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Arthropods in Natural Communities in Mescal Agave (*Agave durangensis* Gentry) in an Arid Zone

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Abstract: Problem statement: The arthropods have a very important role in the arid zones due to their interactions with many organism and because they constituted an important element in the structure of the plant community. Nevertheless their importance there are few knowledge about the community of arthropods associated to vegetation in arid zones in the North of Mexico. The present study had the objective of determining the abundance, richness and diversity of arthropods in three localities where there are natural populations of mescal agave in the State of Durango, Mexico. **Approach:** In order to know the structure community of the arthropods associated to the mescal agave, we perform a sampling schedule during March 2008 to November 2010 by direct collection, using transects in three different localities with the presence of mescal agave. The relative abundance, species richness, Shannon's diversity index, Pielou's Index of evenness, Jaccard's similitude and Simpson's dominance indexes were determined. **Results:** A total of 4665 individual arthropods associated to mescal agave corresponding to 39 species were found. El Mezquital had the highest abundance and relative abundance (44.1%) with 29 species. The mean species abundance was not significantly different between localities using Turkey's test. The highest density per unit of area was found in El Mezquital (La Breña had the highest species diversity (1.89), evenness (0.61) and dominance (0.78). At the taxon level, Hymenoptera had the highest number of species represented (14), followed by Coleoptera (9) and hemiptera (5), with the remaining taxons with four, two and one species each. **Conclusion:** The greatest similitude was observed between La Breña and El Mezquital (46%) which shared seven taxons, while the least similitude was observed between El Venado and La Breña (29%). Dominance/diversity curves are presented for each locality. The species *Caulotops* sp., *Acutaspis agavis*, *Chilorus* sp., *Scyphophorus acupunctatus* and *Peltophorus polymitus* were the ones with highest relative abundance. Although the diversity values are above the minimum, previously unreported arthropod species associated to mescal agave were recorded. The results can be useful to know the dynamic in the community associated to agave, in order to development best conservation and exploit management of that important plant.

Keywords: Diversity index, species richness, relative abundance, arthropod species, mescal agave, *Peltophorus polymitus*, Durango, Mexico

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INTRODUCTION

The Agavaceae family, with nine genera and approximately 310 species, is distributed in the arid and semiarid regions of America. In general it forms dispersed groups or conglomerates within the xerophyte vegetation, in grasslands and in combination with nopal cacti, microphyle shrubs and forests (García-Mendoza, 2007). Occasionally various species of this family tend to dominate the local vegetation and adapt to the lack of water and soils with low nutrient content (Peinado *et al*., 2011).

The *Agave* genus is the most diverse containing approximately 200 species in America, growing from Southern United States to Colombia and Venezuela, including the Caribbean Islands

Mexico is the center of origin and diversification of agaves where 273 species have been reported; of which 50 species belong to the Agave genus with 69% endemism (García-Mendoza, 2002). These species have adapted to the dryness of the most expansive ecological zone in the country, arid and semiarid environments, which encompass 84 million hectares representing 45.3% of the national territory (Toledo, 1989).

In Mexico, agave plants have been mainly used as a source of food, drink, forage, fiber and construction materials, since pre-Columbian times (Parsons and Darling, 2002; Zizumbo-Villarreal *et al*., 2009). According to various authors, there are four alcoholic drinks obtained from agave which are considered to be important in the country; these are: aguamiel, pulque, tequila and mescal (Rojas *et al*., 2007; Lappe-Oliveras *et al*., 2008). The latter is obtained from distilling the ferment of cooked stems from certain wild and cultivated agave plants in arid and semiarid regions in the country, mainly in the States of Jalisco, Tamaulipas, Guerrero, Oaxaca, San Luis Potosi, Zacatecas and Durango, of which Oaxaca is the main producer with 5 million liters annually (Ramírez, 2002).

There are 43 species of this family in the State of Durango, of which 24 species are from the *Agave* genus. Nevertheless, Elizondo (2009) reported 30 species of these genus, that develop on rocky outcroppings and areas with thin soils acting as generators, conservers and retainers of soil, of which 5 species are used for manufacturing mescal. These species are *Agave durangensis* (maguey cenizo o mezcalero) in the municipalities of Nombre de Dios, El Mezquital and Durango; *A. angustifolia* Haw (mezcal chacaleño or espadín) in the municipalities of Tamazula and El Mezquital (tepemete); while *A. bovicornuta* Gentry, *A. maximiliana* Baker and *Agave* sp. are located in the South of Durango (Elizondo, 2009; Gallegos *et al*., 2007).

Mescal consumption has increased during the last 10 years therefore there is an increasing demand for raw materials by local producers, as well as from those in other states and there is the, El Mezquital and Durango in order to decrease the pressure on the natural resource and in this manner guarantee the survival and productivity of the species (Gallegos *et al*., 2007).

It is important to note that in these habitats arthropods play an important role in soil structure and fertility, plant pollination, nutrient cycle, organic matter decomposing and predation (Coleman and Hendrix, 2000) Furthermore, they carry out an important function in energy flow through the trophic levels of the food chain (Ward, 2009), even though, in comparison to other animals, they are limited by water availability and the extreme environmental parameters present (Andersen and Majer, 2004). Some authors have mentioned that entomological studies can be processed, analyzed and applied in systematics, ecology and biogeography, as well as provide information on the health status of ecosystems, allow the direct recognition of the biodiversity of a site and are a useful tool for resource conservation (Noss, 1990; Alvarez, 2004).

Agave lives in natural communities within the State and is susceptible to damage by arthropods, which themselves are part of the community, but when plantations are established pest problems occur. Nevertheless, in the State there is little information on the abundance and species diversity of arthropods associated to *A. durangensis*. One of the ways to know the structure of communities is through inventories. Therefore the purpose of this study was to describe the taxonomic composition, measured as abundance and species diversity and richness of arthropods in natural populations at three sites within the State of Durango, Mexico in order to understand the biology of species that can become pests when plantations of *Agave durangensis* are established in the State.

MATERIALS AND METHODS

Study area: Arthropods were collected in three plant communities where agave can be found naturally: El Venado and La Breña which are located in the Municipality of Nombre de Dios and El Mezquital which is located in the municipality of the same name in Durango, Mexico.

Altitude and geographical coordinates of the study locations were obtained from a Garmin 60 CS×GPS (Global Positioning System).

Table 1: Geographical references of the locations where arthropod collections were carried out from mescal agave

Site	Geographical coordinates	Mean annual temperature (°C)	Mean annual precipitation (mm)	Altitude (m asl)	Plant associations
El Venado	Lat. N 23° 47' 54.5"	16.6	452.0	1714	*Dasylirium* sp.,
	Long. W 104° 18' 21. 2"				*Agave* sp., *Opuntia* sp., *Yucca* sp.
La Breña	Lat. N 24° 02' 32"	16.6	452.0	1886	*Opuntia* sp., *Acacia* sp., *Dasylirium* sp.,
	Long. W 104° 14' 01"				*Yucca* sp., *Jatropha* sp.
El Mezquital	Lat. N 23° 30' 03"	19.4	540.4	1982	*Prosopis* sp., *Acacia* sp., *Lippia graveolens*
	Long. W 104° 23' 29"				HBK, *Bursera* sp., *Agave* sp.

Information on mean annual temperature and precipitation was taken from García (2005) the general characteristics of each location are shown in Table 1.

Quadrants of 1×1 m^2 were traced within each locality and arthropods were collected directly from agaves that were located in these quadrants. Adults were placed in glass jars that had 70% alcohol. Larvae that were collected alive were placed on pieces of agave leaf within ventilated plastic jars in order to allow them to finish their cycle and obtain the adult. The material was processed in the entomology laboratory of CIIDIR-IPN, Durango Unit.

Qualitative description: Slater and Baranowski (1978); Arnett (1985); Morón Rios and Terrón (1988) and Mackay and Mackay (1989) dichotomic keys were used to determine the taxonomy of individuals collected. Support was provided by specialists of the Laboratory of Mites of the Biology Institute of the National Autonomous University of Mexico (UNAM), the Microarthropod Ecology and Systematics Laboratory of the Faculty of Sciences, UNAM, the Plant Health Institute of the Postgraduates College and R. Muñiz †(personal communication). All individuals are preserved in the Entomological Collection of CIIDIR-IPN, Durango Unit.

Quantitative description: Diversity alpha (a). The methods used for quantifying this type of diversity were as follows.

Direct indexes: Species richness (S), absolute abundance (N) and relative abundance (%).

Index of Evenness: These are the ones that take into consideration the species abundance and how uniformly they are distributed.

Shannon's (H'): It is a maximum likelihood estimator and is highly sensitive to changes in abundance of rare families (Magurran, 1989). Pielou's: Based on the values of Shannon's index, it expresses the evenness as the proportion of the observed diversity in relation to the maximum expected diversity (Magurran, 1989; Zar, 2009; Moreno, 2001).

Simposon's: Manifests the probability that two individuals taken randomly from a sample are from the same species making this index influenced by the species that are most abundant in the sample (Magurran, 1989; Moreno, 2001).

Diversity beta (β): Indicates how similar or not are two communities or samples.

Jaccard's: Expresses the degree in which two samples are similar in terms of the species or orders that are present within them (between locations) (Mackay and Mackay, 1989).

An Analysis of Variance (ANOVA) was used to determine the effect of the sample location on the abundance of species (SAS Institute, 2000). Differences between mean abundance among sites were analyzed using Turkey's post-hoc tests ($p \leq 0.05$). All indices were obtained using the PAST software package (Hammer *et al*., 2001).

RESULTS

General quantitative description: Arthropod taxon and family composition by locality can be observed in Table 2. A total of 4665 individual arthropods were captured representing 9 taxa, 23 families and 39 species. The locality with the highest relative abundance was El Mezquital (44, 1%), followed by El Venado (31, 4%) and La Breña (24, 5%). In general, three taxa constituted 93% of all the arthropods that were collected. These were Hemiptera, Coleoptera and Hymenoptera, with the remaining groups reaching levels below 3% each (Fig. 1). The abundance by families shown in Fig. 2.

Quantitative description by location: El Mezquital had the highest species richness (Table 2). The highest relative abundance corresponded to Hemiptera (68%) with eight species distributed in seven families.

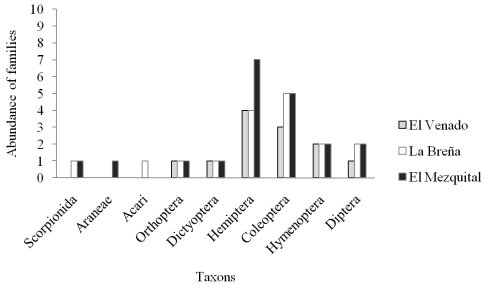

Fig. 1: Number of families in different arthropod orders associated to mescal agave in three localities of Durango state, Mexico

Fig. 2: Abundance of families of arthropods associated to mescal agave in three localities of Durango State, Mexico

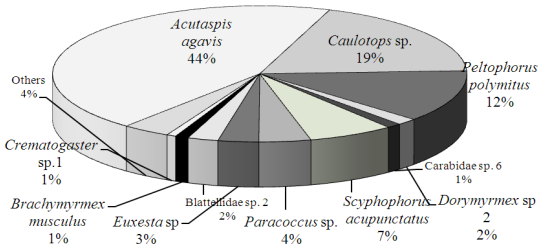

Fig. 3: Relative abundance of the main species collected in *Agave durangensis* in the locality of El mezquital, Mezquital, Durango

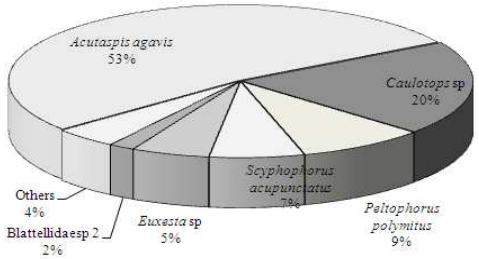

Fig. 4: Relative abundance of the main species collected in *Agave durangensis* in the locality of El Venado, Nombre de Dios, Durango, Mexico

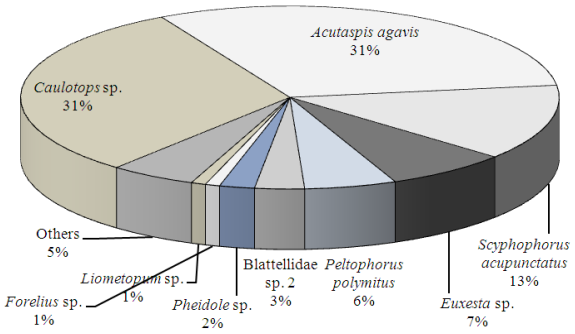

Fig. 5: Relative abundance of the main species collected in *Agave durangensis* in the locality of La Breña, Nombre de Dios, Durango, Mexico

The most abundant species found in this locality are listed in Fig. 3. Regarding the finding of unique or rare taxons, i.e., those that were found in a single location, one species each of the Tetragnathidae, Pseudococcidae and Formicidae families were found.

The density per area unit in this locality reached 256.87 ind m^{-2}, which was composed by Hemiptera at 175.5 ind m^{-2}, Coleoptera at 53.5 ind m^{-2}, Hymenoptera at 11.87 ind m^{-2} and the remaining taxons contributing to less than 10 ind m^{-2}. The Agave scale (*Acutaspis agavis* Townsen and Cockerell) was the species with the highest density at 114 ind m^{-2}.

El Venado locality had the least richness of species and families (Table 2). The taxon with the most relative abundance was Hemiptera (72%) in four species from four families, followed by Coleoptera (17%) with five species in four families, the remaining taxons shown an abundance lower than 11%. The most abundant species can be seen in Fig. 4. A single species of the Chrysomelidae family was collected and thus deemed unique or rare. In this locality the density per unit of area (ind m^{-2}) reached 183.83 ind m^{-2}, of which Hemiptera represented 133.5 (ind m^{-2}). The Agave scale *Acutaspis agavis* was also the species with highest density (95.37 ind m^{-2}). La Breña had a species richness intermediate to that of the other two localities (Table 2). The highest relative abundance was also for Hemiptera (63%) with five species in four families, followed by Coleoptera (20%) with six species in four families, with the remaining taxons representing 17% of the total relative abundance.

The most abundant species in this locality can be found in Fig. 5. Two species were deemed to be unique or rare and these belonged to the Tetranychidae and Cucujidae families.

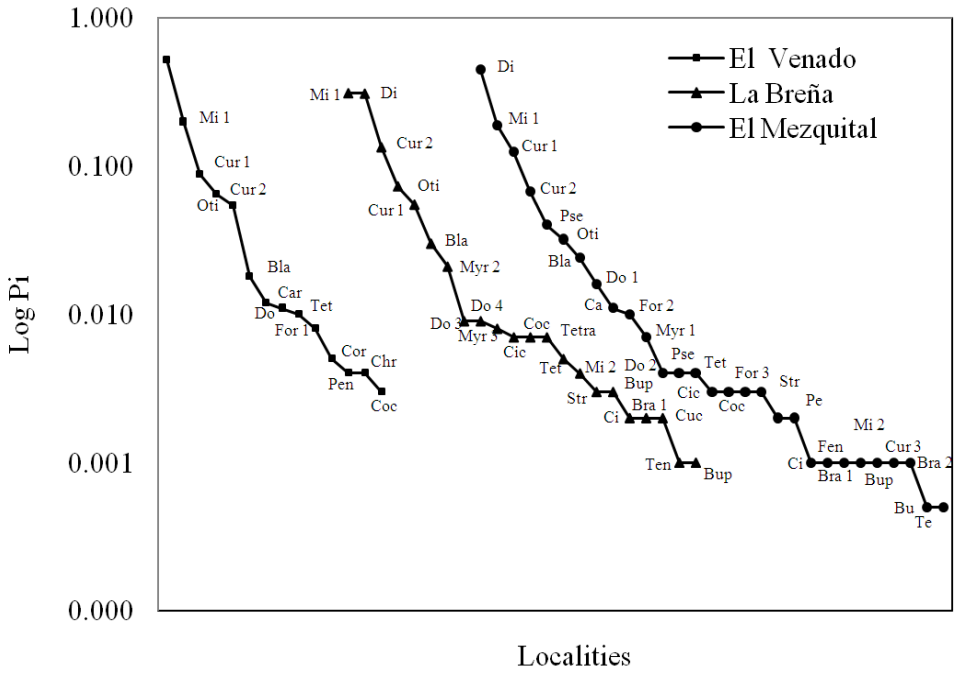

Fig. 6: Dominance-Diversity curves of the localitites of La Breña, El Venado and El Mezquital where mescal agave develops in the State of Durango, Mexico. The initials represent the following families and subfamilies of arthropods: Bu = Buthidae, Te =Tetragnathidae, Teta = Tetranychidae, Bl = Blattellidae, Co = Coreidae, Pe 1= Pentatomidae sp. 1. Pe2= Pentatomidae sp. 2, Mi1 = Miridae sp. 1, Mi2 = Miridae sp. 2, Ci = Cicadidae, Cic= Cicadellidae, Di = Diaspidae, Pse = Pseuococcidae, Ca = Carabidae, Bu = Buprestidae, Cuc = Cucujidae, Coc = Coccinellidae, Te=Tenebrionidae, Chr = Chrysomellidae, Cur 1= Curculionidae sp. 1, Cur 2 = Curculionidae sp. 2, Cur 3= Curculionidae sp. 3, For 1, Formicinae sp. 1, For 2 = Formicinae sp. 2, For 3 = Formicinae sp. 3, Myr 1 = Myrmicinae sp.1, Myr 2 =Myrmicinae sp. 2, Myr 3 = Myrmicinae sp. 3, Do 1= Dolichoderinae sp. 1, Do 2= Dolichoderinae sp. 2, Do 3= Dolichoderinae sp. 3, Do 4 = Dolichoderinae sp. 4, Do 5 = Dolichoderinae sp. 5, Pseu = Pseudomyrmecinae, Bra1= *Bracon*idae sp. 1, Bra2 = Braconidae sp. 2, Ot = Otitidae, Str = Stratiomydae

Table 2: Abundance of arthropods collected in the three localities where mescal agave occurs in Durango State, Mexico

		Study locations and number of species						
Taxonx	Family and subfamily	El Venado	Num. of species	La breña	Num. of species	El mezquital	Num. of species	Total species
Scorpionida	Buthidae	-		1	1	1	1	1
Araneae	Tetragnathidae	-		-		1	1	1
Acari	Tetranychidae	-		8	1	-		1
Orthoptera	Tettigonidae	14	1	6	1	7	1	1
Dictyoptera	Blattellidae	26	1	34	1	49	1	1
Hemiptera	Coreidae	7	1	-		8	1	1
	Pentatomidae	6	1	-		4	1	2
	Miridae	292	1	359	2	388	2	2
	Cicadidae	-		2	1	3	1	1
	Cicadellidae	-		8	1	6	1	1
	Diaspididae	763	1	352	1	912	1	1
	Pseudococcidae	-		-		83	1	1
Coleoptera	Carabidae	17	1	--		23	1	1
	Buprestidae	-		3	1	2	1	1
	Cucujidae	-		2	1	-	-	1
	Coccinellidae	4	1	8	1	6	1	1
	Tenebrionidae	-		1	1	3	1	1
	Chrysomelidae	6	1	-		-	-	1

Table 2: is continue

Curculionidae	225	2	216	2	394	3	3
Hymenoptera Formicidae							
Formicinae	12	1	-	-	27	2	3
Myrmicinae	-	-	33	2	15	1	3
Dolichoderinae	16	1	20	2	40	2	5
Pseudomyrmecinae	-	-	-	-	8	1	1
Braconidae	-		2	1	5	2	2
Diptera Otitidae	79	1	84	1	65	1	1
Stratiomyidae	-	-	4	1	5	1	1
Abundance (N)	1467		1143		2055		
Richness of families		13		18		23	
Richness of species (S)		14		22		29	39
Mean*	37,61a		29,31a		52,69a		

*: Means with the same letter are not statistically different using Turkey's test (p≤0, 05)

Table 3: Values of the spatial diversity index of arthropods in mescal agave in three localities of the State of Durango

	Localities		
Indices	El Venado	La Breña	El mezquital
Shannon's index (H')	1, 55	1, 89	1, 86
Pielou's index of evenness (J')	0, 59	0, 61	0, 55
Simpson's index	0, 67	0, 78	0, 74

The density per unit of area was 142.87 ind m^{-2} of which Hemiptera had 90.12 ind m^{-2}, Coleoptera 28.75 ind m^{-2}, Diptera 11 ind m^{-2} and the remaining taxons ith densities below 10 ind m^{-2}. The plant bug *Caulotops* spp. had the highest density at 44.25 ind m^{-2}.

No significant differences could be found when omparing mean abundance by locality using an ANOVA (p = 0.05) (Table 4).

These were followed by Coleoptera (22%) which had seven species in five families, while the remaining taxons accounted for 10% of the total. Nevertheless, Hymenoptera had eight species in two families (Table 2).

Diversity alpha (α): Shannon's diversity index, Pielou's Index of evenness and Simposon's dominance index varied between localities (Table 3). At the taxon level, Hymenoptera had the highest Shannon's diversity index, followed by Coleoptera, Hemiptera and Diptera, while the rest had values at zero due to the fact that they were only represented by a single species. Furthermore, in Pielou's Index of evenness Hymenoptera had the highest level.

There were significant differences in the abundance between taxons according to the ANOVA analysis (p≤0.05) divided into two groups. On the one hand is Hemiptera with the highest relative abundance, an intermediate value in Shannon's diversity index, low evenness and Simpson's dominance index. On the other, the remaining taxons are included, of which Hymenoptera had the highest diversity, evenness and dominance (Table 4).

In Fig. 6 shows the dominance/diversity curves in the studied localities. In the abcise axis are represented the arthropods families in decreassing order of abundance and the y's axis represente the logaritmes of the abundance. La Breña and El Mezquital had approximately the same pattern, with the dominance of one or few species. In El Venando, all the families are equal represente, and any shown very low values. Also, the figure shows three groups, one containing dominant species, another with intermediate species and a third with scarce or rare species.

Diversity beta (β): The results obtained with Jaccard's similitude index indicate low similitude between the three localities with an average of 35%. The greatest similitude was observed between La Breña and El Mezquital (46%) since they share 7 taxons, while the least similitude was obtained between El Venado and La Breña (29%). Regarding Simpson's index, La Breña had the highest value while El Venado had the lowest (Table 3).

According to their abundance the most important species were *Acutaspis agavis* Townsen and Cockerell (47%), *Caulotops* sp. (25%), *Peltophorus polymitus* var. *leopardinus* (Desbrochers) (11%) and *Scyphophorus acupunctatus* Gyllenhal (9%), with the remaining species attaining relative abundances below 2% (Fig. 4). Also, individuals of *Chilocorus cacti* L., *Bracon* sp. and *Chelonus* sp., were collected, which are enemies of some species considered as pests.

It is noteworthy that 4 subfamilies of Formicidae were observed; Dolichoderinae, Myrmicinae, Formicinae and Pseudomyrmecinae, as well as 12 species in the following distribution: in El Venado *Brachymyrmex* sp. and *Tapinoma* sp. were found; in La Breña *Crematogaster* sp. 2, *Pheidole* sp., *Forelius* sp. and *Liometopum* sp.; and in El Mezquital *Brachymyrmex musculus* Forel, *Camponotus* sp., *Crematogaster* sp. 1, *Dorymyrmex* sp. 1, *Dorymyrmex* sp. 2 and *Pseudomyrmex pallidus*. Of these the most abundant were *Dorymyrmex* sp. 2, *Pheidole* sp., *Brachymyrmex musculus* and *Tapinoma* sp.

Table 4: Parameters of diversity of the arthropod Taxons present in the mescal agave (*A. durangensis*) communities in the State of Durango

	Parameters and Indices					
Taxa	Absolute (N) and relative (%) abundance	Num. of species	Mean*	Shannon's index (H')	Pielou's Index of Evenness (J')	Simpson's index (λ)
Hemiptera	3193 (68.5)	9	1064.333a	0.84	0.38	0.49
Coleoptera	910 (19.5)	9	303.33b	1.04	0.47	0.5 8
Diptera	237 (5.1)	2	79.0b0	0.16	0.23	0.73
Hymenoptera	178 (3.8)	14	59.33b	2.45	0.93	0.90
Dictyoptera	109 (2.3)	1	36.33b	-	-	-
Orthoptera	27 (0.6)	1	9.0b0	-	-	-
Acari	8 (0.2)	1	2.67b	-	-	-
Scorpionida	2 (≤1)	1	0.67b	-	-	-
Araneae	1(≤1)	1	0.33b	-	-	-

*: Means with different letters are statistically different according to Tukey's test (p≤0, 05)

DISCUSSION

Qualitative distribution: Knowledge of arthropods in communities where agave is the predominant species is incipient in Mexico. Studies that have been carried out are mostly focused on botany, agronomy and pest control in *Agave tequilana* var. *azul* in the states of Jalisco, Guanajuato and Querétaro (Elizondo, 2009; Solís-Aguilar *et al*., 2001; Jones and Luna-Cozar, 2007). The present study increases the records of insect species present in the State of Durango with approximately 2% of that which had been recorded by (Llorente-Bousquets and Ocegueda, 2008) not including Scorpionida, Araneae and Acari. Although the percentage is low, in terms of those in mescal agave, there is an advance in arthropod knowledge. Arthropods are an important element in arid zones due to their role in plant community structuring as well as due to their interactions with microorganisms and at diverse trophic levels in the food chain (Coleman and Hendrix, 2000; Ward, 2009).

Species richness and composition was different among localities lending support to the argument that environmental conditions and human activities can determine the habitat preferences of arthropods among communities, even though abiotic factors such as temperature and humidity seem to have greater relevance in species richness and abundance since they are related with life cycles and could be the key to their success in extreme environments such as those in Durango. El Mezquital offers the best ecological conditions for the development of arthropod species since it has a more humid climate, a mean annual temperature reaching 19.4°C, an altitude of 1982 momsl and effects by human activities are lower. In comparison, La Breña and El Venado had similar temperatures but different altitudes (Table 1) and human activities. El Venado is an area where the vegetation is fragmented due to houses, farmland and grassland paddocks for cattle as well as plant extraction, while La Breña is farther from population centers therefore has less effects from human activities, although there is plant extraction.

Analysis of diversity:

Diversity alpha (α): Taking into consideration Shannon's diversity index and Simpson's dominance index, La Breña had the highest diversity and dominance, while El Venado had the least diversity but the highest dominance. According to Magurran (1988) and Peinado *et al*. (2011) this could be due to an increase in individuals in relation to a low number of species since Simpson's index is influenced by the most abundant species in the locality. Meanwhile, the evenness index showed that there was no stability in any of the localities even though the values were highly similar between localities ranging from 0.55-0.61.

According to Shannon's diversity index usually falls between 1.5 and 3.5 and rarely goes above 4.5. The results obtained in this study barely surpass the minimum proposed by said author, therefore they are considered to have poor diversity, but various authors have pointed out that fauna diversity is poor in arid zones anyway.

In terms of Simpson's dominance index La Breña had the highest values, which is expected if one takes into account that at high values this index indicates dominance of one of the species present in the locality, such as Miridae in this case. El Venado had the lowest index value which translates into low dominance and a more uniform distribution of individuals among species (Magurran, 2003).

Analyzing the dominance/diversity curves (Fig. 6), we observe that ther are few dominant species, and most of species are rares, which is related with a low diversity.

Diversity beta (β): The grouping analysis carried out using Jaccard's index shows that the localities of La Breña and El Mezquital had the highest similitude

between them (46%) with a mixture of species found in only one location and shared species (16). The localities with the least similitude between them (29%) were El Venado and La Breña since they only had seven species in common from a total of 28 species among both localities. Nevertheless, the similitude between El Venado and El Mezquital was intermediate between the other two (30%).

At the taxon level, the highest diversity index occurred in Hymenoptera while the least diversity occurred in Dictyoptera, Orthoptera, Scorpionida, Aranae and Acari which only had a single species.

The range-abundance curves show low evenness since in the three localities there is high dominance of rare species such as *Centruroides* sp., *Tetragnatha* sp., *Tetranychus* sp., *Thysanta* sp., *Euchistus* sp. and *Pantomorus* sp. among others. Following these species the next dominant groups in general are Hymenoptera, Coleoptera and Homoptera. The species *Acutaspis agavis*, *Caulotops* sp. and *Peltophorus polymitus* formed a group that had numerical importance.

Taxons Homoptera, Coleoptera and Hymenoptera were the most abundant groups in the three localities but the composition of species was different in each locality (Fig. 2).

It is important to mention that the bug *Acutaspis agavis* apart from being found in *Agave tequilana* var. azul (Hammer *et al*., 2001) it has also been reported in forest trees such as fabaceae and euphorbiaceae in Florida and Texas (Miller, 2005).

The species *P. polimitus* var. *leopardinus* was found to be feeding mainly from the base of young leaves. Jones and Luna-Cozar (2007) when studying curculionidae in the State of Querétaro found that *P. polymitus* Boheman was present in deciduous low forest and *Quercus* sp. forests, which points to this being a species that can adapt to diverse natural plant populations and could in the future become a pest in established plantations of *A. durangensis* in the State of Durango.

Scyphophorus acupunctatus Gyllenhal was located in the base, on the leaves and heart of the agave as larvae or adult, although an attack by larva is more severe since it bores into the hearts and stems and creates galleries within the plant. This species is the main pest of pulque agave (*Agave atrovirens* Kart), tequila agave (*A. tequilana* Weber) and mescal agave (*A. angustifolia* Haw) (Halffter, 1957) although it has been observed in other plants such as the tuberose (*Polianthes tuberosa* L.) (Lavin *et al*., 2002) and tree yucca (*Yucca valida* Brandegee) (Servin *et al*., 2006). It is known to have caused up to 24.5% of the damage in *Agave tequilana* Weber var. Azul in the State of Jalisco, (Solís-Aguilar *et al*., 2001) between 10-26% deterioration in Agave *angustifolia* and 13.35% damage in *A. tequilana* in the State of Oaxaca (Solís-Aguilar *et al*., 2001). There is also evidence that it is a vector of the bacteria *Erwina caratovora* which causes decay in the heart and plant death (Fucikovsky, 2002). The sisal weevil has also been collected in Guanajuato on agave (Salas-Araíza *et al*., 2001), as well as in the State of Querétaro (Llorente-Bousquets and Ocegueda, 2008).

In this regard, authors have mentioned that arthropods interact between them in an environment and that there is a balance between not growing to infinity and decreasing to extinction as a result of the regulating mechanisms in natural ecosystems. Meanwhile in a monoculture, by simplifying the number of plant species, the system's instability is favored predisposing the presence of pests.

The insect species *Pantomorus* sp., *Acantocephala* sp., *Euschistus* sp. and *Thyanta* sp. as well as the *Centruroides* sp. scorpion, the *Tetragnatha* sp. spider and the *Tetranychus* sp. phytophagous mites were found as rare species. Rare species, either accidental or in low abundance, are species that search for microhabitats such as plants, soils or fallen leaves, or are temporary species that are passing through due to the activities they carry out during the day or night and are thought to be the most sensitive to environmental disturbances (Magurran, 1989). Also, rare species are thought to depend upon certain characteristics such as the habitat, level of plasticity, tolerance to environmental changes, specific forms of dispersion and biological characters, among others (Soulé, 1986). Andersen (1989) points out that natural and human disturbances can produce drastic changes in terms of local extinctions and changes in recruitment levels and growth in populations with rare species. Nevertheless, even though they are rarely present, these species are of importance in other zones. Such is the example of *Pantomorus* sp. which has been reported in *Acacia* sp., Mimosa sp., Prosopis sp., Persea americana Mill. and Marrubium vulgare L. in Guanajuato (Salas-Araíza *et al*., 2001) and in the State of Querétaro (Jones and Luna-Cozar, 2007). Furthermore, Acantocephala sp., Euschistus sp. and Thyanta sp. have been observed in goldenrod (*Solidago* spp.) from which they feed upon (Fontes *et al*., 1994). The Centruroides sp. scorpion is the most common in Mexico with widespread distribution as a group but at the specific level it has restricted distribution even in those species that have spatial distribution patterns that are clearly influenced by microhabitat preferences (Polis, 1990). Spiders are considered to be generalist predators and have been found in diverse crops (Sunderland, 1999).

The agave scale (*Acutaspis agavis*) was the species with the highest relative abundance followed by the *Caulotops* sp. bug, the weevil *Peltophorus polymitus* var. *leopardinus* and the sisal weevil *Scyphophorus acupunctatus* that also were the most frequent species in the three localities, thus they are considered to be of widespread geographical distribution and that they can be found in other microhabitats of the region and should be considered as species of economic importance.

In this study a total of four subfamilies of Formicidae with 9 genera were observed, which were Dolichoderinae, Myrmicinae, Formicinae and Pseudomyrmecinae. The majority of these species are considered to be generalist foragers, except *Pseudomyrmex pallidus* Smith which is a predator that visits extrafloral nectaries. Wilson (1990) stated that ants are the most abundant insects and that they play an important role in the ecosystem. They are important in arid and semiarid environments since they have high species richness and due to the biological interactions that they establish with other organisms such as the predation with various invertebrates and the removal and consumption of seeds (Huxley and Cutler, 1991; Polis, 1991). This family was the one that afforded the greatest species richness which can be explained by the heterogeneity of the localities of this study since they encompass different types of vegetation which allow various microhabitats. It must be pointed out that the species that were found in these communities have been reported to be present in other arid zones in northern Mexico in the States of Baja California, Sonora, Chihuahua, Nuevo León and Coahuila (Alatorre-Bracamontes and Vasquez-Bolaños, 2010) as well in the central part of the country (Guzmán-Mendoza *et al*., 2010; Varela and Castaño-Meneses, 2010) . It is believed that this occurs because they are not subject to the seasonal presence of a resource but rather make use of a wide range of food sources (feces, arthropod carcasses, plant exudates and animals) that are available at any time of the year, as well as interacting with microorganisms (Whitford, 1978; Rios-Casanova *et al*., 2004). Nevertheless, there is little information on their diversity and importance (Rojas and Fragoso, 2000).

Ladybird beetles of the *Chilocorus cacti* L., which is a predator of scales, were found. It has been reported that up to 20 individuals have been found per plant when there is an increase in the populations of *Acutaspis agavis* in plants of *Agave tequilana* var. azul (Jones and Luna-Cozar, 2007). Also, *Chelonus* sp. and *Bracon* sp. were found, which are parasitoids of certain pest species, have been used as biological control of plant louse, beet armyworm, stem borers, sisal weevils, avocado branch and pit borers and fruit fly and has been taxonomically studied in the States of Coahuila, Chiapas, Guanajuato, Morelos, Nuevo León, Tamaulipas, Yucatán and Oaxaca. Morales *et al*. (2002) reported that *Bracon* sp. was found parasitizing pupae of the fly drill of the stem of the tomato *Melanagromyza tomaterae* Steyskal and larvae of lepidopterae that damage leguminous plants, corn, melon and cotton (Marchiori and Penteado-Dias, 2002).

CONCLUSION

A total of 4665 individual arthropods associated to *Agave durangensis* were collected, which corresponded to 39 species. The species found in this study showed the abundance, richness and diversity of species associated to the plant reflecting its importance on plant communities since it is a vital resource for a group of organisms that have diverse feeding habits.

It must be pointed out that the sampling of arthropods on *Agave* was not carried out intensively. Nevertheless, it is thought that the results demonstrate the importance of these taxa in regards to the abundance and number of species and it is necessary to carry out more intensive studies with other types of sampling and for longer periods of time in order to obtain a more complete inventory, determine the role that each species has in the ecology of Agave, the extent of harm that each can have on the plant and which protect the plant by keeping in check other insect populations.

This study reports the presence of arthropods that had not been reported for this agave such as the *Centruroides* sp. scorpion, the *Tetragnatha* sp. spider, the *Thyanta* sp. and *Euschistus* sp. stink bugs, *Peltophorus polymitus* var. *leopardinus* weevil and various ant species.

The most abundant species were the plant bug *Caulotops* sp., the agave scale *Acutaspis agavis*, the weevil *Peltophorus polymitus leopardinus* and the sisal weevil *Scyphophorus acupunctatus* which are considered to be of importance due to the damage they can cause in *A. durangensis* when plantations become established in the State. The latter is based in the experiences from plantations of *Agave tequilana* in other States of the Mexican Republic.

The process of habitat fragmentation is growing in the region due to the development of productive and economical activities. This affects the stability of the system causing a impoverishment of the local entomological fauna as well as of the vegetation. The use of management strategies in natural communities could help to conserve the stability of these ecosystems and preserve the environment.

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