THE SOUTHWESTERN NATURALIST 50(2):237–281 JUNE 2005

NOTES

AQUATIC INVERTEBRATES OF CUATRO CIÉNEGAS, COAHUILA, MÉXICO: NATIVES AND EXOTICS

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ABSTRACT—A recent survey of benthic macroinvertebrates of the Cuatro Cienegas basin found 118 species in the 21 sites collected. Four exotic macroinvertebrates that could threaten the native biota were found within or near the basin.

RESUMEN—Una inspección reciente de macroinvertebrados bénticos del bolsón de Cuatro Ciénegas encontró 118 especies en los 21 sitios que se muestrearon. Cuatro macroinvertebrados exóticos que podrían amenazar la biota nativa se encontraron dentro o cerca del bolsón.

The Cuatro Ciénegas basin is a small valley (about 1,500 km^2) in central Coahuila formed by the mountain ranges of the Sierra Madre Oriental. Although it is in one of the driest areas of the Chihuahuan Desert (<200 mm of rainfall per year), it is estimated to contain more than 200 springs and other associated aquatic habitats with many endemic organisms and modern stromatolites. Six types of aquatic habitats occur in the basin: pozas (small spring-fed pools), lagunas (larger spring-fed lakes), playa lakes (large lakes fed by surface runoff, but without outlets), ciénegas (shallow swamps), human-made canals (constructed between the late 1800s and 1960s), and rivers (Minckley, 1969). The aquatic and terrestrial vegetation has been well described (Pinkava, 1984), as have fish and aquatic snail faunas (Minckley, 1984; Hershler, 1985). Largely due to its great biodiversity and high degree of endemism, but also due to imminent threats of water extraction and exotic species, the Mexican government declared the basin a protected area of flora and fauna in 1994 (Secretaría de Desarrollo, 1994).

Initial studies of the Cuatro Ciénegas basin focused on endemic aquatic organisms and their habitats (e.g., Minckley, 1969). Despite the presence of large numbers of species of endemic snails and crustaceans (Taylor, 1966; Cole, 1984; Hershler, 1985), there have been no comprehensive surveys of aquatic insects and other non-gastropod and non-crustacean invertebrates (e.g., Annelida, Acarina), nor have regional surveys been published. The entire state of Coahuila lacks distributional records of even some common aquatic insect orders, such as mayflies (Ephemeroptera) (McCafferty and Lugo-Ortiz, 1996). The order and suborders that are well studied in Coahuila are dragonflies (Odonata: Anisoptera) and damselflies (Odonata: Zygoptera) (Needham and Westfall, 1954; Westfall and May, 1996). Within the basin, Crustacea, Gastropoda, and parasitic flukes have been studied (for respective reviews see Cole, 1984; Hershler, 1984; and Guajardo-Martinez, 1984). The only published work on aquatic insects of the basin described a new widespread species of *Rhagovelia* (Hemiptera: Veliidae), which occurs throughout the Sierra Madre Oriental (Polhemus, 1997). Anecdotal reports on aquatic insects in the valley usually describe them as depauperate.

We conducted seasonal surveys of 21 sites in the basin during June and July 1999, October 1999, January 2000, and August 2000 (Table 1,

TABLE 1—Aquatic habitats sampled during survey of Cuatro Ciénegas basin, Coahuila, México, 1999 through 2000. All UTM coordinates are for Zone 13. Site codes are cross-referenced to Table 2.

Locality	UTM coordinates		Habitat	Site
	North	East		
Poza Becerra	2976191	784293	Poza	1
Canal de la Becerra	2976730	186706	Canal	2
Charcos Prietos	2979912	198466	Laguna	3
Poza Churince	2981039	191524	Poza	4
Poza Escobedo	2977959	193371	Poza	5
Poza Juan Santos	2978786	187438	Laguna	6
Laguna Grande	2972981	783337	Playa lake	7
Las Playitas Intet	2980193	796276	Playa lake	8
Las Playitas SE Shore	2979863	796817	Playa lake	9
Los Gatitos	*	*	Ciénega	10
Ciénegas de los Gatos	2977405	798314	Ciénega	11
Los Hundidos	2977405	194917	Laguna	12
Poza Mojarral Este	2981484	189919	Laguna	13
Poza Mojaral Oeste	2980897	785725	Poza	14
Poza Azul	2969600	795644	Poza	15
Puente Chiquita	2981076	793510	River	16
Río Garabatal	2977958	782316	River	17
Río Mesquites las Palapas	2980218	789999	River	18
Canal de Saca Salada	2980345	793672	Canal	19
Poza Tio Cándido	2974517	790796	Laguna	20
Río Salado de Nadadores	*	*	River	21

* data not available.

Fig. 1). Twenty of the sites were within the protected area of the basin; one, the Río Salado de Nadadores was just outside the basin. Number of sites collected in each period depended on the time available; thus, we could not collect in all 21 sites every time. We collected aquatic insects and other invertebrates using aquatic dip nets (mesh size 250 μm), Ponar dredge samplers, as well as hand sorting of littoral vegetation. Quantitative samples of lentic and littoral habitats are difficult to collect and process, so we focused our efforts on qualitative presence-absence data and comprehensive sampling of all microhabitats. Because the endemic hydrobiid snails were well studied, our surveys did not include them. Invertebrates were preserved in 95% ethanol and we used keys to North American taxa (Needham and Westfall, 1954; Menke, 1979; Pennak, 1989; Thorp and Covich, 1991; Westfall and May, 1996; Merritt and Cummins, 1996; Wiggins, 1996) to key specimens to the lowest possible taxon, usually genus. Because most taxonomy is based on terrestrial adult stages, identification of larvae to species is difficult or impossible for many taxa. Lack of keys to Mexican taxa and limited distributional data also make species identification difficult.

We identified 2,459 individuals of 118 taxa (Table 2). The number of taxa by habitat ranged from 94 in rivers to 16 in ciénegas. Although we limited our collections to presence-absence, we observed that most taxa were present only in low densities. We were only able to collect single individuals of some taxa despite spending full days sampling. Additionally, because we could not sample every site in every season, seasonality represents overall occurrence in the basin and not occurrence in a specific site (Table 2). The only taxa commonly present in large numbers were *Hyalella* (Amphipoda: Taltridae) and *Palaemonetes suttkusi* (Decapoda: Palaemonidae). *Hyalella* in the basin are probably at least 2 different species, but Cole (1984) suggested that there might be 6 species.

We used Non-Metric Multidimensional Scaling (NMDS) combined with Multi-Response Permutation Procedure (MRPP) to discern differences in invertebrate assemblages between

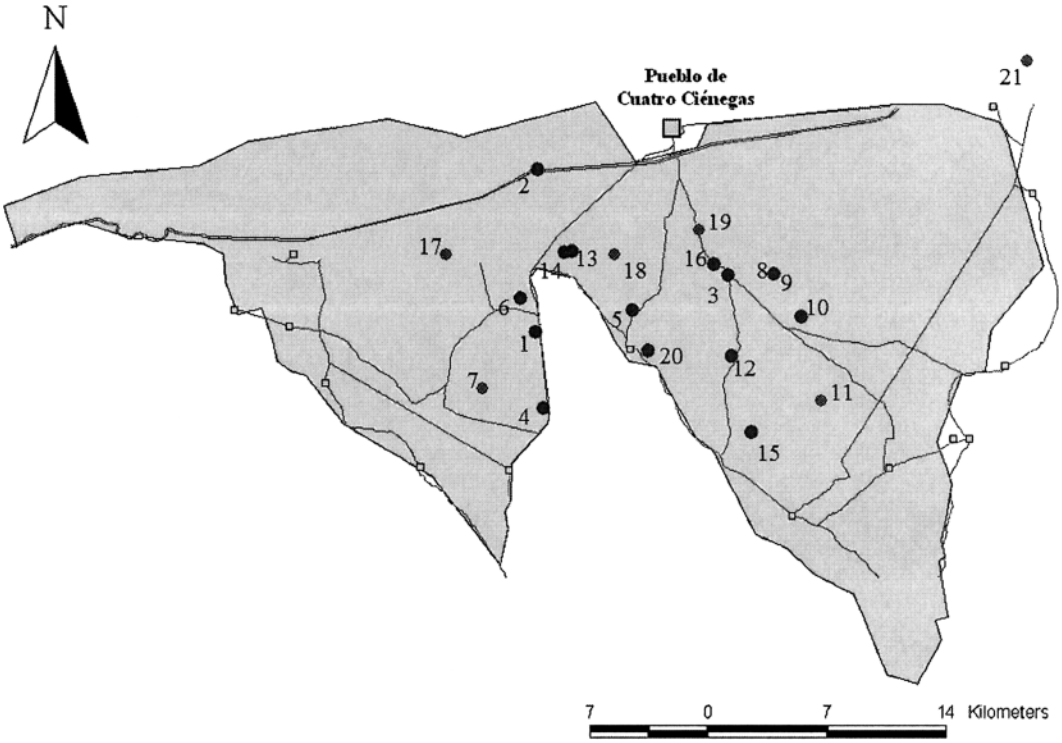

FIG. 1—Map of the Cuatro Ciénegas basin, Mexico, showing aquatic habitats sampled for aquatic invertebrates in 1999 and 2000. See Table 1 for names of numbered habitats. Shaded area defines the boundary of the Protected Area. Lines are major roadways located in and around the basin.

habitat types. NMDS allows visualization of patterns, and MRPP is a significance test using randomization that tests null hypotheses of no grouping (e.g., invertebrate assemblages are not different from one habitat to another). MRPP analysis showed that there were significant differences in the invertebrate assemblages among all habitat types ($P = 0.002$), but pairwise comparisons showed that invertebrate assemblages in pozas were not significantly different from laguna assemblages ($P = 0.43$), suggesting that these habitats share many qualities, such as water chemistry and substrate types. For a complete description of analyses and test results, see Dinger (2001).

Our knowledge of the distribution of aquatic insects throughout the basin is incomplete. For example, we made visual observations of adult alkali flies (Diptera: Ephydridae) in one location (Las Salinas), but upon our later return, we did not find them in any of our samples. Furthermore, previous records of anostracans in Laguna Grande (Cole, 1984) suggest that we should have collected them, but they were not present in any of our samples. Continued sampling over a longer time frame will fill in the gaps of our knowledge. All specimens are currently in the collection of ECD, but will be deposited in invertebrate collections of the University of Texas at Austin, Universidad Autónoma de Nuevo León, and Universidad Nacional Autónoma de México.

Identification of possible endemic species is confounded by the limitations of larval taxonomy, as well as a lack of distributional data for the region. With further studies, certain invertebrate taxa could prove to be endemic to the basin. These are likely to be insects with limited dispersal capabilities, such as riffle beetles (Coleoptera: Elmidae), or other groups with low vagility, such as leeches (Annelida: Hirudinea). It is hoped that our preliminary study will stimulate future regional studies.

Our collections also included several exotic species (Table 3), including the previously reported turban snail, *Melanoides tuberculata* (Gas-

TABLE 2—List of taxa, habitat preference, seasonality, and distributional data for aquatic invertebrates collected form Cuatro Ciénegas basin, Coahuila, México, 1999 and 2000. Habitat type: Ca = canal, Ci = ciénega, PL = playa lake, Po = poza, R = river, L = laguna. Seasonality: S = summer, F = fall, W = winter. Site code key is in Table 1.

Taxa	Habitat	Season	Site
Insecta			
Coleoptera			
Curclionidae			
Notiodes	Ca	W	12
Dryopidae			
Helichus suturalis	Po, R	S, W	15, 17
Dytiscidae			
Brachyvatus	PL	S	7
Cybister	L, R	S, W	17, 20
Hydrovatus	L, Po, R	S, W	5, 12, 17
Rhantus	L	W	12
Elmidae			
Heterelmis	Ca	S	19
Hexacylloepus scabrosus	R	S	16, 17, 19
Macrelmis	R	S	RSN
Microcylloepus	Po, R	S, W	15–17
Stenelmis	Po	S	15
Gyrinidae			
Gyretes	R	S	16
Haliplidae			
Haliplus	L, PL	S, W	7, 9, 12
Hydrochidae			
Hydrochus	L	S	7
Hydradenidae			
Octhebius	Ca	W	12
Hydrophilidae			
Berosus	L, PL, Ca, R	S, W	7, 12, 17
Enochrus	L, R	S, W	17
cf. *Helochares*	R	S	17
Laccobius	PL, Po	S, W	5, 9
Tropisternus	Ci, L, R	S, W	6, 10
T. lateralis	L, Ca	W	12
Lutrochidae			
Lutrochus	Po, Ca	S, F, W	2, 5, 9
Psephenidae			
Psephenus texanus	Po, R	S, W	4, 16, 18
Diptera			
Ceratopogonidae			
Bezzia/Palpomyia	Po, R	S, F, W	16–19
Probezzia	PL	S, F	2, 15
Culicoides	Ca, R	S, F	2, 17, 19
Chironomidae			
various taxa	All	S, F, W	All

TABLE 2—Continued.

Taxa	Habitat	Season	Site
Culicidae			
Aedes	Ca	W	12
Dixidae			
Dixella	L, Po	W	5, 6, 15
Simuliidae			
Simulium	R	S, W	3
Stratiomyidae			
Nemotelus	Ca	W	12
Stratiomys	Po, Ca, R	S, W	4, 5, 12, 17
Tabanidae			
Chrysops	L, Po, Ca, R	S, F, W	4, 12, 15, 16, 20
Tabanus	R	S	17
Tipulidae			
Hexatoma	Po, Ca	S, F	14, 19
Limonia	Po	W	15
Limnophila	R	F	16
Ephemeroptera			
Baetidae			
Americabaetis	Po, R	S, W	15, 16, 18
Baetodes	R	S	18
Baetis	L	S, F, W	6
Callibaetis	L, Po, R	S, F, W	4–6, 16–18
Camelobaetidius	Ca	S	19
Fallceon	Ca, L, R	S, W	2, 3, 17, 19
Caenidae			
Caenis	Ci, L, PL, Po, R	S, F, W	3, 7, 9–12, 14, 15, 17
Ephemeridae			
Hexagenia	PL, Po, R	S, F, W	7, 15, 18
Leptophebiidae			
Thraulodes	L, Po, Ca, R	S, F	5, 6, 12, 15, 16, 18
Traverella	Ca, R	S, W	18, 19
Tricorythodidae			
Tricorythodes	Ci, PL, Po, Ca, R	S, F, W	2, 5, 7, 11, 14–19
Leptohypes	R	S, W	18
Hemiptera			
Gerridae			
Metrobates	Po, R	S, F	15, 16
Trepobates	R	S	17
Aquarius	Ci	S	10
Belostomatidae			
Abedus	R	S	RSN
Belostoma	Ci, R	S	11, 17
Lethocerus	R	S	17
Corixidae			
Trichocorixia	Ci	S	9, 11

TABLE 2—Continued.

Taxa	Habitat	Season	Site
Hebridae			
Merragata hebroides	Ci, Po, R	S	4, 10, 17
Hydrometridae			
Hydrometra	R	S	17
Mesoveliidae			
Mesovelia	R	S	17
Naucoridae			
Ambrysus californicus	Ci, L, Po, Ca, R	S, F, W	2, 3, 5–7, 10, 12, 16–18
Nepidae			
Ranatra	Ca	S	19
Veliidae			
Rhagovelia novahispanae	R	S, F	16
Lepidoptera			
Pyralidae			
Petrophila	L, Po, R	S, F, W	6, 16
Megaloptera			
Corydalidae			
Corydalus luteus	Ca, R	S, W	14
Sialidae			
Sialis	PL, R	S, F, W	7, 18
Odonata (suborder Zygoptera)			
Calopterygidae			
Hetaerina americana	R	S, W	16
H. titia	R	S	RSN
Coenargrionidae			
Argia fumipennis	R	S	17
A. plana	R	S	RSN
A. pulla	L, Po, Ca, R	S, F, W	3–5, 12, 15, 17, 18
A. nahuana	Po	S	4
A. sedula	R	S	16, 18
A. tonto	PL	S	5
A. translata	L, Po, R	S, F, W	1, 5, 13, 14, 16
Enallagma basidens	L, Po, R	S, F, W	1, 5, 15–18
Enallagma 1	Po, Ca	W	5, 12, 15
Enallagma 2	L	W	12
Enallagma 3	Po	W	14
Hesperoagrion heterodoxum	R	S	17
Nehallenia minuta	Po	W	5
Protoneuridae			
Protoneura	R	S	RSN
Odonata (suborder Anisoptera)			
Aeshnidae			
Anax junius	L, R	S, W	12, 16
A. walsinghami	L, R	S	17

TABLE 2—Continued.

Taxa	Habitat	Season	Site
Gomphidae			
Erpetogomphus compositus	PL, R	S, W	7, 16–18
Phyllogomphoides	PL, Po, R	S, W	7, 15, 16
Progomphus borealis	PL, Po, Ca, R	W	5, 7, 12, 17
Libellulidae			
Libellula auripennis	Po, R	W	18
Pachydiplax longipennis	R	S	17
Macomiinae			
Macromia annulata	Ci, L, PL, Po, R	S, F, W	4, 9–11, 16, 18, 20
Orthoptera			
Acridadae			
Leptysma	R	S	17
Trichoptera			
Helicopsychidae			
Helicopschye	Ca	S	19
Hydrobiosidae			
Atopschye	R	S, W	18
Hydroptilidae			
Hydroptila	R	S, W	16
Leucotrichia	R	S	RSN
Mayatrichia	R	S	16
Metrichia	Ca, R	S	17, 19
Oxeytheira	L, R	W	6, 17
Hydropschydiae			
Leptonema	Ca, R	S, W	18, 19
Smicridea (Rhyacophylax)	Ca, R	S	19
Smicridea (Smicrideae)	Ca, R	S	16
Leptoceridae			
Nectopschye	R	W	16
Oecetis	PL, R	S, W	19
Polycentropidae			
Cernotina	Po, R	S, F, W	4, 15–17
Polyplectropus	Ca, R	S, W	3, 16, 19
Crustacea			
Amphipoda			
Taltridiae			
Hyalella 1	All	S, F, W	All
Hyalella 2	L, R	S, W	18
Decapoda			
Palaemonidae			
Palaemonetes suttkusi	All	S, F, W	4, 6, 7, 10–12, 15–18, 20
Cambaridae			
Procambarus clarkii	L, R	S	13, 17, 18

TABLE 2—Continued.

Taxa	Habitat	Season	Site
Ostracoda			
various taxa	Ci, L, PL, Po, R	S, F, W	4, 7, 10, 12, 16–18, 20
Arachnida (Chelicerata)			
Acarina			
various taxa	All	S, W	4–7, 10–12, 14–18
Annelida			
Hirudinodiea			
Glossiphniidae			
Helobdella 1	R	S	16, 17
Helobdella 2	R	W	18
Hirundinidae			
Unknown	R	S	16
Oligochaeta			
various taxa	All	S, F, W	All
Mollusca			
Gastropoda			
Physidae			
Physella	Ci, L	S, F, W	7, 11, 12, 16, 17
Ancylidae			
Hebetancylus	Po, R	S, W	14, 16
Thiaridae			
Melanoides tuberculata	Ca, Po, R	S, F, W	2, 4
Turbellaria			
Dugesia	L, Ca, R	S, F, W	1, 3, 4, 6, 12–19
Nematoda			
various taxa	Po	S	17

TABLE 3—Known locations of invertebrate exotic species collected from Cuatro Ciénegas basin, Coahuila, Mexico, 1999 and 2000. Río Salado de Nadadores is immediately outside the basin, but was connected through canals.

Species	Collection locality	New record
Cobicula fluminea, Asiatic clam	Río Salado de Nadadores	Yes
Melanoides tuberculata, turban snail	Poza Churince	No
	Río Mesquites	No
	Santa Tecla	No
	Canal de la Becerra	No
Thiara granifera, turban snail	Río Salado de Nadadores	Yes
Procambarus clarkii, southeastern crayfish	Río Garabatal	Yes
	Río Mesquites	Yes
	Mojarral Este	Yes

tropoda: Thiaridae) (Contreras-Arquieta, 1998). *Melanoides tuberculata* was collected in 1994 by Contreras-Arquieta (1998) at 2 sites, including Poza de La Becerra, where we failed to find living specimens despite approximately 40 total hours of searching in all possible microhabitats (only one shell with travertine deposits on it was found). This does not mean that *M. tuberculata* is not there, but if they are, then any potential ecological effect in this poza is probably minimal. In Poza Churince, *M. tuberculata* was abundant only in the decaying detritus of cattails (*Typha dominguensis*) that lined portions of the littoral zone. *Melanoides tuberculata* did not inhabit locations where native hydrobiid snails occur. *Melanoides tuberculata* was abundant in intermediate size classes only (1 to 2 cm) in Canal de la Becerra. The fourth site with *M. tuberculata* was Santa Tecla, where they were collected with limited sampling effort.

The southeastern crayfish, *Procambarus clarkii* (Decapoda: Cambaridae) is at the edge of its natural range just outside the basin (Campos and Rodríguez-Almaraz, 1992), but given the number of canals built in Cuatro Ciénegas and the failure of early researchers to record its presence, we suspect that it has been recently introduced. Although we collected it at 4 sites in the basin, this is a conservative estimate, because our standard collection techniques often did not collect crayfish. Because *P. clarkii* is omnivorous, is resistant to desiccation, and burrows (Hobbs, 1991), it has the potential to negatively affect multiple trophic levels.

We collected another exotic species, the Asiatic clam *Corbicula fluminea* (Pelecypoda: Corbiculidae), only in one artificial site—the Canal de Río Cañon. While not yet collected in a natural site, presence of *C. fluminea* in the Río Salado de Nadadores, east and downstream from the basin, and the turban snail, *Thiara granifera* (Gastropoda: Thiaridae), indicate that both *C. fluminea* and *T. granifera* pose potential threats to the basin. Contreras-Arquieta (1998) observed the upstream migration of *M. tuberculata* from the Río Salado de los Nadadores into Cuatro Ciénegas from 1986 until their collection in 1994. It is likely that these exotics will continue to emigrate upstream until they inhabit the waters of Cuatro Ciénegas.

Our results show that there is a diverse assemblage of aquatic insects in Cuatro Ciénegas despite their low abundances. In addition, 4 exotic invertebrates pose potential threats to the native fauna and should be carefully monitored.

We thank The Nature Conservancy, the National Science Foundation, and the Merriam-Powell Center for Ecological Research for financial support of this project. Special thanks to F. J. García de León and SEMARNAT permit 02-3015. Thanks also to A. Moline, C. Williamson, H. Kloeppel, A. Guevara, M. Stephens, and the entire SEMARNAT staff at Area Protegida de Flora y Fauna, Cuatro Ciénegas. Verifications of identifications were provided by O. Flint (Trichoptera), M. Meyer (Ephemeroptera), and W. Shepard (Elmidae: Coleoptera). M. Meyer and an anonymous reviewer helped improve early drafts.

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Submitted 28 June 2002. Accepted 31 August 2004.
Associate Editor was Steven Goldsmith.

STATUS OF *DIONDA DIABOLI* AND REPORT OF ESTABLISHED POPULATIONS OF EXOTIC FISH SPECIES IN LOWER SAN FELIPE CREEK, VAL VERDE COUNTY, TEXAS

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ABSTRACT—Sampling from April 2001 to March 2003 revealed San Felipe Creek, Val Verde County, Texas, still supported a breeding population of the threatened Devils River minnow (*Dionda diaboli*). The species was restricted to creek habitats and was not found in the outflow channels of San Felipe Springs. We determined that breeding populations of introduced tropical fish species *Hypostomus* (a South American armored catfish) and *Oreochromis aureus* (an African cichlid) also were present in San Felipe Creek. We obtained evidence to suggest that presence of exotic species, particularly *Hypostomus,* might have a negative effect on the Devils River minnow. We recommend periodic monitoring of fish populations in San Felipe Creek to document future changes in the population of Devils River minnow and other endemic species, and to facilitate design and implementation of conservation plans in San Felipe Creek.

RESUMEN—Muestreos entre abril de 2001 y marzo de 2003 mostraron que el riachuelo San Felipe, condado de Val Verde, Texas, todavía alberga una población reproductiva de la amenazada sardinita *Dionda diaboli.* La especie estuvo restringida a los hábitats del arroyo, y no se encontró en los canales de corrientes del manantial de San Felipe. Determinamos que poblaciones reprod-