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Tequila and other *Agave* spirits from west-central Mexico: current germplasm diversity, conservation and origin

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Abstract Current germplasm diversity used in the production of *Agave* spirits in west-central México is in danger of erosion due to an expansion in the cultivation of the clone *A. tequilana* Weber var. azul, used for the elaboration of the famous drink ''Tequila''. In order to define critical areas of in situ conservation and to determine the role of local native and mestizo cultures in the generation and maintenance of diversity, an ethnobotanical exploration was conducted in the center and south of the state of Jalisco. Results situate the nucleus of greatest diversity at present in the south of Jalisco and indicate that this is a result of a continuous process of selection initiated by the indigenous population for the production of food and fermented drinks, which continued into the final years of the 16th century but with a new objective: distillation using the Filipino technology introduced to west-central Mexico through Colima. More than 20 variants were found to be cultivated by the traditional farmers, the majority relating to the *A. angustifolia* Haw. complex. We discuss the possibilities of in situ germplasm conservation and its legal protection.

Keywords *Agave tequilana* · *Agave angustifolia* · Mezcal · Tequila · Intraspecific diversity · In situ conservation · Genetic resources · Domestication

Introduction

Mesoamerica is one of the three most important areas of origin and diversity of cultivated plants in the world. In the case of the agaves, it was here that ''The great genetic diversity in a genus rich in use potential came into the hands of several peoples who developed the main agricultural center of the Americas'' (Gentry 1982, p. 3), allowing this area to become the center of an explosive diversification through human selection. A group of species of this genus, collectively known in many

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regions of Mexico as ''mezcals'' (from the Nahuatl ''metl'' = *Agave* and ''ixcalli'' = cooked or baked), is among the most important and widely used prehispanic food plants in the seasonally dry regions of Mexico and Central America, where it is naturally distributed (Bruman 1940). Its history of diversification under cultivation and human selection can be divided into three important periods: its use as food, dating back at least 11,000 years, its use in the elaboration of fermented drinks, and its use in the elaboration of spirits. This last stage, which began towards the end of the 16th century, has registered a considerable commercial growth over the last 50 years, with characteristics that are endangering the current diversity of this group of species.

In order to maintain the current diversity of cultivars and their genetic and productive improvement, along with legal protection of the germplasm and derived products, special attention must be given to the role that local and indigenous cultures have played in these processes, since it is within these cultures that the most drastic diversification and genetic improvement of cultivars has been occurring, i.e. the passage from wild populations to domesticated ones. In the case of Mexico, it is within the indigenous and mestizo cultures that this diversity continues to show a dynamic development, maintenance and improvement (Hernández-Xolocotzi 1978), thus research in these areas is of vital importance. The rapid socio-economic and cultural changes involved in the globalization of markets represent a threat to the cultural diversity which has maintained the agricultural biodiversity. However, globalization of markets offers, at the same time, new opportunities to maintain and spread the diversity of its cultivars.

Before the development of agriculture, the group of *Agave* species known as ''mezcales'' represented a basic food source for the gatherer populations living in the arid and semi-arid areas to the north of the Isthmus of Tehuantepec and as far as Rio Gila in Arizona. The ''quiotes'' (floral peduncles) and in particular the ''heads'' (stalks and leaf bases that remain attached to the stalk after the leaves are removed), both cooked in pits, have been used in the same way since 9000 BC approximately (Fig. 1) (Bruman 1940; Callen 1965; Smith 1986). This group of species was one of the basic food sources to which other plants, such as maize, beans and squash were eventually added. In time these crops gradually displaced the agaves, their importance declined and they became a food source for times of scarcity.

The use of cooked ''heads'' in the elaboration of fermented drinks did not extend as far north as their use as food, but it was quite extended at the time of the Spanish Conquest, forming what Bruman (1940, pp. 17–18) called the great cultural region of ''Mezcal wine'' (Fig. 1). Within this great region, this author defined five areas according to the alcoholic drinks predominating in them. The area in which drinks based on agaves and *Spondia purpurea* L. predominated, he called ''Mezcal-Jocote'' (Fig. 1), delimiting it as the area occupied by ethnic groups inhabiting part of the modern states of Sinaloa, Nayarit, Jalisco, Colima, Michoacan and Guerrero in the west of Mexico (Bruman 1940, p. 142–147).

The crucial event for the origin of *Agave* spirits was the introduction of the still in Colonial times (Bruman 1940). Within the ''Mezcal-Jocote'' cultural area, this introduction derived originally from the Filipinos brought by the Spaniards to the coasts of Colima and Jalisco in the Manila Galleons in the late 16th century (Bruman 1940, 1944, 2000). The Filipinos introduced the elaboration of fermented and distilled drinks from coconuts (*Cocos nucifera* L.) with their own technology,

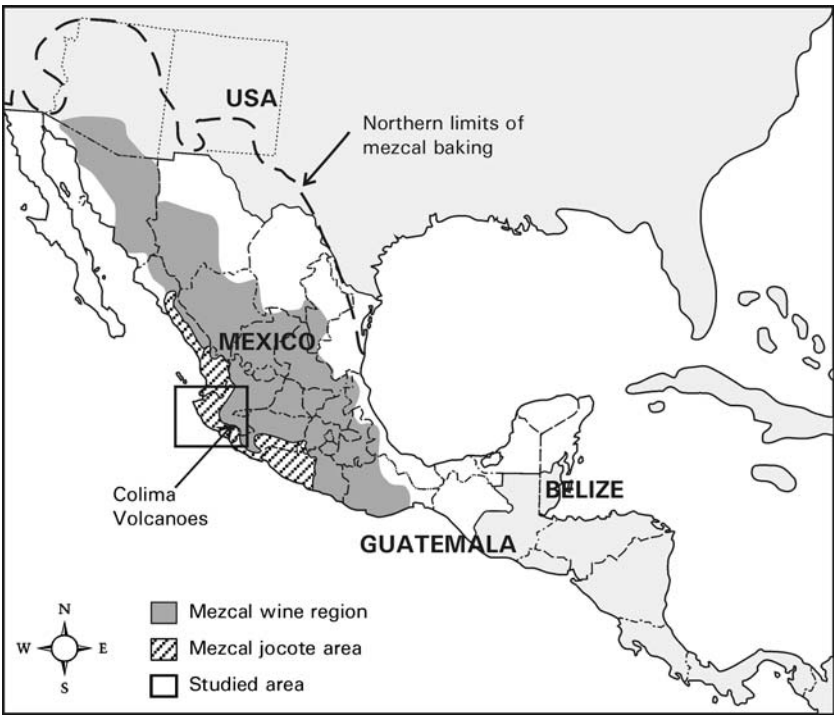

Fig. 1 The great cultural region where agave is used as food, the ''Mezcal wine'' region where fermented agave beverages were very important in prehispanic times, and the ''Mezcal-Jocote'' cultural area, in which fermented drinks were derived mainly from agaves and from *Spondias purpurea* L. Modified from Bruman (1940, 2000)

using a still unlike any in Europe and which could be built with local materials, very different from the Arabian still made of copper, used at that time by the Spaniards.

> The introduction of the process of distillation was so early, the product of the stills so attractive to the natives, and stills, once seen, so easily fashioned from native materials, that the mezcal wine soon come to be looked upon almost everywhere, an intermediate stage (Bruman 1940, pp. 18–19).

Wherever an *Agave* distilling industry arose in the colonial period, as a result of the introduction of the Asian or European stills, it is possible to confirm, according to Bruman (1940, p. 18; 2000, p. 20), that an undistilled *Agave* fermented beverage was already known in pre-Columbian times, which in turn was preceded by the knowledge of a plentiful source of wild *Agave* plants for food.

Walton (1977), synthesizing the findings of Bruman (1940, 1944), while adding new data, proposes that the 400-year-old history of Tequila and the other *Agave* spirits has been brought forward from its beginnings in the 16th century when the indigenous population living in the foothills of the volcanoes of Colima first submitted the fermented *Agave* beverage to the Filipino still. Its subsequent diffusion in the 17th and 18th centuries, according to this author, was directed north, towards the district of Tequila and the region of ''Los Altos'' in the present-day state of Jalisco;

to the south in the modern states of Michoacan, Guerrero and Oaxaca, after which it then spread to the mining centers of the north: Sonora, San Luis Potosi and Tamaulipas.

During the 19th century, one of these agave spirits drinks, the ''mezcal'' produced in the city of Tequila, in the state of Jalisco, became known by the name of the city in which it was elaborated, giving rise to the famous ''Tequila'' (Walton 1977). Legally recognized as a Denomination of Origin in 1974 (Diario Oficial de la Federación 1974, 1997), this drink has become enormously popular at national and international levels, which has led to a dramatic increase in its areas of cultivation. Given the fact that, since 1949, the Official Mexican Standard for Tequila stipulates that only the distilled drinks produced with the clone known as *A. tequilana* Weber var. azul or ''blue agave'' can use this name, its explosive increase has had a negative effect on the cultivation of other species and varieties of agaves used traditionally in the region of Tequila for the same purpose (Valenzuela-Zapata 1994, 1997). Its asexual propagation by shoots and, more recently, its cloning propagation in vitro, has also led to a drastic reduction in its genetic diversity (Gil-Vega et al. 2001). *Agave tequilana* Weber was recognized by Gentry (1982) as a clone derived from the complex *A. angustifolia* Haw.

This work presents the results of an ethnobotanical exploration of the current diversity of germplasm in relation to the production of Tequila and other *Agave* spirits in west central Mexico. The objectives were (1) Define critical areas for in situ conservation, and (2) Determine the role played by local native and mestizo cultures in the generation and maintenance of this diversity. Based on the hypothesis that if the foothills of the volcanoes of Colima was the area in which the Filipino still was adapted to the distillation of traditional fermented drinks from agaves in west central Mexico, then it is precisely in this area that the primary nucleus can be found from which the traditional farmers initiated the selection of germplasm for this purpose. Therefore, it is in this area that the ancestral populations of the native cultivars and their greater diversity can be found. This is the hypothesis which will direct a series of studies commencing with the present work.

Methodology

The ethnobotanical exploration was carried out in September 2003 and April 2004, following the principles of Hernández-Xolocotzi (1971). It was conducted in two regions: (1) In the south of Jalisco, including the area surrounding the River Armería-Ayuquila, which flows into the valley of Colima, and the area around the River Cohuayana-Naranjo-Tuxpan which flows through the valley of Alima (Fig. 2). Both river basins are situated in the foothills of the volcanoes of Colima. Since the production of spirits requires an abundant supply of cold water, the use of the still could have been extended along the banks of these rivers, passing through these valleys to the foothills of the volcanoes. (2) In the center of the state of Jalisco, the exploration was conducted in the region of Tequila-Amatitán (Fig. 2), the area in which the Tequila mezcal became famous, and which is now the most important area of production.

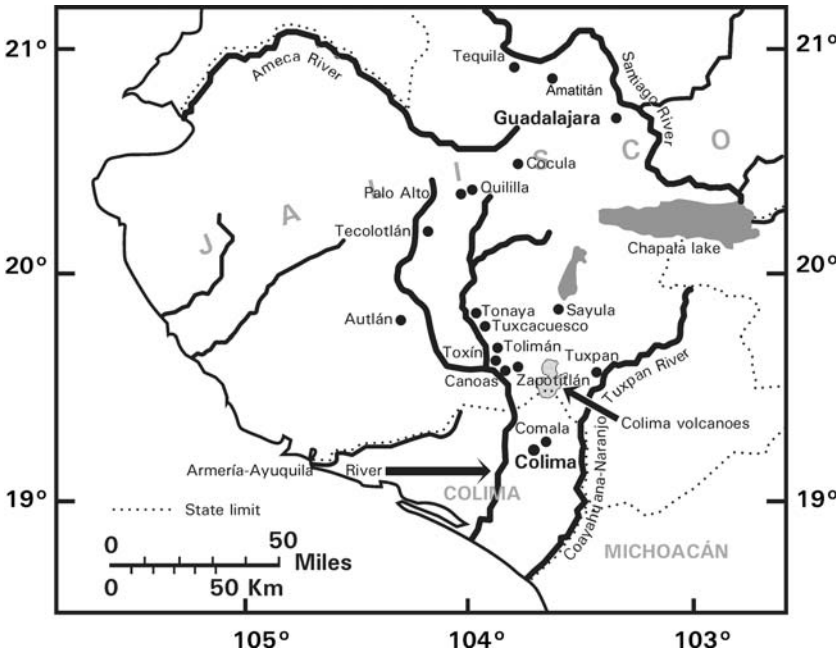

Fig. 2 Studied area. Localities explored in the Center and South of Jalisco, México

In the south of Jalisco, we explored from Cocula to Tuxpan, including Palo Alto, Tecolotlán, Quililla, Sayula, Tonaya, San Pedro Toxín, Tolimán, Tuxcacuesco, Zapotitlán and Canoas (Fig. 2). We interviewed one or two farmers from each town in their fields, asking them about the diversity of the agaves used, their biological and productive differences, the selection criteria and the elaboration processes for the spirits. We collected live plants and herbarium specimens in their areas of cultivation and in the natural habitats. We also included the wild populations of *A. angustifolia* Haw. growing on the semi-arid slopes between Cocula and Tecolotlán, and which Gentry (1982, pp. 583–584) mentioned as being very similar to those of *A. tequilana*, and from which this author believes the farmers of Tequila may have made their original selections. In the center of Jalisco, the exploration was carried out in the region of Tequila-Amatitán (Fig. 2), where we interviewed eight farmers in their fields, collecting samples from the cultivated varieties. One of the farmers accompanied us on an inspection of the natural areas of potential distribution of the wild populations.

The live samples were deposited in the Collection of *Agave* Germplasm in the Centro de Investigación Científica de Yucatán (CICY) (Colunga-GarcíaMarín 2004). The samples of herbarium were also deposited in the CICY.

Specific historical information of the area under study, used to discuss the ethnobotanical information, was obtained from sources that describe the living and production conditions of the ethnic groups inhabiting the Bishoprics of Michoacan and Nueva Galicia during the 16th and 17th centuries. These bishoprics were the political-religious entities to which the area under study belonged at that time. The works consulted were Acuña (1987, 1988), Sevilla del Río (1977) and Tello (1637–1653).

Results

South of Jalisco. Valley of the river Armería-Ayuquila

We found natural populations of *A. angustifolia*, from Cocula to Tuxpan (Fig. 2), including those highlighted by Gentry (1982, pp. 583–584) for their morphological similarity with *A. tequilana*. In Palo Alto, near the locality mentioned by Gentry (1982), we found peasant farmers maintaining encouraged populations of this species for spirit elaboration, beside their traditional crops. In Quililla, also near this locality, we found people who collect the floral peduncles to be cooked and sold.

In the towns of Zapotitlán and Canoas, the most isolated of the populations visited, we found 15 cultivated variants, most of them belonging to the *A. angustifolia* complex sensu Gentry (1982): ''azul'', ''cimarrón cenizo'', ''cimarrón verde'', ''cimarrón negro'', ''chancuella'', ''cuaquesoca'', ''cuchara'', ''de brocha'', ''ixtero amarillo'', ''ixtero verde'', ''lineño'', ''perempis o siriaco'', ''prieto'', ''telcruz'' and ''pencudo''. One producer, alone, Macario Partida, cultivates 11 of these in association with cattle and the traditional food crops: maize, beans and squash, a veritable in situ germplasm bank (Fig. 3). Macario, in addition to the production of food for his family, is also engaged in the elaboration of *Agave* spirits. He frequently roams the foothills of the Colima volcanoes and the ''Sierra de Manantlán'' searching for wild *Agave* populations and, in his own words, ''of any plant that he finds interesting, he brings home two to four samples''. The ones that give good spirit, he propagates and improves through the selection of the best individuals. His criteria for selection are: sweeter juice, a larger fleshy stem which is softer and therefore easier to grind, a more precocious plant with a greater production of shoots and resistance to plagues, diseases and grazing. He also maintains older variants from his town and some that have been selected in others.

The pre-hispanic tradition of elaborating fermented drinks from the *Agave* in this region was recorded by the Spanish chroniclers of the 16th century, who, in the ''Relación de Zapotitlán'' say:

Fig. 3 Macario Partida's plot where he grows 11 agave cultivars for elaboration of spirits (mezcals). Cultivars are in association with staple food crops and cattle breeding. Zapotitlán, Jalisco. (**A**) General view. At the background, the Biosphere Reserve ''Sierra de Manantlán''. (**B**) Detail showing the cultivation of *Zea mays* L. and *Cucurbita* sp

> There is in this province a tree named ''MEXCATL'', that Spaniards named ''maguey'', they produced with it, wine, vinegar, syrup, rope, fabric, timber, needles, nails, and a very proven balsam for injuries. (Acuña 1988, p. 68).

In this region, most of the *Agave* spirits are still elaborated with the same procedures described in the 16th and 17th centuries. In places called ''taverns'', close to rivers and streams, the agave ''heads'' are baked in ground pits and pounded on rock outcrops with wooden mallets (Fig. 4). The crushed material is fermented in pits hand-hewn in the rock below ground level (Fig. 5). The fermented beverage is, even to this day, called ''tuba'', a Filipino term referring to traditional fermented and distilled coconut drinks (Bruman 1944). Although the cooking of the *Agave* ''heads'' is often carried out in groups among several farmers, the raw material is labeled so the fermentation process and subsequent distillation is done individually, allowing each farmer to evaluate his own genotypes.

The similarity of the stills used today (Fig. 6), with the stills used in the 16th and 17th century by the Filipinos in the elaboration of ''coconut wine'', is perfectly clear in the description provided by Fray Antonio de Tello for Colima in 1623:

> The stills are hollow trunks, the thickness of a man, covered by a copper encasing full of water, which is changed as it is heated, and in the middle of the hollow part there is a round fitted board, with a pipe protruding from one side, through which the distillation occurs (Tello 1637–1653, p 650 front).

Fig. 4 (**A**) *Agave* ''heads'' (leaf bases and stems) being carried to the ground pit. (**B**) Heads being baked. (**C**) Heads pounded on rock outcrops with wooden mallets. Canoas, Jalisco

Fig. 5 Fermentation pits hand-hewn in the rock below ground level. Río Armeria. Canoas, Jalisco

This similarity was noted by Bruman (1944) through the comparison between the stills he found in use during 1938 in Bolaños, Tuxcacuesco, Tolimán and Tuxpan, Jalisco, and the Filipino stills described by Feliciano (1926).

In Zapotitlán and Tolimán (Fig. 2), we found coconut plantations apparently introduced since the 16th century. In Zapotitlán, we found the two oldest ''taverns'' of the locality, now abandoned: ''Los Chinos tavern'' and ''Del Campanario tavern''. These ''taverns'', according to the oldest *Agave* spirit makers of the community, were built long ago by ''outsiders'' (probably Filipinos or ''Chinese Indians'', as they were named by the Spaniards). They report that at the turn of the 20th century the ''taverns'' were still used. The fermentation pits are very small, both in diameter and in depth. When they were not being used, these pits were covered with earth in order not to be detected. These facts suggest that the ''taverns'' were originally used by the Filipinos who evaded the colonial laws, running away upriver, to continue with the production of coconut spirit (Gálvez 1785; Sevilla del Río 1977). The enormous influence of the ''Chinese Indians'' in this region has been demonstrated in several studies (Zizumbo-Villarreal 1996; Fuchigami 1990; Gómez-Amador 2000).

In Tonaya (Fig. 2), a less isolated town where commercial production of ''Mezcal Tonaya'' has developed, we found six cultivated variants. One of these, the ''green mezcal'' or ''lineño'', is the preferred for the elaboration of this drink.

Fig. 6 A traditional ''tavern''. Zapotitlán, Jalisco. (**A**) Filipino type still made out of a trunk of *Enterolobium cyclocarpum* (Jacq.) Griseb. The external receiver is an agave leaf. (**B**) Upper portion showing the condenser made with a copper pot and running water from the stream. (**C**) Inner receiver (''spoon'') made of wood

South of Jalisco. Valley of the Río Coahuayana-Naranjo-Tuxpan

In the locality of Tuxpan we found two *Agave* cultivated variants to produce spirits: ''garabato'' and ''peruano''. *Agave* spirits from ''garabato'' are very distinctive of this town.

The farmers from the south of Jalisco are greatly concerned by the expansion of the ''blue agave'' (*A. tequilana* var. azul) used for the production of Tequila. They think that this expansion will result in: (1) the substitution of traditional varieties, (2) a reduction of the area destined to the traditional food crops, such as maize, beans and squash, all of which can be cultivated in association with the traditional varieties of *Agave*, but not with the ''blue agave'', and (3) soil erosion propitiated by monoculture, since this species is planted in the direction of the slope, it is not associated with other crops that protect the soil, such as squash; furthermore, herbicides are applied which eliminate all the plant cover causing exposure of the soil for longer periods (Fig. 7). The main mechanisms of expansion of the ''blue agave'' are land leasing by the Tequila companies and the pressures they exert on the local farmers to stop cultivating their traditional cultivars so as to prevent them from

Fig. 7 Tequila (*Agave tequilana* Weber var. azul) plantations in the ''Barranca de Amatitán'', Jalisco. Soil erosion is propitiated by this monoculture, since it is planted in the direction of the slope and without association with crops that could protect the soil, such as squash. Herbicides are applied to eliminate all the plant cover causing soil exposure for long periods

mixing with the ''blue agave'' sold to the companies. The farmers are also concerned about the elimination of wild populations as a result of purchases made by Tequila companies when ''blue agave'' is scarce.

The interest shown by the farmers in conserving their own varieties resides in their better adaptation to the productive conditions of the area, and to the local market flavor preferences. Since they are more resistant to plagues and diseases, they can be cultivated in association with traditional food crops or with grasses for cattle breeding and without using herbicides and pesticides. The local population prefers the flavor of these varieties over that of the ''blue agave''.

Center of Jalisco. Tequila-Amatitán region

We did not find wild populations of ''blue agave'' nor of *A. angustifolia*, and there was no evidence of any botanical collection having been carried out in this region. This fact indicates that this region is probably outside the natural distribution of the species or that it has disappeared from the area. As for the cultivated variants, already reported by Valenzuela-Zapata (1994, 1997), we found, predominantly, the ''blue agave'', and a few examples of ''sigüin'', ''chato or saguayo'', ''bermejo'', ''pata de mula'' and ''listado''. The farmers referred to the ''zopilote'' and the ''moraleño'' but no examples were found. The erosion of the germplasm of agaves used in the production of spirits in this region has already been documented by Valenzuela-Zapata (1994, 1997) as a consequence of the marked tendency of 19th century producers to select the ''blue agave'' because of its short maturing cycle, its higher industrial characteristics and its greater production of shoots, on the one hand, and, the ordinance by the Official Mexican Standard of Tequila since 1949 requiring the exclusive use of this variety, on the other.

In spite of current pressures on the farmers of this area to stop cultivating the other Tequila varieties so as to comply with the current Official Standard it is still possible to find producers who maintain them in special plots. Their main motivation being their appreciation of the flavor of the spirits derived from them.

Discussion and conclusions

The ethnobotanical exploration confirmed the hypothesis to the effect that the traditional farmers inhabiting the foothills of the volcanoes of Colima, in the south of the present day state of Jalisco, maintain a wealth of local varieties of *Agave* for the traditional production of spirits (more than 20), more in fact than the nine reported for the region of Tequila-Amatitán at the end of the 19th century by Pérez (1887, pp. 132–136). The exploration also showed that the still used at present in this process is the same as that described in the begining of the 17th century for the production of coconut spirits by the Filipino population (Tello 1637–1653), and similar to the elaboration process of *Agave* spirits described by Lumholtz (1902) in the 19th century among the indigenous population of the north and south of Jalisco, and in the first half of the 20th century by Bruman (1940, 1944) in the same area. This evidence suggests that present day varieties involved in the elaboration of Tequila and the other *Agave* spirits in west-central Mexico are the result of a continuous selection process initiated by the native population for the early use of agaves for food and fermented beverages that continued at the end of the 16th century with a new objective: the elaboration of spirits using the Filipino technology introduced through Colima. The selection of varieties for distillation continues today among the descendents of those human populations, now mestizos, who follow this local tradition.

The main characteristics of the three important stages in the history of diversification and evolution under cultivation and human selection of these varieties could have been the following:

Diversification and evolution under human selection

Agaves as food

During this stage, early human selection pressures seem to have focused on the taste of the fresh floral peduncle, determined by their quantity of sugars, water, and saponines (pungency). The localization and harvesting of the peduncles must have favored individuals with taller and thicker floral peduncles. The selection would have initiated for a great number of species in a wide geographical area, from Arizona to the Peninsula of Yucatan (Colunga-GarcíaMarín and Zizumbo-Villarreal 1986; Colunga-GarcíaMarín et al. 1993). The cutting of the peduncle could have indirectly favored the species and individuals with greater capacity for young shoot production, both in the sexual reproductive stage and as juvenile. The selection of taller peduncles could also have favored plants with greater size.

The later baking and consumption of the stalks could have reinforced the selection of plants with a greater capacity to store sugars, less fiber and pungency, and greater size. This type of use, which involves cutting the plant at ground level, at the sexual reproduction stage, favored the species and individuals with a production of young shoots in the juvenile stage. This form of consumption, which increased human interest in the agaves, led to a marked nutritional dependency on them in the semi-arid areas. This, combined with the natural capacity for vegetative propagation of many *Agave* species, favored the recurrent selection of clones with anthropocentric characteristics. Their cultivation under favorable environmental conditions, such as those prevailing around human settlements, allowed selection of individuals

with less resistance to plagues, diseases and grazing, as well as the survival of polyploids and other mutants which presented a reduced capacity for sexual reproduction, generating a reciprocal human-plant dependency.

Agaves for fermented beverages

This use probably involved new selection pressures: the success of fermentation and the flavor derived, through the indirect selection of specific associations with bacteria and yeasts. The reduction of the area in which strong selection pressures on the agaves for food and fermented beverages had been occurring, as a consequence of agriculture development, probably also involved a reduction of the species under human selection for these purposes. The populations of *A. angustifolia* of west-central Mexico maintained a relevant role for these objectives.

Agaves for spirits

The Filipino still, adapted in west-central Mexico to the elaboration of *Agave* spirits, became a key selective instrument to exert new selection pressures on the germplasm already selected during previous stages, which included cultivars adapted to the agro-ecosystems of the region, with high production of shoots and sugars stored in the stem, with specific successful associations with bacteria and yeasts for fermentation and which, therefore, produced fermented beverages with different flavors. The versatile design and relatively small size and weight of the Filipino still, which allows distillations on a small scale, made it possible to continue the individual selection of the genotypes most suitable for the new use. We found in the south of Jalisco a great diversity of genotypes selected with this technique. The introduction of cattle and new agricultural systems, both extensive and intensive, made it necessary to also select variants suitable for these agro-ecosystems.

The diffusion of the idea of producing *Agave* spirits in other areas, some of them with different agro-climatic characteristics, once again increased the diversity of species subjected to human selection and management which decreased when their nutritional importance declined. Such is the case of *A. salmiana* Otto ex Salm in San Luis Potosi (Aguirre et al. 2001); *A. cupreata* Trel & Berger; *A. potatorum* Zucc. and *A. hookeri* Jacobi in Guerrero and Michoacán and *A. marmorata* Roezl and *A. karwinskii* Zucc. in Oaxaca. There are at least 11 species used in Mexico to produce *Agave* spirits nowadays (García-Mendoza 2003).

A very rich and diverse Mexican culture of agave spirits (mezcals) emerged with the different adaptations of the Filipino still, the later adoption of the Arab still, introduced by Spanish colonists for sugar cane distillation, to produce *Agave* spirits, and the blending of both the Asian and the Arab techniques. All these technical alternatives were adapted to the native raw materials and the indigenous and mestizo cultural practices. Another adaptation of the Filipino still may be observed in the description of Bourke (1893) in Michoacan. This adaptation is in use at present. An example of the blending of both techniques may be found in the description of Bahre and Bradbury (1980) in Sonora.

Evidence regarding the early introduction of the Filipino still and its role in the origin of *Agave* spirits presented by Bruman (1940, 1944) and Walton (1977), and confirmed in this work, is in marked contrast with recent postulations regarding the origin of Tequila as an idea of Spaniards, originated in Tequila, Jalisco, based on the

technological model for the fabrication of rum using the arab still, and as a process out of the hands of the indigenous community (Valenzuela-Zapata 1997, p. 36–37; CRT, 2002; Luna-Zamora 2002, p. 33; Muriá 2003, p. 4). Valenzuela-Zapata and Nabhan (2003, p. 9), based on a wrong assignation of affirmations in the works of Bruman and Walton, state that

> The Filipinos brought sugar cane to the coasts of Jalisco and Oaxaca, along with the distillation of rum or aguardiente (Bruman 1935[1]; Walton 1977). The backyard technology for making cane sugar into firewater became the model for transforming pit-roasted and fermented mezcal into the first ''vinos de mescal'' as they were originally called.

The hypothesis for Prehispanic distillation of *Agave*, first proposed by Lumholtz (1902) upon his finding of Huichol and Cora stills, and proposed again by Hernández (2002) due to similarities between the archeological ovens found in Tlaxcala and those used at present in Oaxaca has yet to be proven (Barrios-Ruiz 2004).

Agaves for Tequila

Finally, to paraphrase Gentry (1982), just as this genus rich in use potential came into the hands of those human groups who developed the main agricultural center of the Americas, propitiating its explosive diversification; towards the end of the 17th century it fell into the hands of a commercial plantation system which has been drastically reducing the diversity generated over the previous 10 centuries.

Germplasm conservation and legal protection

The isolated conditions in which traditional agriculture has remained in the south of Jalisco and its socio-economic productive conditions have allowed it to continue being a dynamic scenario for the selection, diversification and conservation of germplasm. This situation, however, is being increasingly endangered by the expansion of the cultivation of the ''blue agave'' clone, that has been reducing the wild populations and the areas cultivated with other traditional varieties.

It is necessary to implement an in situ conservation program in the surrounding areas of the Armería-Ayuquila and Coahuayana-Naranjo-Tuxpan rivers and their tributaries for both the genetic resources of these cultivates and the cultural processes that originated them. This program must support and encourage farmers in their desire to conserve their local varieties and to continue generating new germplasm, through the legal protection of their germplasm and the products derived from it, in order to benefit them directly. These actions may be carried out in accordance to the ''International Treaty on Plant Genetic Resources for Food and Agriculture'' (FAO 2004) and the ''Payment Schemes for Environmental Services'' that the Mexican Government has been trying to stimulate. As this area is located within the Biosphere Reserve ''Sierra de Manantlán'', these actions may be facilitated.

[1] The correct year of publication for the paper cited, is 1944. In this work, and in that of Walton (1977) no mention is made to the effect that the Filipinos introduced sugar cane on the coasts of Jalisco and Oaxaca along with the distillation of rum. Quite the opposite in fact, it says they introduced the coconut and its distillation on the coasts of Colima and Jalisco and from there it passed to the indigenous population for the distillation of Agave fermented beverages.

Germplasm conservation and the generation of new germplasm will be of great importance for future genetic and productive improvements in the *Agave* spirits industry, especially if there is a change in the productive and legal focus that aims at diversification rather than homogenization. The globalization of markets offers opportunities for diversification, due to a worldwide increase in the interest for local agricultural products, the protection of their areas of origin and the diffusion of their cultural dimensions.

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