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MANAGEMENT AND USE OF *Cnidoscolus* spp. IN TOTONACAPAN, PUEBLA AND MIXTECA BAJA, OAXACA

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ABSTRACT

The ethnobotanical study of two species of *Cnidoscolus* (Euphorbiaceae) is discussed; *C. rostratus* and *C. multilobus*, both of which are considered to be of anthropocentric importance in the communities involved in this study: Acaquizapan, Oaxaca, and Ecatlán, Puebla, respectively. The aim of this study was to establish the first qualitative-quantitative approach related to the documentation of its use. Considering a sample of 47 informants from Ecatlán and 90 from Acaquizapan, and employing participatory research and ethnobotanical indices, interviews that included 14 variables were conducted. Regarding the degree of management, *C. rostratus* in the wild, was observed to be tolerated and promoted, being used as food (seeds), medicine (branches and leaves) and live fence; obtaining a value of use of 3, value of importance of use 0.92 and cultural significance 34.5. *C. multilobus*, "mala mujer" (bad woman), appeared to be subject to a degree of wild management and toleration, the flowers are consumed as quelites, the leaves have medicinal use and as a domestic tool; a value of use of 3, value of importance of use 0.234 and cultural significance 5. This information is considered to be important for expanding the use and conservation of its genetic diversity, as well as in terms of the culture involved, in addition to representing a potential source of economic income for the residents.

Keywords: traditional knowledge, ethnobotany, degrees of management, importance of use, cultural significance.

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INTRODUCTION

Due to the current crisis in which biodiversity finds itself, whether due to processes of cultural erosion, irrational expansion of the agricultural frontier or due to the high demand for production, the proposal is to take into account traditional knowledge safeguarded for generations of native peoples to implement local agricultural development (Ferreira *et al*. 2005). The knowledge that peasants from indigenous and mestizo communities have about the use and management of plant resources, as well as how this associates with their cultural significance, are topics that in recent years have aroused great interest among the research community interested in the study of ethnobotany, with several of them emphasizing the quantitative evaluation of these aspects through biological and sociocultural indices (Prance *et al*., 1987; Phillips and Gentry, 1993a, Phillips and Gentry 1993b; Hoffman and Gallaher , 2007). In some writings, ethnobotanical works are criticized, qualifying them as purely descriptive, relegating them to pseudoscience and recommending the need for quantitative evaluations of ethnobotanical phenomena (Phillips and Gentry, 1993a; Phillips and Gentry, 1993b; Phillips, 1996; Reyes *et al*., 2007; Albuquerque, 2009); however, it is also argued that giving weight only to quantitative evaluation loses sight of

the theoretical and ethical bases that provide the essential element various ethnobotanical phenomena (Gaoue *et al*., 2017).

In any case, all research in ethnobotany has contributed significantly to the expansion and dissemination of knowledge pertaining to different native peoples and communities concerning the use of biodiversity, because in this way their wisdom about nature and the generation of more knowledge are promoted over western science. The presence in Mexico of human groups speaking 68 native languages (Secretaría de Cultura 2018), 24 million Mexicans living in the countryside (Food and Agriculture Organization-FAO, 2020), coupled with environmental diversity, indicates 97 climatic types and subtypes (García, 2004), 32 types of vegetation (Miranda and Hernández, 1963), more than 23,423 species of vascular plants (Villaseñor, 2004), 31 soil types (Instituto Nacional de Estadística y Geografía-INEGI, 1999) along with vast geological and physiographic diversity (Morrone, 2019), constitute a true laboratory, where natural resources and their use are extremely diverse, and are almost impossible to comprehend in the medium term, however likewise this knowledge must constitute the basis of strategies for the enhancement of local wisdom or for reinforcing people's cultural knowledge about resources and their use, an essential premise for those who are involved in community and regional development projects. It is apparent that any community in Mexico, especially those typified as practicing traditional agriculture, offer scenarios for ethnobotanical study.

In Mexico, arid or semi-arid zones comprise a little more than half of the territory, in addition to being important for the wide variety of plant species; about 6 thousand, of which slightly more than 50% are endemic to these areas (González, 2012). In the lower Mixtec area of Oaxaca; a semi-arid region, in addition to the richness of endemic species, there is wide cultural diversity (Casas *et al*., 2001; Lira *et al*., 2009), this interrelationship has resulted in an endless number of plant genetic resources being used by the inhabitants of the area, among which are included species from the *Cnidoscolus* genus. The same situation is observed in the transition or ecotone zones, where temperate and humid mountain forests converge, resulting in ample biodiversity (Morrone, 2019) that coincides with ethnic and cultural diversity. In the Totonacapan area, which is an ecotone region, a vast repertoire of knowledge is presented that arises from the plant-cultural relationship, which as in the Mixteca zone, includes species from the *Cnidoscolus* genus.

The *Cnidoscolus* Pohl genus, section *Calyptosolon*, pertains to the Euphorbiaceae family, that includes 99 species, of which 25 are endemic to Mexico (Maya and Steimmann, 2019). They are described as herbs, shrubs or small trees that can be either monoecious or dioecious. The stems and leaves are generally armed with small stinging trichomes, with evident discharge; leaves are alternate, simple, entire or digitally lobed with a slight or deep central division, and usually palmate nerve pattern, with either dicassium or panicle inflorescences, which are terminal or pseudoaxillary, solitary, and usually bisexual with proximal pistillate flowers and distal staminate flowers; the fruit is in the form of a capsule that is ovoid or sub-globose, hispid, with a thin columella and spherical seeds that have an aril and caruncle (Martínez *et al*., 2002; Maya and Steimmann, 2018); they are considered to be an allogamous species (Medeiros *et al*., 2006). Due to these characteristics, some

species are known as "mala mujer", "piñon (pine nut)", "mala chaya" or nettle, depending on the region and its use. These plants are considered wild for collection (Granados *et al*., 2004), but in some cases they are tolerated, encouraged or even cultivated (Ross and Molina, 2002; Jiménez *et al*., 2014); generally, they are used by residents, in areas where these species are established (Granados *et al*., 2004).

The leaves and stems are used in traditional medicine for various ailments, including rheumatism and arthritis, and as an antidote for cases of snake or scorpion stings (Granados *et al*., 2004; Jiménez *et al*., 2014). *C. aconitifolius* or *C. chayamansa* is one of the best known species (commonly known as chaya), appreciated in southeastern Mexico as a remedy for diseases such as anemia, diabetes, gastrointestinal disorders and also for its cardioprotective potential (Ross and Molina, 2002; Loarca *et al*., 2010; Jiménez *et al*., 2014; García *et al*., 2014). The milky and irritating exudate, in the case of *C. tehuacanensis*, found in the region of Huajuapan Oaxaca, is used as natural rennet or thickener to produce cream cheese and cheese (Téllez *et al*., 2002) or for producing the so-called Talpa chewing gum (*C. tepiquensis*) in Jalisco, Mexico (Cházaro *et al*., 1997). The seeds from *C. angustidens* and *C. quercifolius* are edible (León *et al*., 1999; Oliveira *et al*., 2011). Besides the previously mentioned studies on the uses of some species from the genus, research on the phytochemical characteristics of certain species stand out (De Oliveira-Júnior *et al*., 2018, Tadeu *et al*., 2011), as do taxonomic studies (Maya and Steinmann, 2018) and a number concerning management (Aguilar *et al*., 2011). In spite of the information generated for the different species of *Cnidoscolus*, few studies have addressed issues such as management and use in a qualitative-quantitative way. The species *C. multilobus* and *C. rostratus,* found in the communities of Ecatlán, Puebla, an ecotone zone and Acaquizapan, Oaxaca, a semi-arid zone, respectively, are remarkable for the use given to them in these communities and the lack of studies regarding these topics.

Cnidoscolus multilobus (Pax) I.M. Johnst., is endemic to Mexico (Steinmann, 2002). In the northern highlands of Puebla it is known as "mala mujer", nettle, *'tetzon quilit'* (hairy quelite, Nahuatl) (Mora *et a*l., 1985), *'xa xaa'nat cag'ni'* (Totonac), and the tender leaves, are boiled, having been previously "scorched" to burn off the thorns. These are harvested during the period from February to April (Basurto *et al*., 2017); in the same region, Martínez *et al*. (2007) mention that the "mala mujer", naturally associated with the useful flora found in coffee plantations, is nutritious for self-sufficiency purposes. In the central zone of the State of Veracruz, it is reported to have anticancer properties and uses (López and Veracruz, 2009). In the State of Hidalgo, in the highlands, it is known as a nettle and considered wild; the leaves are used to make mouth washes to cure dental problems, as it turns out to have anti-bacterial properties (Rosas *et al*., 2012). This species (nettle) is used as an antirheumatic and an antihemorrhagic, to prevent a rash and to produce breast milk, and for various ailments, toothache (latex), dog bites, venereal diseases, vaginal infections, measles and erysipelas (Jimenez *et al*., 2014). The species is considered to accumulate manganese (Mn) in the soil, with the potential to reestablish vegetation and stabilize Mn levels, thus reducing the effects of erosion (Juárez *et al*., 2010). Likewise, it has been found to have a biological relationship, of commensal

type, with the insect *Pachycoris klugii* (Cervantes, 2002) and the spider *Peucetia viridans* (Arango *et al*., 2012). Oil has been obtained from the seeds for transformation into biodiesel, a potential biofuel (Reyes *et al*., 2013). Identified chemical compounds include β-sitosterol, moretenol 3-acetate, moretenone, lupeol-3-acetate and lupeol (Delgado *et al*., 1994). Studies, focusing on various aspects such as those referred to above concerning *C. multilobus*, provide information that serves as background to address issues on the use and management of this species in the Totonacapan region in the northern highlands of Puebla, particularly in the town of Ecatlán, from the municipality of Jonotla, Puebla.

Cnidoscolus rostratus Lundell is recognized as endemic to Oaxaca and Puebla; typical of the low deciduous forest (Martínez *et al*., 2002), but Villaseñor (2016) reports that the species is also distributed throughout the states of Guerrero, Hidalgo, State of Mexico, Michoacan, Morelos, Oaxaca, Puebla and Veracruz; up to now there are no registered reports on its use in the lower Mixtec region of Oaxaca and particularly in the community of Acaquizapan, in the municipality of Santiago Chazumba, where the presence of this species has been mentioned; however its management and use have not been documented. In the Tehuacán-Cuicatlán biosphere reserve, where the lower Mixtec area (la mixteca baja) is located, the endemic species *C. tehuacanensis* (mala mujer) is given a use value of 2.4 and *C. tubulosus* a use value of 13 (Secretaría de Medio Ambiente y Recursos Naturales-Comisión Nacional de Áreas Naturales Protegidas-SEMARNAT-CONAP 2013), without mentioning what scale of measurement is used, however these quantitative references indicate the great potential that other species of *Cnidoscolus* may have for the region's inhabitants.

Numerous references mention that the Mixtec and Totonac inhabitants have a great diversity of plants that they use as resources for various purposes: medicinal, food, forage, construction and/or fuel (Martínez *et al*., 1995; Casas *et al*., 2001; Martínez *et al*., 2002; Lira *et al*., 2009); however, for *C. multilobus* and *C. rostratus* there is little qualitative-quantitative evidence concerning their management and use, combined with the unfortunate decline in traditional knowledge about resource use (Byg and Balslev, 2001).

Considering that *C. rostratus* and *C. multilobus* are phytogenetic resources that are found distributed throughout Acaquizapan, Oaxaca and Ecatlán, Puebla, respectively, species little explored and with little history about local management and use, aspects, which are made evident by the local people; the objective of the present study was to qualitatively and quantitatively describe traditional knowledge concerning the management and use of these species as a resource, by the inhabitants from these communities. The intention was to generate the first reference information about diverse uses, contributing to an increase in use, conservation of species as resources and traditional knowledge associated with these aspects.

MATERIALS AND METHODS

Study areas

The study areas comprise the communities of Santa María Acaquizapan, Oaxaca (Figure 1) and Santiago Ecatlán, Puebla (Figure 2).

Acaquizapan is a small Mixtec indigenous town in the north of the State of Oaxaca in the district of Huajuapan de León, municipality of Santiago Chazumba, located in the lower region of the Mixtec region, with coordinates 18.1439 N and -97.73226 W +-13 m, at 1742 m (in the center of the community). Low deciduous forest vegetation according to Miranda and Hernández (1963); climate BS_1 *(h') (i') m(w)*, that is, dry or arid, the least dry of the dry (with a P/T ratio that exceeds 22.9), average mean annual temperature above 22 ºC and temperature during the coldest month above 18 ºC, with little thermal oscillation (20 to 30 ºC) and summer rainfall (mean annual rainfall between 700 to 800 mm) (García, 2004). This community belongs to one of the municipalities in the Tehuacán-Cuicatlán biosphere reserve, an area of great importance due to the number of endemic species and elevated biological and cultural diversity (Casas *et al*., 2001; Lira *et*

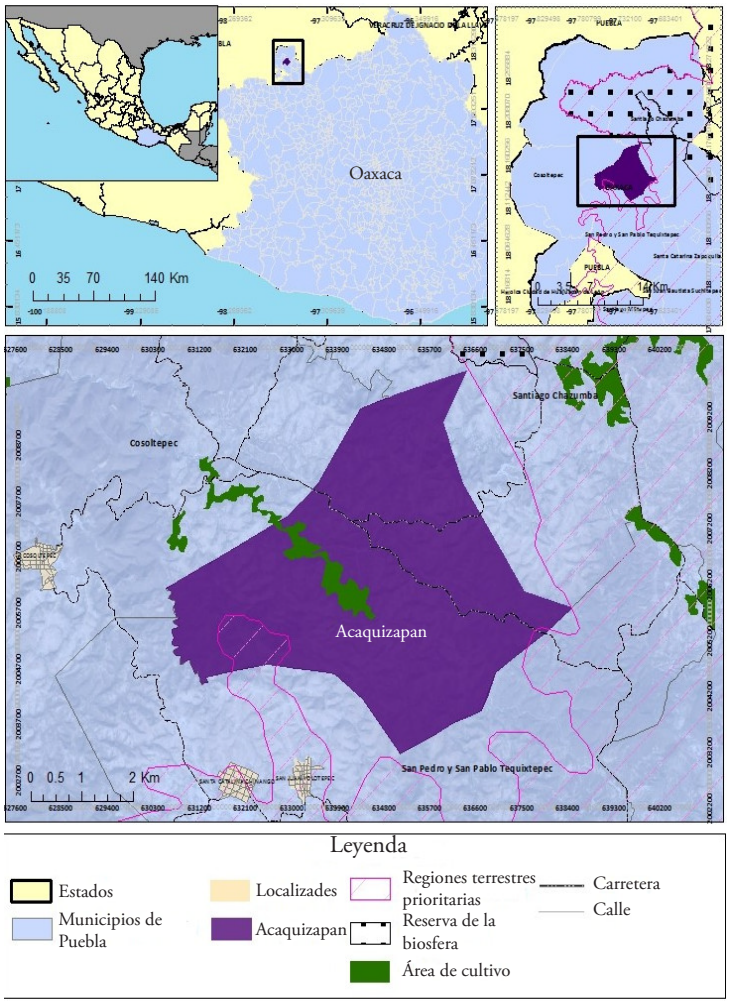

Figure 1. Geographic location of the population of Acaquizapan, Santiago Chazumba, Oaxaca, Mexico.

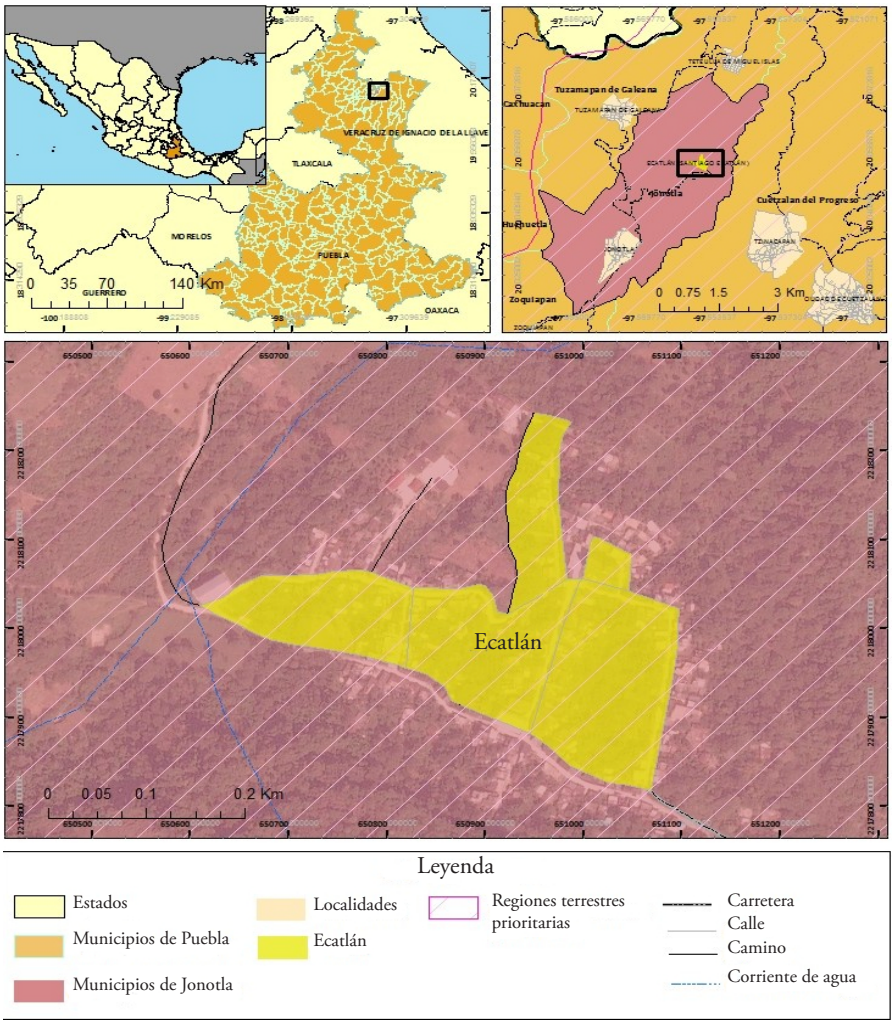

Figure 2. Geographical location of the population of Ecatlán, Jonotla, Puebla, Mexico.

al., 2009). A population of 343 inhabitants is registered, of which 145 are men and 198 women, the native culture and language is Mixtec (INEGI, 2010).

Santiago Ecatlán, is an indigenous town located in the municipality of Jonotla in the Sierra Norte de Puebla (Northern mountainous region of Puebla), which belongs to the Totonacapan region, with coordinates 20.053333 N and -97.555278 W at an elevation of 620 m. This is an ecotone zone, where two types of vegetation converge: mesophyllous mountain forest and high evergreen forest, the latter mostly predominant, according to the classification by Miranda and Hernández (1963). The type of climate is A(C) (w) i'g, meaning, warm with a tendency towards being temperate, and a rainy season in summer that shows little oscillation and an annual Ganges-type temperature distribution (double maximum irradiance), according to Garcia (2004). Ecatlán belongs to the PTR (Priority

Terrestrial Region) 105 of CONABIO (2020). Santiago Ecatlán has 710 inhabitants, of which 376 are women; of these 523 are adults. The predominant culture and language among the population is Totonac (INEGI, 2010).

Field work

Visits to the community of Acaquizapan were carried out in the months of July and September 2017; March and June 2018; March and May 2019. In Ecatlán they were undertaken in June and November 2017; April, March and November 2018 and February and May 2019.

In the community of Acaquizapan, field trips were made among people recognized as collectors of pine nut seeds (*C. rostratus*); in Ecatlán, field trips were carried out with collaborating informants. In this way, in both communities it was possible to unequivocally locate the plants of interest, as suggested by Canales *et al*. (2006). Herbarium specimens were collected from both species and kept in the Jorge Espinosa Salas Hortorio herbarium ("JES"), in the Biology department of the Agricultural High School at the Autonomous University of Chapingo (UACh).

The participatory observation technique consisted of combining daily activities (both in the field and at home) carried out by the informants, who were involved in guiding the field trips; thus, it was possible to record how the population interacts with and manages the plants (Martínez *et al*., 2017). Semi-structured interviews (Martin 2000) and participatory observation (Cunningham, 2001) were the ethnographic techniques used to record information concerning the use and management of resources. Interviews were applied by means of simple random sampling of 90 people in Acaquizapan (25.2% out of the entire population) and 47 people in Ecatlán (8.9% of the adult population). Based on previous observations of these communities, it was estimated that in Acaquizapan, the age range spanned from 20 to 85 years, men comprised 55.5% and women 44.4%; in Ecatlán, it spanned from 35 to 88 years old, 63.82% were women and 36.17% men; of the total number of interviewees from both communities.

Variables, expression scales and index calculation

Interviews consisted of 14 written questions, which were formulated based on what was stated by Cuevas (1991), Bermúdez *et al*. (2005). These questions related to the management and use of the species in each town, the common name in Spanish and in the indigenous language (Mixtec or Totonac). The variables related to management were: season, harvest technique, management technique, degree of management and means of preservation (Table 1). Those related to use were: anthropogenic group (use), part of the plant used, way of using it (fresh or dried), use technique, adverse effects, frequency or intensity of use, exclusivity of use and perception of cultural importance (Table 1).

The information record was collected on a database divided into categories of use and the questions in the interview were formulated in order to organize the subject for each column. Variables were classified into qualitative and quantitative for management and use (Table 1). To measure the degree of management, the classification proposed by Caballero

Table 1. Classification of qualitative and quantitative variables concerning the management and use of *Cnidoscolus rostratus* and *Cnidoscolus multilobus*.

	Management	Use
Quantative variables	Level of management	Category of use Useful part of the plant Frequency or intensity of use Exclusivity Perceived importance (0 to 0.5 not important, 0.5 to 1 very important)
Qualitative variables	Management technique Time of harvest Harvest technique Conservation method	Name of the plant Means of use (fresh or dry) Technique for use Adverse effects

Source: Cuevas (1991) and Bermúdez *et al*. (2005).

and Cortés (2001) was taken as a starting point and a value was assigned to each one (Table 2), in a subjective way (Turner, 1998). Each use was assigned a name according to the anthropogenic category list proposed by Martínez *et al*. (1995) and assigned a value (subjective assignment) according to Turner (1988) (Table 3). The variable of frequency of use, was arranged in a binomial matrix (0 little / 1 highly) (consensus of informants) and analyzed using a binomial test; the results were considered to assign the intensity of use value (Table 4) to each anthropogenic category for each species.

From the corresponding quantitative variables (Table 1), the following indices related to use were used:

Reported use value (*RU*)

$$RU = \sum_{i}^{n} Specie_{i}$$

Total number of uses reported for each plant (Gomez, 2002). This is the same value as VU_{is} (Phillips and Gentry, 1993a), except that the number of species citation "events" per

Table 2. Criteria for assigning values to degree of management of plant species.

Level of management	Description	Assigned value
Domesticated	Plants that require obligatory special management to survive and ensure production	5
Cultivated	Plants that require special management techniques in order to fulfill their potential	4
Encouraged	Plants which require some care for a particular purpose	3
Tolerated	Plants which are tolerated in some area of activity in the community	2
Wild	Plants with no type of management	1

Source: Caballero and Cortés (2001).

Table 3. Criteria for designating use values according to anthropogenic category.

Anthropogenic Category	Description	Assigned value
Edible	Plants used for food	4
Medicinal	Plants used to treat illnesses	3
Live fence	Plant used as fence for plots and/or vegetable gardens	2
Domestic	Plant used as a domestic tool	1

Source: Turner (1988).

informant is always one (interviews were not repeated) (Hoffman and Gallaher, 2007) (based on consensus of informants).

Use value reported for each part of the plant ($RU_{plantpart}$)

$$RU_{plantpart}$$

The number of uses cited for each part of the plant (e.g. outer bark, inner bark, root, leaf, flower, fruit) (Gomez, 2002) (based on consensus of informants).

Value in terms of part of plant (*PPV*)

$$PPV = \frac{\sum RU_{plantpart}}{\sum RU}$$

Ratio between the total number of uses reported for each part of the plant and the total number of uses reported for the plant (Gomez, 2002).

Importance value (IV_{s})
Byg and Balslev's (2001) importance value measures the proportion of informants who consider a species to be the most important (based on informant consensus).

Table 4. Criteria for designating values of intensity and exclusivity in terms of plant use.

	Description	Assigned value
Intensity of use	Extremely intensive use	5
	Moderately high intensity of use	4
	Medium intensity of use	3
	Low intensity of use	2
	Minimal intensity of use	1
Exclusivity of use	Irreplaceable.	2
	Could be replaced but this is not done	1
	It is replaced with other plants for the same purpose	0.5

Source: Turner (1988).

$$IV_s = \frac{n_{is}}{n}$$

n_{is}: number of informants who consider the species to be the most important; n: total number of informants. It measures the proportion of informants who consider the species to be the most important. The values range from 0 to 1 (based on the informants that resulted from the variable of importance for the species, greater than 0.5).

Index of cultural significance (*ICS*)
Index generated by subjective assignment (values assigned by the researcher) (Table 3 and 4, respectively) (Turner, 1988).

$$ICS = \sum_{i=1}^{n} (q * i * e)$$

ICS: Index of Cultural Significance; *q*: use by anthropogenic category; *i*: intensity of use and *e*: exclusivity of use. The *ICS* value was calculated for each species according to anthropogenic category, these were added together to obtain the final index for each species.

RESULTS AND DISCUSSION

Management and use

In accordance with what Caballero and Cortés (2001) record in terms of degree of management, in the community of Santiago Ecatlán, *C. multilobus* is placed in the category of wild to tolerated, values 1 and 2, respectively; likewise it is also considered a weed, as according to local perception, during the season when land is cleared for planting the milpa or maize, at the moment when the plant emerges, it is cut down because its capacity to sting is not considered acceptable. This species can be found in the areas of human activity on a daily basis (Cuevas, 1991), either in plots (as weeds), along roads (on verges) or in the mountains (wild). The plants are evergreen, the production of flowers and seeds is annual, but heterogeneous during the year, which, it is inferred, depends on the degree of management, which in turn depends on the degree of interest in the resource, as most of the these plants are cut down (similar to pruning), thus stimulating the production of new shoots, as if forced production was being unintentionally practiced, because they are considered as weeds; similarly, no intention to conserve this species was reported by the inhabitants.

C. multilobus is known as "mala mujer". The information obtained revealed a number of ways the plant is used: 1) the flower is consumed boiled, as quelite (fresh), mixed with egg; 2) the fresh leaves, mixed with other herbs, such as hoja santa, cedar leaf, plum leaves and bitter leaves such as tenejilla, are used for baths, made to combat "evil"; Another use of the fresh leaves is to place them as a base, at the bottom of a container, to cook the 'mixiote'; or to cover the top or lid of the stew (two specific uses of the leaf), leaves that have more "thorns" (stinging trichomes) are preferred because it is believed that this has the effect

of making the stew boil better, "it cooks beautifully " in the words of the residents. Only 13 people mentioned that the raw seed is consumed when it becomes "plump", that is, ripe; this information is not widely known, perhaps due to the fact that seed production is not common or constant every year, a situation that was observed during the visits to the community. A chemical analysis might shed more light on this endemic use and encourage production. *C. multilobus* is categorized anthropogenically as food (flowers and seeds), medicinal and for domestic use (leaves), according to the list proposed by Martínez *et al*. (nineteen ninety five). The interviewed residents did not mention any adverse effect in relation to the uses given to this species.

The use value for *C. multilobus*, according to the reported use value (RU) index (Gomez, 2002), was 3; the reported use for each plant part ($RU_{plantpart}$): for leaves was 2, for flowers and seeds was 1; as well as a PPV (ratio between the total uses reported for each part of the plant and the total number of uses reported for the plant) of 0.66 for leaves and 0.33 for flowers and seeds, with an importance value (IV_s) (Byg and Balslev, 2001) of 0.234 (Table 5). According to Turner's methodology (1988), the value of the cultural significance index (CSI) for *C. multilob*us was 5. The low tendency for the $RU_{partplant}$, PPV, IV_s and ICS indices, used to measure the importance of the species for the community is clearly evident. It is also notable that the frequency of use was low, as the observed proportion of this variable for the food category was 0.70, while for another category (medicine and domestic) it was 0.79, meaning that more than 50% of respondents indicated scarce use of the species (Table 6). These values indicated that intensity of use should be assigned as 2 (low intensity of use) for food and 1 (minimal use intensity) for medical and domestic use. The exclusivity of use as food was 0.5 and in the domestic context was 1.

The population does not consider this species as medicinal, and in general, the importance of its use is not particularly relevant (IV_s = 0.234 taking into account the value of 0.5 as intermediate to assess lesser or greater importance and an *ICS* = 5). In other regions of Mexico where *C. multilobus* is known as "nettle", it is used in cases of ailments and the latex is used to alleviate toothache; it is also used for dog bites, for venereal diseases and vaginal infections, against measles and erysipelas, as an antirheumatic and antihemorrhagic, to prevent nettle rash and to produce breast milk (Jiménez *et al*., 2014). According to data in the literature, *C. multilobus* has anticancer, antirheumatic, antihemorrhagic (López

Table 5. Values of *RU*, $RU_{plantpart}$, *PPV*, IV_s, *ICS* for *C. rostratus* and *C. multilobus*, in Acaquizapan, Oaxaca and Ecatlán, Puebla, respectively.

Species	Part of the plant	*RU*	$RU_{plantpart}$	*PPV*	IV_s	*ICS*
C. rostratus	Leaves	3	2	0.66	0.92	34.5
	Flowers		1	0.33		
	Seeds		1	0.33		
C. multilobus	Branches with leaves	3	1	0.33	0.234	5
	Seeds		1	0.33		

RU: Use value, $RU_{plantpart}$: Use value per useful plant part, *PPV*: Plant value per useful plant part, IV_s: Importance value, *ICS*: Index of Cultural Significance.

Table 6. Frequency of use values for *C. multilobus* and *C. rostratus*, in Ecatlán, Puebla and Acaquizapan, Oaxaca, respectively.

Species	Frequency of use by anthropogenic category		0 / 1	N	Proportion observed
C. multilobus	Food	Group 1	0	33	.70
		Group 2	1	14	.30
		Total		47	1.00
	Medicinal and domestic	Group 1	0	37	.79
		Group 2	1	10	.21
		Total		47	1.00
C. rostratus	Food	Group 1	1	59	.66
		Group 2	0	31	.34
		Total		90	1.00
	C. rostatus Medicinal	Group 1	0	82	.91
		Group 2	1	8	.09
		Total		90	1.00
	Live fence	Group 1	0	90	1.00
		Total		90	1.00

N: number of respondents, 0: little used, 1: widely used.

and Veracruz 2009) and antibacterial (Rosas *et a*l. 2012) properties, which is why its use against infections is corroborated, due to the main metabolites that have been identified in *Cnidoscolus* species, among which flavonoids, triterpenes, diterpenes, coumarins, derived from cinnamic acid and steroids stand out (De Oliveira-Júnior *et al*., 2018). It is recognized that a decrease in oxidative stress is associated with phenolic compounds such as flavonoids and other polyphenols, which is why some studies have documented that species from the *Cnidoscolus* genus may have antioxidant potential, recognizing the important medicinal uses for the species. In other areas, the species *C. urens*, also known as "mala mujer", is used in the same way as *C. multilobus*, serving as a treatment for venereal diseases, back pain, against scorpion stings, as a stimulant to produce breast milk, for lowering cholesterol, as a deterrent for alcoholics and as a laxative and diuretic (Jiménez et al., 2014), however the importance of use has not been quantified. Considering the stinging effect of *C. multilobus* and the intensity of the burning sensation or pain that this plant can cause among humans, a certain analogy with one of the principles of homeopathy is apparent, as this establishes that the cure for a disease can be found in something that produces a similar response (Avello *et al*., 2009).

In Acaquizapan, the perception that the inhabitants have of the *C. rostratus* resource suggests that this species is assigned to three statuses or degrees of management: wild (1), tolerated (2) or promoted (3) (Table 2). Granados *et al*. (2004) mention that species of *Cnidoscolus* in the Tehuacán-Cuicatlán Valley (Chazumba and Zapotitlán) are recognized as wild plants for collection in primary habitats undisturbed by human activities, from which useful parts are directly obtained. However, *C. rostratus* is regarded as wild in terms of degree of management, but likewise is tolerated and/or promoted by the same pickers and other residents, as they sow seeds in their plots and backyards, where they also carry out

certain agricultural procedures such as earthing up, pruning and irrigation, among other activities that are taken into account when classifying degree of management (Caballero 1994; Caballero and Cortes, 2001; Casas *et al*., 2001). The flowering season occurs from mid-March to mid-June, fruiting spans from mid-June to mid-November, seed maturity is from late July to mid-December, the season in which this resource is exploited, data that concur with those reported by Granados *et al*. (2004) for *C. aconitifolius* in the Tehuacán-Cuicatlán valley.

Harvest of the resource (the seed) is annual, whereas management of the plant (leaves and branches) can take place during most of the year, similar to that reported for *C. aconitifolius* in the Tehuacán-Cuicatlán valley (Granados *et al*., 2004), with the exception of winter, the season when the plants lose their leaves. Harvest is undertaken from the end of July to mid-December by pickers; four people (women) mentioned that they had taken part in this work. The pickers harvest bunches of fruit that have a brown color and a small opening in the mesocarp; this can be done manually or with the help of a stick or branch with a hook, very similar to the tool known as a "chicole", which is used for the harvest of pitayas and pitahayas, in order to avoid being hurt by the stinging trichomes of the plants. Regarding conservation of the species, 14.5% of the interviewees mentioned that the way to conserve it was not to cut down the plant, 5.5% mentioned taking a specimen or seeds home for care and reproduction, whereas the rest of the interviewees (90%) did not make any effort to preserve it.

In the community, *C. rostratus* is commonly known as piñón (Spanish) or "cintiáhua" (Mixtec), which was registered in three anthropogenic categories: food (seeds), medicinal (leaves and branches) and live fence. The consumption of *C. rostratus* seeds as human food is a use similar to that recorded for *C. angustidens* in the northwestern region of Baja California Sur (León *et al*., 1999) and with that reported for *C. phylla-canthus* and *C. quercifolius* located in the semi-arid region of northeastern Brazil (Caval-canti and Bora, 2010; Oliveira *et al*., 2011; Santos *et a*l., 2017). Use of seeds is thought to relate to similarity in environmental conditions and not strictly to the cultural setting of the peoples who use them.

The technique used to exploit the seeds is to clean and select the material (dry seeds); the grains are soaked to soften them and are placed to boil until the grain turns black in color, and the water a dark coffee color. This is then left to cool and is now ready to eat. The difference in the consumption of the raw seed occurs depending on whether people carry out their work in the field or collect it. Other useful information provided by the residents about *C. rostratus*, and valuable as a biological indicator, is the remark that the snakes eat the seed, possibly indicating that the seeds are not toxic, likewise, this event may be an ecological indicator of the period in which the seeds can be consumed, meaning that there is no apparent adverse effect resulting from the consumption of the grains.

The seeds are relatively small, measuring an average of 2 cm for their three dimensions and weighing 0.3 g, similar to those reported for *Jatropha curcas* seeds (Zavala *et al*., 2015); they are often consumed as snacks; raw or cooked in salted water; the pickers (four people) take seeds to the markets to sell. Similar observations are reported by Granados *et al*.

(2004), who mention that in the Zapotitlan and Chazumba valleys, the tender seeds of "mala mujer" *(C. aconitifolius*) are boiled and roasted with salt, a product that is taken to the markets, where it is used mainly in barter transactions. Similarly, in the northwestern region of Baja California Sur, the seeds of *C. angustidens* are consumed lightly roasted (León *et al*., 1999). In times past, the seed was mainly prepared for self-consumption and most families collected and prepared it in their homes. Currently the people employed to gather seeds from this stinging plant are few, and although this is for self-consumption, local and regional sale is more widespread, marketing the grain raw or cooked in nearby markets such as Chazumba.

The branches and leaves with stinging trichomes are used against rheumatism, as occurs in a similar way with some species of nettles (Randall *et al*., 2000). This type of medicinal use involves "brushing" (using a branch from the plant with fresh leaves), the person in the area of the body where the pain is felt. Thus, in the words of a local, discussing this remedy: "pain is eliminated with pain", which is a principle of homeopathy. However, this comment refers to a possible adverse effect resulting from frequent use of this remedy, even though the interviewees did not mention any adverse effect.

Tellez *et al.* (2002) and Granados *et al*. (2004) mention that in the Tehuacán-Cuicatlán region, species of *Cnidoscolu*s are used as medicine against adverse effects caused by poisonous animals (scorpions and snakes) and their latex as natural rennet to make cheeses and curds (Martínez *et al*., 2017); however, in Acaquizapan these uses were not mentioned. Due to the stinging trichomes pertaining to this species, it is also used as a living fence because it is effective for preventing the passage of animals and even people. Interestingly, in Caatinga, Brazil, sheep feed on some species of *Cnidocolus,* such as *C. quercifolius* (Roberto *et al*., 2016).

The reported use value (RU) for *C. rostr*atus was 3; the value of use for each useful part of the plant ($RU_{plantpart}$) was 1 for seeds and for branches with leaves, the entire plant was not considered in terms of its use as a living fence. A PPV value of 0.33 was obtained for each useful part of the plant (ratio between the total uses reported for each part of the plant and the total number of uses reported for the plant). For its part, the importance index was 0.92, a value considered high (measuring ranges from 0 to 1), meaning that the species is of great importance among the inhabitants, without assuming that the importance of a plant is mainly a function of how many different ways it is used; this is an assumption that has rarely been tested (Byg and Balslev, 2001). Moreover, importance was not measured according to the number of different ways it was used, but according to the perception of the respondent.

The cultural significance index (ICS) was 34.5 (Table 5), a value consistent with the importance value of the species.

In Acaquizapan, *C. rostratus* registered a high frequency due to food use (observed frequency of 0.66, above 50% is considered frequently used). For medicinal use and live fence, the frequency of use was low, 0.91 is considered to indicate little use (Table 6). These values were references to assign an intensity of use of 4 (moderately to high intensity of use) for food and 1 (minimal use intensity) for medicine and live fence. The exclusivity

of use for food was 2 (its replacement is not possible), whereas for medicine and live fence it was 0.5 (it is replaced by other species for the same use).

The management and use of the plants by the inhabitants of both communities, from different regions, depends on various factors, particularly the degree of interest on the part of the inhabitants and the temporary availability of the resource (Albuquerque and Andrade, 2002). Both species have use value (*RU*) of 3, however, the importance (IV_s, according to the perception of the respondents) that was given to each one in their respective community, differs completely, as does the degree of management and cultural significance (ICS). While *C. rostratus* was of greater importance, significance and with a degree of management promoted by the inhabitants of Acaquizapan, *C. multilobus* was less important and less significant, in terms of uses (Table 5) and tolerated with a degree of management in Ecatlán. Byg and Balslev, (2001), in a study on the uses and importance of palms in eastern Madagascar, mention that the specific characteristics of the species and human populations determine the degree to which a palm is used and valued; they indicate that the importance values were zero or close to zero for most species, while only one species had a high importance value.

Some studies on the use of other species of the same family, such as *Jathropha curcas* in the Totonacapan region (Valdés *et al*., 2013; Vera *et al*., 2014), reveal that the use of seeds for consumption is common, which is similar to the use of *C. rostratus* seeds in Acaquizapan. The management of *Cnidoscolus* seeds in Ecatlán is not common due to the stinging trichomes the plant possesses, so resource use has focused on species that are easy to manage, are more accessible and available (Albuquerque and Andrade, 2002); and even more, because in this region there are other options similar to them, such as *J. curcas*, which does not present physical problems such as trichomes. This combines with the fact that this species is important worldwide for its usefulness in agroindustry (Achten *et al.*, 2008; Dias *et al*., 2012), especially as the species that grows in the Totonacapan region is not toxic (Valdés *et al*., 2013; Vera *et al*., 2014). This clarifies the reason for its exclusive use in Ecatlán with a value of 0.5, which likewise would indicate the possibility of being replaced by another plant, at least considering seed use. These aspects directly affect the degree of management to which the species is subjected and the domestication process it has undergone.

Contrastingly, in the semi-arid region where there are no species of similar use (exclusivity of food use was 2, its replacement is not possible) as in the case of the *Jatropha* species in Totonacapan, the availability, access or popular choice has focused on the use of *C. rostratus* seeds which is more commonly picked, better known and also more widely distributed and valued among the population.

The differences in the management and use of *Cnidoscolus* species in both regions may relate to the degree of interest in the plant, as a result of the relationship between environmental and cultural conditions, where for years in the two regions, these have been developing. Due to the fact that the diversity of species in the semi-arid zone is dissimilar to that of the Totonacapan, it appears that the domestication and use of plants has also been different. Likewise, the knowledge that communities have about plants can be interpreted

as indicative of the attitude that people show towards their natural environment (Byg and Balslev, 2001).

Several studies have recognized that the species most used by people correspond to the anthropogenic food, medicinal, fuel and construction categories, these comprising the main activities in daily life (Martínez *et al*., 1995; Lira *et al*., 2009; Martínez *et al*., 2012); consequently, the two species of *Cnidoscolus* are placed in the first two categories.

The methodologies for obtaining ethnobotanical indices can lead to different levels of expression that underestimate or overestimate the phenomena. Considering the scales or gradients proposed by Turner (1988) for the ICS index, *C. rostratus* appears to show moderate significance, whereas for *c. multilobus*, significance seems to be low, data that represent an important reference for defining the status in which these species are found.

CONCLUSIONS

Generally, there is little knowledge about *Cnidoscolus* species and their uses in Mexico; this does not extend beyond the local populations that take advantage of them. However, recognizing the usefulness of some of these as food and medicine offers the possibility of expanding their use in these communities and surrounding areas, through sustainable management that would positively impact the conservation of species, the knowledge associated with them and their exploitation, offering multiple benefits to the people.

Various studies, such as this one, which explores the nature of the processes of exploitation and management, can contribute to the conservation of the species and the cultural heritage of the plant genetic resource, in this case, for the populations of Acaquizapan and Ecatlán.

Although there is some knowledge concerning the benefits provided by these species in the regions where they are found, results show that both species are little valued and used; the knowledge that has been transmitted about these resources is scarce and is not known beyond the personal legacy of those who consume these plants as a remedy or as food.

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