Seasonal variation of the macro-arthropod community associated to Tillandsia carlos-hankii (Bromeliaceae) in an oak-pine forest in Oaxaca, Mexico

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Seasonal variation of the macro-arthropod community associated to *Tillandsia carlos-hankii* (Bromeliaceae) in an oak-pine forest in Oaxaca, Mexico

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ABSTRACT. Here we describe the seasonal variation of the macroarthropod community associated to *Tillandsia carlos-hankii* Makuda (Bromeliaceae) in a deciduous forest located at "Petenera", Santa Catarina Ixtepeji, Oaxaca, Mexico. Eight T. *carlos-hankii* specimens were collected during the wet season and 10 during dry season. We recorded 874 macroarthropod individuals, belonging to one phylum, four classes, 17 orders, 60 families and 81 morphospecies. The richest order was Araneae (21 morphospecies), from which Salticidae (4 spp.), Staphylinidae (4 spp.) and Lygaeidae (4 spp.) were the most abundant families. Richness at the family and morphospecies level was significantly higher during the dry season (44 vs. 37, and 57 vs. 48, respectively). Likewise, abundance was also greater during the dry season (468 vs. 215). Overall, Araneae was the most abundant order represented by 173 individuals, whereas Blattellidae was the most abundant family (142 individuals). The most abundant morphospecies were: *Parcoblatta* sp. 1, *Tipula* sp. 1, *Phloeopora* sp. 1, *Scytodes aff. thoracica* and *Underwoodia* sp. 1. The proportion of individuals belonging to each feeding guild was as follows: 50% zoophagous (represented by *Phloeopora* sp. 1, Staphylinidae), 33% were herbivores (represented by *Tipula* sp. 1, Tipulideae), and 17% were detritivores (represented by *Parcoblatta* sp.1, Blattellidae). Richness differed significantly among guilds during both seasons: zoophagous were more species-rich than the detritivore guild. In addition, abundance differed significantly between guilds during the dry season (zoophagous were most abundant), but was similar during the wet season. Finally, alpha diversity was similar between seasons (wet season: H′ = 3,27, dry season: H′ = 3,28; p › 0,05). Our results show that there is still much that needs to be explored regarding bromeliad-arthropod interactions, and that further investigations should consider seasonal changes in arthropod richness, composition and abundance associated to this plant family.

RESUMEN. Se caracterizó la comunidad de macroartrópodos asociada a *Tillandsia carlos-hankii* (Bromeliaceae), en un bosque caducifolio y se evaluó su variación estacional. El estudio se realizó en el paraje "La Petenera" en el municipio de Santa Catarina Ixtepeji, Oaxaca. En septiembre 2005 (lluvias) y en marzo 2006 (secas), se colectaron ocho y diez bromelias adultas, respectivamente. Las bromelias fueron deshojadas en busca de artrópodos. Se encontraron 874 organismos representados en un phylum, cuatro clases, 17 órdenes, 60 familias y 81 morfospecies. El orden más rico fue Araneae (21 morfospecies); siendo las familias Salticidae (4 spp), Staphylinidae (4spp) y Lygaeidae (4spp) las mejor representadas. Se encontró una mayor riqueza tanto a nivel de familia (44 vs. 37), como a nivel de morfospecies (57 vs. 48) durante la época de secas, lo mismo que una mayor abundancia de individuos (468 vs. 215). El orden con mayor abundancia fue Araneae con 173 individuos; en tanto la familia con más individuos fue Blattellidae con 142, mientras que las morphospecies más abundantes fueron *Parcoblatta* sp.1, *Tipula* sp.1, *Phloeopora* sp.1, *Scytodes aff. thoracica* y *Underwoodia* sp.1. La comunidad estuvo compuesta mayormente por zoófagos (50%) representados por *Phloeopora* sp.1 (Staphylinidae), seguidos por fitófagos (33%) representados por *Tipula* sp.1 (Tipulidae) y por último por saprófagos (17%) representados por *Parcoblatta* sp.1 (Blattellidae). La composición de la comunidad de macroartrópodos, de acuerdo a su hábito alimenticio, se analizó de manera independiente para cada época, encontrando que la riqueza de morfoespecies por hábito alimenticio difería significativamente tanto en épocas de secas como en épocas de lluvias, siendo más ricos los zoófagos en ambas temporadas y los menos ricos los saprofitos. La abundancia de individuos por hábitat alimenticio no mostró diferencias significativas durante la época de lluvias, contrarío a lo encontrado en época de secas en donde se presento una mayor abundancia de zoófagos.

La diversidad alfa en época de lluvias (H`= 3,27) fue similar a la encontrada en época de secas (H`= 3,28). Nuestros resultados muestran que aun queda mucho por explorar sobre la asociación entre los macroinvertebrados y las bromelias, y que dentro de dichos estudios se deben considerar los cambios estaciónales ya que al parecer estos tienen una fuerte influencia en la riqueza, abundancia y composición de la comunidad de macroinvertebrados.

KEY WORDS. Deciduous forest, Macroarthropods, Plant-arthropod interaction, Phytotelmata, *Tillandsia carlos-hankii*

Epiphytic bromeliads are one of the most conspicuous components of neotropical forest canopies. Bromeliaceae plays an important role in tropical forests by being involved in nutrient and water cycling processes (Nadkarni & Matelson 1991, Clark *et al.* 1998, Benner & Vitousek 2007), as well as interactions with animals, other plants and microorganisms (Strong 1977, Ordano & Ornelas 2004, Grippa *et al.* 2007, Liria 2007). They also have a strong contribution to total plant species richness (Gentry & Dodson 1987).

Among epiphytes, tank-type bromeliads have been classified as keystone species because they provide shelter, brood site, food and water for numerous organisms, mainly arthropods (Nadkarni 1994). Arthropods are the most diverse group in the planet, representing about 80% of all known species (Rojas & Casanova 2002). They are of central importance for ecosystem function, and play different roles as: detritivores, herbivores, pollinators, seed dispersors, carnivores, among others (Borror *et al.* 1981, Daly *et al.* 1998).

Picado's (1913) initial work represented the first attempt to describe associations between arthropods and epiphyte bromeliads. Although more recent studies have looked at such relationships, most have done so in tropical forests (Richardson 1999, Richardson et al. 2000, Armbruster *et al.* 2002, Stuntz *et al.* 2002, Liria 2007), and very few have been conducted in temperate ecosystems (Palacios-Vargas 1981, Palacio-Vargas & Castaño-Meneses 2002, Rojas & Casanova 2002, Ospina-Bautista *et al.* 2004). Moreover, although it is known that arthropod populations are affected by environmental conditions, very few studies have documented seasonal changes in the structure and composition of the macroarthropod community associated to bromeliads (Palacios-Vargas 1981, Mestre *et al.* 2001, Liria 2007). The present study (1) describes the macroarthropod community associated to the tank-type epiphytic bromeliad *Tillandsia carlos-hankii* in a temperate deciduos forest and (2) examines possible changes in the macroarthropod community between the dry and wet season.

MATERIAL AND METHODS

Study Site. Study plants were collected at the "La Petenera", in the municipality of Santa Catarina Ixtepeji, Oaxaca, Mexico (17º 12′ 29″ N, 96° 35′ 29′′ W), at 2 547 m. The climate is temperate to subhumid cold with summer rains. The mean annual temperature and rainfall are 14°C and 1 000 mm, respectively (INEGI, 1998). The area is characterized by a dry season is characterized as the period during which rainfall is lowest (150 mm), the number of rainy days ranges between 0 and 29, and the mean temperature is 28 ºC (extending from November to April). The rainy season on the other hand, includes the period during which rainfall is greatest (up to 900 mm), the number of rainy days ranges from 90-119, and the mean temperature is 24 ºC (extending from May to October). This climatic caracterization was generated based on twenty years of data from the closest meterological station (INEGI, 1998).

According to the vegetation and soil map from INEGI (1985), the study site presents an oak-pine forest association which reaches a height of 16 m, and is mostly composed of *Quercus scytophylla*, *Q. crassifolia*, *Pinus patula*, and *P. ayacahuite*. Of these, *Quercus* trees are the most important hosts for bromeliads. Other tree species are *Q. laurina*, *Q. rugosa*, and *Q. castanea*. Epiphytic communite is composing by mosses, lichens, ferns, orchids, species of Crassulaceae, Piperaceae and bromeliad (Mondragón et al. 2006).

At the Petenera there are four especies of epiphytic bromeliad: *Tillandsia bourgaei*, *T. carlos-hankii*, *T. prodigiosa* and *T. magdougalli*, the first three are considered tank bromeliad, and the last is a small size bromelia with some feautures of atmosferic plant (Mondragón et al. 2006). Garcia (2008) report 400 adult individuals of *T. prodigiosa* at this place.

Study Species. *T. carlos-hankii* is a tank-type bromeliad (phytotelmata) endemic to the oak-pine forests of the state of Oaxaca, Mexico (Espejo-Serna *et al.* 2004). It can measure up to 70 cm in height, and its leaves are rigid with a rosette configuration (i.e., tank form). The scape is erect, ramified, and robust. Scape-bracts are imbricated, light green on the bottom side, and red on the upper side. The inflorescence is dense, narrow, cylindrical (57—70 cm in length); its primary inferior bracts exceed the upper ones. Axillary spikes are short-stipitate, with floral bracts densely-imbricated. Flowers have lanceolated sepals, yellowish green and petals tubular-erect, yellow-green (Smith & Downs 1977).

Specimen sampling was conducted during September 2005 (rainy season) and March 2006 (dry season). We choose these two sampling periods because both climate and thus vegetation exhibit strong seasonal changes.

A total of eigth adult individuals of *T. carlos-hankii* from different individuals were randomly collected during the rainy season (September 2005), while another 10 were collected during the dry season (march 2006) using a ladder to access the tree crown. Special care was taken during specimen collection, and all of the selected individuals had inflorescences. Collected plants were placed in plastic bags, firmly tied and labeled with the date, collection site, and specimen number.

All collected specimens were carried to the epiphyte laboratory at the Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Unidad Oaxaca (CIIDIR-IPN-Oaxaca). Plants were defoliated leaf by leaf on a white-colored table in order to facilitate the search for macroarthropods; inflorescences were also examined. Macroarthropods were individually placed in containers with 70% alcohol, and labeled with the collection date and the plant number. A collection number was given to each macroarthropod morphospecies, and specimens were then given numbers from 01 to 87 and stored at the entomological collection of the CIIDIR-IPN-Oaxaca. Taxonomic identification of arthropods was conducted at the CIIDIR-IPN-Oaxaca, using taxonomic keys by Borror *et al.* (1981), Kaston (1978), and Castner (2004). Several specialists in arthropods taxonomy were consulted for corroboration or specimen identification (see acknowledgments section). The abundance of each morphospecies was calculated, and arthropod feeding guild classification was conducted based on the work by Borror *et al.* (1981).

We tested the completeness of our inventory during the two seasson, comparing the asymptote value of the cumulative species models with those provided by the Lineal Dependence that predicted lower asymptotes and the Clench model that predicted higher asymptotes than the observed species richness; these models are useful as predictors representing the lower and upper limits between which the true species richness value should lie (Soberón & Llorente 1993, Moreno & Halffter 2000). Each sample was randomized 100 times with the *EstimatesS* software (Colwell 2005) and fitting to the model according to Moreno and Halffter (2000), in order to avoid bias derived from the order in which data were incorporated into the graph.

In order to determine if there were significant differences across seasons in macroarthropod species richness and/or abundance associated to *T. carlos-hankii* we developed a T student test, the sample size for each season was set at eight plants to rainy season and ten dry season. Alpha diversity was estimated based on Shannon's diversity index (H') and compared with Hutcheson t test (Zar 1984). To compare species richness and abundance among feeding guilds and between seaonal seasson we developed a two way ANOVA test, tranforming richness and abundance data with LN transformations in order to get normality. Since there weren´t a significant interaction between feeding guilds and seaonal seasson ($F=0.572$ $p= 0.568$ $df= 2$ for abundance and $F= 2.524$ $p= 0.089$ $df= 2$ for richness), differences among feeding guilds were analysed in separate way for ech seasson, we use Tukey HSD Test to made post-hoc comparations.

RESULTS

We found 81 morphospecies, belonging to one phylum, four classes, 17 orders and 60 families. According to the commulative curves our sample effort represent the 70% of the 116 potential morphospecies predicted by Clench's equation and the 95 % of the 85 mophospecies predicted by the log-linear model. When considering each season separately, Clench's equation predicted a total of 100 and 91 species for the wet and dry season, respectively, while the log-linear predicted 64 and 67 especies, respectively. When considering each season separately, Clench's equation predicted 100 and 91 species for the wet and dry season, respectively; the log-linear predicted 64 and 67 species for each season, respectively. This indicates that, based on Clench model results, our sampling effort was able to represent 48 and 69 % of the total number of species for the wet and dry season, respectively. On the other and, based on the prediction by the log-linear model, we were able to capture 75 and 94% of the total number of species for the wet and dry season, respectively.

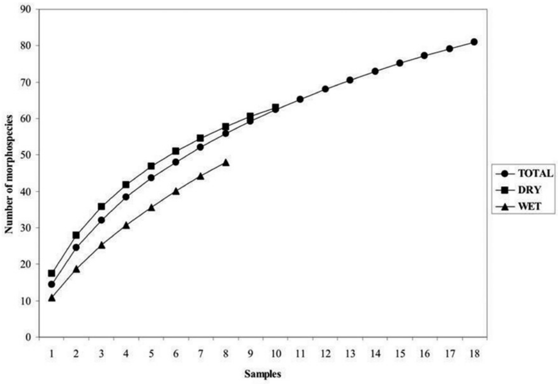

Figure 1. Accumulation's curve of arthropofauna associated to T. Carlos-hankii, total and by season of collects.

All of the recorded macroarthropods belonged to phylum Arthropoda, and distributed among four classes, 17 orders, 60 families, and 81 morphospecies (Appendix 1). The most species-rich order was Araneae (21 morphospecies), followed by Coleoptera (15), Diptera (9), Hemiptera (8) and Hymenoptera (4). The most species-rich families were Salticidae (4), Staphylinidae (4) and Lygaeidae (4); all other families were represented by only one or two morphospecies (Appendix 1).

Although the number of classes and orders remained constant across seasons, the number of families recorded was greater during the dry season (44 vs. 37). Likewise, the number of morphospecies was also greater during the dry season (57 vs. 48; average per plant: 18 + 5 SD for the dry season, and 11 + 5 SD morphospecies/bromeliad specimen for the rainy season; F-snedecor = 1,234 p ‹ 0, 05). In regard, although the most species-rich orders were Araneae, Coleoptera, Diptera y Hemiptera, their contribution to total species richness varied considerably across seasons. For instance, Araneae represented 22% of the total number of species recorded during the rainy season, while it increased to 35% in the dry season. Likewise, Coleoptera, Diptera and Hemiptera each represented 19% of the total number of recorded species during the rainy season, while for the dry season these numbers changed to 24, 16 and 10% respectively.

Abundance data indicated that, from the 874 macroarthropod individuals collected, most belonged the order Araneae (173 individuals), Diptera (165), Orthoptera (143), Coleoptera (93) and Collembola (66). The most abundant families on the other hand, were Blattellidae (142), Tipulidae (81), Staphylinidae (69), Entomobryidae (66), Caseyidae (48) and Scytodidae (48). Lastly, the most abundant morphospecies were *Parcoblatta* sp. 1, *Tipula* sp. 1, *Phloeopora* sp. 1, *Scytodes aff. thoracica* and *Underwoodia* sp. 1.

Abundance patterns across seasons indicated that macroarthropods were more numerous during the dry season compared to the rainy season (468 vs. 215, respectively; average per plant: 66 + 29 SD and 27 + 15 SD macroarthropods/bromeliad specimen, respectively), and this result was statistically significant (Student t p ‹ 0, 05, F-snedecor = 0,266). The most abundant classes, during both the dry and wet season, were Insecta (457 and 120 individuals, respectively), followed by Arachnida (159 and 48, respectively). The most abundant orders during the dry season were Araneae (140), Diptera (133), and Orthoptera (106), while during the rainy season these same orders were also the most abundant but in a different order: Orthoptera was the most abundant (37), followed by Araneae (33) and Diptera (32). Finally, Blattellidae was the most abundant family during the dry season (86 individuals), followed by Tipulidae (78) and Staphylinidae (61); Blattellidae was also the most abundant family during the rainy season (35), followed by Caseyidae (26), Chironomidae (12) and Vaejovidae (12) (Fig. 2).

The feeding guild structure of the collected macroarthropods on T. carlos-hankii plants indicated that most specimens were zoophagous (50%), followed by phytophagous (33%) and saprophagous (17%). The most abundant zoophagous morphospecies were: Phloeopora sp. 1 (Staphylinidae), Scytodes aff. thoracica (Scytodidae), Paraboreochlus sp. 1 (Chironomidae), Clubiona sp. 1 (Clubionidae) and Spilomicrus sp. 1 (Diapriidae). The most abundant phytophagous morphospecies were: Tipula sp. 1 (Tipulidae), Orchesella sp. 1 (Entomobryidae) and Underwoodia sp. 1 (Caseyidae). Finally, the most abundant saprophagous morphospecies was Parcoblatta sp. 1 (Blattellidae).

Feeding guild structure of macroarthropods in Tillandsia carlos-hankii differed among groups and seasons (Fig. 3 and 4). Richness differences (F= 53.832 d.f=2 p= 0.000 dry; F= 4.889 d.f=2 p= 0.018) were done by diversity of Zoophagous versus saprophagous (p= 0.014) in wet season; and diversity among gilds in dry seasson (Zoophagous versus phytophagous p= 0.009, Zoophagous versus saprophagous p= 0.000, phytophagous versus saprophagous p= 0.000, Fig. 3). Similarly, abundance of zoophagous species was highest in the dry season (F=6.778 df= 2 p= 0.004; Zoophagous versus saprophagous p= 0.003), but no differences among guilds were detected in the wet season (Fig. 4)". Finally, alpha diversity was similar between seasons (rainy: H' = 3,27, dry: H' = 3,28; Hutchenson p = 0,05).

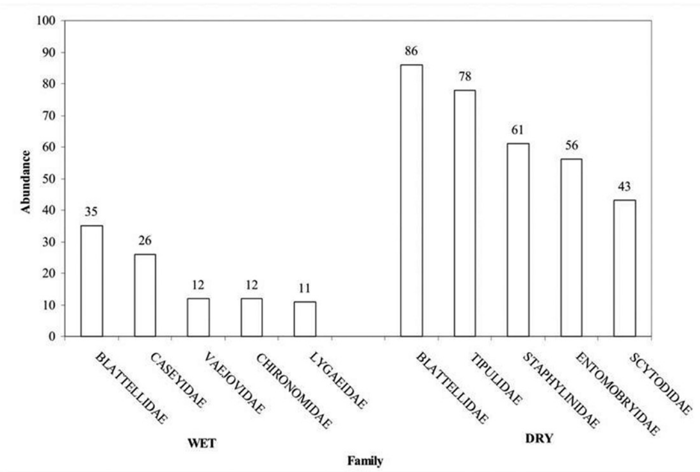

Figure 2. Five more abundant families by season, collected in the period september/2005 and march/2006 in the place "La Petenera", Santa Catarina Ixtepeji, Oaxaca.

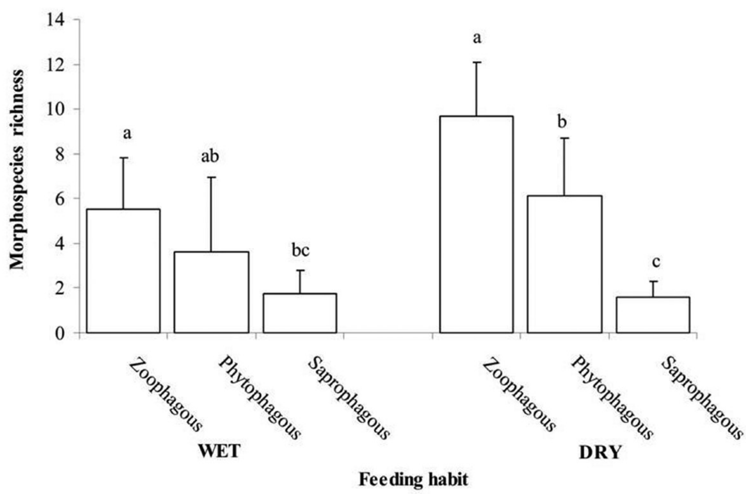

Figure 3. Morphospecies richness by feeding habit in season of rains and droughts. The equal letters indicate that significant differences do not exist, with the Tukey's test (p<0.05).

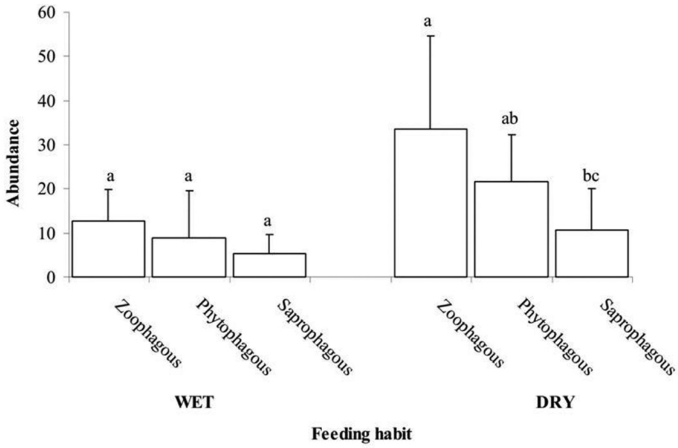

Figure 4. Abundances by feeding habit in season of rains and droughts. The equal letters indicate that significant differences do not exist, with the Tukey's test (p<0.05).

DISCUSSION

Although much progress has been achieved in describing the fauna associated to bromeliads, as well as identifying which factors influence such association, there is still much that remains to be addressed. For instance, in this study we report the presence of the order Chordeumatida, as well 20 families, all of which had not been previously reported for Bromeliaceae in México (Table 1) (Beutelspacher 1971, Zaragoza-Caballero 1974, Privat 1979, Palacios-Vargas 1982, Benzing 1990, Beutelspacher 1999, Richardson 1999, Benzing *et al.* 2000, Richardson *et al.* 2000, Mestre *et al.* 2001, Rojas & Evangelista 2002, Stuntz *et al.* 2002, Ospina-Bautista 2004, Liria 2007). This result is not suprising since only 7 out of 57 bromeliad genera have have been studied under the context of plant-arthropod associations, these are: *Aechmea, Ananas, Bromelia, Guzmania, Hohenbergia, Streptocalyx, Tillandsia*, and *Vriesea*. Such research gap becomes more evident in terms of species numbers, as the proportion of studied genera account for only 1.23% of the 3086 species described for Bromeliaceae (Luther 2006).

Although it is generally accepted that arthropods do not exhibit specificity for bromeliad species (Benzing 1990, Richardson 1999, Stuntz *et al.* 2002), arthropod species richness, composition, and abundance are directly influenced by plant size and architecture (Dejean et al. 1995, Armbruster *et al.* 2002, Stuntz et al. 2002, Srivastava 2006). Like for example in dreasing size order in *Vriesea sanguinolenta* Cong. 8.4 morphospecies/bromeliad and 79 individuals/bromeliad were reported (Stuntz *et al.* 2002), we found 18+5 morphoespecies/bromeliad and 66+29 individuals/bromeliad in *T. carlos-hankii*, and in *T. fasiculata* Sw 5.2 morphospecies/bromeliad and 35.9 individuals/bromeliad (Stuntz *et al.* 2002).

Macroinvertebrate richness and abundance may also be influenced by climatic changes across seasons. This was clearly evidenced in this study by differences across seasons, namely, a greater mean species richness was found during the dry season compared to the rainy season (18 vs. 11 morphospecies/bromeliad, respectively, and 66 vs. 27 individuals/bromeliad, respectively). Our results agree with findings reported by Liria (2007), who evaluated Phytotelmata fauna associated to *Aechmea fendleri* André and *Hohenbergia stellata* Schult. This author found a greater species richness and abundance during the dry season. Greater richness and abundance of arthropods associated to bromeliads during the dry season may be related to the microclimatic conditions provided by bromeliads, which are characterized by lower temperatures and greater humidity compared to adjacent sites. In this sense, arthropods may exhibit a more aggregate distribution and individuals may concentrate at specific microclimatic refugees, some of which are given by bromeliads (Stunz et al. 2002). Furthermore, particularly tank-type bromeliads have the ability to store water which makes them a source for nutrients used by macroinvertebrates that visit or live inside them (Benzing 1990, 2000). The lower richness and abundance during the rainy season may be due to an excess of water stored in bromeliads, which in many cases forces arthropods outside the plant. In addition, environmental conditions are less adverse during this season, which diminishes the importance of bromeliads as microclimatic refugees (Palacios-Vargas 1981, Palacios-Vargas & Castaño-Meneses 2002).

The feeding guild composition of macroarthropods associated to *T. carlos-hankii* was also clearly affected by seasonal changes. Results indicated that zoophagous, phytophagous and saprophytic guilds all had similar abundances during the rainy season, while in contrast, during the dry season zoophagous individuals were much more abundant than saprophytes (phytophagous individuals had a similar abundance compared to those belonging to the other two guilds). These differences may be due to changes in predator foraging patterns (could be the case of Clubiona and Scytodes), as these may concentrate at specific sites which provide food and refuge (i.e., bromeliads) during the dry season. Previous studies have shown a high proportion of predatory arthropods in bromeliads (Stunz *et al.* 2002, Ospina-Bautista *et al.* 2004), nonetheless, these studies did not evaluate changes across seasons. The sharp increase of some phytophagous genus, like Tipula could be related with the fact that *T. carlos-hanskii* producee flower during the dry seasson (*per. obs*) provaiding food to member this genus thath has been reported to feed on nectar (Borror *et al.* 1976). The deacrease in abundance of saprophytes during the dry season may be due to the fact that oak trees (*Quercus* spp), which are the main host for bromeliads, drop their leaves at this time and the leaf litter they produce which falls on bromeliads is generally highly lignified and nitrogen-poor (Richardson 1999, Palacios-Vargas & Castaño-Meneses 2002). Such condition may negatively affect the quality of the resources offered by bromeliads, resulting in lower species richness of detritivores.

Overall, results from the present study indicate that there is still much that remains to be investigated regarding the association between macroinvertebrates and bromeliads. Overall, results from the present study indicate that there is still much that remains to be investigated regarding the association between macroinvertebrates and bromeliads. Future studies should consider seasonality as a relevant source of variation in macroinvertebrate species richness, composition and abundance associated to Bromeliaceae.

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Appendix 1. Arthropod fauna associated to *T. carlos-hankii* at "La Petenera", Santa Catarina Ixtepeji, Oaxaca. Mexico. The taxonomic level and number of sampled individuals at each season.are indicated.

Class	Order	Family	Morphospecies [record no.]	Season		
				guild	Wet	Dry
Arachnida	Acari	**Parasitidae****	*Parasitellus* sp. [01]	Z	1	5
		Tromdidiidae	*Trombidium* sp. [02]	Z	1	0
	Araneae	Amaurobidae	*Amaurobius* sp. [03]	Z	0	1
		Anyphaenidae	*Anyphaena* sp. [04]	Z	0	5
		Araneidae	*Araneus* sp. [05]	Z	0	1
		Clubionidae	*Clubiona* sp. [06]	Z	0	40
			Elaver sp. [07]	Z	0	2
		Dyctinidae	*Dictyna* sp. [08]	Z	9	0
		Gnaphosidae	*Haplodrassus* sp. [09]	Z	2	0
		Nesticidae**	*Nesticus* sp. [10]	Z	0	1
		Oonopidae	*Oonops* sp. [11]	Z	6	0
			Yumates sp. [12]	Z	0	1
		Pholcidae	*Psilochorus* sp. [13]	Z	0	12
		Plectreuridae**	*Plectreurys* sp. [14]	Z	3	4
		Salticidae	*Corythalia* sp. [15]	Z	4	2
			Marpissa sp. [16]	Z	0	2
			Euophrys sp. [17]	Z	0	1
			Evarcha sp. [18]	Z	2	16
		Scytodidae	*Scytodes aff. thoracica* [19]	Z	5	43
		Theridiidae	*Achaearanea* sp. [20]	Z	0	4
			Theridion sp. [21]	Z	0	3
		Theridiosomatidae	*Pityohyphantes* sp. [22]	Z	2	0
			Theriodiosoma sp. [23]	Z	0	2
	Pseudoscorpiones	**Olpiidae****	*Serianus* sp. [24]	Z	1	6
	Scorpiones	**Vaejovidae****	*Vaejovis franckei* [25]	Z	12	8
Chilopoda	Geophilomorpha	**Geophilidae****	*Geophilus* sp. [26]	Z	0	2
	Lithobiomorpha	**Henicopidae****	*Henicops* sp. [27]	Z	10	0
		Lithobiidae	*Lithobius* sp. [28]	Z	10	19
	Scolopendromorpha	**Scolopendridae****	*Scolopendra* sp. [29]	Z	1	0
Diplopoda	**Chordeumatida***	**Caseyidae****	*Underwoodia* sp. [30]	P	26	22
Insecta	Coleoptera	Carabidae	*Platynus aff. acuminatus* [31]	Z	0	2
			Platynus aff. conicicollis [32]	Z	0	1
		Bostrichidae**	*Lyctus* sp. [33]	P	0	2
		Curculionidae	*Metamasius* sp.1 [34]	P	0	2
			Pantomorus sp.1 [35]	P	0	1
		Elateridae	*Alaus* sp. [36]	P	3	6
		Leiodidae**	*Agathidium* sp. [37]	P	1	0
		Ptiliidae	*Acrotrichis* sp. [38]	P	0	2

Class	Order	Family	Morphospecies [record no.]	Season		
				guild	Wet	Dry
		Scarabaeidae	*Dichelonyx* sp. [39]	Z	1	0
		Staphylinidae	*Unidentified* [40]	Z	1	4
			Phloeopora sp. [41]	Z	3	53
			Tinocharis sp. [42]	Z	2	0
			Quedius sp. [43]	Z	2	4
		Tenebrionidae	*Paratenetus* sp. [44]	P	0	1
	Collembola	**Trogossitidae****	*Tenebroides* sp. [45]	Z	0	2
		Entomobryidae	*Seira* sp. [46]	P	4	15
			Orchesella sp. [47]	P	6	41
	Diptera	Dolichopodidae	*Systenus* sp. [48]	S	7	1
		Syrphidae	*Copestylum* sp. [49]	P	1	2
			Eristalis sp. [50]	Z	5	7
		Tephritidae**	*Anastrepha* sp. [51]	P	0	2
		Ceratopogonidae	*Sphaeromias* sp. [52]	Z	3	0
		Chironomidae	*Paraboreochlus* sp. [53]	Z	12	30
		Culicidae	*Aedes* sp. [54]	Z	0	1
		Sciaridae**	*Sciara* sp. [55]	P	1	12
		Tipulidae	*Tipula* sp. [56]	P	3	78
	Hemiptera	Lygaeidae	*Acroleucus* sp. [57]	P	6	3
			Neortholomus sp. [58]	P	1	2
			Pachybrachius sp. [59]	P	1	0
			Paromius sp. [60]	P	3	0
		Reduviidae	*Stenolemus* sp. [61]	Z	1	1
		Rhopalidae**	*Harmostes* sp. [62]	P	1	0
		Veliidae**	*Microvelia* sp. [63]	Z	0	3
		Issidae**	*Thionia* sp. [64]	P	1	1
	Hymenoptera	**Ceraphronidae****	*Ceraphron* sp. [65]	Z	0	4
		Diapriidae**	*Spilomicrus* sp. [66]	Z	0	38
		Formicidae	*Tapinoma* sp. [67]	Z	1	0
			Crematogaster sp. [68]	Z	0	1
		Ichneumonidae	*Unidentified* [69]	Z	0	3
	Lepidoptera	Arctiidae	*Unidentified* [70]	P	0	3
			Spilosoma sp. [71]	P	0	8
		Pyralidae	*Ostrinia* sp. [72]	P	2	11
			Unidentified [73]	P	1	0
	Orthoptera	Blattellidae	*Parcoblatta* sp. [74]	S	34	80
			Plectoptera sp. [75]	S	1	6
		Blattidae	*Eurycotis* sp. [76]	S	1	20
		Tettigoniidae	*Pterophýlla* sp. [77]	P	1	0

Class	Order	Family	Morphospecies [record no.]	Season		
				guild	Wet	Dry
	Psocoptera	Pseudocaecillidae	*Anomopsocus* sp. [78]	P	9	0
		Psyllipsocidae**	*Psyllipsocus* sp. [79	P	0	2
		Liposcelididae**	*Liposcelis* sp. [80	P	0	1
	Thysanoptera	Phlaeothripidae	*Haplothrips* sp.1 [81]	P	1	1
		TOTAL	81		215	659

* = New record at the Order level in tank bromeliads.
** = New records at the Family level in tank bromeliads.
[Record no.] = Record number assigned to each morphospecies stored at the entomological collection of CIIDIR – IPN – OAXACA.
Z=zoophagous, P=phytophagous S=saprophagous