Aquatic Groups in Freshwater Systems in the Semidesierto Queretano, Mexico: Algae, Bryophytes, Vascular Plants, and Odonata

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INTRODUCTION

Freshwater ecosystems occupy an estimated 5.4-6.8% of the global land surface and host almost 9.5% of the Earth´s described species, including one-third of vertebrates. A large proportion of aquatic biodiversity is threatened by factors such as climate change, pollution, biological invasions, infectious diseases, and salinization (Reid et al. 2019). Freshwater habitats in arid zones are especially vulnerable due to isolation, and because they have relicts and endemic species (Davis et al. 2013).

Mexico has a large proportion of mountains and deserts, and as a consequence, wetlands are scarce, accounting for barely 0.6% of the world's wetlands. Olmsted (1993) estimates that only 3.3 million hectares are wetlands, 44% of which are either estuarine or coastal. Continental wetlands span over 6,500 km^2 (Berlanga et al. 2008) including dams or small reservoirs, but estimates of lotic areas are lacking (Mora et al. 2013). Querétaro is a small state in the central portion of Mexico (Figure 1) which mirrors the situation of the country. It has mountains and deserts and large wetlands are absent. Only freshwater systems are present since the state lacks coastal areas. The state has two ecoregions, the Pánuco that drains to the Atlantic, and the Lerma-Chapala which runs to the Pacific (Abell et al. 2008).

A narrow strip in central Querétaro is locally known as "Semidesierto Queretano" (SQ). Floristically, it is the southernmost portion of the largest and richest Mexican arid zone, the Chihuahuan Desert (Figure 2a, b; Granados-Sánchez et al. 2011; Bayona 2016). The area has been under a long human occupation by Otomis and Mestizos that survive on extensive grazing of cows and goats, and rain-fed agriculture (CONAGUA 2020). Therefore, the few water resources available in the area are under high human pressure (Bezaury-Creel et al. 2017; CONAGUA 2020). Lotic environments are represented with first, second, and third-order rivers such as the Moctezuma, Estorax, and Tolimán (Pineda et al. 2009). Natural lentic

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environments include springs, phytotelmata, and temporary ponds. Cattle watering holes and dams are also present (Díaz-Pardo 2016).

A few studies have addressed the SQ aquatic biota, mostly as part of a general description of Querétaro, the Pánuco drainage, or Central Mexico. Studied groups include fish (Gutiérrez-Yurrita and Morales-Ortiz 2004), aquatic macroinvertebrates (Pineda et al. 2009; Torres-Olvera et al. 2018), Odonata (González-Soriano and Novelo-Gutiérrez 1996; Alonso-Eguía et al. 2002; González-Soriano and Novelo-Gutiérrez 2014), and finally, algae, vascular plants, and fish parasites (Pineda et al. 2009).

Monitoring biodiversity in freshwater ecosystems provides information on population status and their extinction risk (Reid et al. 2019). Therefore, systematic sampling is important to estimate the biodiversity of aquatic species per site and their conservation (Heino et al. 2009; Johnson and Hering 2009). Literature of the Pánuco watershed identified 47 algae genera, 40 species of vascular plants (Pineda et al. 2009), and 78 species of Odonata (Alonso-Eguía et al. 2002). However, only three of our sampled localities are in common with previous works for Odonata (Río Victoria-Palmas, El Oasis, and Rancho Quemado) and two for algae and vascular plants (El Oasis and Río Extórax). Bryophytes (*sensu lato*) had not been previously collected in our study sites

The aims of our study were to 1) establish the biodiversity of macroalgae, bryophytes, vascular plants, damselflies and dragonflies in the different natural aquatic environments in the area, and 2) establish which localities are conserved or deteriorated using biota richness as an indicator.

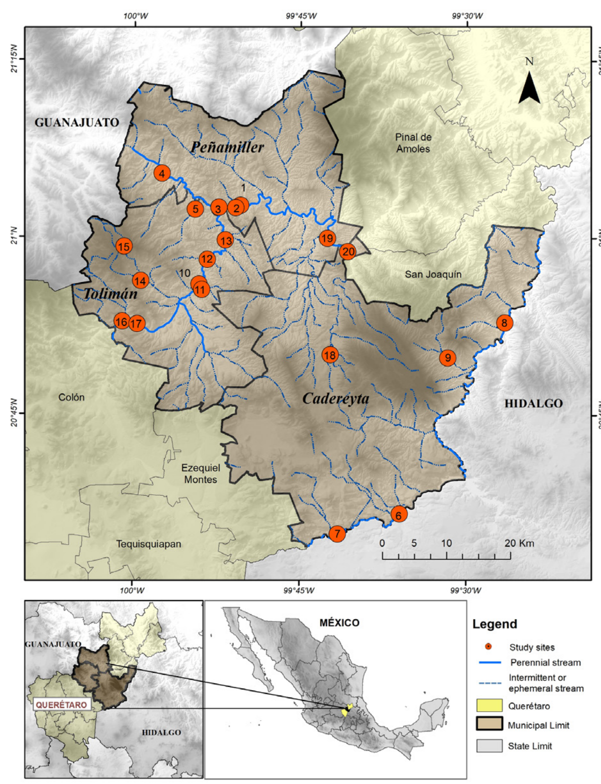

Figure 1. Study sites: 1 - Guamuchil, 2 - El Salado, 3 - Adjuntas de los Guillén, 4 - San Miguel Palmas, 5 - El Manantial, 6 - Tzibanzá, 7 - Pathé, 8 - Las Moras, 9 - Maconí, 10 - La Cañada, 11 - El Chilar, 12 - Crucitas, 13 - La Vereda, 14 - Bomintzá, 15 - El Zapote, 16 - Gudiños, 17 - Panales, 18 - El Púltpito, 19 - El Oasis, and 20 - Rancho Quemado.

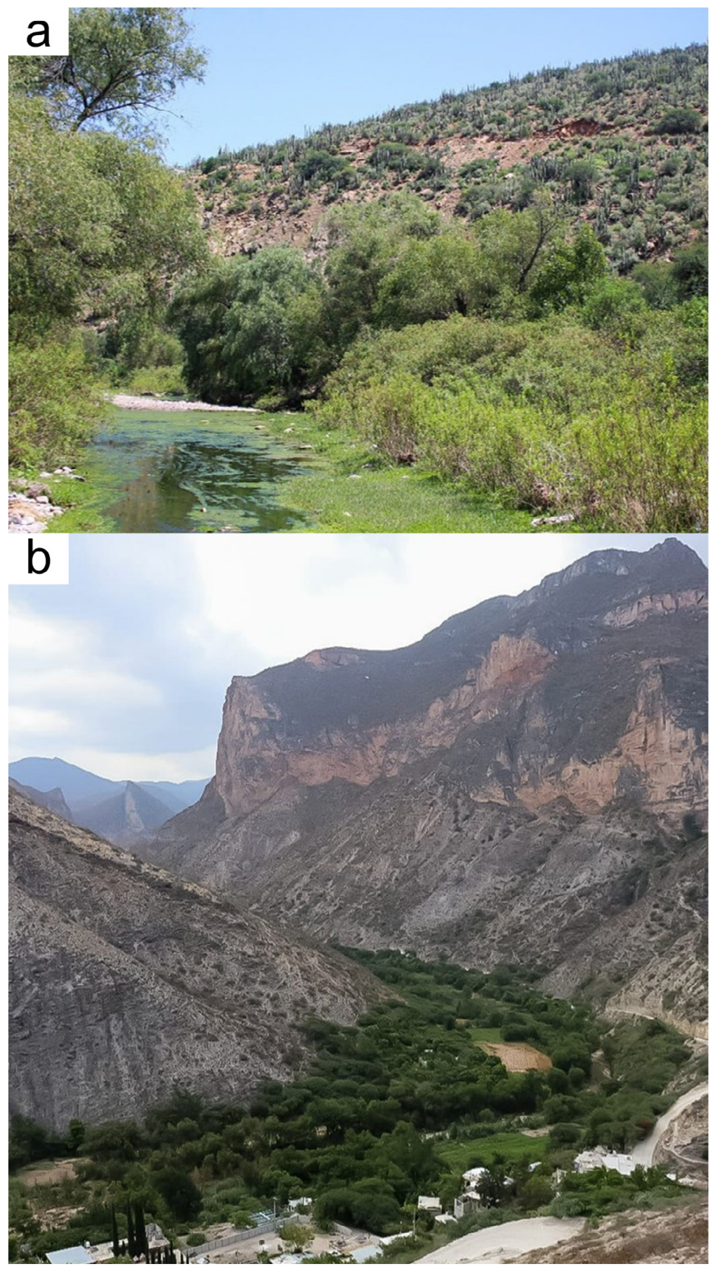

Figure 2. View of two study sites: a) *Salix* riparian forest at El Chilar, Tolimán and b) spring at Rancho Quemado, Cadereyta. (Photos by Mahinda Martínez)

Table 1. Sampling sites – characteristics and summary results for hydrophilic bryophytes, vascular plant water associations, and aquatic invasives.

Site	Locality	River/ Stream	Predominant cover	Water association				Aquatic invasive taxa
				Hydrophilic bryophyte	Aquatic	Sub-aquatic	Riparian	
1	Guamuchil	Extoraz	Unvegetated, isolated *Salix* trees		1	4		
2	El Salado	Extoraz	*Salix* riparian forest			2		1
3	Adjuntas de los Guillén	Victoria	Unvegetated riverbank		3	4		
4	San Miguel Palmas	Victoria	*Salix*/*Taxodium* riparian forest		5	4	1	1
5	El Manantial	Spring	*Platanus*/*Salix* riparian forest	1	2	1	1	
6	Tzibanzá	Moctezuma	Unvegetated area					
7	Pathé	Spring	*Salix* riparian forest		2	5		2
8	Las Moras	Moctezuma	*Taxodium* riparian forest		1			
9	Maconí	Spring	*Platanus*/ *Salix* riparian forest	1	1	2	3	1
10	La Cañada	Tolimán	*Salix* riparian forest			3		
11	El Chilar	Tolimán	*Salix* riparian forest		1	6	3	
12	Crucitas	Tolimán	Unvegetated riverbank					
13	La Vereda	Tolimán	Unvegetated, isolated *Salix* trees	1				
14	Bomintzá	First order river	*Platanus*/*Salix* riparian forest			1		
15	El Zapote	Spring	Oak forest	1	1	2		
16	Gudiños	Tolimán	*Salix*/*Platanus* riparian forest		3	4	1	2
17	Panales	Tolimán	*Taxodium* riparian forest		2	3	1	1
18	El Púlpito	El Púlpito	Desert shrubs			1		
19	El Oasis	Spring	*Salix* forest	3		4	1	1
20	Rancho Quemado	Spring	Unvegetated area	1	1	2		2

MATERIALS AND METHODS

Study Area and Site Selection

We sampled 20 sites in the municipalities of Peñamiller, Tolimán, and Cadereyta de Montes in the SQ (Figure 1). Site selection depended on accessibility and water seasonality. Aquatic vegetation in any of its forms had to be present, so ephemeral localities were not sampled. From the 20 sites, two sites were along the Extoraz, Victoria, and Moctezuma rivers and six for the Tolimán (Table 1, Figure 2a). Finally, we found five springs (Figure 2b) that feed the rivers. Overall, our 20 sites belong to 12 independent systems.

Data Collection

Fieldwork was initiated in June 2020 and ended in July 2021. Vegetation cover near water-logged areas includes riparian forest (e.g., *Salix humboldtiana*, *Taxodium mucronatum*, and *Platanus mexicana*), oak forest, and grasslands, with some highly degraded areas devoid of vegetation (Table 1). Table 1 indicates the sampling site, the river to which it belongs, the vegetation cover, and the water association of bryophytes and vascular plants.

Algae and plants. In each site algae and plants were collected using linear transects perpendicular to the water flow. Because of the different forms of the watersheds, we sampled two or three 50x50 cm quadrants from the river shore to the watercourse. We sampled a total of 127 quadrants. All algae observed by naked eye as well as all bryophytes and vascular plants were recorded and collected.

Bryophytes and vascular aquatic plants were classified according to their association to water. Bryophytes were considered hydrophilic (*sensu* Glime and Chavoutier 2017) when found in water-logged microhabitats, or splashed-out places. For vascular plants, we defined their water affinities as either strictly aquatic or subaquatic using the criteria of Lot et al. (2015). We also included trees and shrubs defined as riparian by Lot (2015).

Algae were analyzed under an Olympus BX43 microscope and identified to genus using Wehr and Sheath (2003) and Bellinger and Sigee (2015). Mosses were determined with Sharp et al. (1994) and Allen (2002). Aquatic vascular plants were determined using Lot (2015) and Flora del Bajío (Rzedowski et al. 2021) and Lot et al. (2015) for aquatic vegetation. Nomenclature follows AlgaeBase (Guiry and Guiry 2021), the electronic version of LATMOSS (Delgadillo http://www.ibiologia.unam.mx/briologia/www/index/latmoss.html), the Classification of the Bryophyta (Goffinet and Buck, http://bryology.uconn.edu/classification/), and Tropicos (Tropicos.org). Mosses and vascular plants are deposited at QMEX (Index Herbariorum http://sweetgum.nybg.org/science/ih/).

Odonata. We collected adults of odonates flying near water bodies or on the surrounding vegetation using conventional sampling techniques with entomological nets. The sampling effort at each site was two hours. Captured specimens were injected with acetone and submersed at 100% acetone for 24 hours to preserve color (Morse 1998). Each individual was then placed in a glassine bag with the collection data. Samples were determined using Abbott (2005) Odonata Central (https://www.odonatacentral.org) and the help of specialists. Specimens are deposited at the University entomological collection (UAQ-E).

Data Analyses

Algae, bryophytes, vascular plants, damselflies and dragonflies were recorded in a presence/absence data matrix. Taxonomic biodiversity (expressed as species number) for each river or stream was estimated. Occurrence frequencies for each species (F) were estimated using the Moura-Júnior et al. (2013) equation:

In which:
n_i = number of sites where the i species was found
N = number of sampled sites

RESULTS[1]

Biodiversity

We aggregated the results of our 20 sampling sites into 12 independent systems as shown in Table 1. Therefore, results and discussion centers around the 12 systems. We found 17 taxa of five algae groups (Cyanobacteria, Charophyta, Chlorophyta, Bacillariophyceae, and Xantophyceae); for bryophytes we found 18 taxa, 15 genera, and 11 families; for vascular plants 67 taxa, 64 genera, and 39 families, and for Odonata 28 taxa, 20 genera, and six families (Appendix). The Tolimán river, with 49 taxa was the most diverse, while El Púlpito was the least with eight (Figure 3). Not all groups were present at each site, algae were absent from Maconí, and Odonata were not found at Bominzá and El Zapote (Figure 3).

Cyanobacteria (e.g., *Anabaena* sp., *Oscillatoria* sp., and *Phormidium* sp.) and Chlorophytes (e.g., *Cladophora* sp. *Hydrodictyon* sp. and *Stigeoclonium* sp.) with six taxa each were the most diverse algae. Although diatoms (Bacillariophyceae) are not filamentous, we found *Synedra*

[1] Datasets are available from the corresponding author on reasonable request

sp. and *Terpsinoe* sp. (Appendix) with a large biomass that made them visible in San Miguel Palmas (Río Victoria) and Gudiños (Río Tolimán). Rio Victoria had the highest algae richness (Figure 4a-c).

Six bryophyte species were classified as hydrophilic because they grow on water-logged places, either on rocks or soil or in waterfalls or streams. They included *Amblystegium varium*, *Barbula bolleana* (Figure 4d) and *Splachnobryum obtusum* (Figure 4f). The place with the highest number of aquatic bryophytes was El Oasis.

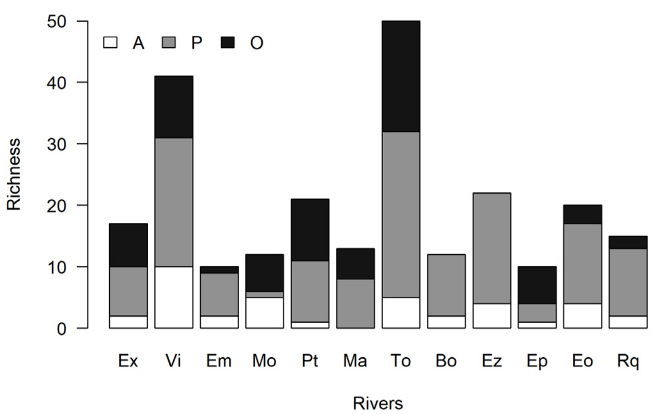

Figure 3. Species richness at the study sites. A - algae, P - plants (bryophytes and vascular plants), and O -odonates. Site codes: Ex - Extorax river, Vi - Victoria river, Em - El Manantial, Mo - Las Moras, Pt - Pathé, Ma - Maconí, To - Tolimán, Bo - Bomintzá, Ez - El Zapote, Ep - El Púlpito, Eo - El Oasis, and Rq - Rancho Quemado.

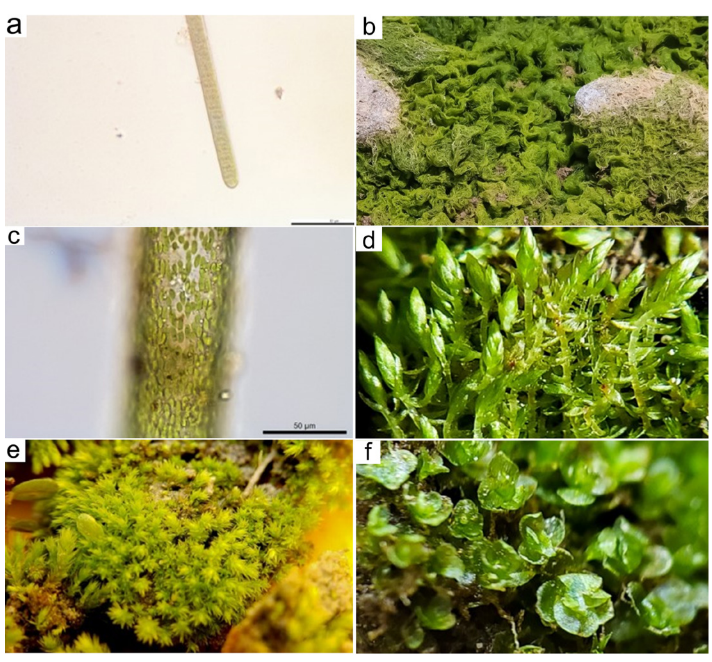

Figure 4. Some algal and bryophyte species found at the Semidesierto Queretano: filamentous algae - a) *Chladophora* (in the field), b) *Oscillatoria*, c) *Vaucheria*; *bryophytes* - d) *Barbulla bolleana*, e) *Philonitis elongata*, and f) *Splachnobryum obtusum*. (Photos by Patricia Herrera-Paniagua)

Twelve strictly aquatic vascular plants were found, notably *Marsilea mollis* and *Zannichellia palustris*. San Miguel Palmas (Río Victoria) was the richest site with five taxa (Table 1; Appendix). Subaquatic vascular plants included 15 taxa, especially *Bacopa monnieri* and *Commelina coelestis*. Tolimán was the river with most subaquatics. Five tree taxa constitute the riparian vegetation along with shrubs, such as *Heimia salicifolia*. Riparian forest was best developed at Maconí and El Chilar (Table 1). Five exotic invasive vascular plants were present in the area: *Arundo donax*, *Egeria densa*, *Eichhornia crassipes*, *Plantago major*, and *Rorippa nasturtium-aquaticum* (Appendix). Forty percent of our sampling sites contained exotic species, while Pathé, Gudiños and Rancho Quemado had two each (Table 1).

The Anisoptera suborder (Odonata), had the highest diversity with 17 species belonging to 13 genera of three families (Aeshnidae, Gomphidae, and Libellulidae). Of the Zygoptera suborder we found 11 species of six genera from three families (Calopterygidae, Coenagrionidae, and Lestiidae; Figure 5 a-f). Fifty-five percent of the sampled sites had five or more Odonata. Pathé with 10 species was the

Figure 5. Frequent Odonata species at the Semidesierto Queretano: a) *Acanthagrion quadratum*, b) *Pseudoleon superbus*, c) *Orthemis ferrugínea*, d) *Hetaerina americana*, e) *Argia anceps*, and f) *Libellula saturata*. (Photos by Olga Gómez-Nucamendi)

richest place, followed by La Cañada with 9, and El Chilar with 8. The poorest sites were La Vereda and El Manantial with one species each. Odonata were absent from Bominzá and El Zapote (Figure 3).

Thirteen species of all the taxonomic groups were widely distributed in the area (Figure 6). *Cladophora* (algae) was present at nine sites, *Bacopa monnieri* (vascular plant) at 8, and *Libellula saturata* (Odonata; Figure 5f) at 12 (see Appendix). None of the bryophytes was present at more than five localities, but *Splacnobryum obtusum* (Figure 4f) was recorded at three (15% frequency).

Site Conservation

All our taxa were widely distributed, and we did not find relicts or endemic species that could be used as a strong biological indicator of conserved sites. La Vereda (site 13, a portion of the Tolimán River) is a locality where the riparian forest has been devastated by human impact. We found one bryophyte and one Odonata, plus *Chladophora* (associated to human eutrophication) was present in large quantities (Figure 4a). Other degraded sites that lack aquatic vegetation cover were Tzibanzá (site 6) and Las Moras (site 8 both part of the Moctezuma). The Extoraz (sites 1 and 2), Victoria (sites 3 and 4) and the upper portion of the Tolimán (sites 10, 11, 16, 17) had well preserved areas with aquatic and subaquatic plants (Table 1). The lower drainage of the Tolimán and the Moctezuma had several sites with low aquatic diversity that represented degraded areas because of water scarcity and probable eutrophication.

We found other places with low species diversity: El Manantial (site 5), Bominzá (site 14), and El Púlpito (site 18, Table 1). There are several explanations for such diversities, or for the absence of some groups. El Manantial is a spring surrounded by riparian forest that prevents light from reaching the water. Bominzá is a first-order river fed by intermittent springs, whereas El Púlpito is a small pond surrounded by xerophytic shrubs. Therefore, in spite of their low diversity, these places do not seem to represent degraded areas.

DISCUSSION

The Tolimán River had the highest species diversity of vascular plants and Odonata. Since it is the river where we

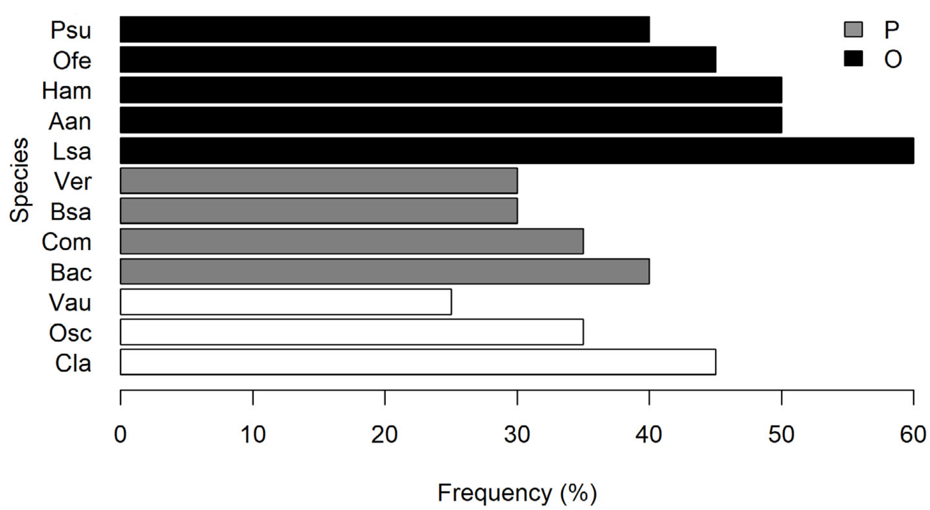

Figure 6. Species frequency (in percentage) per site. A – algae, P – plants (bryophytes and vascular plants), and O – odonates. Aqu – *Acanthagrion quadratum*; Psu – *Pseudoleon superbus*; Ofe – *Orthemis ferruginea*; Ham – *Hetaerina americana*; Aan – *Argia anceps*; Lsa – *Libellula saturata*. Ver – *Verbesina tumacensis*; Bsa – *Baccharis salicifolia*; Com – *Commelina coelestis*; Bac – *Bacopa monnieri*. Vau – *Vaucheria*; Osc – *Oscillatoria*; Cla – *Cladophora.*

had the largest number of sampling sites, the result might be biased. Nevertheless, adjacent areas have endemic plants (Machuca-Machuca 2017) and unique bird records for Querétaro have been reported there (González-García et al. 2004). Consequently, the river was found to support a large biodiversity, and more species are likely to be found with additional effort. The river is the most important surface water flow of the Tolimán valley and is a tributary of the Extorax and Moctezuma (CONAGUA 2020).

The frequent algae genera we found are common in Mexican aquatic ecosystems, either oligotrophic or eutrophic (e.g., Ramírez et al. 2002; Carmona et al. 2016). *Cladophora* is found in a variety of marine and freshwater systems worldwide. While its presence might be due to cultural eutrophication, it provides habitat and food for numerous organisms (Dodds and Gudder 1992). Cyanobacteria is the largest and most diverse group of photosynthetic prokaryotes in freshwater (Bellinger and Sigee 2015) and *Oscillatoria* was the most ubiquitous filamentous blue-green algae in the study area. The taxon is considered pollution-tolerant and is present at high densities during the warmer months in Mexico (Ramírez et al. 2002; Cuttah et al. 2008). We found *Vaucheria* (Xantophytes) which is associated with oligotrophic habitats (Carmona et al. 2016), but the specimen did not have reproductive structures so determination to species level was not possible (Bonilla-Rodríguez et al. 2013). To our surprise, the genus had not been previously collected in Querétaro, as we found it in rivers, streams, and artificial ponds.

Bryophytes are considered key elements of some aquatic ecosystems, but their presence and ecology are poorly documented in many parts of the world (Stream Bryophyte Group 1999; Schevock et al. 2017). We found *B. arcuata* and *S. obtusum*, which also occur in other Mexican states; they are pantropical and widely distributed (e.g., Delgadillo et al. 2014). However, their association with water is still poorly understood (Herrera-Paniagua et al. 2018). We collected 18 species of bryophytes associated with the aquatic systems, six of which are considered hydrophilic. Several site characteristics, such as elevation, water seasonality (perennial, intermittent, ephemeral), water velocity, light incidence, and water pollution influence their frequency and composition (e.g., Fritz et al. 2007; Vieira et al. 2012; Gecheva et al. 2013; Schevock et al. 2017). Therefore, places devoid of vegetation cover, modified river banks, and general degradation probably explain why hydrophilic bryophytes are significantly less diverse in the SQ than vascular plants. Bryophytes were frequent in *Salix*, *Taxodium* or *Platanus* riparian forest. The few that were found in disturbed habitats were mostly associated with the few relict trees. Bryophytes are likely to have been extirpated from La Vereda, since it is a strongly modified watershed.

According to Martínez and García (2001), there are 117 species of aquatic vascular plants (ferns, gymnosperms, and angiosperms) in Querétaro. Lot (2015) estimates that 982 aquatic and subaquatic species grow in Mexico, excluding weeds that can grow for short periods of time under inundation. Therefore, Querétaro has only about 12% of the aquatic diversity of Mexico. Based on our study, the SQ had 36 strictly aquatic and subaquatic plants (Appendix) that represent 3.6% of the Mexican aquatic and subaquatic vascular plant diversity, and 30% of Querétaro. We only observed eight aquatic species in our study. This low diversity was no surprise since most of our environments were lotic - part of rivers in dry area mountains. The highest diversity of aquatic plants in Mexico is found in lentic tropical areas (Mora et al. 2013).

Odonates have been used as pollution and climate change bioindicators. They are also important for determining ecological conditions and provide important environmental services such as mosquito controllers (Bried and Samways 2015). González-Soriano and Novelo-Gutiérrez (2014) reported 355 species for Mexico, but 10 states (Chiapas, Jalisco, Michoacán, Morelos, Nayarit, Oaxaca, San Luis Potosí, Sonora, Tamaulipas, and Veracruz) have over 100 species. These states are not only highly diverse because of their tropical conditions but they have also been subjected to stronger collection efforts.

Alonso-Eguía et al. (2002) found 16 species in the three localities they had in common with our study sites. We did not find *Progomphus belisshevi, Macrothemis pseudimitans* or *Orthemis discolor*, but observed *Ischnura denticollis* (Zygoptera) and *Sympetrum corruptum* (Anisoptera) that had not been previously recorded for the SQ. Two of the six frequent species (*Acanthagrion quadratum* and *O. ferruginea*; Figure 6 a, c) were only rarely encountered by Alonso-Eguía et al. (2002). All the species we found have a wide geographic distribution from the southern U.S. to South America, and were therefore expected to occur in our study area (GBIF, www.gbif.org).

Invasive vascular plants, a major threat to freshwater biodiversity (Reid et al. 2019), were present in several sites. Most commonly distributed were *A. donax* (3 localities) and *R. nasturtium-aquatium* (4 sites). We found two other highly invasive species (*E. crassipes* and *E. densa*) at only one site, whereas they have already invaded other aquatic systems elsewhere in Querétaro (Martinez and García 2001). The presence of these species can affect odonates as invertebrate assemblages in México are known to be sensitive to floristic composition changes (e.g., Rocha-Ramírez et al. 2007; Mora-Olivo et al. 2013; Chediack et al. 2018). Monitoring the presence of these invasive plants in neighboring places could prevent further invasions in the study area.

CONCLUSION

Our study shows that aquatic biodiversity in the Mexican semi-deserts wetlands is high, since we found 130 taxa directly associated to water. Biodiversity is still poorly known. We established new records for the algae *Vaucheria*, the bryophyte *Philonotis elongata*, and two Odonates *Ischnura denticollis* and *Sympetrum corruptum*. Species richness alone cannot be used as a conservation indicator, because not all groups were present in all sites. We found differences in community composition between the different streams. Absence and/or presence of a given species can indicate direct or indirect anthropogenic stresses, as demonstrated by bryophytes and invasive vascular plants at some sites. Our results emphasize the need of more research to improve our understanding of species assemblages. The monitoring of streams diversity and the description of environmental parameters are of crucial importance. Therefore, although difficult, different taxonomic groups can be used to monitor aquatic biodiversity.

Freshwater conservation lags when compared to terrestrial ecosystems (Abell et al. 2008). The SQ aquatic systems are part of the Pánuco river basin, which has been considered threatened (Bezaury-Creel et al. 2017) because of high human water demand and inefficient water use. Our sites are further threatened by river basin alteration, invasive species, and severe drought.

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APPENDIX. List of algae, bryophytes, vascular plants and odonates recorded at the Semidesierto Queretano. Occurrence = X. River/Stream: Ex - Extoraz; Vi - Victoria; Em - El Manantial; Mo - Moctezuma; Pt - Pathé; Ma - Maconí; To - Tolimán; Bo - Bomintzá; Ez - El Zapote; Ep - El Púlpito; Eo - El Oasis; Rq - Rancho Quemado. Water association = *hydrophilic bryophyte, **aquatic vascular plant, ***sub-aquatic vascular plant, ****riparian.

Group/Taxon	Ex	Vi	Em	Mo	Pt	Ma	To	Bo	Ez	Ep	Eo	Rq
Algae												
Anabaena sp.	X											
Chara sp.		X					X				X	
Cladophora sp.				X			X				X	X
Hydrodictyon sp.	X								X			
Leptolyngbya sp.		X										
Lyngbya sp.	X	X										
Microcoleus sp.								X				
Oedogonium sp.			X						X			
Oscillatoria sp.		X	X				X		X	X		
Phormidium sp.		X		X								
Prasiola sp.				X								
Pithophora sp.				X								
Spirogyra sp.		X									X	
Stigeoclonium sp.		X			X				X			
Synedra sp.		X										
Terpsinoë sp.							X					
Vaucheria sp.		X		X			X				X	X
Bryophytes and vascular plants												
Acalypha sp.								X				
Amblystegium varium (Hedw.) Lindb.*									X			
Artemisia ludoviciana Nutt.											X	
Arundo donax L.***	X				X						X	
Aster subulatus Michx.***		X			X		X					
Azolla filiculoides Lam.**		X	X									
Baccharis conferta Kunth								X	X			
Baccharis pteronioides DC.							X					
Baccharis salicifolia (Ruiz & Pavón) Pers.***	X	X			X		X			X		
Bacopa monnieri (L.) Wettst.***	X	X			X		X			X		
Barbula arcuata Griff.*						X						
Barbula bolleana (Müll. Hal.) Broth.*											X	
Brachythecium occidentale (Hampe) A. Jaeger									X			
Bryoerythrophyllum campylocarpum (Müll. Hal.) H.A. Crum									X			
Bryum miniatum Lesq.*											X	
Bryum sp.		X										

Group/Taxon	Ex	Vi	Em	Mo	Pt	Ma	To	Bo	Ez	Ep	Eo	Rq
Callitriche deflexa A. Braun ex Hegelm.**									X			
Calyptocarpus vialis Less.							X	X				
Chenopodium ambrosioides L.		X										X
Commelina coelestis Willd.***		X			X		X		X			
Croton ciiato-glandulifer Ort.								X				
Cynodon sp.		X										
Cyperus canus Presl.***							X	X				
Cyperus sp.***		X										
Didymodon sp.									X			
Dodonaea viscosa (L.) Jacq.								X				
Dryopteris cinnamonea (Cav.) C. Christens												X
Eclipta prostrata (L.) L.***	X										X	X
Egeria densa Planch.**							X					
Eichhornia crassipes (C. Mart.) Solms**					X		X					
Eleocharis acicularis (L.) Roem. & Schult.***		X				X	X				X	
Entodon beyrichii (Schwaegr.) Müll. Hal.									X			
Erythranthe glabrata (Kunth) G.L. Nesom**		X	X									
Euphorbia sp.												X
Fraxinus uhdei (Wenz.) Lingelsh.****						X						
Gnaphalium stramineum Kunth												X
Grimmia trichophylla Grev.									X			
Haplocladium angustifolium (Hampe & Müll. Hal.) Broth.									X			
Heimia salicifolia (Kunth) Link****			X				X					
Heteranthera sp.							X					
Hydrocotyle sp.**		X			X		X					
Ipomoea sp.												X
Iva sp.					X							
Juncus acuminatus Michx.***									X			
Lemna gibba L.**		X										
Lilaeopsis schaffneriana (Schltdl.) Cham.**		X										
Ludwigia peploides (Kuth) P. H. Raven**	X	X					X					
Marchantia sp.						X						
Marsilea mollis Rob. & Fern.**		X										
Melinis repens (Willd.) Zizka								X				
Monstera sp.***							X					

Group/Taxon	Ex	Vi	Em	Mo	Pt	Ma	To	Bo	Ez	Ep	Eo	Rq
Nissolia pringlei Rose								X				
Oxalis sp.					X							
Peperomia campylotropa A. W. Hill									X			
Philonotis elongata (Dism.) H.A. Crum & Steere											X	
Philonotis uncinata (Schwägr) Brid.*			X									X
Piper auritum Kunth											X	
Plantago major L.***												X
Platanus mexicana Moric.****						X	X					
Pluchea carolinensis (Jacq.) G. Don											X	
Polygonum hydropiperoides Michx.***	X						X					
Polygonum punctatum Ell.***		X	X				X					
Prosopis laevigata (Hum. & Bonpl. ex Willd.) M.C. Johnst.										X		
Racopilum tomentosum (Hedw.) Brid.									X			
Ricinus communis L.		X					X					
Rorippa nasturtium-aquaticum (L.) Hayek**		X				X	X					X
Rozea andrieuxii (Müll. Hal.) Besch.									X			
Salix humboldtiana Willd.****		X				X	X				X	
Salvia sp.									X			
Schinus molle L.										X		
Schistidium apocarpum (Hedw.) Bruch & Schimp.									X			
Sedum sp.									X			
Selaginella sp.									X			
Sida sp.							X					
Solanum americanum L.					X							
Splachnobryum obtusum (Brid.) Müll. Hal.*						X	X				X	
Taxodium mucronatum Tenn.****							X					
Tropaeolum majus L.							X					
Verbena litoralis Kunth	X		X									
Verbena longifolia M. Martens & Galeotti												X
Verbesina turbacensis Kunth	X	X					X				X	X
Viguiera dentata (Cav.) Spreng.								X				
Vichellia farnesiana (L.) Wight & Arn.								X				
Xanthosoma robustum Schott			X									
Zannichellia palustris L.**				X			X					

Group/Taxon	Ex	Vi	Em	Mo	Pt	Ma	To	Bo	Ez	Ep	Eo	Rq
Odonata												
Acanthagrion quadratum Selys, 1876		X					X				X	
Aeshna persephone Donnelly, 1961										X		
Archilestes grandis (Rambur, 1842)							X					
Argia anceps Garrison, 1996		X		X	X	X	X			X		
Argia cuprea (Hagen, 1861)						X						
Argia oenea Hagen in Selys, 1865	X						X					
Argia sp	X	X				X						
Brechmorhoga praecox (Hagen, 1861)		X										
Dythemis nigrescens Calvert, 1899	X			X	X		X					
Dythemis sp				X			X					
Enallagma civile (Hagen, 1861)							X					
Erpetogomphus crotalinus (Hagen, 1854)							X					
Erythrodiplax umbrata (Linnaeus, 1758)					X							
Hetaerina americana (Fabricius, 1798)		X		X	X		X					
Hetaerina vulnerata Hagen in Selys, 1853						X	X					
Ischnura denticollis (Burmeister, 1839)					X							
Libellula croceipennis (Selys, 1868)			X				X					
Libellula saturata Uhler, 1857	X	X		X	X		X					
Libellula sp.							X					
Orthemis ferruginea (Fabricius, 1775)	X	X		X	X		X					
P*altothemis lineatipes* Karsch, 1890						X	X					
Pantala flavescens (Fabricius, 1798)	X	X					X					
Perithemis domitia (Drury, 1773)					X		X					
Progomphus borealis McLachlan in Selys, 1873		X					X					
Pseudoleon superbus (Hagen, 1861)	X	X			X		X					X
Sympetrum corruptum Newman, 1833							X			X		
Sympetrum illotum (Hagen, 1861)							X					
Telebasis salva (Hagen, 1861)					X							