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THE AGAVES, A REMARKABLE GROUP OF USEFUL PLANTS.

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GENERAL NOTES.

The early explorations in America brought to the attention of Europeans various novel forms of plant life which were utilized by the Indians for food or in their primitive industries. Some of these plants were found in the wilderness, where the natives searched for their products at the proper season; others had become of such importance and value that they were cultivated in a crude way over large areas. The European colonists, recognizing their utility, developed several of these plants, the most notable of which, for the part it has played in the early settlement and subsequent growth of America, is Indian corn.

Among the many strange and interesting plants found in the Mexican wonderland by Cortez and his followers were those forming the group variously known to-day as Century-plants, Agaves, or Magueys, one of the most remarkable groups of the plant world. Humboldt considered the Agaves, next to maize and potatoes, the most useful of the natural products of tropical America. They are placed by botanists in the genus *Agave* of the Amaryllidaceæ, a family closely related to the lilies.

CHARACTER AND DISTRIBUTION OF AGAVES.

The Agaves are natives of America, where they occur from southern Nevada, Utah, and Texas, south through Mexico and Central America into Brazil. Their strongly individualized and picturesque character renders them especially interesting for decorative purposes, and the early botanical travelers, sent to gather strange plants for European commercial gardens, brought home numerous species for propagation, which were distributed to various parts of Europe. Many of these were new to science and attracted the attention of botanists, who gave them names, but were usually unable to state definitely the place of origin of the species described. Others have been described from herbarium specimens, often with an equal lack of information as to the region whence they came. The result is a multitude of named species with but little definite information of the distribution of

more than a very few. Dr. J. N. Rose, probably the best American authority on these plants, estimates that there are about 150 recognizable species now known in the genus *Agave*, although botanists have bestowed upon them more than twice that number of names. From present knowledge of the group, however, it is safe to predict that future study will demonstrate the existence of many more species. Agaves are most numerous, both in species and individuals, in the arid and semiarid parts of the table-land of Mexico and adjacent mountain slopes. Their center of abundance is in the Austral life zones between the altitudes of 2,000 and 8,000 feet; still some species thrive on the low coastal plains of the Tropics, and others on the rugged crests of desert mountains in the Transition zone, from 8,000 to 10,000 feet above the sea. During the summer of 1902 the writer found a sturdy species similar to *Agave wislizeni* in rocky places among the firs and pines at an altitude of 10,000 feet in the State of Coahuila, Mexico.

The geological formation has a direct influence on the growth and abundance of Agaves. Limestone areas, where the bed rock is exposed in many places, and has only a thin cap of soil when covered, appears to be most favorable to their development. In Mexico and the Southwestern United States are vast limestone areas, especially in Yucatan and the plains and mountains of the northeastern part of the Mexican table-land and western Texas. In many parts of these areas various species of *Agave* often grow in such thorny abundance that it is difficult to pick one's way among them. Mr. Vernon Bailey has estimated that about 20,000 square miles of limestone territory in western Texas is covered more or less abundantly with the small *Agave lecheguilla*.

Second in importance to limestone in its influence on the growth and distribution of Agaves are volcanic formations such as are seen about the southern end of the Mexican table-land.

All Agaves require years for their development before flowering, and this has given rise to the popular name "Century-plant," borne by *Agave americana*; but it is doubtful if any species under natural conditions actually spends more than fifteen or twenty years in maturing.

The Century-plant (*Agave americana*) may be taken as a typical member of the genus, though there are numerous modifications of this type among the many known species. Practically all agree in having more or less rigid leaves, each broadly attached at the base and terminating in a strong, horny spine. The leaves vary greatly. In some species they are long and slender, with smooth edges; in others long and fleshy, with heavy, recurved claw-like spines set at short intervals along their borders; and in others short, broad, and still more formidably armed with spines. These armed leaves, clustered about

FIG. 1.—GROUP OF AGAVE WISLEZENI, WESTERN TEXAS.

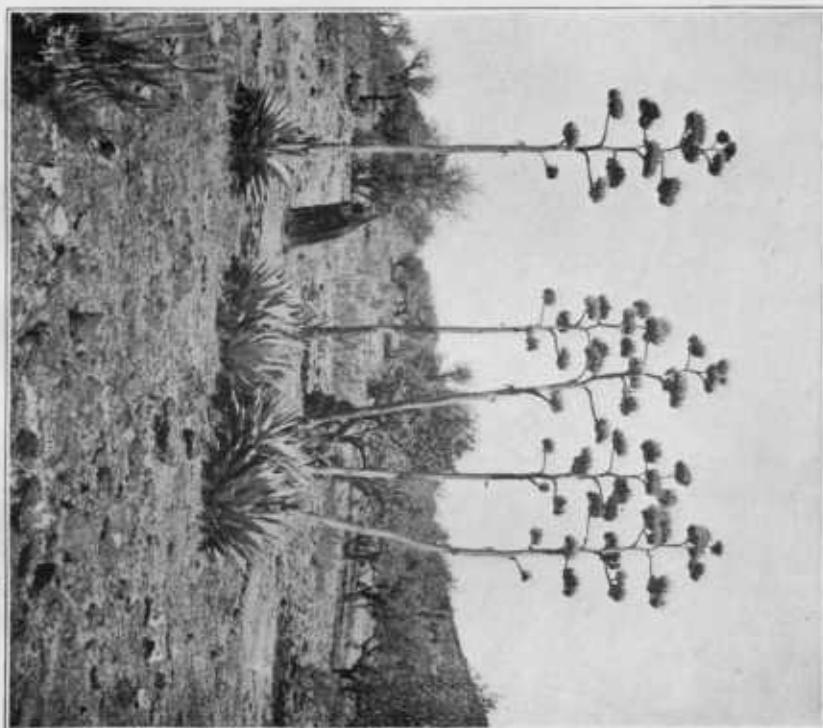


FIG. 2.—PULQUE GATHERER, VALLEY OF MEXICO.



the base of the plant, bristle threateningly at all comers, and serve forcefully to protect the tender tips of the budding flower stalks that might otherwise furnish tidbits to hungry rabbits and ruminants. The puncture made by the stout spine at the end of the leaf is very painful. When, in addition to this terminal spine, the leaves of a large plant have their sides thickly set with strong, claw-like thorns, the protection they afford becomes very evident to the plant collector who tries to reach the flower stem without first cutting away the outer leaves.

PRINCIPAL TYPES OF AGAVES.

There are four principal types of development among these plants: (1) *Agave wislizeni* (Pl. XXXIII, fig. 1), with short, broad leaves, found in the mountains of western Texas; (2) the tequila plant of Jalisco, with large, fleshy base bearing numerous long, slender leaves; (3) the Sisal Agave of Yucatan, with yucca-like trunk; and, (4) a form found on the Mexican table-land, characterized by the development of large, fleshy leaves on a comparatively small base.

The most striking member of the last-mentioned type is the huge Pulque Maguey, the giant of the entire group, which thrives best between 6,000 and 8,000 feet above sea level on the semiarid plains of the southern half of the Mexican table-land. It reaches its greatest development in Toluca Valley and the valley of Mexico, where the huge, fleshy leaves are sometimes 9 feet long and weigh over 100 pounds each, though usually much smaller. Every plant bears from 25 to 50 leaves around a massive, fleshy base, and the largest plants weigh from 1 to 2 tons each.

THE PULQUE MAGUEY.

Pulque, the national drink of the Mexicans, is made from the juice or sap of the Pulque Maguey. The valley of Mexico is the center of cultivation of this plant, and many extensive haciendas or plantations that are devoted entirely to growing it yield large revenues to their owners. The plants when two or three years old are set out in long, parallel rows; they reach maturity in from twelve to fourteen years. In order to insure a succession of harvests, new settings are planted yearly, and even with the long delay in the first crop the business is very profitable. The large, fleshy leaves, as in other members of this genus, are persistent, and spend all the years of their immaturity in slowly storing up quantities of sweet sap. At the expiration of this long period, which might almost be called a period of incubation, a change occurs in the plant's organism. It has attained the supreme moment toward which all the hoarding of sap during the past years has been directed; the character of its activity changes, and with marvelous rapidity a gigantic central flower stalk shoots up 20 to 50 feet. This stalk, which is sometimes a foot in diameter at the

base, is fed generously from the store of sap in the base and leaves. Its upper end branches like a candelabrum, and greenish-white flowers spring forth in palmated clusters. Hummingbirds, orioles, and various insects, attracted by the nectar of the blossoms, pass from plant to plant, and thus insure fertilization, the object of the plant's existence. After the seeds form, the leaves and base, having exhausted themselves in this final effort, wither and die.

On the pulque plantations the plant is not permitted to run its natural course, but is subjected to special treatment. Pl. XXXIII, fig. 2, shows the process of collecting and transporting the juice of the pulque by gatherers, who every day or two for several months visit the tapped plants.

The value of the total product of pulque amounts to millions of dollars annually.

The Pulque Maguey is also commonly set out as a hedge about fields and gardens and its sap gathered for family consumption. This mode of cultivation is shown on Pl. XXXIV.

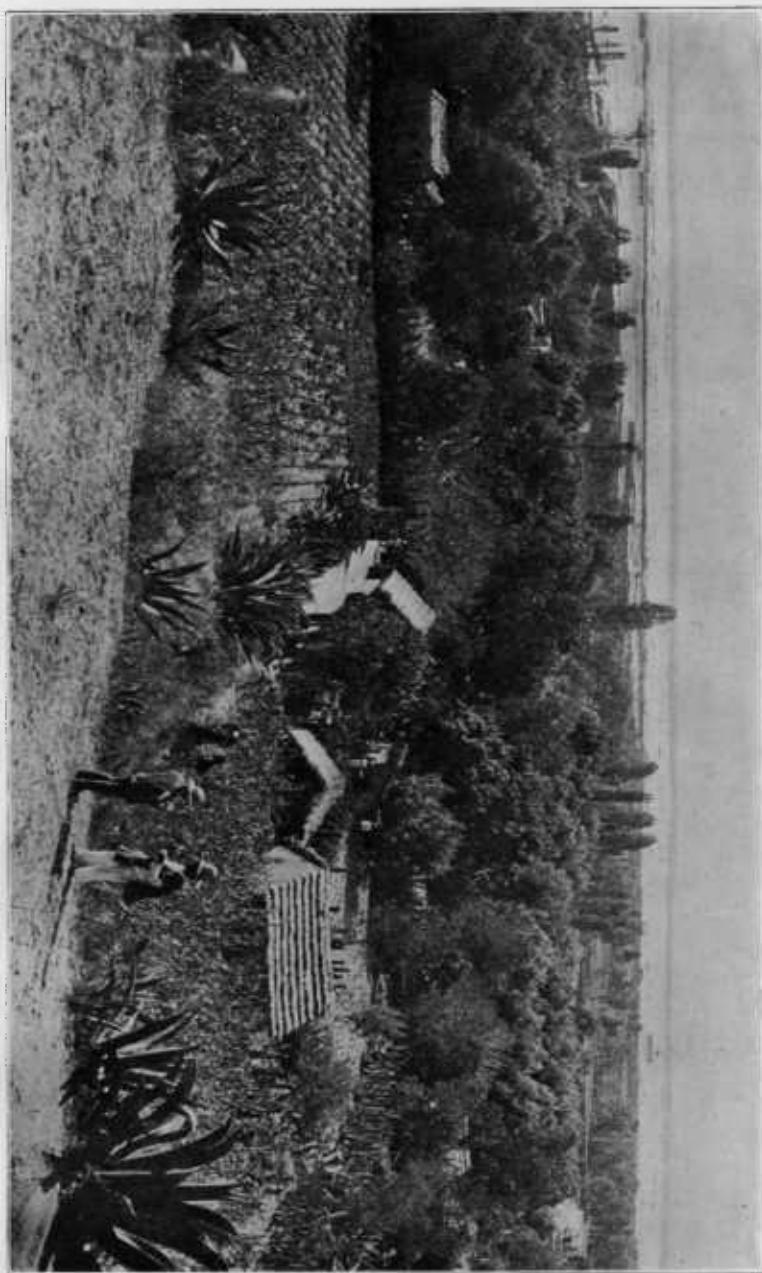
THE MESCAL.

In addition to the species of *Agave* that yield pulque, a number are utilized to produce distilled alcoholic liquors of different kinds. An alcoholic drink common in Mexico, the product of the *Agave*, is known as "mescal."

Other liquors distilled from various species of the Mescal *Agave* are known as "tequila," "huila," and "comiteco." Pl. XXXV shows a tequila plantation and the manner of transporting the fleshy bases of the plant.

USE OF AGAVES AS FOOD.

So far in the story of these plants there has been room for question as to their ultimate benefit to mankind. There is no doubt, however, concerning the usefulness of certain other members of the genus. The fleshy bases of numerous species of *Agave* are roasted and eaten by Indians and mountaineers both in Mexico and the Southwestern United States. Several of the six species growing wild in southern Nevada, Arizona, New Mexico, and Texas have been well known to the Indian tribes of that region from time immemorial, and still retain the Mexican name "Mescal," whence was derived the name of the Mescalero Apaches of southern New Mexico. The fleshy bases of the mescal are prepared for food in practically the same manner both in Mexico and the United States. Mescal "pits" are made by heaping up masses of *Agave* bases with fuel and covering them with stones and earth, much in the form of charcoal pits, after which the mass is fired. The slow roasting which results lasts from one to three days and brings about certain changes. The fleshy substance becomes sweet,



HEDGES OF PULQUE MASUEY, VALLEY OF MEXICO.



FIG. 1.—TEQUILA PLANTATION, JALISCO, MEXICO.



FIG. 2.—MULE TRAIN CARRYING BASES OF TEQUILA AGAVE TO DISTILLERY, JALISCO, MEXICO.

and the heart of the plant tender, with much the taste and consistency of an artichoke. Sometimes a shallow pit is dug and lined with stones, which are thoroughly heated by building a fire on top of them. The bases of the Agaves are then freed from their leaves and placed on the stones, a fire is built over them, which, when well started, is covered with earth, and they are left to roast. Roasted mescal is still commonly sold in the market places of small towns over a large part of Mexico and to some extent among Mexicans in towns along the southwestern border of the United States.

MISCELLANEOUS USES OF AGAVES.

The juice of the young leaves of some species is acrid and a mild irritant, and the fresh pulp applied to the skin produces an irritation similar to that of a weak mustard plaster. In ancient times the fresh juice was used to cauterize and cleanse wounds.

The strong terminal thorns of some species were used by the Aztec priests to pierce their tongues, ears, and other parts during certain rites of expiation. The slender flower stalks formerly served for lance shafts, and the large ones are still used by the natives as rafters for their small houses and for fences. The large hollowed leaves are frequently employed to thatch the huts of the poor, both in the country and about the borders of towns.

A number of species of Agaves, known as "Amoles," contain such an abundant supply of saponin that the fleshy parts of the leaves, bases, and sometimes of the roots when rubbed up in water make a good lather and serve excellently for soap. This substance is a satisfactory emollient to the skin, and the Mexican women prize it for washing their hair, which it makes both soft and glossy. It has already entered into the composition of a manufactured hair wash, and efforts have been made to make a soap from it. It is free from alkali, removes stains from delicate fabrics, is said to set colors, and does not shrink flannels like ordinary soap. In southern Arizona *Agave schotti* is the main soap-yielding species, and its properties are well known to the Mexicans of the region, who also call it "Amole."

The Aztecs also utilized the Agave leaves for making a tough paper, upon long, narrow sheets of which were painted in brilliant colors their pictured historical records. Some of these records, known as codices, still exist in collections, and both the colors and paper appear to be little affected by the lapse of the centuries since they were made. The paper of the Aztecs is of a dingy color, but in 1854 a company in Mexico succeeded in making from the Agave leaves a great variety of papers, from the coarsest cardboard to the finest white letter paper, all characterized by unusual toughness and durability, some grades almost equaling parchment in this respect.

TEXTILE PRODUCTS FROM AGAVES.

All Agaves have series of long, slender fibers extending in a thin longitudinal layer just under the surface of each leaf, and centering in the strong horny spine at the tip. The writer has at various times seen the natives, when wishing to hastily repair a coarse garment or sacking, break loose this thorny point of an Agave leaf, and, stripping it away with some of the attached fibers, thus provide themselves with a stout, ready-made needle all threaded for use. The length, strength, quantity, and quality of this fiber varies greatly in different species. The length of the fiber in each case is governed by the length of the leaf. The fibers of the Pulque Maguey are small in quantity and not very strong, but are very long, soft, and silky in texture. They were woven by the Aztecs into soft, delicate garments for the nobles. These garments were often brilliantly colored with native dyes and handsomely embroidered, and their fineness and beauty excited the admiration of the early Spanish invaders.

The uses of Agave fiber among the Mexicans have come down as an inheritance from prehistoric times. Each community knows perfectly the quality of fiber yielded by every kind of Agave growing in its district, and the ranchmen and villagers gather from the wild plants on the surrounding hills the material for their cords, ropes, sacking, and a variety of other articles. The articles made in excess of local demand are taken to market in the larger villages, and form one of the regular but small sources of income to the natives. In some districts, where the wild agaves yield a specially good quality of fiber, the outside demand for the product has created local industries of some importance. Usually products of this kind are in the hands of scattered individuals, mainly Indians, who work in the crudest manner, but in many places the industry has a larger growth under direction of the owners of haciendas, who thus add materially to the revenues of their possessions.

The best fiber-producing Agaves grow in districts where the geological formation is wholly limestone, and often on areas where the underlying rock is covered with barely enough soil to give the plants foothold. The only two districts in Mexico where Agaves are cultivated extensively for their fiber—Tamaulipas and Yucatan—are of this character, the underlying limestone outcropping at short intervals and at best only thinly covered with soil. The first of these areas is situated at an altitude of between 1,500 and 5,000 feet above sea level in western Tamaulipas, and covers the valleys of Jaumave and Tula. It annually exports through the port of Tampico to the United States nearly \$500,000 worth of the fiber, which is obtained partly from a wild Agave (*Agave heteracantha*) growing on the sloping borders of the valley and partly from a similar plant cultivated in the valley



FIG. 1.—CUTTING LEAVES OF SISAL AGAVE IN YUCATAN, MEXICO.

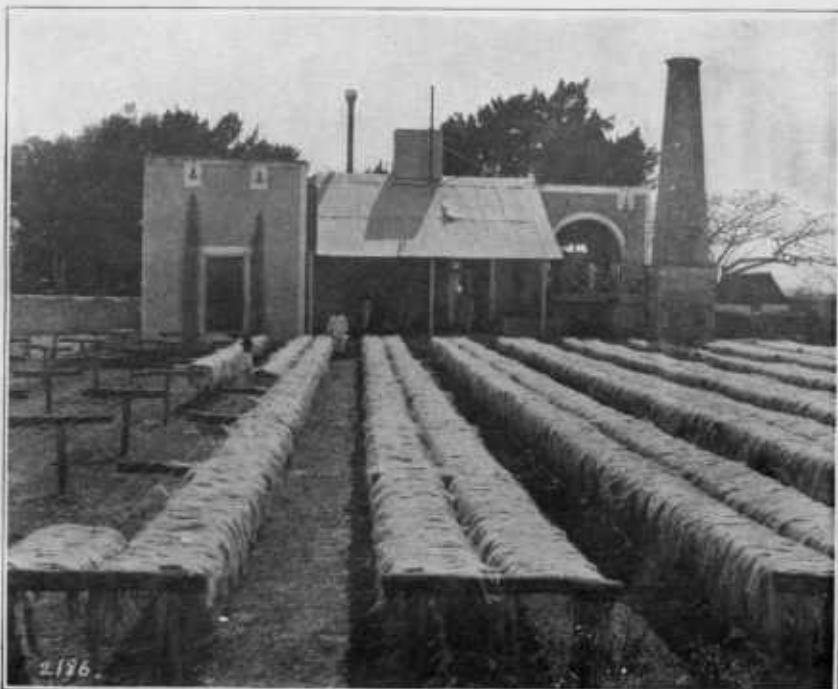


FIG. 2.—DRYING SISAL FIBER AT STRIPPING MILL, NEAR MERIDA, YUCATAN, MEXICO.

bottoms, which reaches a much larger size. The fiber from this district is called "ixtle," and is packed on mules to the nearest railroad point for shipment to the coast.

Yucatan is the main center of production for Agave fibers in Mexico. The peninsula of Yucatan is a limestone plain but little above sea level and with a thin covering of soil. On this thrives *Agave sisalana*, the plant which yields the "sisal," "sisal hemp," or " hennequin" of commerce. This is cultivated on large plantations, which, under present conditions, are enormously profitable to their owners. Pl. XXXVI, fig. 1, shows the Indian workmen cutting the fiber-bearing leaves of the sisal on a plantation near Merida, the capital of Yucatan. Yucatan now exports annually about \$12,000,000 worth of this fiber to this country, and the amount is steadily increasing. The climate of the peninsula in the sisal district is arid tropical, and the country, though its extremely rocky character renders it almost worthless for any other crop, from this source alone is rapidly becoming, in proportion to its population, one of the richest sections of Mexico. Some ingenious machinery has been invented for stripping the fleshy pulp from the fiber of the leaves. Pl. XXXVI, fig. 2, shows the freshly cleaned fiber lying on drying frames at one of the stripping mills on a plantation near the city of Merida.

The success of the cultivation of the Yucatan Agave has led to its introduction into the Bahamas and some of the West Indian islands. Over sixty years ago it was introduced into southern Florida by Dr. Perrine, American consul at Campeche, who tried to acclimatize useful tropical plants in this extreme southern part of the United States. More recently it is reported that efforts are being made to introduce it into the State of Tamaulipas, Mexico. Yucatan lies below the frost line, and it is a question whether the Agave of that region will prove hardy enough to grow within a frost-visited area. But the "lecheguilla," as the Agave that produces the ixtle fiber of western Tamaulipas is called (probably a distinct species from the *Agave lecheguilla* of Texas), is hardy enough to withstand sharp frosts, and thrives naturally on land practically worthless for other purposes. It is quite possible that it might be profitably grown on land not otherwise available for agriculture in the large area in western Texas where the *Agave lecheguilla* is found, or in other sections of some of the southwestern border States. It may be that the native plant, the *Agave lecheguilla*, which has a shorter, coarser fiber of unknown value, would repay exploitation. The enormous increase during recent years in the value of the Mexican fiber product from this source, with its main market in the United States, appears to justify experiments in the introduction of some of the species of demonstrated value.

CONCLUSION.

By way of conclusion of this brief account of the Agaves, it may be stated that their varied employment for food, drink, soap, clothing, cordage, needles and thread, paper, parts of dwellings, parts of weapons, sacrificial implements, medicaments, and ornamental garden plants amply justifies Humboldt's estimate of their usefulness to mankind.