

THE CALIFORNIA REDWOOD IN MODERN ENGINEERING.

BY H. A. CRAFTS.

The California redwood (*Sequoia sempervirens*) has been chiefly celebrated in its primitive form of gigantic trees; its place in modern mechanics has not been so extensively dwelt upon. Yet at the same time the wood occupies an important position in the industries of the country, especially those of the Pacific slope.

While the use of redwood is large and increasing, the supply is limited. The principal field of supply extends along the Pacific coast from the northern boundary of California nearly to San Francisco Bay, and reaches inland only from ten to twelve miles. There is a limited area of redwoods south of San Francisco, but it does not count much in the general supply of lumber. Humboldt County in the north, which contains the larger redwood forests, has cut 52,000 acres of the wood, but still has left 486,000 acres. It is estimated that this acreage contains 49,000,000,000 feet of redwood lumber, which at the present rate of consumption, about 250,000,000 feet annually, would last about two centuries. More conservative estimates, based upon a broader knowledge of supply and demand and the probable increase in consumption, give only one century for the final exhaustion of the country's supply of redwood. As no measures are being employed with an idea of conserving the supply, this estimate will doubtless prove to have been pretty nearly correct.

The demand for redwood in the lumber trade is increasing. Its use is at present almost wholly confined to the Pacific slope, but the millmen of the coast are exerting themselves to push the material into the eastern markets, especially the market of Chicago. The redwood in a manufactured state has thus far been used in the East in the shape of shingles; but its adaptability to the manufacture of doors, sash, blinds, mantels, as well as to making of both

exterior and interior finish, stave pipe, etc., will be demonstrated.

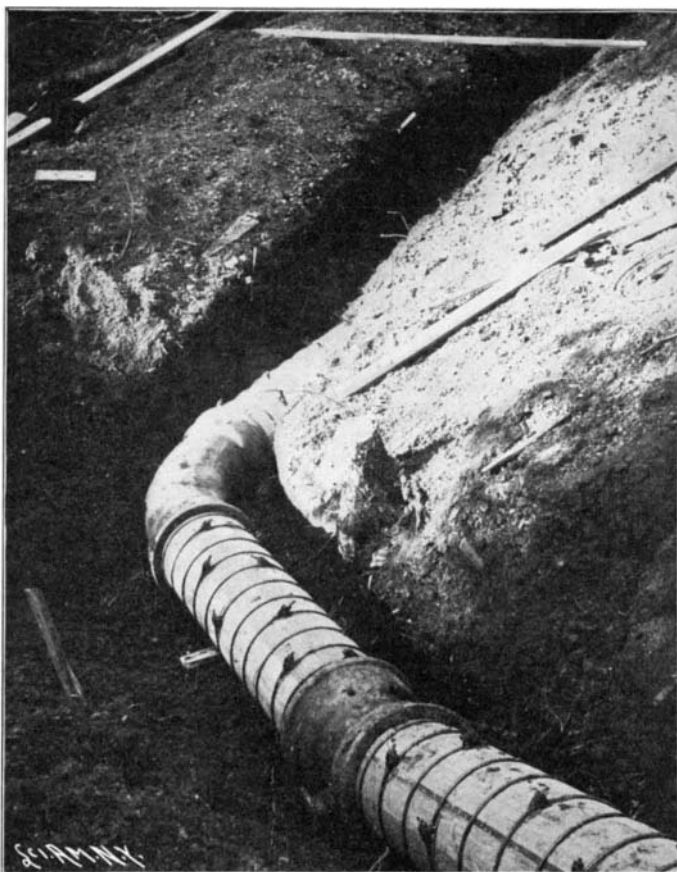
The uses to which the redwood is put in California are almost innumerable; but its employment in the manufacture and use in stave pipe and tanks is of special interest. The principal uses to which redwood stave pipe are put include domestic water supply, ir-

rigation, water power, and outfall sewers. The pipe is slowly finding its way even into the more extreme East, the Excelsior Wooden Pipe Company, of San Francisco, having just secured the contract for installing a system of domestic water supply in Lynchburg, Va., which includes twenty miles of pipe of 30-inch internal diameter. The same company not long since installed a section of water-power pipe of the same wood at Cornell University, New York, of an internal diameter of 60 inches.

But it is in the great mining, irrigation, and domestic water supply operations of the Pacific slope that the more striking features of the use of redwood stave pipes and tanks are observable. The stave pipes vary in size from an internal diameter of eight inches to nine feet; while one manufacturing company has in contemplation the construction of a pipe to have an internal diameter of ten feet. The redwood tanks are used principally for the holding of water, but at the same time many are used for the storing of oil and wine, while they enter largely into the construction of cyanide plants for the separating of ores. In the construction of this class of tanks it is interesting to note that a former custom of building them larger at the bottom than at the top has become almost entirely obsolete, the modern tank being built in the shape of a perfect cylinder.

The larger stock tank has a capacity of 100,000 gallons. A tank of this capacity would have an outside diameter of 31 feet 9 inches and a height of 18 feet.

The larger-sized redwood stave is made in short sections, and the radii of the curves in the completed pipe lines are necessarily long. The radius of the ordinary curve in a ten-inch pipe is about 125 feet, while that of a nine-foot pipe is about 800 feet. In meeting sharp curves it is found necessary to introduce riveted steel elbows. In the smaller pipes, however, it is found pos-



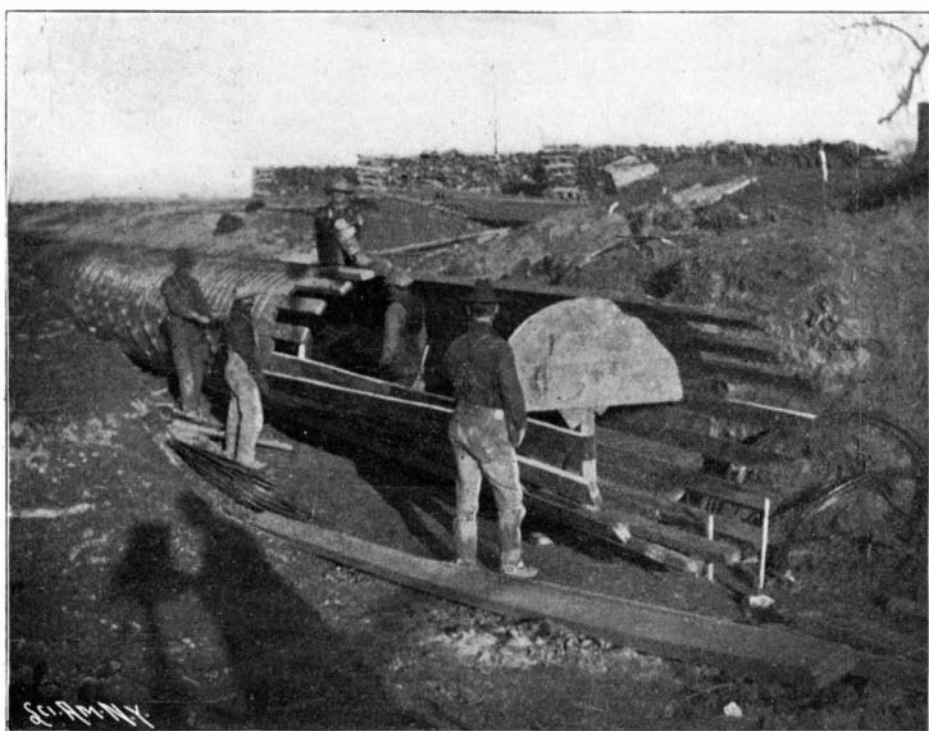
Redwood Pipe with Steel and Iron Elbows.



Redwood Stave Pipe that has Supplanted an Irrigation Flume.



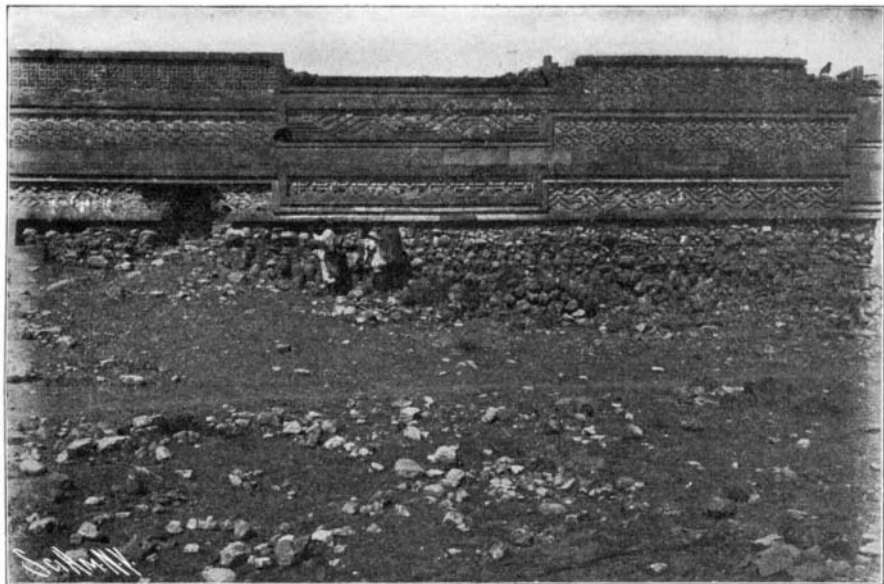
Two-foot Domestic Water Service Redwood Stave Pipe Showing Two-foot Gate.



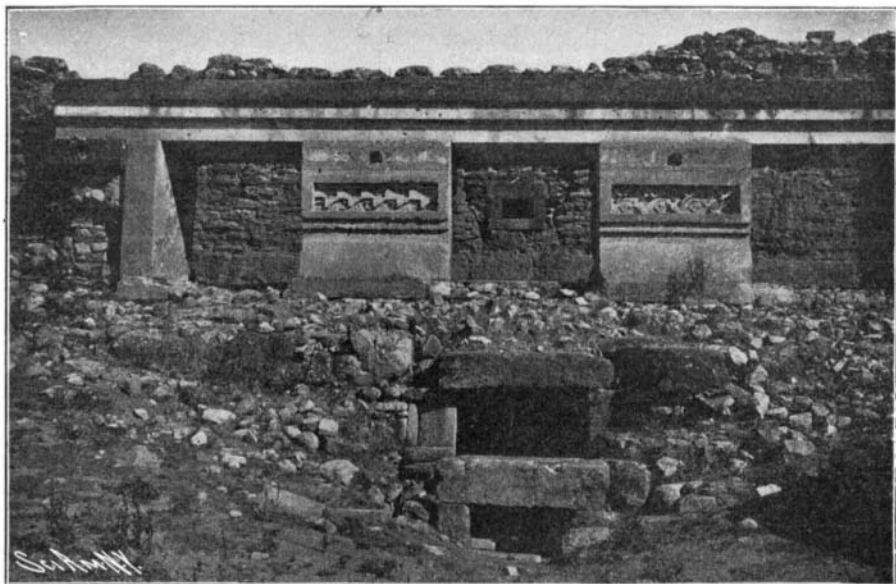
Laying a Redwood Stave Water Pipe.



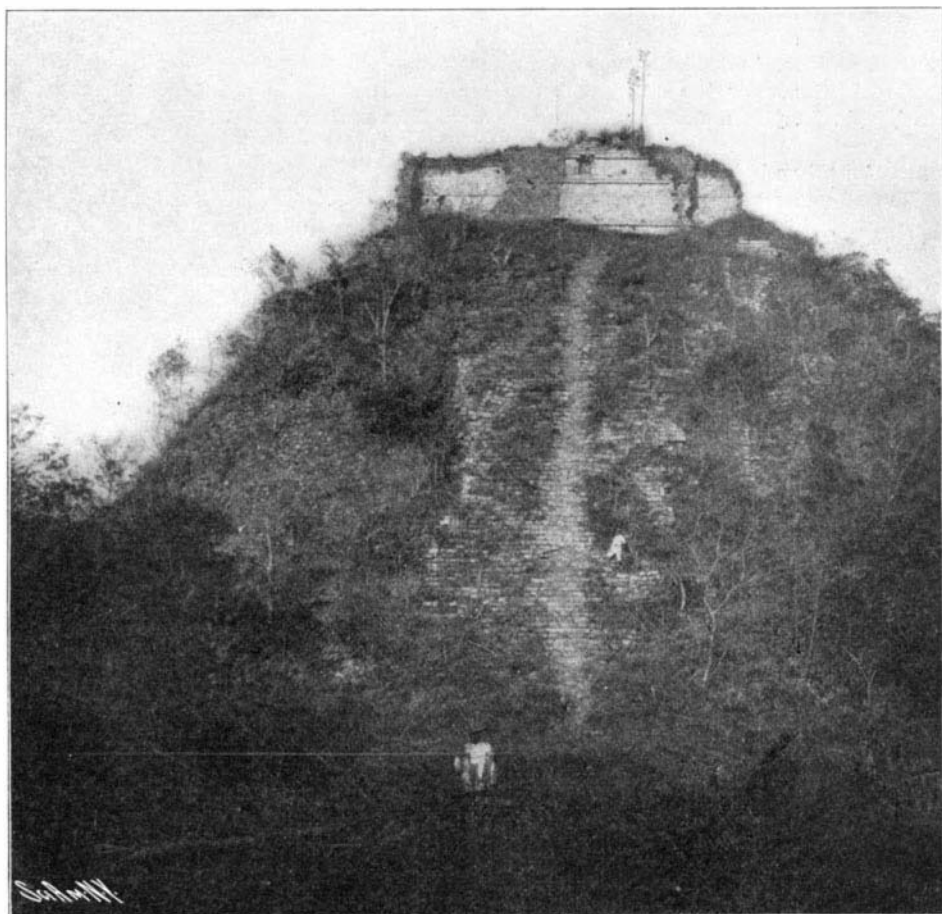
Three 54-inch Redwood Stave Pipes Used for Power Purposes.



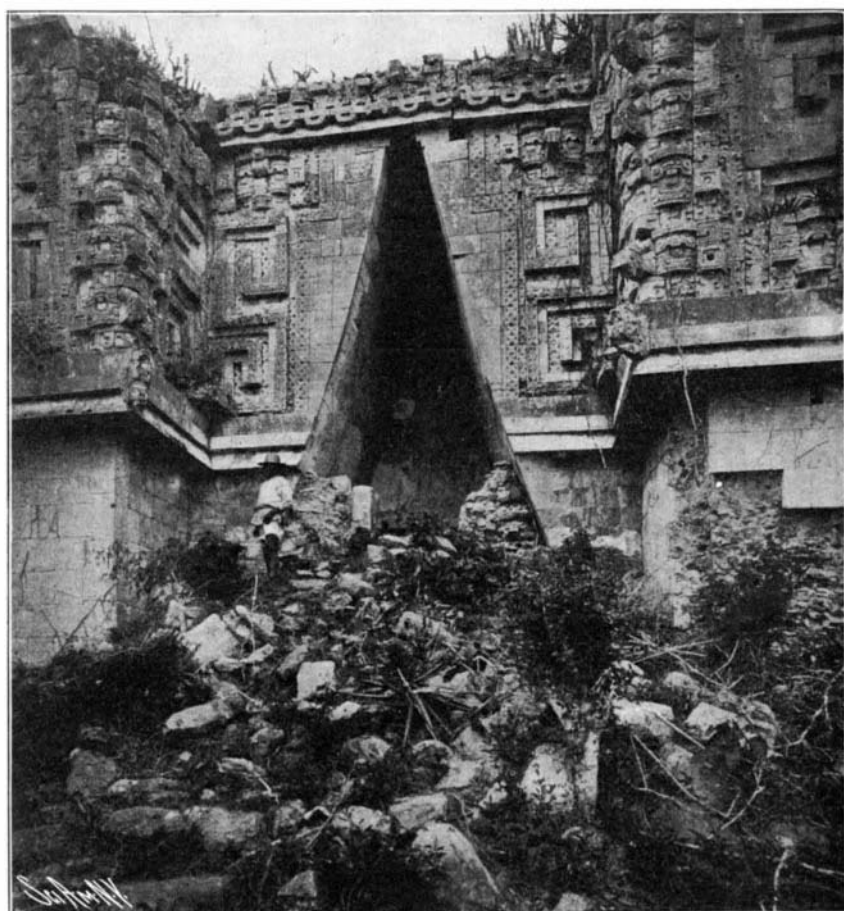
Exterior View of the Temple of the Columns, Mitla, Oaxaca, Mexico.



Facade of the Temple at Mitla. Below Appears the Obstructed Opening Leading into the Subterranean Chambers.



Ruins of the Great Pyramid Temple Called the "House of the Magician," Uxmal, Yucatan.



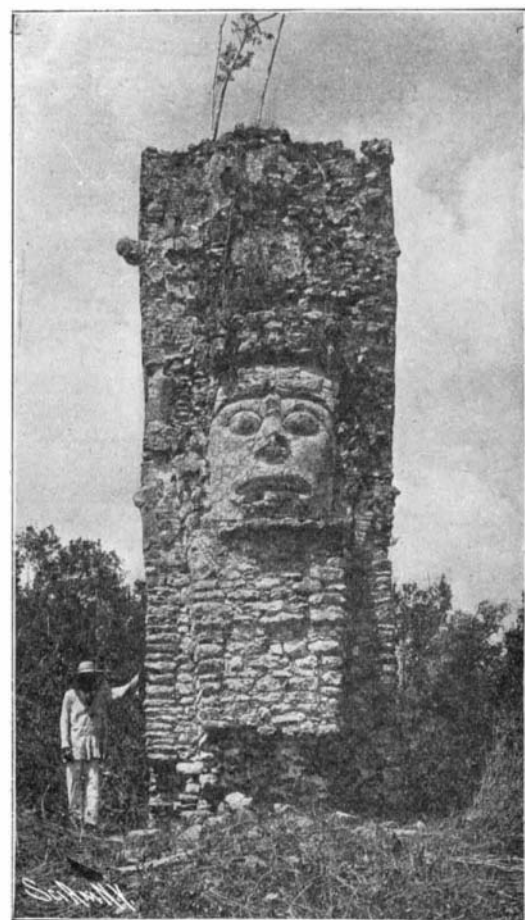
One of the Great Arched Doorways of the House of the Governor, Uxmal, Yucatan.



Aztec Sculpture Representing Two or More Deities of the Aztec Pantheon. Height, 10 Feet; Weight, 12 Tons.



The Ruin of a Small Temple on Cozumel Island, Eastern Yucatan.



Ruin of the Building Showing Remains of a Great Stucco Face, Noenchich, Northern Yucatan.

sible to use cast-iron elbows. In constructing wood stave pipe around a curve, the staves are fitted together, partially banded, and then, by applying such power as the surrounding conditions will permit, the pipe is made to assume its desired shape. During the application of the power the staves are driven endwise, in order to close the butt joints. To bring the larger-sized pipe into proper curve, it is usually the custom to employ jack screws.

The use of the redwood stave pipe has been found especially favorable to hydraulic engineering in the West, because of its lightness and ease of transportation. For the construction of pipe lines in mountainous countries, remote from railroad transportation facilities, it fills the bill almost completely, for the reason that it can be carried in the "knocked-down" shape. If need be, the staves may be lashed to the backs of burros, and thus carried into places absolutely inaccessible to a vehicle of any kind. When thoroughly seasoned, the California redwood has a lighter specific gravity than almost any other known wood, weighing only about two and a half pounds to the board foot. The wood also possesses a great power of resisting decay, for the reason that it is very free from knots, seams, and pitch.

In the irrigated districts of the Pacific slope the use of redwood stave pipe is being largely employed in the conducting of water across deep canyons and gulches, taking the place of the old-fashioned trestled flume. Pipe thus employed usually does its work in the shape of an inverted siphon.

The manufacture of stave pipe is quite a simple process, the staves being turned out by an ordinary machine called a "sticker." The edges of the staves are of course cut on radial lines, and the sides on concentric circles that conform to the inside and outside radii of the pipe or tank under construction.

THE ANCIENT RACES OF YUCATAN AND MEXICO.—II.

BY RANDOLPH I. GEARE.

The number of ruined cities in Yucatan, and the State of Chiapas to the southeast, is very large. Two explorers alone discovered the remains of fifty-four ancient cities, including in Chiapas the wonderful remains at Ocozingo and Palenque, and in Yucatan the monumental ruins at Maxcanu, Uxmal, Sacbey, Izamal, Chichen, and a host of others, in the interior; and at Tuloom, Tancar, and on the island of Cozumel on its eastern coast. Among these the ruins of Palenque, Uxmal, and Chichen are among the most remarkable for their architectural forms and ornamentation, but they, as well as others represented by the illustrations, have been made so well known in these columns that it seems unnecessary to dwell on their characteristics in this article, which, as already indicated, is intended to deal rather with the people than with their buildings.

The men who built these cities were, as has been pointed out, far removed from the condition of nomadic tribes. Taste and luxury had long been grafted on the mere wants of the natives. They had learned to build, not only for protection against the elements, but for permanent residence. Here, however, as in Egypt, the remains are chiefly of temples, palaces, and tombs. The worship of God, the safety of the body after death, and obedience to authority, are demonstrated by the temple, tomb, and rock-built palace.

The country of the Aztecs, now called Mexico, was formerly known as Anahuac, a Toltec word signifying "situated near the water." At first this name was applied only to the Valley of Mexico, on account of its numerous lakes. When Grijalva in 1518 discovered the shores of Anahuac, the country was divided into four kingdoms, three republics, and a host of small states. Mexico was the chief kingdom; then came Colhuacan, Tlacopan, and Michoacan. The republics were Tlaxcala—whose citizens, for centuries enemies of the Aztecs, made common cause with Cortez—Cholula, and Huexotzinco.

When Europeans first landed in Mexico, they found a numerous race of people called Nahuas, or Aztecs, who had developed a civilization at once astounding and incomprehensible to the adventurers. Their industrial attainments were fully evidenced by their spacious temples and other large and elaborate structures, which to-day, in part at least, testify to their former greatness. Their principal community was at that time in the Valley of Mexico, although, according to tradition, the original home of the Aztecs was Aztlan, in or near the Gulf of California.

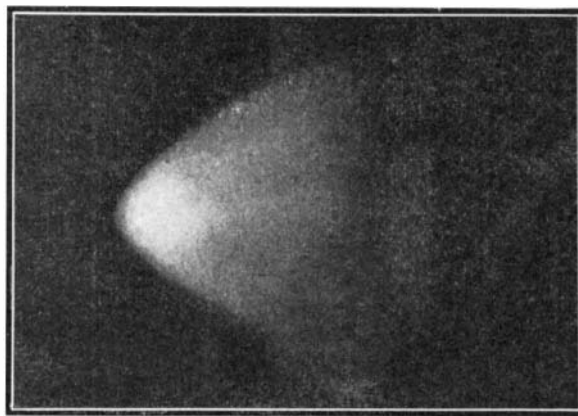
About the year 648 A. D., seven of the principal tribes of the great nation of the Nahuatlacs left their homes, advanced toward the valley of Anahuac, and subsequently returned. Many years later they set out again, crossed the modern province of Xalisco, following the course of the Toluca River, and stopped at Culiacan. Here Huitzilpochtli, the terrible god of war, demanded that they should build him a tabernacle, and that the priests should carry it. The Aztecs, special protégés of this god, were commanded to sep-

arate from their companions and to take the name of Mexi, in honor of their being favorite sons of Mexitli, which was another name of this war god.

The Aztecs for a long time led a sedentary life, while the Nahuas natives spread over Anahuac, and covered it with kingdoms. Thus divided and subdivided, the Nahuas were for centuries engaged in conflict with one another, resulting in the smaller states being annihilated by the larger, which in turn would perhaps have been absorbed by the Aztecs, had it not been for the advent of the Spaniards. Then leaving Culiacan, the Aztecs entered Colima, and went as far east as Tollan. Wandering ever in search of a final resting-place, they reached Tzompango ("place of bones"), a large city of the valley to which they were destined afterward to give their name of Mexicatls, and from which the word Mexico was later formed. Here they were sorely persecuted by one of the generals of the Chichimec king Xolotl, and they therefore sought refuge at Chapultepec, which belonged to the Colhuas. The Colhuas soon declared war against them, and the Aztecs were reduced to a state of slavery. After fighting successfully for their masters against the Xochimilcos, in the hope of regaining their liberty, they were treated worse than ever, and were finally ordered to leave the country. Their wanderings began again, and finally they settled (and this time permanently) near the lakes Tezcoco, Xochimilco, Chalco, and Xaltocan. Here in 1325 they founded the great city of Tenochtitlan, now the city of Mexico, where they reared huge temples and other buildings.

In appearance the Aztec was of medium height, thick-set and well-proportioned. He had a narrow forehead, flat nose, black eyes, large mouth, thick purple lips, short regular teeth, well set in rose-colored gums. His hair was black, thick, and coarse, and his beard scanty. His skin was of a dull copper color.

South of Vera Cruz lies the State of Oaxaca, a region which also seems to have once been the seat of an advanced civilization. Interesting remains, including tumuli, are known to exist at Tachila, at Monte Alban, six miles from the city of Oaxaca, where there are



COMET "1904 A" AS SEEN MAY 19, 1904. 10 H. 19 M.

tumuli and pyramids, at Coyula, at San Juan de los Cúes, at Guengola, at Quiotepec, and at Mitla. Most of these ruins present pyramidal shapes in combination with the vertical. The ruins of Mitla are perhaps the most interesting of all, with their monuments and palaces, which excite universal wonder and admiration for the power of this ancient people, giants in the art of building and decorating edifices of stupendous dimensions and of exceedingly ornate decoration. There it was that the Aztecs in 1494 finally subdued the natives, and it is supposed that large numbers of the unfortunate Zapotec inhabitants of Mitla and Huaxaca (or Oaxaca), who had previously become prisoners of Ahutzotl, swelled the splendid but brutal sacrifice of human victims with which the great temple of Mexico was dedicated in 1487.

The cruelty of the Mexican sacrifices of human beings has always been one of the principal arguments against the civilization theory of the Aztec race; but all religion includes the idea of sacrifice, and the Aztec sacrifice arose probably from a blended motive of propitiation and policy. The human sacrifices by that people were perhaps founded on the idea that the best way of getting rid of culprits, dangerous people, and prisoners of war taken in large numbers, and whom it was impracticable to support or retain in subjection, was to offer them to the gods. Viewed only in the light of their idolatry, it is difficult to account for their intellectual advancement in architecture and other industrial and artistic pursuits; but as the latter are readily demonstrated, it must be held that these manifestations of a system of advanced civilization prove their social condition to have been much more refined than their religion, from which we may conclude that the Valley of Anahuac, although a hotbed of priestcraft and superstition, was also the center of a cultivated society.

According to the reports of explorers, the chief object sought in the erection of the grand edifices at Mitla and elsewhere, was to preserve the remains of

their princes; and it is alleged that at the death of a son or brother, the sovereign retired to this place, and taking up his residence in a portion of the building, performed religious services and indulged in ceremonious grief. Other reports say that these spacious though solitary abodes were inhabited by an association of priests who devoted their lives to expiatory services for the dead. Their isolated sites are certainly well adapted for any purpose of a gloomy nature; for, according to travelers, the silence of the lovely valleys is unbroken even by the songs of birds. A large portion of the valley, overlooked by a noble group of mountains, is said to be still covered with heaps indicating the sites of ancient architecture; but as most of the ground is under cultivation, every relic of the architecture at this point is destroyed, and even the ground-plans have become so indistinct as to make research useless. There is another lot of ruins at Mitla, however, consisting of four connected or nearly connected buildings, each fronting a cardinal point, and the whole inclosing a square court. They have been described in detail by several explorers, and the reader is referred to the literature for the facts concerning the ruins at this place and others, some of which are illustrated in this article from photographs secured by Mr. William H. Holmes in connection with his explorations of this highly interesting region in 1894-95.

Many accounts of the peopling of Mexico by the Aztecs have been written, most of which seem to agree in the main essentials, namely, that Yucatan and the territory of the Zapotecs were once inhabited by a refined people, who were later subordinated to the Aztecs by conquest; that regarding the settling of the Vale of Anahuac, the original inhabitants came from some unknown place "at the north," and in the fifth or eighth century, settled at Tollan or Tula, in the neighborhood of the Mexican Valley; that this spot became the parent hive of an industrious and progressive people, whose northern frames and characters were civilized and not emasculated by the more genial climate to which they migrated; that they cultivated the soil, built extensive cities, conquered their neighbors, and after performing their allotted task in the development of the continent, wasted away in the tenth or eleventh century under the desolation of famine and unsuccessful wars, the Toltec remnant emigrating southward; that during the next hundred years, the valleys and mountains of this beautiful region were nearly abandoned, until a rude tribe known as the Chichimecas came from the north, and settled among the ruins abandoned by the Toltecs; and that some years afterward several tribes of the Nahuatlacs reached the valley, announcing the approach of another band from the north, known as the Aztecs.

Thus it will be seen that wave after wave of population poured from the north into the valley till it was reached by the Aztecs, who about the year 1160 left their mysterious and unknown site at Aztlan. After one hundred and sixty-five years of wanderings they descried an eagle grasping in a claw a writhing serpent, and resting on a cactus which sprang from a rock in the Lake of Tezcoco. This had been designated by the Aztec oracles as the spot where the tribe should settle after its long and weary migration; and accordingly the city of Tenochtitlan (now the city of Mexico) was founded on the sacred rock, and like another Venice rose from the bosom of the placid waters.

COMET "1904 A."

M. L. Rudaux, who for some time past has been making some interesting discoveries and observations at his private observatory at Douville, France, has recently succeeded in photographing the new comet called "1904 A."

From the viewpoint of the discovery of this comet, the utility of astronomical photography is clearly shown, since it was in a photograph enlarged eight and a half times that the discovery was made. On the other hand, this discovery brings into prominence the advantages to be gained by the use of simple portrait lenses for this kind of photography. The comet 1904 A was very faint and of about the 9th magnitude, and yet owing to the rapidity of the objective, it required a short exposure of but half an hour for the star to make a sharp impression upon the plate. Contrary to what usually occurs, the negative reveals scarcely any trace of tail, while direct observation shows a short fan-shaped one.

In the 4½-inch equatorial provided with a magnifying power of 45 diameters, the comet was difficult to see. At the outset, nothing was distinguished but a small nebulous mass and a brilliant nucleus. Afterward, there was perceived a wide fan-shaped appendage. The nucleus occupied internally the apex of a triangle formed by the fan, so that the front of the comet appeared to be pointed. The luminous intensity of the tail was seemingly produced by different sectors or, better, trains provided with a coma. Finally, the nucleus appeared to be multiple, but at instants solely, because of the great difficulty of observing it.