven into the ground, to be picked up and



FIG. 46.—Little Anyui River. Fourth elevated silt bank, showing camp. Up-river trip, September, 1914.



FIG. 47.—Little Anyui River. Sixth elevated silt bank, separated by slough from Anyui proper. No fossils found. Down-river trip, September, 1914.

taken to Nizhni Kolymsk on our return trip. This precaution proved to be quite necessary, as a thin crust of newly fallen snow covered the ground before we reached the settlement again.

The general aspect of these different elevated silt banks resembled very much that of similar places in Alaska and Yukon Territory. The tops of the high, steep ramparts were overgrown with moss, lichen, a few Arctic plants, and grasses—among them our own "Labrador tea"—and thin larches without any underbrush. The lower moist places of the surface exhibited an abundance of "niggerheads."

Through many deep, narrow, cross gullies, worn by erosion into these elevated silt beds, little streams of muddy water trickled into the river below.

Often there was no shelf at all at the base of these elevated silt beds. Sometimes the shelves were extremely miry, overrun by sticky mud avalanches and very difficult of access.



FIG. 48.—Big Anyui River. First elevated silt bank, looking up-stream, June, 1915.

Bedrock was nowhere observed. However, during the last third of the journey the current became rather suddenly swift and greatly obstructed further progress of the clumsy dory. A fine reddish gravel appeared on the river bars, mixed with quartz and slate pebbles, rapidly increasing in size. As soon as the gravel appeared, small fossils began to show on the river bars, while the mud flats below had been entirely bare of such. On the last camping place reached, fossils were found on the bars, and other elevated silt ridges apparently bordering the river farther above were noticed.

Finally the advanced season and lack of supplies compelled us to return. Approximately 50 versts above the mouth of the Little Anyui, we were directed by a lonesome half-breed fisherman—the only human being we met on this river—to a connecting slough which took us into the Big Anyui.

There we heard from another settler of three fossil banks farther above on the Big Anyui, but could not examine them at the present time. The winter was too near. I resolved, however, to return at the earliest opportunity.

We reached Nizhni Kolymsk September 29 with our last provisions and the first permanent snow. Two weeks later winter was upon us in good earnest and the broad Kolyma was frozen over solidly.



FIG. 49.—Big Anyui River. Second elevated silt bank near center, looking up-stream. June, 1915.



FIG. 50.—Tundra silt facing ocean. Notice amount of driftwood in this little gully. The mammoth skull was found about 300 yards from the beach. Between Cape Big Baranoff and Chaun Bay. August, 1915.

During the long winter months I had no opportunity whatever for further research.



The breaking up of the ice in 1915 was exceptionally gentle and early. By the middle of June the usual spring freshet, following the break-up, had so far subsided that I thought it feasible to make another attempt to revisit the fossil places examined the previous fall and to extend my explorations to the elevated silt beds reported to be on the Big Anyui River.

This time I hired a "carbass," one of the light fishing boats of the natives, and set out on June 17, 1915, accompanied by the photographer of the party.

All the elevated fossil banks on the Little Anyui were overhauled once more carefully with the exception of the last two that had yielded no fossil material before and were not likely to do so now. This time only a few scattered insignificant fossil remains could be found. All these places were practically as bare as I had stripped them the previous fall. The reason is evidently this: All these silt ridges were freezing fast when I left them late in September,



FIG. 51.—Tundra beach near Chaun Bay. Fossils found here, August, 1915.

1914. The power of the sun, still feeble, had not yet been able to thaw them, nor had the water, running only such short time again, been able to undermine them. Therefore, no recent slides had occurred and no new fossil remains had been brought to light.

We hurried downstream again, entered—by the same connecting slough mentioned above—the Big Anyui and went up river. In general appearance this river is practically an exact counterpart of the Little Anyui.

Approximately 60 versts above the mouth of the Big Anyui a first elevated silt ridge, two versts in length and about 80 feet high, was encountered on the left river bank. Fifteen versts farther on a second one of the same dimensions appeared on the same side. And finally, another 15 versts beyond and facing the river likewise on the left bank, a third silt ridge of about the same height but only half the length was met with. The general appearance of these frozen bluffs did not in any way differ from that of similar places on the Little Anyui described above.

From the second ridge on upward the heretofore rather sluggish river current quickened perceptibly and quite suddenly. Again pebbles and small fossil remains appeared on the bars, formerly composed only of very fine alluvial matter.

All these three places yielded a moderate amount of fossils. These remains are now all in the possession of the United States National Museum.

At midnight, on July 1, we returned to Nizhni Kolymsk, and five days later our schooner left on the return trip. I reached Nome on September 17, and Seattle on October 9.

Between Cape Big Baranoff and Chaun Bay a few more fossils were added to the collection. Some of them were found on the base of the elevated tundra silts facing the ocean, on many places between mountain ridges. The elevations of this tundra beach differ greatly according to locality. The surface of



FIG. 52.—Tundra beach near Chaun Bay. This picture shows detail of central part of figure 51, which compare. Fossils found here.

the frozen tundra was in August, 1915, overgrown with luxuriant Arctic grasses and herbs. The driftwood found along the beach comes from distant localities and has been brought down by the large rivers of the north. In many instances it is even undoubtedly of American origin.

Some of these fossils—among them a fairly complete mammoth skull—were found in little cross gulches dug by small water courses.

Mr. J. W. Gidley, in charge of fossil mammals in the National Museum, reports that the collection of bones sent in by the Siberian expedition contains a few fine specimens together with a considerable number of isolated bones which are valuable for study and comparison. They all indicate a late Pleistocene age, as the bones of many of the forms represented can with difficulty be distinguished from those of species still living in that region.

The animals represented in this collection are as follows: Mammoth (*Elephas primigenius*), bison, carabou, horse (two or more species), rhinoceros, musk-ox, wolverine, and wolf.

The prize specimen of the collection is a finely preserved, almost complete skull of *Elephas primigenius*. It is of especial interest in that this is the only skull of the Siberian mammoth in any of our American museums.

#### COLLECTING FOSSIL ECHINODERMS IN THE OHIO VALLEY

The explorations for fossil echinoderms during the summer of 1915, conducted under the supervision of Mr. Frank Springer, associate in paleontology in the U. S. National Museum, were limited to two areas of Silurian rocks in the Ohio Valley from each of which much valuable material was procured for the study of certain definite problems. In southern Indiana Mr. Herrick E. Wilson, under Mr. Springer's direction, spent a number of weeks quarrying for Niagaraian echinoderms, particularly crinoids, in the vicinity of St. Paul where numerous outcrops of the Laurel limestone occur. The object of this work was to secure as many specimens as possible for comparisons of this peculiar fauna with those from European Silurian rocks. Not only was much material obtained by the quarrying operations, but all of the local collections of fossils were purchased for Mr. Springer so that the Museum, which hitherto had practically no fossils from the Laurel limestone, is now in possession of a splendid general collection of fossils from this particular formation.

The second area of exploration was in west Tennessee along the Tennessee River where Mr. W. F. Pate spent some weeks in searching for the peculiar crinoidal bulb, *Cameroerinus*, and the associated crinoid, *Scyphocrinus*, both of which Mr. Springer has proved to belong to the same organism. Mr. Pate was successful in finding several localities where excellent specimens of the *Cameroerinus* and *Scyphocrinus* were associated. Much material was secured and the specimens will be used in the preparation of Mr. Springer's monograph upon this group of crinoids.

#### GEOLOGICAL WORK IN PENNSYLVANIA AND VIRGINIA

Dr. Edgar T. Wherry, assistant curator of the division of mineralogy and petrology, U. S. National Museum, by arrangement with the U. S. Geological Survey, continued his studies of the geology of the Reading quadrangle in eastern Pennsylvania for a month during the summer. He completed the areal mapping of the Cambrian and Ordovician rocks of the region, and has transmitted to the Survey the manuscript of a report upon his work. He also mapped Cam-



brian and Triassic formations on the Quakertown and Doylestown quadrangles, which lie to the east of the Reading.

A brief visit was made to a newly discovered cave near Lurich, Virginia, where the cave marble was reported to be of economic importance. This view proved to be unjustified, but some unusual stalactitic formations were found, two specimens of which were obtained for the Museum collections.

#### GEOLOGICAL SPECIMENS FROM NEW ZEALAND

By an arrangement with Prof. Joseph P. Iddings, the Institution was enabled to secure during the year, a number of boxes of rock



FIG. 53.—A typical Buggi's house at Toli Toli, Celebes.  
Photograph by Raven.

material and fossils from New Zealand and Tahiti, where Prof. Iddings was engaged in geological work during 1915. This material is a valuable addition to the Museum's collections for study and comparison.

#### EXPEDITION TO BORNEO AND CELEBES

Mr. H. C. Raven's material from Celebes alluded to in last year's exploration pamphlet<sup>1</sup> was received early in 1915. It includes 464 mammals, 870 birds, 50 reptiles, and some miscellaneous specimens.

<sup>1</sup> Smithsonian Misc. Coll., Vol. 65, No. 6, pp. 23-25.



FIG. 54.—The *Alnoer* anchored off Soemalata, Celebes.  
Photograph by Raven.



FIG. 55.—At Soemalata, Celebes. Photograph by Raven.



FIG. 56.—A Celebean lemur (*Tarsius*).  
Photograph by Raven.



FIG. 57.—Skull of the Babirusa, a pig peculiar to Celebes and adjacent islands.  
Collected by Raven.



The mammals and birds are of great value to the Museum as the first adequate representation of a fauna that has particular interest in connection with previous work on other parts of the Malay Archipelago. Some of Mr. Raven's Celebean photographs, also that of the skull of a babirusa, which he collected, are here reproduced (figs. 53 to 57). Early in the summer Mr. Raven returned to America and spent several months on vacation and in preparing for further explorations in Celebes and other parts of the East Indies. Doctor Abbott has generously offered his continued support to this work. Mr. Raven left Washington for the east by way of Japan and Singapore, about the middle of October. Two months later he reported from Buitenzorg, Java, that he was making good progress toward the collecting ground.

#### EXPLORATIONS IN CHINA AND MANCHURIA

Mr. Arthur de C. Sowerby has been very active in China and Manchuria. Early in the year he made a short trip to the recently opened hunting reserve, about 60 miles northeast of Peking, north of the Eastern Tombs, and south of Jehol. Here, he writes, "I found a well wooded district which I am convinced contains a lot of new stuff. The best thing that I got was a series of squirrels of a species quite new to me. They are striped like chipmunks, but have a thick, soft, much more grayish fur. They are almost entirely arboreal in habits, living in holes in oak trees. These squirrels are very active and take enormous leaps from one tree to another, though they cannot be said to 'fly.' There is no cheek pouch as in the chipmunks." He also obtained an interesting hare, and a cat, *Felis cuptilura*, not previously represented in the Museum by a good specimen. The squirrel is a representative of a group hitherto unknown in northeastern China. It has been described as a new species under the name *Tamias vestitus*.

In March and April Mr. Sowerby visited the Tai-pei-shan district of southern Shensi with the special object of observing the race of Takin, a large goat-like animal, peculiar to that region. "I am pleased to say," he writes under date of May 29, "that I have a fine bull Takin (*Budorcas bedfordi*) for you which I shot at 300 yards range. It is an enormous animal." The skull of this individual is shown in figure 58. He further obtained a female of the Chinese musk deer, now becoming very scarce as the result of excessive hunting by the natives; also a few interesting small mammals including four pikas, small, lemming-like animals related to the hares. "The

little pikas simply swarmed above an altitude of 8,000 feet, and it was only because I was exhausted with the difficulty of the country



FIG. 38.—Skull of the South-Shensi Takin. Collected by Sowerby.

and the hard work entailed in hunting the Takin that I did not collect more."

During July, August, and September an important expedition was made to the lower reaches of the Sungari River and the I-mien-po

district in north Manchuria. Of his experiences Mr. Sowerby writes: " Had a fearful trip this time owing to floods, insect pests, and dysentery; still I have some 70 or so mammals, 35 birds and a good collection of fish. I have the skull of a good black bear. The skin went bad owing to our being delayed by Russian police. Also I have a good hide and skull of a wapiti, besides series of various small mammals " Of the specimens obtained, only a small package sent by mail has been received in Washington. It includes three species not hitherto represented in the Museum collections.



FIG. 59.—The *Eagle* in winter quarters at Nizhni Kolymsk.  
Photograph by Amory.

December and January found Mr. Sowerby at Shanghai and on the Yangtze. He visited the Sikawei Museum to see the collections of Chinese large mammals that formed the basis of the writings of Heude. As this is the first time that these specimens have been examined by anyone acquainted with present-day methods in the study of mammals the result of Mr. Sowerby's observations will be awaited with much interest. They must, however, be reserved for a later report.

GERRIT S. MILLER, JR.

#### WORK BY COPLEY AMORY, JR., IN EASTERN SIBERIA

In June, 1914, Mr. Copley Amory, Jr., a collaborator of the National Museum, joined the party accompanying Captain John Koren to the northeast coast of Siberia. The party left Seattle on June 24



and reached Nome, Alaska, in July. A photograph of the *Eagle*, the schooner in which they sailed, appeared in last year's report on explorations (fig. 25).<sup>1</sup> The same boat is here shown (fig. 59) in winter quarters. Collecting in Siberia began on July 31 at Emma Harbor, the innermost part of Plover Bay. A view of the harbor and its surroundings is given in figure 60. After a week's work here the party went north through Bering Strait and then west along the north coast to Nizhni Kolymsk near the mouth of the Kolyma River. They arrived here about the end of August and established



FIG. 60.—Emma Harbor, Siberia. Photograph by Amory.

permanent headquarters. Large collections were made at Nizhni Kolymsk during the autumn and winter, while from this point as a base special trips were undertaken up the Little Anyui River (September 6 to 16, November 9 to 26, and December, 1914), up the Kolyma to Verkhni Kolymsk (March and April, 1915), and to the foothills of the Tomushaya Mountains west of Verkhni Kolymsk (May, 1915). In August and September Mr. Amory with the *Eagle* made the return voyage to Nome.

As his part of the results of the expedition Mr. Amory turned over to the National Museum 365 mammals, 264 birds, and various miscellaneous specimens principally of plants, fish, and birds' eggs. Most of this material was prepared by Mr. Amory himself, though

<sup>1</sup> Smithsonian Misc. Coll., Vol. 65, No. 6, p. 26.

various members of the expedition contributed to the collections of both mammals and birds. At present the Amory collections are being



FIG. 61.—Chookchees in their "kayaks," skin-covered boats used by the men in hunting aquatic animals, especially seals. Photographed by Amory near Cape North.

studied with every prospect of important results. Among the mammals about 25 wild species are represented. These are of particular

interest as furnishing opportunity to compare the many Alaskan species well represented in the Museum with their nearest Asiatic



FIG. 62.—Tungus family breaking camp in foothills of Tomushaya Mountains. They ride their reindeer and use no sleds (sleds in foreground belong to Amory). Note similarity of lodge structure to that of Chippewa and Montagnais Indians. Photograph by Amory.



FIG. 63.—On the trail between Sredni and Verkhni Kolymsk, showing the two methods of winter travel on the upper Kolyma. Except the first pair each reindeer is tied to the sled in front of it.

relatives. The skull and antlers of the moose shown in figure 64 present a striking example of the similarity which exists between



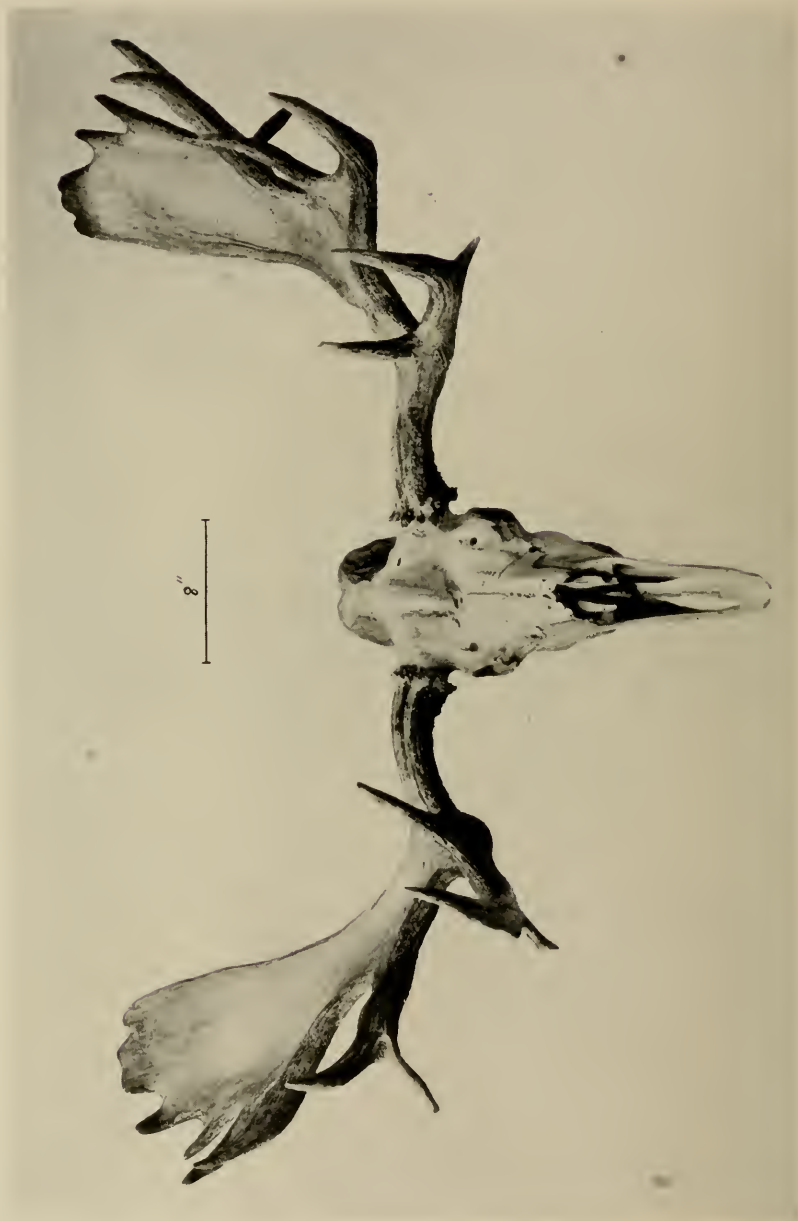


FIG. 64.—Skull of the East-Siberian Moose. Collected by Amory.

Asiatic mammals and their better-known American representatives. Several interesting photographs contributed by Mr. Amory are also reproduced.

GERRIT S. MILLER, JR.



FIG. 65.—At the fur market at Pontilayka, 40 versts northwest of Nizhni Kolymsk. The large men are Chookchees. Their reindeer parkas are covered with drill parkas on which the breath does not frost. Photograph by Amory.



FIG. 66.—Chookchees in a walrus skin "umiak" near Cape Yakan. Note that this boat is not overloaded, although there are at least 14 people aboard. Photograph by Amory.

## EXPERIMENTS WITH CERIONS ON THE FLORIDA KEYS

The Bahama Cerion Colonies planted on the Florida Keys were examined by Dr. Bartsch this year between June 18 and 30. A more detailed report of the status of the various colonies was published in the Year Book No. 14 of the Carnegie Institution of Washington, pages 194-196.

A large number of adult specimens of the first generation of Florida grown individuals were found, and these show much more



FIG. 67.—Noddy terns (*Anous stolidus*) on their nesting ground, Bird Key, Tortugas.

fully than the scanty material available last year did, that this first generation has responded to the new conditions in a remarkable manner. The facts which were pointed out in a paper by Dr. Bartsch, Publication No. 212 of the Carnegie Institution of Washington, pages 203-212, plates 1-8, have been fully substantiated and materially added to by the data obtained this year.

A new experiment was started in the transplantation of 307 specimens of the Florida tree snail *Liguus fasciatus* to the Tortugas, one set of which was planted on Garden Key within the Fort, and two on Loggerhead Key.

As in previous years records on the birds observed on the Florida Keys and the southern portion of the peninsula were kept, and these observations have been published in the Year Book No. 14 of the Carnegie Institution for 1915, pages 197-199. The past two years have yielded a list of 76 species to which 13 were added this year, bringing the total list of birds noted to date to 89.



FIG. 68.—Sooty terns (*Sterna fuscata*) on their nesting grounds, Bird Key, Tortugas.

#### BIOLOGIC STUDY OF CHESAPEAKE BAY

In October, 1915, the United States Bureau of Fisheries began a hydrographic and biologic study of Chesapeake Bay. The work being carried out under the direction of Mr. Lewis Radcliffe with the aid of the Fisheries steamer *Fish Hawk*.

Two cruises were made in 1915. On the first, which extended from October 25 to October 28, Mr. Wm. B. Marshall, assistant curator, division of marine invertebrates, represented the National Museum, while on the second, which covered the period from December 2 to 6, Mr. Clarence R. Shoemaker of the U. S. National Museum



took part. During the first cruise observations were made at 30 stations, that is, 8,336 to 8,365 inclusive. These stations extended from the lower bay to the mouth of the Patapsco River, while during the second cruise 35 stations were examined, Nos. 8,366 to 8,390 inclusive, which approximately covered the same parts of the bay examined during the first trip. The efforts of the members of the Museum staff were directed to the securing of bottom samples and bottom life, the hydrographic work being done by the representatives of the Bureau of Fisheries.



FIG. 69.—Looking out through Gregerie Channel, Danish West Indies, where much dredging was done.

The results of these two cruises indicate a remarkable scarcity of animal life, the washing of an entire dredge haul frequently yielding only a handful of shells, worms, and small crustaceans. The bottom material consisted chiefly of mud in a semi-fluid condition, which appears to be discouraging to animal life. A few notable exceptions were encountered in what one might term garden spots in which a decided concentration of living organisms was encountered. No shore collecting was done.

#### EXPEDITION TO ST. THOMAS, DANISH WEST INDIES

Mr. C. R. Shoemaker of the division of marine invertebrates, spent the two months from the middle of June to the Middle of August,



FIG. 70.—Collecting in Morning Star Bay, Danish West Indies.



FIG. 71.—Edge of Water Island, Danish West Indies, where much shore collecting was done.

1915, in the Danish West Indies, under the auspices of the Carnegie Institution of Washington, D. C., securing collections of corals and other marine invertebrates.

The collecting was done in the open water, bays, and channels at St. Thomas, St. John, and St. James. The deeper waters were explored by means of dredging from a motor boat, while native divers, working from the heavy West Indian row boats, were used for collecting in the shallow waters. In addition to this, much shore



FIG. 72.—Drift Bay, Danish West Indies, where many fine corals and sponges were collected.

collecting was done. Owing to the very strong and constant trade wind, work on the exposed reefs was in many cases made impossible by the heavy surf. Collecting in the protected bays, however, was most successful, as a great variety of bottom was to be found in many of them.

While the chief aim of the expedition was to secure as complete a representation of the coral fauna as possible—and this aim met with considerable success—fine collections of other marine invertebrates were also obtained, including protozoa, sponges, hydroids, medusæ, alcyonarians, anemones, bryozoans, starfish, sea urchins,

holothurians, annelids, crustaceans, mollusks, and ascidians. Collections were also made on land whenever opportunities offered, including insects, mollusks, reptiles, and batrachians.

This expedition has enriched the collections of the National Museum by about five thousand specimens, which it is hoped will throw considerable light on the correlation of these islands in the West Indian complex.

#### CACTUS INVESTIGATIONS IN BRAZIL AND ARGENTINA

Dr. J. N. Rose, associate in botany, U. S. National Museum, (at present connected with the Carnegie Institution of Washington in the preparation of a monograph of the Cactaceae of America), accompanied by Mr. Paul G. Russell, of the U. S. National Museum, continued the botanical exploration of South America during the summer of 1915, spending over five months in travel and field work in Brazil and Argentina.

Bahia, Brazil, was the first place visited, which city served as a base for collecting trips into the interior of the State of Bahia. One of these was to the town of Joazeiro, located about three hundred miles north northwest of Bahia, and lying in a typical cactus desert, although this region is traversed by the large Rio São Francisco. Notwithstanding the fact that this stream is full the entire year, little or no attempt is being made to use the water for irrigation purposes. The country is of that type known as "catinga," and resembles in a remarkable way the deserts of the West Indies; indeed, the genera of plants are in many cases the same, though the species are distinct. Here was seen the "carnuba," or wax palm, from which is obtained the wax utilized in making records for phonographs. Near Joazeiro is the Horto Florestal, or "forest garden," a government experiment station in charge of Dr. Leo Zehntner, who rendered great assistance in the study and collection of the cactuses of the region.

After making short stops at various stations in returning to Bahia, a trip was made to Machado Portella, a small town about 175 miles west and a little south of Bahia, the terminus of a little narrow gauge railway. This is also a semiarid region, and proved exceedingly interesting botanically. The next side trip was to Toca da Onça, still farther south, on the edge of a thick tropical forest, and in a region much more humid than the northern part of the state.

About six weeks were then spent in beautiful Rio de Janeiro and vicinity. Here, even in the city itself, a botanist finds a great deal to interest him, for the trees are covered with epiphytic cactuses,



mostly of the genus *Rhipsalis*, and within the city itself rises the picturesque Corcovado, a thickly wooded mountain on whose slopes are found many rare ferns and tree-inhabiting cactuses. The Jardim Botânico in this city is one of the finest in the world. Over

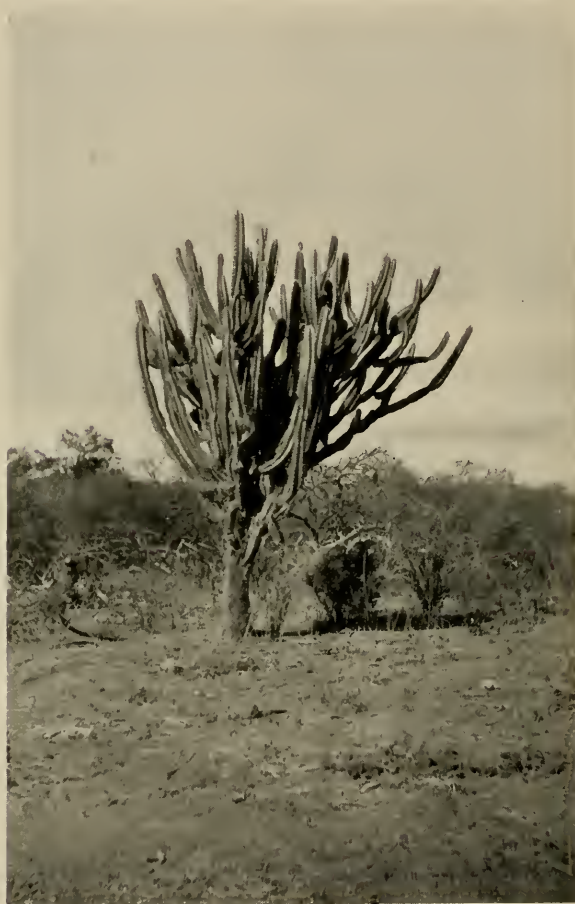


FIG. 73.—*Cercus jamacaru* DC., near Joazeiro, Brazil, one of the largest cacti in the State of Bahia, Brazil. Photograph by Russell.

two hundred species of palms from all parts of the tropics are here grown in the open, besides many other rare tropical plants. In another section of the city, in a fine large park called the Quinta Boa Vista, is the Museo Nacional, where a number of rare cactuses were found in the herbarium.



FIG. 74.—Transportation on the Rio São Francisco near Joazeiro, Brazil.  
Photograph by Russell.



FIG. 75.—Slopes of Mount Itatiaya, the highest mountain in Brazil, showing *Araucaria brasiliana* A. Rich., in the foreground. In the distance the morning mists hide the valley. Photograph by Russell.

From Rio de Janeiro an ascent of Itatiaya, the highest mountain in Brazil, was made, and on the very top, 10,000 feet above the sea,



FIG. 76.—The wax palm, in the State of Bahia, Brazil, from which is obtained "carnauba," the wax used in the manufacture of phonographic records. Photograph by Russell.

was found a small cactus with beautiful rose colored flowers. Excursions were also made to Cabo Frio, to Ilha Grande, and to the islands in the Bay of Rio de Janeiro. A few days were spent in



FIG. 77.—The avenue of palms in the Botanical Garden at Rio de Janeiro, Brazil. Photograph by Russell.



the Organ Mountains, near Petropolis, the summer home of the wealthiest classes of Rio de Janeiro. This range of mountains merits a more thorough biological exploration than has been hitherto undertaken.



FIG. 78.—*Cercus Forbesii* Först., from the desert region near Cordova, Argentina. Photograph by Russell.

Proceeding southward, a day was spent at Santos, Brazil, the world's greatest coffee center. Buenos Aires was visited next, although but little time was spent in the city. Several visits were

made to the fine suburb of La Plata, where resides Dr. Carlos Spegazzini, the leading authority on Argentine cactuses.

From Buenos Aires a trip was taken across Argentina to Mendoza, a city situated near the foot of the Andes, in a region favorable to the growth of succulent plants. From there a short excursion was made to Portrerillos, Argentina, on the railway which leads to Valparaiso, Chile. Many very interesting plants were found in both these places.

In the city of Cordova, Argentina, northwest of Buenos Aires, the cactus collection of Dr. Frederick Kurtz was found to contain some rare types, which were very kindly submitted for examination and study. In this vicinity, as well as in the neighboring town of Cosquin, many cactuses were collected on the semiarid peneplain.

In addition to good sized collections of cactuses, consisting of living, herbarium, and formalin specimens, moderately large collections of insects, shells, diatoms, and other natural history specimens were obtained. In all about 8,000 herbarium specimens were obtained and over 90 cases, large and small, of living plants were sent back to the United States. The living collection is now on exhibition at the New York Botanical Garden.

The expenses of this expedition were chiefly borne by the Carnegie Institution of Washington and the New York Botanical Garden.

#### SHELL MOUNDS ON THE PACIFIC COAST

While serving as representative in charge of the exhibit of the Institution at the Panama-Pacific International Exposition, Dr. Walter Hough had an opportunity to examine some of the shell mounds which are numerous around San Francisco Bay. In this work he was aided by Prof. T. T. Waterman and Mr. E. W. Gifford of the University of California. A large mound in West Berkeley which had been sectioned by grading for factory sites, leaving a mass which appeared to be the central portion, and presenting a face 12 feet in height, was selected for operations and enough work was done to secure data as to its strata of accumulation, human, animal, and art contents. Within three feet of the base under ashes were found the skeletons of several infants. This find was considered noteworthy, a similar deposit not having been found before. Artifacts were not common in this section of the mound. There were found plummets, sinkers, hammers, grinding stones, awls, antler wedges, and rarely obsidian blades.

## ARCHEOLOGICAL RECONNOISSANCE IN WESTERN UTAH

Previous to June, 1915, our meager knowledge of the archeological remains in western Utah had been gleaned mostly from casual notes in the official reports of early government geologists, surveyors, and army officers attached to frontier posts. Very few scientific excavations had been attempted and almost nothing had appeared in print regarding their results. The cultural relationship between the builders of the ancient Utah dwellings, remains of which consisted primarily of mounds, and the prehistoric pueblos and cliff-dwellings of southeastern Utah and the adjoining sections of Colorado, New



FIG. 70.—Small storage bins in rectangular adobe dwellings at Beaver City, Utah.

Mexico and Arizona, furnished a much mooted question, a solution of which seemed highly desirable. The preliminary task of securing definite and first-hand information regarding these mounds was commenced in May, 1915, by Mr. Neil M. Judd, of the National Museum, who, under the auspices of the Bureau of American Ethnology, remained in Utah six weeks, engaged in researches that extended the entire length of the state.

Mr. Judd began his reconnoissance at Willard, on the northeastern shore of Great Salt Lake. Years of continued soil cultivation had quite leveled the dozen or more mounds once noted at this place; only one remained in the spring of 1915 in a comparatively undisturbed condition. Excavations in this mound disclosed the remains

of a very primitive structure, the roof of which had consisted, apparently, of logs that rested upon the ground and leaned against crosspieces supported by four vertical posts surrounding the fireplace. The adjacent timbers composing the roof had in turn supported layers, respectively, of willows, grass, and clay. This structure had been circular in form and was probably not more than 15 or 16 feet in diameter.

Dwellings of the same type were discovered near Beaver City, in Beaver County, in close proximity to larger structures whose walls were made of adobe and whose flat roofs had consisted of heavy

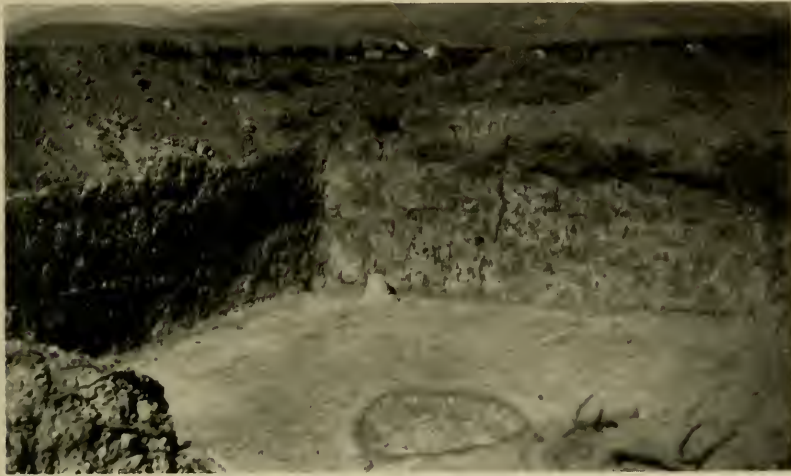


FIG. 80.—Walls and fireplace of a large adobe structure at Beaver City, Utah.

beams covered with willows, grass, and clay in succession. The artifacts recovered from these two types of dwellings differ but little and indicate a close relationship, both in time and in culture, between their respective builders.

One large mound at Beaver City, which was completely excavated, contained 15 rectangular rooms and a circular structure which has been identified as a kiva or ceremonial chamber similar to those associated with prehistoric habitations throughout the San Juan drainage. Of the 15 rectangular rooms, only four were contiguous: the walls of all had been constructed of adobe mud, pressed into place while in a plastic condition. No indication of the use of adobe bricks or of large adobe blocks could be found. In the northern portion of the mound four distinct levels of occupancy





FIG. 81.—Petroglyphs near the southern end of Little Salt Lake in Iron County, Utah.

were exposed, each bearing fireplaces and other remains of habitations. Careful examination of the artifacts from these superimposed levels failed, however, to show that their inhabitants were other than those who had occupied the lower houses or that any considerable period of time had elapsed between the occupancy of the lowest and the uppermost levels.

Similar dwellings were unearthed near Paragonah, in Iron County. Owing to lack of time no effort was made to study the houses concealed by the larger mounds; the four small elevations examined contained only individual rooms which differed but little from those

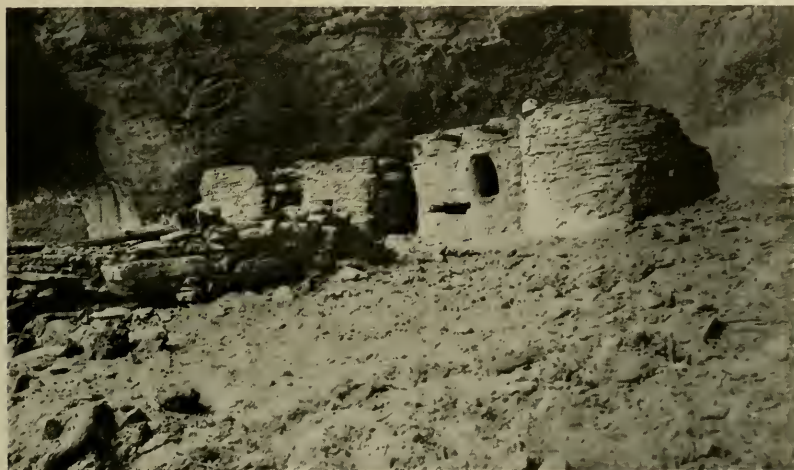


FIG. 82.—Small cliff-village in Cottonwood Canyon, near Kanab, Utah.

near Beaver City. Twenty years ago more than 100 mounds were counted at this place; today, only a few remain, the others having been recently razed and the artifacts they contained scattered over the newly plowed fields. While it is impossible to check this destruction, since the mounds are upon privately owned land, it is not yet too late to determine the architectural peculiarities of the primitive houses over which the mounds have accumulated and to gauge the degree of culture to which the ancient inhabitants had attained.

One day was spent near St. George, in the southwestern corner of the State, a region which received much attention from Dr. Edward Palmer, of the National Museum, between the years 1870 and 1876. The vast increase in the number of cultivated acres has brought about the destruction of most of the formerly abundant archeological remains, only a few small and isolated house sites being now visible.

Few ruins were noted along the road that connects St. George with Kanab, in Kane County. This section is extremely arid and no effort was made to visit the isolated mounds and cliff-houses reported by



FIG. 83.—Caves in limestone formation in Whalen Canyon, showing evidence of occupancy by primitive peoples.

cowboys as existing upon the mesas both north and south of Short Creek. It is believed that close examination will disclose structures similar to those near Beaver City and Paragonah, but probably con-



structed with stone instead of adobe—the availability of laminate sandstone would naturally have led to its use by primitive peoples.

After leaving Kanab, Mr. Judd spent one day in Cottonwood



FIG. 84.—Pits and fractured stone at the so-called “Spanish diggings” in Wyoming.



FIG. 85.—Fractured stone surrounding the aboriginal quarries known as the “Spanish diggings” in Wyoming.

Canyon, investigating a number of caves which contain evidences of prehistoric occupancy. In one of these were several circular rooms, the walls of which had been constructed with masses of



adobe, reenforced by bunches of rabbit-brush or the young twigs of sage. On the rear wall of this same cave were many representations of mythological beings, painted in red, white, brown, and yellow.

Another cave in this canyon contained the ruins of four unconnected cliff-houses and a subterranean kiva measuring 14 feet in diameter. The fact that the four houses of this small cliff-village were entirely detached is quite novel and may lead to extensive revision in prevailing theories regarding the origin of the great communal houses built by prehistoric peoples south and east of the Rio Colorado.

Several caves in Cave Canyon are now flooded with water, but bear unmistakable evidence of having been formerly occupied by



FIG. 86.—Tipi circles or old camp-sites on the hills overlooking Willow Creek, Wyoming.

primitive peoples. Exposed mounds in Johnson Canyon, about 15 miles east of Kanab, indicate the sites of rectangular dwellings similar to those near Beaver City, with the exception that stone was freely employed in the construction of the walls.

Mr. Judd's preliminary examination of the archeological remains in western Utah shows that at least three distinct types of prehistoric habitations formerly existed; that artifacts found in the two types first mentioned indicate a close cultural affinity between their builders, and that the second and third types possess many characteristics in common, together with an unmistakable cultural relationship with the pre-Puebloan ruins scattered widely throughout the southwest.

After leaving Salt Lake City on his return journey to Washington, Mr. Judd made a hurried visit to the "Spanish Diggings," a series

of aboriginal quarries on the Dry Muddy, a branch of Willow Creek, in northern Platte County, Wyoming. These pits take their name from a local belief, still prevailing, which credits the Spanish conquerors with having made the excavations in their untiring search for gold. Although but one day was spent in the Willow Creek basin, it is quite evident that the "Spanish Diggings" are nothing more than pits left by the aboriginal inhabitants of the region in their efforts to obtain suitable stone from which arrow-points, blades, and other chipped artifacts might be made. Most of the quarries are in exposures of fine-grained, bluish quartzite and may be traced over an area nearly 50 miles square. In every valley and upon almost all the low hills which divide the stream courses are countless tipi circles, the former camp sites of wandering bands of Indians, in and about which are innumerable chipped scrapers, blades, etc., and vast quantities of artifacts rejected during the manufacturing process, all of stone quarried from such exposed rock masses as the "Spanish Diggings."

#### TRIP TO THE CHIPPEWA INDIANS OF MINNESOTA

In May of 1915, Dr. Aleš Hrdlička, curator of the division of physical anthropology in the U. S. National Museum, made a rapid but rather extended trip over the White Earth and Leech Lake Reservations in Minnesota, under the auspices of the Department of Justice.

The object of this trip was to determine, as far as possible, the extent of full-bloods and mixed-bloods in the tribe, and especially to pass on the status in this respect of certain families and individuals.

About five years ago the United States Congress passed a law enabling mixed-blood Indians to alienate their land and timber, but did not sufficiently define what constituted a mixed-blood, that is, how he could be safely recognized as such in every instance before the law. As soon as this law was passed the local lumber companies and white settlers took full advantage of the situation, with the result that in a few years hundreds of Indian families and individuals were practically destitute, and those who were induced to sell included not only the easily recognizable mixed-bloods, but also quite a number of those who claimed to be full-bloods, or who could not by any ordinary means be recognized as having any white blood in their veins. Moreover, in some of these cases the sale of the timber or land by the Indians was obtained by misrepresentation and even by actual fraud.

The full-blood Indians, however, and those who could not be legitimately recognized as mixed-bloods, were under the protection of the United States Government. They had no right or power to alienate their property without the Government's consent; and when the attention of the authorities was called to the wholesale deprivation of the Indian of his land and timber, due steps were taken not



FIG. 87.—Chippewa mixed-blood, French-Indian, looking strikingly like a Japanese.

only to prevent the continuation of such deprivation but to recover for the Indian all property that was taken from him illegally. Commissions were appointed to investigate the conditions; the Indians were thoroughly questioned as to their genealogy and blood mixture, and in the course of years hundreds of actions were brought before the courts for the recovery of their property.

As these cases proceeded and the defense developed, it became evident that the most urgent and important problem was to deter-

mine in many of the contested cases who was, and who was not, a full-blood Indian. There was no difficulty in this respect where the amount of white blood was considerable or the mixture fairly recent; but in many instances the mixture first took place many generations ago, and the proportion of white blood in the present representatives of some such families is so small that it is difficult, if not impossible, to determine the degree of white infusion by ordinary observation.

It was with a view of assisting, as far as possible, in the solving of the problem as to who are full-bloods and who are mixed-bloods among the Chippewa, that Dr. Hrdlička was asked to visit the reservations; and he undertook the task with the expectation of coming in



FIG. 88.—A family of Chippewa mixed-bloods, Leech Lake. All the individuals are mixed, but in some the proportion of white blood is small.

contact with many interesting conditions which usually are not directly related to regular anthropological work.

The method of procedure was to drive from dwelling to dwelling over the reservations, and to examine the Indians whose blood status was in doubt by all the means at the disposal of the anthropologist, practicable in field work of this nature. Particular attention was directed to the skin of the body, especially that of the chest, to the hair and eyes, physiognomy, and a number of other features, such as the nails, gums, and teeth, which may be of assistance in determinations of this nature. Furthermore, stress was laid on the examination, in all important cases, of all the living members of the family, for it frequently happens that the brothers and sisters of an individual



throw more light on his blood status than does the examination of his own person.

The results of the work need be mentioned in this place only very briefly. It was found that mixture is very prevalent in the tribe. Most of this mixture dates far back, and taking in account the effects of the changed mode of living of the Indians, which has resulted in some lightening of the skin, it is frequently difficult to determine; yet it was found that there are certain signs by which in a large majority of cases a quite definite judgment can be reached on this question. The most difficult cases were found to be the old people, in whom the hair has changed to some extent through age and neglect, the skin is modified by exposure, the teeth are lacking



FIG. 89.—Chippewa birch-bark lodge, White Earth Reservation. These lodges, the shape of which reminds one so much of the Mongolian and Siberian "yurtas," are now very scarce among the White Earth Chippewa.

or worn down, and the eyes, due to various affections as well as age, are in a more or less unsatisfactory condition for examination.

On the whole there is no question but that a detailed anthropological examination in cases of this nature could be of considerable assistance to the law. It would readily show the true full-bloods, with a very large majority of the mixed-bloods; and the small percentage then remaining would consist almost exclusively of aged individuals whose status could probably be readily adjusted to legal requirements by some sort of compromise.

Scientific results of the work, on the other hand, would probably prove disappointing. The obtainable knowledge as to the nature and time of the admixture is very limited; the members of the families

are widely scattered; conditions are complicated by former polygamy; and there are many blends which doubtless follow some laws of heredity, but the complexity is too great to be unraveled by such investigations as are possible on the great and sparsely populated reservation, and with people who, due to their limitations, can be of but little assistance to the anthropologist.

#### THE NACOOCHEE MOUND IN GEORGIA

In pursuance of a plan for cooperative archeological research by the Bureau of American Ethnology and the Museum of the American Indian of New York, Mr. F. W. Hodge, Ethnologist-in-charge, early in July joined Mr. George G. Heye of the museum mentioned, in the excavation of the Nacoochee Mound in White County, northeastern Georgia, permission to investigate which was accorded by the owner, Dr. L. G. Hardman.

The Nacoochee Mound is an earthwork built by the Cherokee Indians, who occupied it until early in the 19th century. The name "Nacoochee," however, is not of Cherokee origin, or at least it is not identifiable by the Cherokees as belonging to their language, and by no means does the word signify "the evening star" in any Indian tongue, as one writer has claimed.

The summit of the mound, which had been leveled for cultivation about 30 years ago, measured 83 feet in maximum and about 67 feet in minimum diameter; the height of the mound above the adjacent field was 17 feet, 3 inches, and the circumference of the base 410 feet. These measurements, however, are doubtless less than they were at the time the mound was abandoned by the Cherokee, as all the dimensions have been more or less reduced by cultivation, the slope at the base particularly having been plowed away for several feet.

It was the custom of the Indian tribes of the South, and especially throughout the valleys of the Mississippi and its tributaries, to erect mounds for various purposes, namely, to serve as a site for the domicile of the chief or for the "town-house" of the settlement, as a burial place of the dead, or merely as a place of refuge during periods of flood. The Nacoochee Mound was reared both for domicile and for cemetery purposes, and was composed of rich alluvial soil from the surrounding field. The excavations determined that the mound was not built at one time, but evidently at different periods as circumstances demanded. This was shown plainly by the stratification of the mound soil, the occurrence of graves at different depths with undisturbed earth above them, the presence of fire-pits



FIG. 90.—The Nacoochee Mound from the south. The summer-house on the summit was erected about 30 years ago.



FIG. 91.—Forty-foot trench, 4-foot level. View looking north.

or of evidences of fires throughout the mound at varying levels, and by the finding of a few objects derived from the white man in the upper part and in the slopes of the mound, but not in the lower levels. From this last observation it is evident that the occupancy of the mound extended well into the historical period, a fact supported by the memory of the grandparents of present residents of the Nacoochee Valley who recalled the mound when the Cherokee Indians still occupied it and the surrounding area.



FIG. 92.—Trench, east side of mound. View from the south. The lowermost part of the excavation shows the base of the mound.

The fact that the mound was used for burial purposes is attested by the finding of the remains of 75 individuals during the course of the excavations, the graves occurring from slightly beneath the summit to a depth of about 19 feet, or below the original base of the mound. These graves, with few exceptions, were unmarked, and in most instances were not accompanied with objects of ceremony or utility. The exceptions were those remains with which were buried stone implements, shells or shell ornaments, a smoking pipe, a pottery vessel, or the like. The skeletons were found usually with the head pointed in an eastwardly direction, and were all in such a greatly decomposed condition that it was impossible to preserve any of them



for measurement and study, the bones in most cases consisting of only a pasty mass.

As mentioned above, most of the burials were unmarked. The exceptions consisted of two graves encased and covered with slabs of stone, both unearthed near the very base of the mound. One of these stone graves contained a skeleton the bones of which were largely of the consistency of corn-meal, owing to the ravages of insects; but what was lacking in the remains themselves was more than compensated by the finding, near the skull, of a beautiful effigy



FIG. 93.—Sectional view of fire-pit 10 feet in length, showing indurated ash.

vase of painted pottery, the only piece of painted ware, whole or fragmentary, found in the entire mound. The occurrence of this type of vessel and the presence of the stone graves at the bottom of the mound suggest the possible occupancy of the site by Indians before the settlement of the Cherokee in the Nacoochee Valley.

Perhaps the most remarkable feature of the mound was the large number of smoking pipes of pottery, mostly broken, but in many forms and of varying degrees of workmanship. Some of the pipes are of excellent texture and are highly ornamented with conventionalized figures of birds, etc., or marked with incised designs. Another feature of the mound was the great amount of broken pottery found, especially in the refuse at the base and covering the slopes.



FIG. 94.—A flexed skeleton in the Nacoochee Mound, showing ornaments buried therewith.

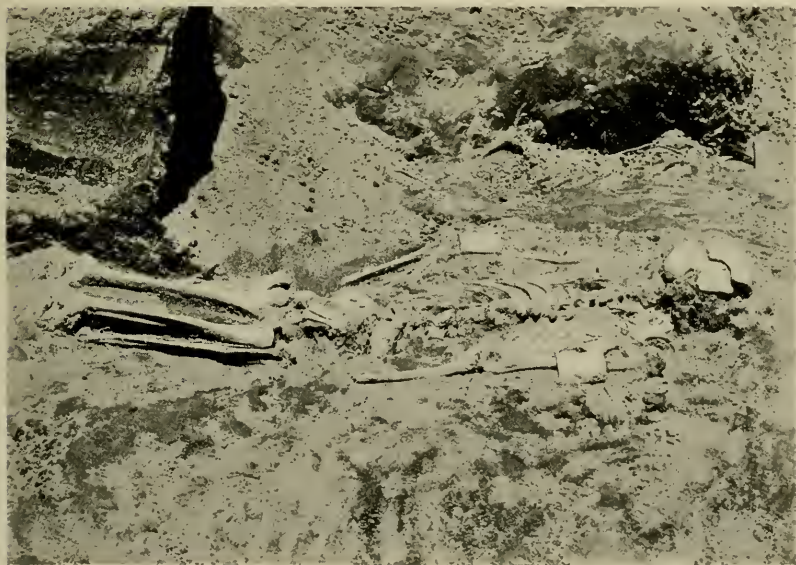


FIG. 95.—One of the burials found in the Nacoochee Mound. Note the copper arm-band, and the beads at the neck.



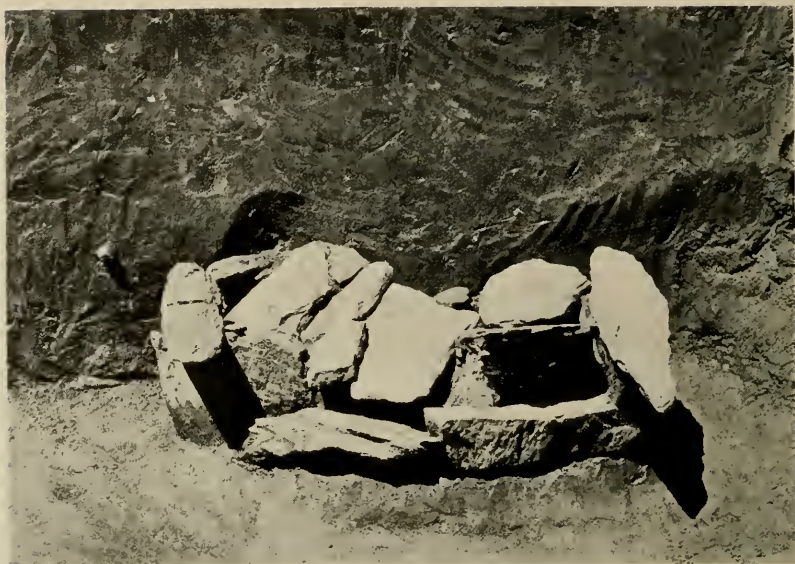


FIG. 96.—Stone grave above the bottom of the mound.

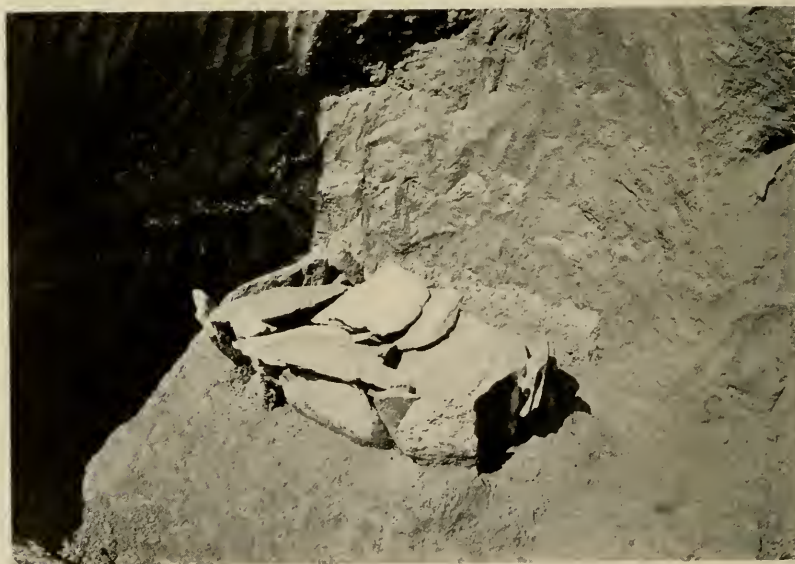


FIG. 97.—Stone grave near the bottom of the mound.



FIG. 98.—Painted effigy vase found with a skeleton in a stone grave at the base of the mound.

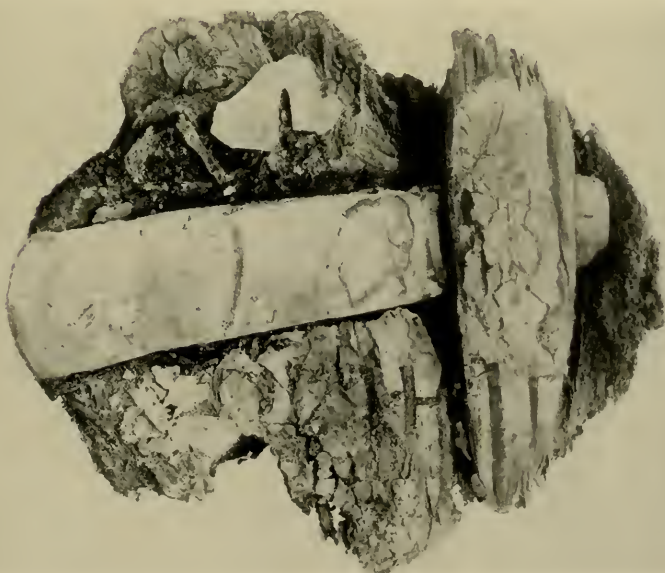


FIG. 99.—Copper axe in handle found with one of the burials at the base of the mound.



This pottery is chiefly of fine texture, although some of the cooking vessels are of coarse ware. With the exception of the painted vessel above noted, the only ornamentation applied by the makers of the pottery consists of incised and impressed designs, the latter conferred usually with a paddle of clay or wood, or worked out in the moist ware, before firing, by means of a pointed tool, a spatula, a piece of cane, or a shell.

#### PREHISTORIC REMAINS IN ARIZONA, NEW MEXICO, AND COLORADO

One of the most interesting historical monuments protected by the Government is the ruin of the old mission church of San José de



FIG. 100.—Ruin of San José de Tumacacori, Arizona.  
Photograph by Fewkes.

Tumacacori, situated on the Santa Cruz River, south of Tucson, Arizona. There were formerly several of these churches along the banks of this river, one of which, the nearest to Tucson, is called San Xavier del Bac. This building is still in use, having been repaired and enlarged to accommodate the inhabitants of the neighboring village of Papago Indians. A few miles south of San Xavier are remains of the old settlement Tubac, and the walls of the fort and former Indian town. Still farther south, about 20 miles from Tucson, stand Tumacacori (fig. 100) and the mounds of the adjacent prehistoric settlements. Although the old church is protected from vandalism, the foundations of the walls, undermined and exposed to

the elements, are sadly in need of repair. Unless something is done to prevent its crumbling walls from falling, after a few years little will remain of this fine example of Spanish mission architecture of the 18th century. The façade and dome are still fairly well preserved; the main walls, roof of the cupola, and mortuary chapel are still standing, and a few hundred dollars judiciously expended would save for posterity this precious relic of the past. Evidences of the walls of a prehistoric compound formerly inhabited by the Indians of that region may be traced near the mission and mounds indicating massive aboriginal buildings are visible. These ought to be excavated and repaired. Dr. Fewkes made a trip to the above mentioned missions in January, 1915, in order to study the distribution of prehistoric settlements now in ruins on the Santa Cruz, one of the gateways

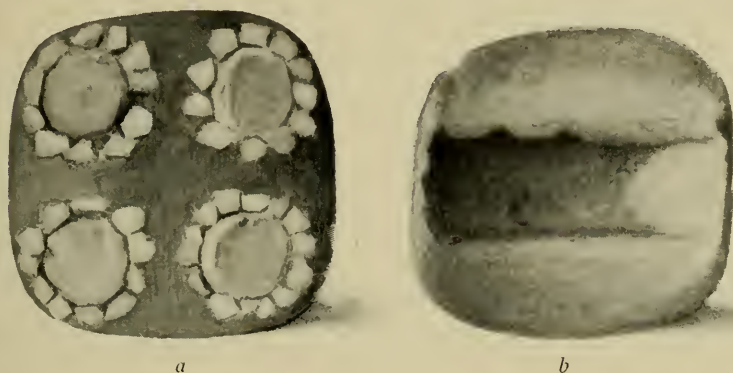


FIG. 101.—Turquoise mosaic (*a*, front; *b*, back) from Mimbres Valley, New Mexico. Original 0.8 inch square. Heye Collection. Drawing by Mrs. R. E. Gamble.

of early communication between Mexico and southern Arizona. He regards the region west of the Santa Cruz as one of the most important unworked ethnological and archeological fields in the Southwest. Little has been recorded on the prehistoric remains in this region and there is still much to be learned of the modern inhabitants whose culture has been little modified by the influence of civilization and who still preserve many of their ancient dances and secular customs.

The slightly known ruins of this region were found to be of practically the same type as Casa Grande on the Gila, suggesting a southern extension of this type of architecture into Mexico. The prehistoric mounds would well repay systematic excavation, and

would yield much material bearing on the diffusion of culture of the ancient people of our Southwest. The object of the visit was a reconnoissance, which was successfully completed. There are large mounds indicating compounds of considerable size between Casa Grande and Vekol, near Quijotoa, and at the Kwahadt settlements.

Having made the brief reconnoissance above mentioned, Dr. Fewkes returned to Deming, New Mexico, and undertook an examination of ruins along the Mimbres River, inspecting various archeological sites as far north as Silver City. He obtained by purchase valuable additions to collections of the characteristic pottery of this



FIG. 102.—Decorated pottery from Mimbres Valley, Heye Collection. *a*, unidentified animal; *b*, bee; *c*, *d*, unidentified composite animals.

region, from Oldtown and elsewhere (figs. 102-111). One of the most striking objects examined is a rare turquoise mosaic with four figures representing flowers (fig. 101). The culture of the Mimbres Valley as shown by archeological data is distinctive, with no likeness to that of the lower Gila, but connecting that of the upper Gila with Casa Grandes in Chihuahua. The prehistoric culture of Mimbres Valley, like that of the Santa Cruz, is destined to play an important rôle in determining diffusion of Southwestern culture.

Important work was carried on by Dr. Fewkes during the last year in the Mesa Verde National Park, where the Department of the Interior is cooperating with the Smithsonian Institution in the excavation and repair of cliff-houses and other prehistoric ruins, to increase

*d**a**b**c*

FIG. 103.—Decorated pottery from Mimbres Valley, Heye Collection. *a*, bird; *b*, turtle; *c*, bear; *d*, reptile.

*a**b*

FIG. 104.—Decorated pottery from Mimbres Valley, Heye Collection. *a*, unidentified animal holding unknown object (see *b*, fig. 107); *b*, bear.





FIG. 105.—Decorated pottery from Mimbres Valley, Heye Collection. *a*, unidentified insect; *b*, dragonfly.



FIG. 106.—Decorated pottery from Mimbres Valley, Heye Collection. *a*, animal with head and body of antelope and tail of fish; *b*, measuring-worm, with rainbow symbol.

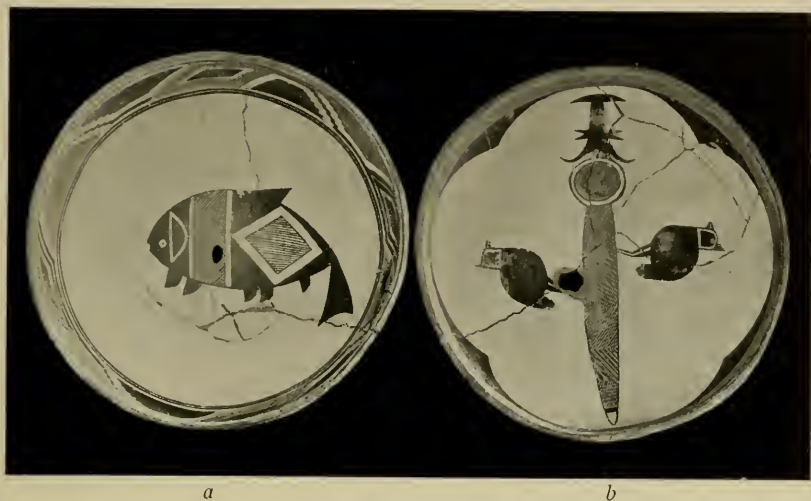


FIG. 107.—Decorated pottery from Mimbres Valley, Heye Collection. *a*, fish; *b*, birds on unidentified object (see *a*, fig. 104).



FIG. 108.—Decorated pottery from Mimbres Valley, Heye Collection. *a*, bird; *b*, frog; *c*, mountain sheep; *d*, fish.



FIG. 100.—Decorated pottery from Mimbres Valley, Heye Collection. *a* and *b*, dancing figures; *c*, bird.



FIG. 110.—Decorated pottery from Mimbres Valley, Heye Collection. *a*, animal with head of antelope and body of insect; *b*, mountain lion.

their value to students and render them more attractive to visitors. The field work last summer (1915) was devoted to a large building situated on the point (fig. 112) opposite Cliff Palace, and to Oak-tree House, an adjacent cliff-dwelling in the neighboring canyon. This work was unusually successful in that it revealed a new type of prehistoric building 121.7 feet long by 340 around the north or semi-circular side. This ruin, to which the name Sun Temple has been given, is considered one of the most mysterious structures in the



FIG. 111.—Bird and larval insect from Mimbres Valley, Heye Collection.

Southwest. It was completely excavated, the fallen earth and stones were removed, and the walls thoroughly repaired, the most improved methods being adopted for their preservation from the elements. The ground plan shows an original building and an annex, shaped like a capital letter **D**. Adjoining the southwest corner of the annex, on the outside, were built two walls forming an enclosure identified as a shrine, the floor of which is formed by the upper face of the southwest cornerstone of the building. In this floor is a fossil palm, suggesting a symbol of the sun, which has given the name to the ruin.



The mound (fig. 113) covering the ruined walls of the Sun Temple dates back to 1555, as indicated by a cedar tree having 360 annual "rings" which was found growing on the top of the highest wall. There is no way of telling how much earlier the mound was formed or how many years before it became a mound the foundations of the building were laid. It is, however, believed that worship at the sun shrine undoubtedly antedated the construction of the building.



FIG. 112.—Sun Temple from point across Fewkes Canyon, Mesa Verde National Park, Colorado. Photograph by T. G. Lemmon.

The Sun Temple was probably built by the neighboring cliff-dwellers and is regarded as more modern than Cliff Palace. The unity of plan shown in the Sun Temple (fig. 115) indicates union of several clans in its construction and the existence of a higher social organization than at Cliff Palace. It was intended for a ceremonial building with a secondary purpose of storage and refuge in time of trouble, but shows evidence that it was never finished.

A cliff-ruin called by guides Willow House, but which might better be known as Oak-tree House, is a typical cliff-dwelling of about the same age and culture as Cliff Palace. It is situated in



FIG. 113.—Sun Temple, Mesa Verde National Park, Colorado, before excavation, from southwest corner. Photograph by E. E. Higley.



FIG. 114.—North wall of Sun Temple, Mesa Verde National Park, Colorado, looking east from annex. Half excavated. Photograph by Fewkes.

Fewkes Canyon, Mesa Verde National Park, under a perfectly arched natural roof, below the mysterious ruin above mentioned. Oak-tree House is not referred to in Nordenskiöld's classic\* on the "Cliff Dwellers of the Mesa Verde," and has not been figured nor described by other archeologists, although it presents several very exceptional architectural features. This oversight may be due in part to the fact that it was practically inaccessible previous to last summer (1915). Notwithstanding its neglect by archeologists this ruin is of no mean size, having had at least six circular subterranean ceremonial chambers, and 25 rooms, some of which were habitations, indicating the existence of a population of at least six clans. Its ground plan shows that it occupied the whole floor of a large cave; the houses were in places four stories high.

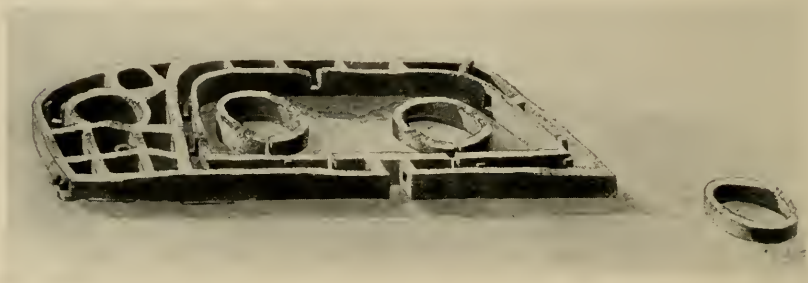


FIG. 115.—Birdseye view of Sun Temple, Mesa Verde National Park, Colorado, looking northeast.

At the close of the work on the Sun Temple, above mentioned, the rooms of Oak-tree House were cleaned out, and the walls repaired and put in condition for permanent preservation. Ladders were placed in position to afford descent from the rim of the mesa to a pathway made on the talus on which it stands. This descent is a somewhat difficult task, but once accomplished it offers beautiful views of Cliff Palace and other ruins down Soda Canyon, as far as Mancos River.

Perhaps the most unusual ceremonial room of Oak-tree House (fig. 117) is a kiva shaped like the letter **D**, in which there is a rectangular chamber between the firehole and the south wall. This chamber communicates with the outside by means of a vertical flue and opens into the main room by two passageways in a wall, corresponding to the deflector of other kivas. Another exceptional feature of Oak-tree House is the presence in the rear of the cave of a circular room,



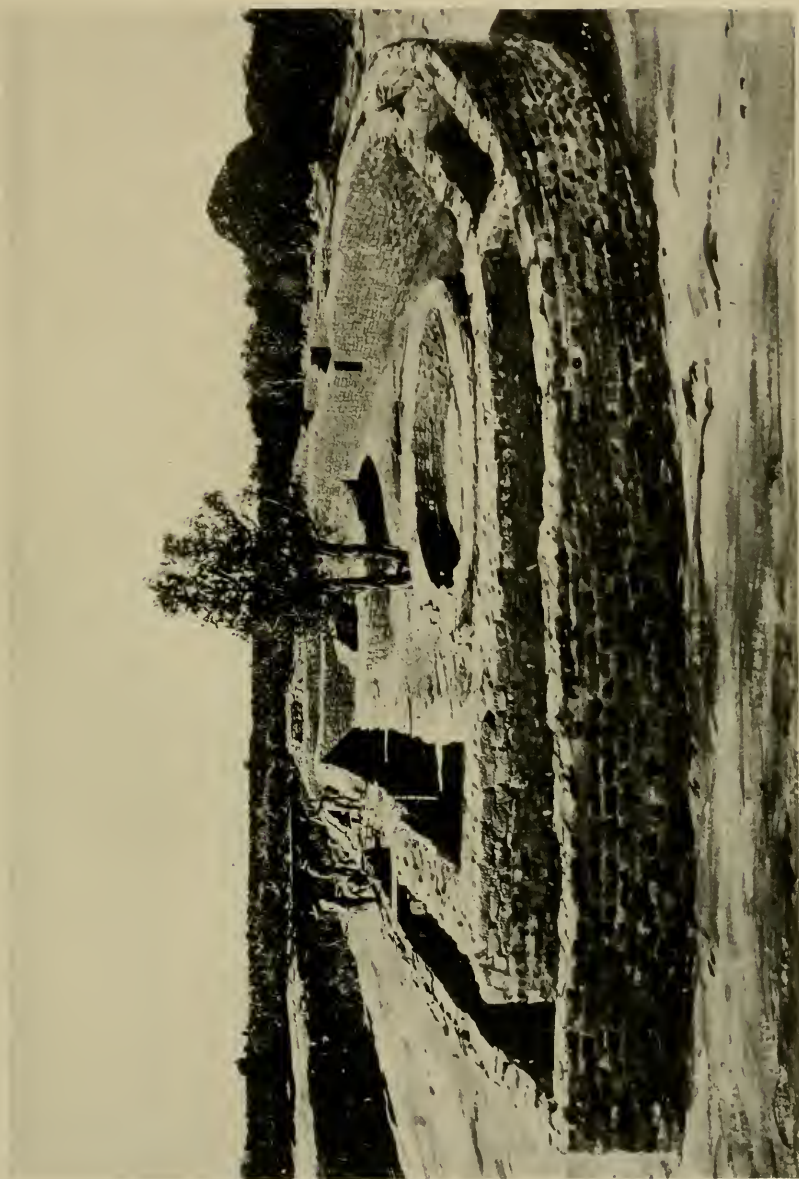


FIG. 116.—View of Sun Temple, Mesa Verde National Park, Colorado, from the east. Photograph by Fred Jeep, with east wall added by W. H. Holmes.





FIG. 117. — Oak-tree House, Mesa Verde National Park, Colorado.  
Photograph by T. G. Lemmon.

the walls of which are not constructed of masonry but of willow twigs and sticks covered with adobe plastering, a feature quite common in the cliff-house walls in northern Arizona, but very rare on the Mesa Verde. This is supposed to be a survival of a pre-Puebloan style of architecture. A small collection of artifacts was made in the course of the repair of Oak-tree House. Among the objects found were two beautiful specimens of typical black-and-white-ware pottery. The so-called snow-shoe (fig. 118) is rare, and the head-rest (fig. 119) exceptionally well made.

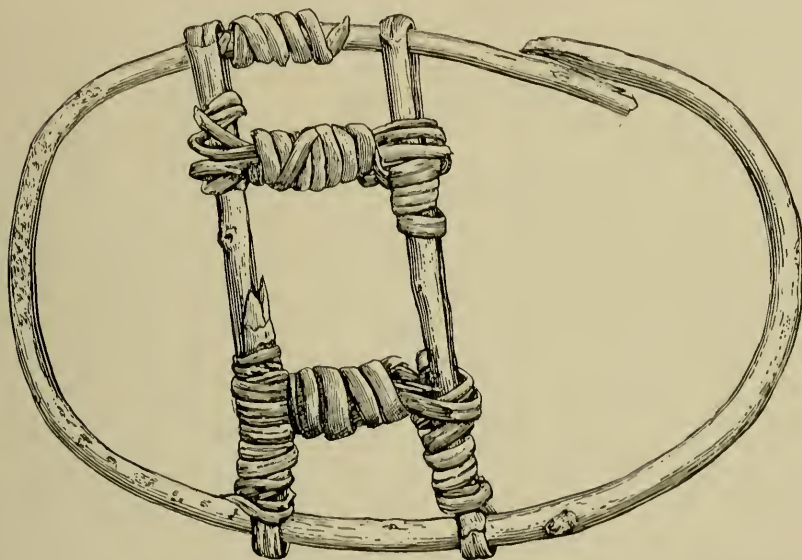


FIG. 118.—"Snow-shoe" from Oak-tree House, Mesa Verde National Park, Colorado.

Following the trail along the north side of the same canyon in which Oak-tree House is situated, the visitor comes to a remarkable ruin called Painted House, which, like Sun Temple on the cliff above, presents a ground plan and architectural features different from any yet described in cliff-dwellings. Like the Sun Temple it appears to have been built for religious ceremonies, but it is quite different in character. Painted House has a long room or court, possibly an open dance plaza or a covered ceremonial room, the north side of which is formed by the vertical cliff of the rear of the cave. At each end of this long room there are rooms with massive walls, that on the east being connected with the court by passage-

ways, too wide for ordinary cliff-house doorways. The walls of one of the rooms of the western group are plastered, and decorated with a procession of animals and men painted in red. Two of the human figures, unfortunately mutilated within the last six years, suggest phallic beings still personated by the Hopi, a similarity which implies that the Mesa Verde cliff-dwellers had a cult like that of the

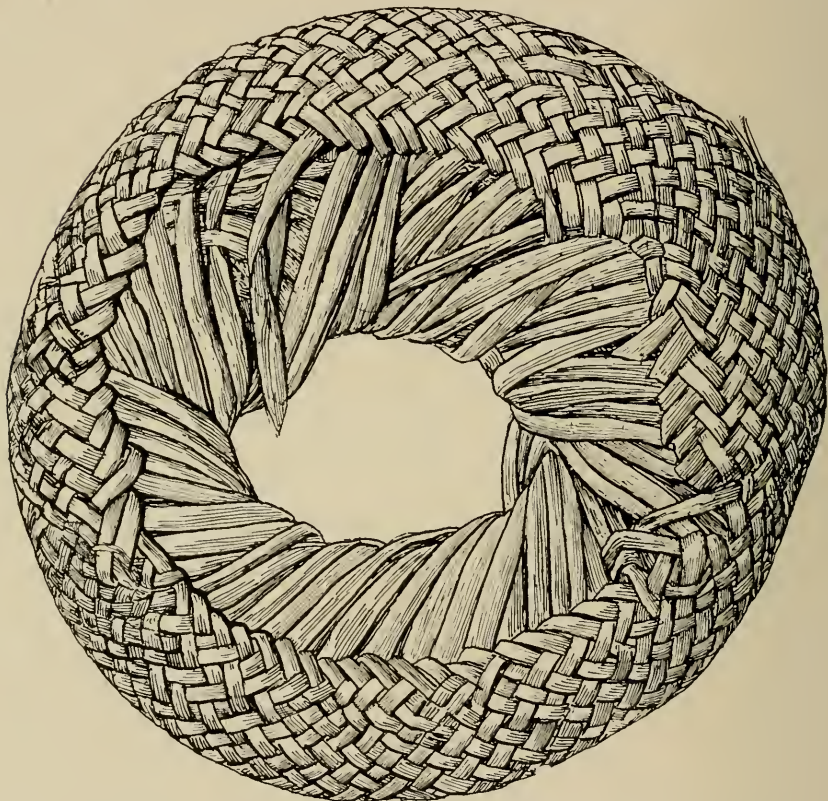


FIG. 119.—Head-rest from Oak-tree House, Mesa Verde National Park, Colorado.

Hopi, and as phallic rites and personages are pre-eminently associated by the latter with New-fire ceremonies, it may be that the cliff-dwellers of Painted House practised the same or similar rites.

The specialization of these two great buildings for ceremonial purposes and the evidences of the former existence of a considerable population nearby, seen in the size of Cliff Palace and other cliff-houses in the neighboring caves, impart peculiar interest to the study



of the distribution of aboriginal culture characteristics of the Mesa Verde National Park.

Information has been brought from time to time to the attention of the Smithsonian Institution that there exists in the northern part of Texas a large ruin known as the Buried City of the Panhandle. The name suggests that this may be a community dwelling, and it has occurred to several students that this "city," if such exists, marks the eastern extension of the Pueblo area. In order to determine the truth of this report Dr. Fewkes visited northwestern Texas and examined certain Indian remains along Wolf Creek, a tributary of the Canadian



FIG. 120.—Sandstone dyke, often mistaken for an artificial wall. Rockwall, Texas.

River, said to be the location of the "city." Sites of aboriginal camping places, probably of nomadic Indians, were found in this locality, but no remains of walls or pottery suggestive of Pueblo occupancy. There are no signs of a "Buried City of the Panhandle" in the region visited.

Archeologists often have their attention called to sand dykes which are locally mistaken for artificial walls. The attention of Dr. Fewkes was directed to what appeared to be a prehistoric artificial wall situated in the suburbs of Rockwall, in Rockwall County, near Dallas, Texas. In order to determine its true character he visited this "wall" and found that it was not constructed by man, but belonged to those natural formations known to geologists as sand dykes. Its resem-



blance to an artificial wall is so close that for many years it was supposed to be the wall of a prehistoric dwelling (see fig. 120).

#### ETHNOLOGICAL RESEARCHES IN OREGON AND WASHINGTON

During the summer of 1915 Dr. Frachtenberg continued his investigations of the languages, traditions, history, and ethnology of the



FIG. 121.—Louis Kenoyer, the last of the Atfalati.

various tribes of Oregon and Washington. He began the year's work in the month of July with a trip to the Yakima Reservation, Washington, where, with the assistance of Louis Kenoyer, he revised the Atfalati (Kalapuya) manuscript material which had been collected by the late Dr. Gatschet in 1877. This material, comprising 421 manuscript pages, consisted of vocables, stems, grammatical forms, and ethnological and historical narratives, obtained in the Atfalati

dialect. The revision of this material marked the completion of the work on the Calapooya (Kalapuya) languages which Dr. Frachtenberg began during the previous summer. It may not be out of place here to mention the fact that Louis Kenoyer is the last surviving member of the Atfalati (or Wapato Lake) tribe of the Kalapuya family.

During the latter part of August Dr. Frachtenberg attended the



FIG. 122.—Thomas Payne, the present nominal Chief of the Quileute.

first Indian Fair, which was held at Siletz, Oregon, by the various Indian tribes living at that agency. During this trip 52 Athapaskan and Shastan songs were collected.

In the month of November Dr. Frachtenberg commenced his ethnological researches of the Chimakuan family. Up to the present writing a preliminary survey of the morphological and syntactic structure of the Quileute language had been made, and 30 native myths and tales were collected.

The Chimakuan family was originally composed of three distinct tribes living in the northwestern part of Washington. These tribes were the Chemakum, Quileute, and Hoh. The Chemakum tribe has disappeared entirely; while the Quileute and Hoh tribes are represented by approximately 350 individuals living at the Lapush Agency, in Clallam County, Washington.



FIG. 123.—A group of Quileute Indians, members of the Shaker Church.

A singular feature of the material life of these Indians, to which attention may be called here in passing, has been observed in the fact that in former days they were actually hunting whales in the ocean instead of eating the meat of whales that drifted ashore. As far as our knowledge goes, the Nootka of Vancouver Island are the only other Indian tribe that ever engaged in the actual hunting of whales in the ocean.

## WORK AMONG THE FOX AND SAUK INDIANS

In June, 1915, Dr. Michelson left for the West to resume his work among the Fox Indians of Iowa. He remained at Tama till about the middle of August, where he devoted his time mainly to securing ritualistic origin myths. These myths, particularly those

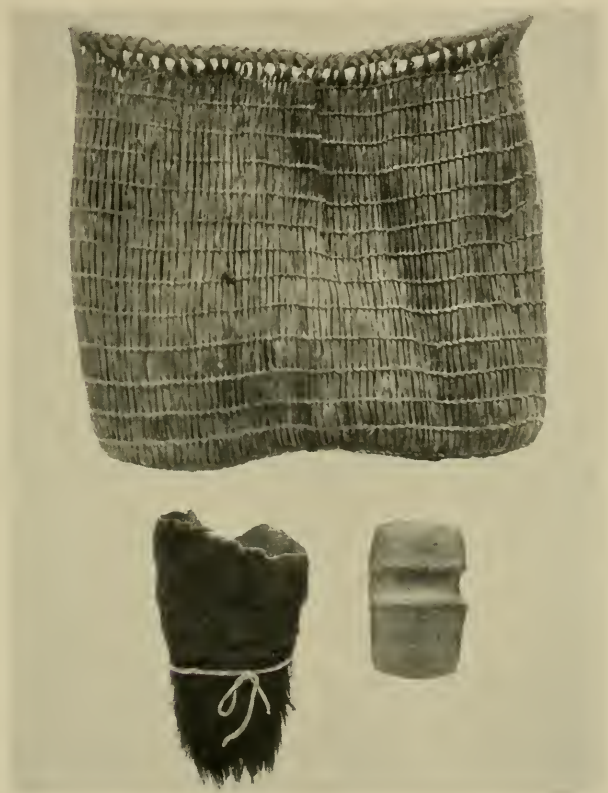


FIG. 124.—Stone ax and wrapping of bear hide, belonging to a sacred pack of the Fox Indians.

appertaining to clan ceremonies, are extremely valuable inasmuch as the existing ceremonies which the myths account for, cannot be witnessed in their entirety. It is clear that these myths were invented long ago to account for the existing ceremonies. In this way is obtained knowledge of one part of Fox ethnology which otherwise would be a blank.



In August Dr. Michelson left for Oklahoma to work among the Sauk and Fox of that state. Here he spent his time mainly in obtaining translations of the myths noted above, as the Fox informants, being extremely conservative, wrote out the myths in the



FIG. 125.—Chief of Fox Indians, Pushitoniqua (Old Eye).

current syllabary with the understanding that these would be translated elsewhere. At the same time the Sauk social organization and the Sauk systems of consanguinity received attention. It appears that the regulations regarding membership in the tribal dual are

quite complex, and it will be some time before the matter can be cleared up. The work on the Sauk system of consanguinity shows that Morgan's Sauk and Fox schedules need revising. Dr. Michelson returned to Washington about November 1.

#### STUDIES AMONG THE CAYUGA INDIANS

Mr. J. N. B. Hewitt, ethnologist, with the efficient aid of Mrs. Mary Gibson, widow of the late Chief John Arthur Gibson, completed the long text in Cayuga of the O'ki'we, being the history and the ritual of the Feast of the Dead which is in charge of the women of the tribe. With the same assistance Mr. Hewitt also finished work on a selected list of Mohawk verbs by supplying each with a Cayuga synonym. Then with the aid of Mr. Richard Hill he was able to correct and elucidate certain moot points in the Mohawk and other texts of the Ritual of the Mourning and Installation Council, and especially to confirm a conjecture as to the reconstruction of a portion of a ritual which had been quite lost and forgotten, namely, the dramatization of the so-called Six Songs, in which these songs are sung by a chief impersonating the dead chief.

#### STUDY OF INDIAN MUSIC

The study of Indian music was continued by Miss Frances Densmore during the season of 1915. The first reservation visited was that of Fort Berthold, North Dakota, where she resumed, under the auspices of the Bureau of American Ethnology, a study of music of the Mandan and Hidatsa, commenced in 1912 under the auspices of the State Historical Society of North Dakota. A competent interpreter for each language was secured, and the work was conducted along more intensive lines than during the previous visit.

One of the principal subjects investigated was the custom of eagle-catching, which is common to both tribes and which, though scarcely to be called ceremonial, is closely associated with their beliefs in the power of the supernatural. The Mandan tradition of the origin of this custom, together with the songs connected with its fetish (the wolverene), was obtained from the only man living who inherited them. It is understood that no other person has the right to sing these songs, and the ownership of songs is held inviolate on this reservation. Miss Densmore visited an eagle trap which is said to have been in disuse for about 70 years. Upright in the ground beside it was a bone that had been used to hold bait for the eagles. This bone was identified as one of the upright vertebræ of a buffalo, and on it could be discerned traces of red paint.

The legend of the origin of the flute was also obtained by Miss Densmore, and its melody recorded phonographically. The Society of the Creek Women among the Mandan was also studied, and its



FIG. 126.—Hidatsa whistle played by owner.



FIG. 127.—Old Mandan earth lodge.

songs were recorded by a member of the society. Other distinctively Mandan songs are those connected with the spring-time custom of "purifying the corn," several songs of the last corn priest

being recorded by his daughter. Mandan songs sung by women in their gardens were obtained from two aged women of the tribe, most of them being plaintive songs concerning absent or slain warriors.



FIG. 128.—Modified form of Mandan earth lodge.



FIG. 129.—Entrance to old Mandan earth lodge.

The Hidatsa material, in addition to that pertaining to the custom of eagle-catching, chiefly concerns war and the various societies, many songs of these classes being recorded. The songs of the Mandan



and Hidatsa, on being transcribed, are found to be of a simpler type than those of the Chippewa and Sioux which have been analyzed.

Specimens of the musical instruments collected among both tribes include a drum, the rattles used by certain societies, and a whistle resembling a flageolet but without finger holes, on which a wide range of tones can be played (fig. 126). Specimens illustrating the material culture of the tribes were collected, and photographs illustrating their dwellings and daily occupations were made (figs. 127-130).

A new phase of Miss Densmore's investigations consisted in the making of pitch-discrimination tests. This was done by means of



FIG. 130. —Mandan woman tanning a hide at entrance of earth lodge.

a set of 11 tuning forks, the fundamental fork having a pitch of 435 vibrations (*a* above middle *c*, international pitch), and the remaining forks being tuned respectively,  $\frac{1}{2}$ , 1, 2, 3, 5, 8, 12, 17, 23, and 30 vibrations higher. These tests were made on both Mandan and Hidatsa Indians and the results recorded.

After leaving the Fort Berthold Reservation Miss Densmore visited the Standing Rock Reservation in North Dakota and the White Earth Reservation in Minnesota for the purpose of making similar tests among the Sioux and the Chippewa. The results of these tests show that some Indians have a pitch discrimination of three vibrations, or one-eighteenth of a tone, while others can discern only an interval of five vibrations, or one-eleventh of a tone. The method used in these tests is that of Prof. C. E. Seashore, of the State Uni-

versity of Iowa, who kindly examined the record of the tests and expressed the opinion that the abilities shown by these Indians are about as good as would be found among average American whites under similar conditions.

### OSAGE WAR RITES<sup>1</sup>

In the month of March, 1915, additional information was secured by Mr. Francis LaFlesche, ethnologist, from Xu-thá Wa-to<sup>n</sup>-i<sup>n</sup>, concerning the Tse-dó-ga I<sup>n</sup>-dse gens version of the great Osage war rites. This information consisted mostly of certain parts of the rites arranged in metrical form for the purpose of reciting at the ceremonies. This arrangement is called wi'-gi-e, or a recitation. The wi'-gi-e are as follows:

1. Wi'-gi-e To<sup>n</sup>-ga has 584 lines and covers 20 typewritten pages without the translations. The wi'-gi-e tells of the coming of the people of the Tsi'-zhu from the sky to the earth and of the origin of the various symbolic articles used in the ceremonies of the war rites, as well as of the gentile symbols from which personal names are adopted.

2. Wa-zhó-i-ga-tha Wi'-gi-e has 406 lines and covers 15 typewritten pages without the translations. This wi'-gi-e deals with the various heavenly bodies that the people of the Tsi'-zhu of the Seven Fireplaces adopted for their gentile symbols. These heavenly bodies are:

1. Mi, the Sun. 2. Mi'-o<sup>n</sup>-ba, the Moon. 3. Mi-ká-k'e Ho<sup>n</sup>-ba do<sup>n</sup>, the Morning Star. 4. Mi-ká-k'e Ho<sup>n</sup>do<sup>n</sup>, the Evening Star. 5. Wá-ba-ha, travois, Ursa Major. 6. Mi-ká-k'e U-ki-tha-ç'i<sup>n</sup>, the Double Star. 7. Ta-pá, Deer's Head, Pleiades. 8. Ta Thá-bthi<sup>n</sup>, the Three Deer. 9. Mi-ká-k'e Zhu-dse (Red Star), the North Star. 10. Sho<sup>n</sup>-ge A'-ga-k'e e-go<sup>n</sup>, Dog at the Side, Canis Major.

3. Ki'-no<sup>n</sup> Wi'-gi-e has 63 lines and covers two typewritten pages without translations. It relates to the symbolic painting of the members of the Tsi'-zhu of the Seven Fire-places when about to go to the ceremony of the Ni'-ki-e degree of the war rites. It refers back to the time when the rites were being formulated. The people asked of one another what they should use for symbolic painting. Then they gathered four stones upon which they put a great pile of dry wood. This they set on fire and the flames that leaped upward

<sup>1</sup>The italic letters in the Indian names indicate peculiarities of pronunciation which it is unnecessary to explain in this brief account.

cast a reddish light upon the darkened sky and upon the people themselves. This reddish light they adopted for their symbolic color and for the color of the symbolic shields which they wear on their breasts when they go to war. They also made it to represent the sun which was their gentile symbol of life.

Besides these *wi'-gi-es* *Xu-thá Wa-to"-i"* gave the ritual of the *Ní'ki-e* degree of his gens, which has four *wi'-gi-e* and five songs.

In the month of September, 1915, at Mr. LaFlesche's invitation, *Xu-thá Wa-to"-i"* visited him on the Omaha Reservation, at which time he gave the *wi'-gi-e* and songs recited and sung by the *Tse-dó-ga I"-dse* gens at the *Wa-shá-be A-thi"*, war ceremonies, together with a detailed description of the ceremonial forms. A description of the *Wa-shá-be A-thi"* was secured from *Wa-xthi'-zhi* of the *I"-gtho"-ga* gens, but ceremonial etiquette restrained him from giving the parts that belonged to the *Tse-dó-ga I"-dse* gens. The *wi'-gi-e* given by *Xu-thá Wa-to"-i"* are as follow:

1. *Wí'-gi-e* of the Sacred Fire, 77 lines.
2. *Wi'-gi-e* relating to certain symbolic articles made by the gens, 400 lines.
3. *Wí'-gi-e* of the Sun and the Moon, 17 lines.
4. *Wí'-gi-e* of the Sacred War-club and the Buffalo Bull, 26 lines.
5. *Wí'-gi-e* of the Elk, Puma, Bee, Black Ant, etc., 58 lines.
6. *Wí'-gi-e* relating to the Cleaning of the Sacred Pipe, 47 lines.

Following are the songs given by *Xu-thá Wa-to"-i"*:

1. *Hí"-no"-xpe Ga-xe Wa-tho"*, Song 1, four stanzas; Song 2, four stanzas; Song 3, one stanza; Song 4, three stanzas; Song 5, four stanzas; Song 6, six stanzas.
2. *Wa-ts'é-the Wa-tho"*, Song 1, eight stanzas.
3. *Wa-tsé Wa-tho" I"-ga*, Song 1, five stanzas; Song 2, four stanzas.
4. *Tsi-ú-thu-gi-pe Wa-tho"*, Song 1, twelve stanzas.

The *wi'-gi-e* and songs that have been recently secured from *Xu-thá Wa-to"-i"*, with explanatory notes, have not yet been put together and typewritten. On account of other work in process, pertaining to the Osage rites, it will be some time before these can be taken up.

While presenting this report, word has been received that *Xu-thá Wa-to"-i"* died in December, 1915. (See portrait, fig. 131.) A member of the *Tse-dó-ga I"-dse* gens informed Mr. La Flesche that the portion of the tribal rites committed to his gens had died with *Xu-thá Wa-to"-i"*. This would have been true but for the fortunate circumstance that last September all that the old man knew of

the rites belonging to his gens was secured. This material, together with a paraphrase of one of the *wi'-gi-e* obtained from *Pá-thi'-wa-we-xta* in 1912, makes possible a fair presentation of the rite.



FIG. 131.—Portrait of Xu-thá Wa-to'-i'n, an Osage.

#### ETHNOLOGICAL WORK AMONG THE NATCHEZ, CREEK, AND CHICKASAW INDIANS

Dr. John R. Swanton was in the field for about two months during 1915, from toward the end of September until well after the middle of November. The first two weeks and the last week were devoted to work among the few remaining Natchez Indians and the recording





FIG. 132.—Watt Sam, one of the three surviving speakers of the Natchez language, and his home.



FIG. 133.—Hilibi square ground and ball post, near Hanna, Oklahoma.

of texts and other linguistic material from one of the three Indians still able to speak the Natchez language. One hundred and thirteen pages of text with interlinear translations were secured.

About three weeks were spent among the Creek Indians, recording myths and obtaining additional ethnological information. About 80 pages of myths were obtained in English, and in addition 33 pages of native text from a young Creek Indian able to write in his own language.

During the remainder of the time Dr. Swanton made a preliminary visit to the Chickasaw in order to learn how much of their ethnology can be recovered. Not much time was spent in any one place, but a



FIG. 134.—“Stomp ground” in the Cherokee country, Oklahoma. There are seven seats, one for each of the seven Cherokee clans. The Natchez Indians living among the Cherokee have a similar ground.

considerable list of Chickasaw clans was secured and some additional notes were obtained regarding various matters connected with the ancient culture of the tribe.

#### WORK AMONG THE INDIANS OF CALIFORNIA AND ARIZONA

Mr. John P. Harrington became a member of the staff of the Bureau of American Ethnology February 20, 1915, and devoted the rest of the year to the study of the Chumashan and Yuman Indians of California and Arizona, establishing headquarters for the convenience of his field studies at the Southwest Museum in Los Angeles and at the Panama-California Exposition in San Diego, where he was

granted facilities by the courtesy of these institutions. Results of researches conducted by him before entering the service of the Bureau have been elaborated and necessary additional material has been obtained.

On May 29 Mr. Harrington went to Santa Inés mission where he found among the old records preserved at the mission a manuscript bearing the title, "Padron que contiene todos las Neofitas de esta Mision de la Purisima Concepcion con expresion de su edad, y partida de Bautismo segun se halla hoy dia 1º de Enero de 1814," by Father Mariano Payeras. This document, which appears to have been unknown to historians, is of the greatest value for the study



FIG. 135.—A Yuma fiesta.

of the Indians of La Purisima and Santa Inés. A copy of it was made for the Bureau and a large amount of other material was extracted from the archives of the mission. While at Santa Inés Mr. Harrington succeeded in locating the sites of some of the former rancherias mentioned in the records of the mission.

On June 19, Mr. Harrington proceeded to Arroyo Grande, where he worked for a week with a poor, sick old woman, the sole survivor of the San Luis Obispo Indians. The importance of the immediate rescuing of her language and the other information which she can furnish can hardly be overestimated.

The latter part of July and the month of August were spent in San Diego working with a Chumashan informant. The period from September 1 to December 31 was spent at San Diego and Los Angeles in the elaboration of the San Luis Obispo and other material.

Interesting results of the work are the finding of the existence of totemic clans among the Indians of the Chumashan stock and the determination of the genetic relationship of Chumashan and Yuman.

#### EXPERIMENTAL FLIGHTS WITH THE ORIGINAL LANGLEY AERODROME

The trial flights with the original Langley aerodrome (built 1898-1903), which were begun in May, 1914, under the direction of Mr. Glenn Curtiss, to determine whether the machine was fundamentally



FIG. 136.—Langley machine in launching condition on skates on Lake Keuka, March 9, 1915.

correct in design and construction, were continued in 1915 at Lake Keuka, New York.

Toward the end of February, 1915, the machine was mounted on three elastic skates preparatory to launching it from the ice on Lake Keuka, with its original motor and as nearly as possible in its original condition. When thus assembled for flight it weighed without pilot 955 pounds, including five gallons of gasoline and the necessary oil and water. The aeroplane frame and wings were on March 2 taken on a tug boat 12 miles down Lake Keuka to where the ice was thick, and placed upon the ice under the brow of a wooded hill whose shelter made it easier to wing and unwing the machine in the wind.





FIG. 137.—Langley machine ascending from the ice on Lake Keuka in March, 1915.



FIG. 138.—Langley machine in flight over Lake Keuka, May 20, 1915.

Short flights were made from the ice. On March 10, after a stationary propeller test on the ice showing a thrust of less than 300 pounds, the aeroplane was headed down the lake against a wind of



FIG. 139.—The Column of Progress at the Panama-Pacific Exposition, 1915.  
Photograph by Walcott.

six miles per hour for a trial flight. She ran over the lake at fair speed with but four cylinders working. The poise on the ice was steady. After a short run the rear skate arose clear of the ice; then the front skates of the machine were sustained in the air for some 75 feet, as shown by the measured breaks in the traces on the ice. The

machine then landed gently on the ice owing to the falling off of the motive power.

In May and June several short test flights were made over the waters of Lake Keuka as shown in figure 138.



FIG. 140.—Nearer view of the Column of Progress at the Panama-Pacific Exposition, 1915. Dedicated to aviation; Langley tablet on west side. Photograph by Butman.

The accompanying photographs, figures 139 and 140, show the Langley Tablet on the Column of Progress, dedicated to aviation at the Panama-Pacific Exposition, 1915.

## FOG CLEARING INVESTIGATIONS

With the aid of a grant from the Smithsonian Institution, a committee of electrical engineering experts under the general direction of Mr. F. G. Cottrell continued during 1915 the investigations begun by the University of California in cooperation with the United States Lighthouse Service, relative to the clearing of fog by means of electrical precipitation. In a preliminary report read at the first meeting of the committee, Prof. Ryan of Stanford University, says, "Science has established the fact that all dust and fog particles in the open atmosphere are electrified and subject to dispersion or precipitation. It is apparent, therefore, that a source of very high direct voltage with facilities for control and application may be of inestimable value in certain quarters and seasons for clearing fog away from a street, from along a passenger railway, from around the landing stages of a ferry, or possibly about or in advance of a ship under headway at sea."

The clearing of fog differs from the treatment of smoke and fumes in several respects, principally in that the smoke particles must plainly be actually deposited on the electrodes to bring about the desired effect, whereas in treating fog, it is only necessary to cause coalescence of the minute particles into larger ones to give much greater transparency, even disregarding the more rapid settling of the larger drops. However, other difficulties are to be expected in the problem of clearing fog, such as the conditions arising from the continual immersion in the wet atmosphere. What is chiefly needed for an intelligent conception of the problem is actual first-hand experience in handling these and other unusual conditions.

A great deal has been learned during the year about the electrical technique of the problem, and although days of suitable fog conditions have been extremely scarce, on the rare occasions of actual trial, very perceptible clearing for a short distance around the high tension wires was obtained as the fog swept past.

## STUDIES IN SOLAR RADIATION

The Mount Wilson Station of the Astrophysical Observatory was occupied by Messrs. Abbot and Aldrich from May to October, 1915, and numerous measurements of solar radiation were made there. During June unusually many days were marred for these observations by cirrus clouds, but the later months were uncommonly fine. In October almost every day proved suitable for the work.



As in former years a principal object of these investigations was to detect and measure changes in the amount of solar heat. Results of the now fully reduced work of 1913 and 1914 show that in 1913 (a time of extremely low solar activity as indicated by the numbers of sun-spots, faculae, etc.), the sun's output of radiation was nearly



FIG. 141.—Observing station of Astrophysical Observatory on Mount Wilson with new tower telescope. Photograph by Abbot.

three per cent below normal, and that with the return of activity in 1914, the output of radiation rose to about one per cent above normal. The work of 1915, not yet fully reduced, seems to indicate that high values will be found to prevail in this year also.

Fluctuations of solar radiation from day to day, while noted, appear to have been less marked in 1914 than in earlier years.

The need is very urgent that other observing stations in remote regions of the earth take up the daily measurement of solar radiation in cooperation with the Astrophysical Observatory. Preferably not less than four stations in relatively cloudless regions, widely separated, should be engaged in this work. The variation of the sun is established. Its influence on terrestrial climate and conditions of growth of vegetation cannot be well determined unless the results of the Astrophysical Observatory are verified and supplemented by prolonged routine observing at several cooperating stations.