N. García-Aldrete, and E. González-Soriano, editors. Biodiversidad, taxonomía y biogeografía de Artrópodos de México: Hacia una Síntesis de su Conocimiento. Universidad Nacional Autónoma de México, Mexico City. Pages 133–145.

MENKE, A. S. 1979. The semiaquatic and aquatic Hemiptera of California (Heteroptera: Hemiptera). Bulletin of the California Insect Survey 21:1–166.

MERRITT, R. W., AND K. W. CUMMINS. 1996. An introduction to the aquatic insects of North America, third edition. Kendall/Hunt Publishing Company, Dubuque, Iowa.

MINCKLEY, W. L. 1969. Environments of the bolson of Cuatro Ciénegas, Coahuila, México, with special reference to the aquatic biota. University of Texas at El Paso, Science Series 2:1–65.

MINCKLEY, W. L. 1984. Cuatro Ciénegas fishes: research review and a local test of diversity versus habitat size. Journal of the Arizona-Nevada Academy of Science 19:13–21.

NEEDHAM, J. G., AND M. J. WESTFALL, JR. 1954. Dragonflies of North America. University of California Press, Berkeley.

PENNAK, R. W. 1989. Freshwater invertebrates of the United States, third edition. John Wiley and Sons, New York.

PINKAVA, D. J. 1984. Vegetation and flora of the bólson of Cuatro Ciénegas, Coahuila, México: IV. Summary, endemism and corrected catalogue. Journal of the Arizona-Nevada Academy of Science 19:23–47.

POLHEMUS, D. A. 1997. Systematics of the genus *Rhagovelia* Mayr (Heteroptera: Veliidae) in the Western Hemisphere (exclusive of the *angustipes* complex). Entomological Society of America, Lanham, Maryland.

TAYLOR, D. A. 1966. A remarkable snail fauna from Coahuila, Mexico. Veliger 9:152–228.

THORP, J. H., AND A. P. COVICH. 1991. Ecology and classification of North American freshwater invertebrates. Academic Press, San Diego, California.

WESTFALL, M. J., JR., AND M. L. MAY. 1996. Damselflies of North America. Scientific Publishers, Gainesville, Florida.

WIGGINS, G. B. 1996. Larvae of the North American caddisfly genera (Trichoptera), second edition. University of Toronto Press, Toronto, Canada.

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-

uctivas de las especies introducidas de peces tropicales *Hypostomus* (un bagre de Sudamérica) y *Oreochromis aureus* (un cíclido africano) también están presentes en el riachuelo de San Felipe. Obtuvimos evidencia para sugerir que la presencia de especies exóticas, particularmente *Hypostomus,* podría tener un efecto negativo sobre la sardinita *D. diaboli*. Recomendamos monitoreo periódico de las poblaciones de peces en el riachuelo de San Felipe para documentar cambios futuros en la población de la sardinita y otras especies endémicas, y para facilitar el diseño e implementación de planes de conservación en el riachuelo de San Felipe.

Introduction of non-indigenous species into fragile desert ecosystems can have irreversible effects on the native fauna (Edwards, 2001; Edwards et al., 2002; Echelle et al., 2003). In western Texas, the increasing demands that agriculture and urban development place on already limited water resources (e.g., Urbanczyk, 2003) create additional threats for native species. Construction of dams, groundwater pumping, and introduction of nonnative taxa, among other human-induced alterations, have caused the decline or disappearance of several fishes in the Chihuahuan region of Texas (Hubbs and Garrett, 1990; Edwards et al., 2002; Hubbs, 2003; Echelle et al., 2003).

Spring-fed San Felipe Creek, Val Verde County, Texas, is one of the remaining habitats for the Devils River minnow (*Dionda diaboli,* Cyprinidae), a species listed as threatened by the Texas Parks and Wildlife Division and the United States Fish and Wildlife Service (Garrett et al., 1992, 2004). The creek also harbors 2 other state-threatened fishes: Rio Grande darter (*Etheostoma grahami*) and proserpine shiner (*Cyprinella proserpina*). All 3 species are listed as vulnerable in the IUCN Red List (http://www.redlist.org/; species 6623, 6139, and 8115, respectively). Range of *D. diaboli* in Texas also includes the Devils River, Sycamore Creek, and a recently discovered population in Pinto Creek (Kinney County). The species was extirpated from Las Moras Creek, parts of the Devils River, and possibly Sycamore Creek (Garrett et al., 1992, 2004). San Felipe Creek was last sampled in 1989, and *D. diaboli* was not found in the headwaters, but densities in other localities had not changed significantly in the last 10 years (Garrett et al., 1992). To our knowledge, this was the last report of the status of *D. diaboli* in San Felipe Creek. Other recent work reported 2 South American exotic fish species in San Felipe Creek. A single specimen of the Raphael catfish (*Platydoras costatus,* Doradidae) was collected in 1999 (Howells, 2001), and 4 specimens of the armored catfish *Hypostomus* (Loricariidae) were captured on November 1997 in the San Felipe Country Club (G. Garrett, pers. comm.; Texas Natural History Collection catalog number 25205). A previous extensive survey in 1989 did not report any exotic catfishes (Garrett et al., 1992).

Presence of a loricariid catfish in San Felipe Creek is of potential concern for Devils River minnow and other endemic species. Loricariid catfishes are specialized and efficient algivores (Power et al., 1989; Armbruster, 2003) that might compete for food resources with other algae-eating species, including *D. diaboli* (Garrett et al., 2002). Loricariids have established relatively large, viable populations in some locations in Texas. *Hypostomus* has been established in the San Antonio River at least since 1964 (Barron, 1964; Edwards, 2001), and reproducing populations of *Pterygoplichthys* were recently reported from Bexar, Hays, and Harris counties (Edwards, 2001; Nico and Martin, 2001). In this note, we offer an update on the status of the Devils River minnow in the lower portion of San Felipe Creek and report potential effects of reproducing populations of the armored South American catfish *Hypostomus* and the African cichlid *Oreochromis aureus*.

San Felipe Creek, a tributary of the Rio Grande, is a spring fed, clear-water stream extending from a point 4 km (2.5 miles) north of United States Highway 90 to its confluence with the Rio Grande, just south of the city of Del Rio, Val Verde County, Texas (Brune, 1981; Texas Parks and Wildlife, http://www.tpwd.state.tx.us/). Five sites were monitored quarterly from April 2001 to May 2003 along the segment of San Felipe Creek that bisects the San Felipe Country Club and borders Roosevelt Park in the city of Del Rio. San Felipe Springs (2 springs located east and west of San Felipe Creek) are located within the country club, and their outflows join the creek within the golf course. Results presented are a subset from a broader, community-level study of this portion of San Felipe Creek (Winemiller et al.,

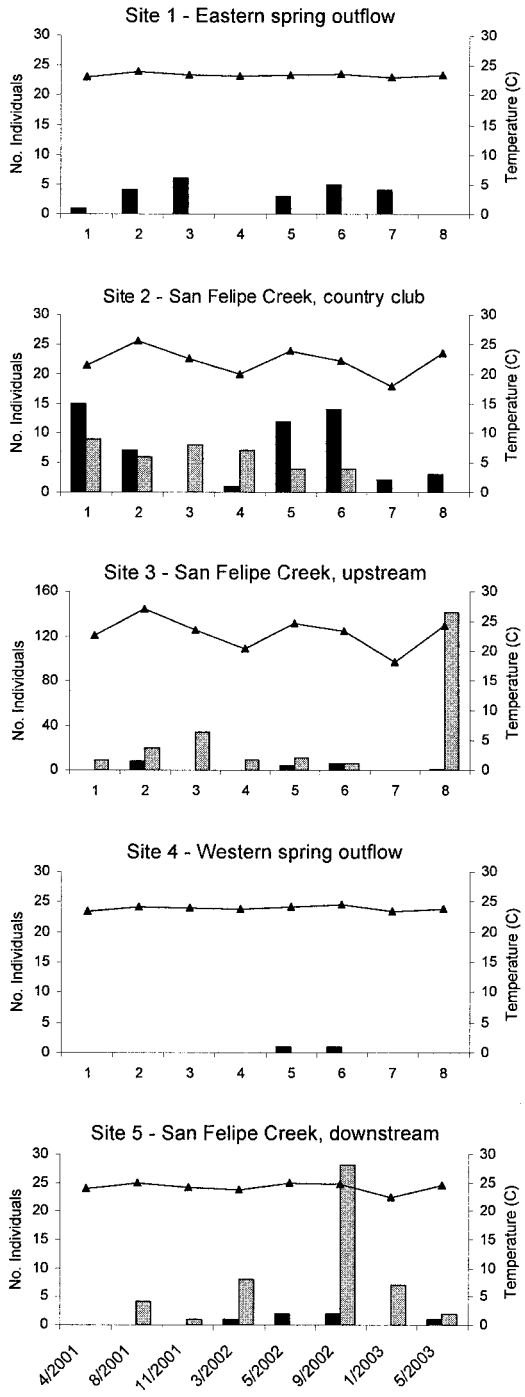

FIG. 1—Water temperature and number of individuals of *Hypostomus* and the Devils River minnow (*Dionda diaboli*) captured at 5 sites in San Felipe Creek and San Felipe spring outflows in Del Rio, Texas, from April 2001 to May 2003. Line = temperature, black columns = *Hypostomus,* gray columns = *D. diaboli.* Note that left-scale for site 3 graph is different from the others.

unpubl.). Sampling sites were chosen to facilitate comparison of aquatic communities from: 1) sites upstream of the spring outflows versus sites downstream from the outflows and 2) sites within spring outflows versus sites on San Felipe Creek. These comparisons should help determine: 1) if the golf course and related activities affect habitat or community assemblage along this segment of San Felipe Creek and 2) whether habitat or fish communities in spring outflows are different from those in the creek. Site 1 (29°22.29N, 100°53.04W) was located approximately 75 m downstream of the eastern spring outflow, several meters above its juncture with San Felipe Creek. Site 2 (29°22.30N, 100°53.04W) was located in San Felipe Creek in the middle of the golf course, approximately 100 m north of United States Highway 90. Site 3 (29°22.24N, 100°53.06W) was located in San Felipe Creek approximately 50 m upstream from the northern boundary of the golf course. Site 4 (29°22.37N, 100°53.15W) was located approximately 75 m downstream of the western spring outflow, upstream from its juncture with San Felipe Creek. Site 5 (29°21.79N, 100°53.29W) was located in San Felipe Creek approximately 200 m south of United States Highway 277, on the western boundary of Roosevelt Park.

Channel width (measured at 9 points and 3 transects along a 30-m channel segment during each sampling event) was 8.5 to 9.5 m on average at sites 1 through 4, and 13.3 to 14 m at site 5. Average channel depth (measured as above) was roughly 42 cm at site 1; 54 cm at site 2; 44 cm at site 3; 65 cm at site 4; and 1 m at site 5. Average water temperature at all sites ranged between 22 and 24°C, but the creek sites showed some seasonal variation, particularly at sites 2 and 3 (Fig. 1). Substrate composition was generally a mixture of sand and gravel, frequently covered by a fine layer of silt and detritus. The only exception was site 3, in which the substrate was entirely formed by bedrock covered with a layer of silt. Sites 1 and 4 (spring outflows), and to a lesser extent site 5 (creek), had dense and diverse cover of sub-

merged plants (e.g., *Chara, Bacopa, Ludwigia*), whereas site 2 had only small patches of *Chara,* and site 3 had virtually no submerged vegetation. Site 1 had the most diverse riparian vegetation, including a variety of grasses and tree species. Sites 2 and 4 had a mixture of golf-course turf and some tall grasses; at site 2, emergent grasses densely covered the left bank of the creek. Site 3 was lined by a belt of tall grasses several meters wide, frequently overhanging, and partially submerged in the aquatic habitat. At site 5, the left bank was channelized by a rock wall that delimits Roosevelt Park, whereas the right bank was covered by tall grasses and residential gardens.

During each survey, we attempted to document assemblage composition and species relative abundances at each site. Fishes were sampled using a 3 m × 1.8 m, 3.2-mm mesh seine along a 30-m reach of stream. All available habitat types in each site were sampled, and each site was seined until 5 consecutive hauls produced no additional species in the sample. Voucher specimens of fishes were deposited in the Texas Cooperative Wildlife Collection, Texas A&M University, College Station.

Devils River minnow was captured in relatively low abundance during most survey events at the 3 San Felipe Creek sites (Fig. 1, gray bars), but was never captured from the 2 spring outflows. Abundance of Devils River minnow was highest at site 3, and peaked during November 2001, when many juveniles were captured, and May 2003, when only juveniles where collected. At site 2, *D. diaboli* numbers declined over the study period and eventually disappeared, whereas *Hypostomus* increased, especially during the summer months. Devils River minnow was also collected at site 5, but usually in low numbers. Juvenile recruitment was evident during each of the 2 summer surveys. Devils River minnow in San Felipe Creek seems to prefer stream seeps, as has been also observed in the Devils River population (Hubbs and Garrett, 1990). *Dionda diaboli* apparently prefers habitats near submerged vegetation (Garrett et al., 2002, 2004), but our samples revealed the species was most abundant at sites 2 and 3, where submerged vegetation was scarce or completely absent. However, sites 2 and 3 had abundant riparian vegetation overhanging the banks, probably offering a structure similar to that of submerged macrophytes.

No specimens of the previously reported Raphael catfish (Howells, 2001) were captured, but 2 other introduced species were found in San Felipe Creek. Juveniles of the African cichlid *Oreochromis aureus* (blue tilapia) were sporadically collected at sites 2, 3, and 5, and adults of the species were seen but not captured at site 5. The blue tilapia has been present in the Rio Grande Basin for at least 40 years, and it is now widespread in the region (Fuller et al., 1999; Edwards et al., 2002). This cichlid is an omnivore-detritivore (Gu et al., 1997) that consumes algae and, thus, might compete with algivorous *D. diaboli*. Blue tilapia reproduce in San Felipe Creek, as demonstrated by the capture of juveniles, but the relatively small population did not seem to be a major threat to *D. diaboli*.

During the first 4 surveys, the loricariid catfish (*Hypostomus*; J. Armbruster, pers. comm.) was captured repeatedly at sites 1 and 2, and sporadically at sites 3 and 5. During the second year, individuals were collected at all 5 sites. Size of captured specimens ranged from 10 to 260 mm standard length. Juveniles (<50 mm standard length) dominated our samples, and the average size of *Hypostomus* tended to increase over time, especially in our summer and fall samples, suggesting that the population was expanding. *Hypostomus* was more abundant at sites 1 and 2, especially during the warmer months, and presence of large numbers of juvenile specimens indicated breeding during that period. Abundance of *Hypostomus* in samples from site 2 largely correlates with water temperature. *Hypostomus* was captured in higher numbers during warmer periods at sites 2 and 3, the locations with greatest temperature variation. Even at site 1, a spring-outflow channel, where temperature was stable year-round, *Hypostomus* was more abundant during summer months.

Hypostomus was probably introduced by aquarium release sometime between 1989 and 1997, and the population has expanded since then, with recruitment apparently during the spring and summer months. Low temperatures partly explain population reduction during the winter. Shafland and Pestrak (1982) found that *Hypostomus* (it is not known if this is the same undescribed species) could resist temperatures as low as 11.2°C, which were never observed during our surveys. More likely, mortality dur-

ing colder months is influenced by other factors. Increased predation on juveniles by native predators (e.g., largemouth bass) during winter, or reduced primary production and food availability might contribute to the observed population decline, particularly reduction of small individuals. It also is possible that *Hypostomus* might be more difficult to capture during the colder months. *Hypostomus* and *D. diaboli* both graze attached algae and associated microorganisms. Combining species abundance at all sites, analysis of total number of individuals of both species showed a significant association between species and sampling date ($\chi^2 = 111.7$, $df = 7$, $P < 0.001$). Independence of abundance of both species across dates is expected if abundance of one species does not affect abundance of the other. On this basis, changes over time in abundance of *D. diaboli* are associated with changes in the population of *Hypostomus*. Given this trend at all sites, gradual reduction of Devils River minnow densities at site 2 might be a consequence of the expansion of the *Hypostomus* population. Further expansion of *Hypostomus* in San Felipe Creek might have additional detrimental effects on the population of Devils River minnow and other native fishes.

San Felipe Creek continues to support a breeding population of *D. diaboli*. Implementation of monitoring of fish populations in San Felipe Creek should reveal future changes in the population of Devils River minnow and other species of concern (e.g., proserpine shiner, Rio Grande darter), and will facilitate conservation planning in the creek. Public relations efforts should be undertaken to discourage people from introducing additional aquarium fishes into the San Felipe Creek system.

We thank the many individuals in the City of Del Rio who provided crucial assistance for the completion of this project: A. Garcia and his staff at the City Engineers Office of Del Rio facilitated field work in Del Rio. N. Allan of the United States Fish and Wildlife Service and D. Fox of the Texas Water Development Board were extremely helpful in providing information and guidance for the project. G. Garrett of the Texas Parks and Wildlife Department commented on an earlier version of the manuscript and provided us with his unpublished manuscript. G. Garrett and R. Edwards provided historical information. J. Armbruster (Auburn University, Alabama) identified the *Hypostomus* specimens, and provided useful comments. Work in the field was possible thanks to the efforts of D. Hoeinghaus, E. Pellegrini Caramaschi, S. Willis, C. Robertson, J. Birnbaum, G. Criglow, J. Walther, A. Grubh, S. Zeug, M. Bennett, A. Arrington, and A. Garcia.

Literature Cited

Armbruster, J. W. 2003. The species of the *Hypostomus cochliodon* group (Siluriformes: Loricariidae). Zootaxa 249:1–60.

Barron, J. C. 1964. Reproduction and apparent over-winter survival of the suckermouth armored catfish, *Plecostomus* sp., in the headwaters of the San Antonio River. Texas Journal of Science 16: 449–450.

Brune, G. 1981. Springs of Texas. Branch-Smith, Inc. Forth Worth, Texas.

Echelle, A. A., A. F. Echelle, S. Contreras Balderas, and M. L. Lozano Vilano. 2003. Pupfishes of the northern Chihuahuan desert: status and conservation. In: G. P. Garrett and N. L. Allan, editors. Aquatic fauna of the northern Chihuahuan Desert. Museum of Texas Tech University, Special Publications 46:113–126.

Edwards, R. J. 2001. New additions and persistence of the introduced fishes of the Upper San Antonio River, Bexar County, Texas. Texas Journal of Science 53:3–12.

Edwards, R. J., G. P. Garrett, and E. Marsh-Matthews. 2002. Conservation and status of the fish communities inhabiting the Río Conchos basin and middle Río Grande, México and U.S.A. Reviews in Fish Biology and Fisheries 12:119–132.

Fuller, P., L. G. Nico, and J. Williams. 1999. Nonindigenous fishes introduced into inland waters of the United States. American Fisheries Society, Bethesda, Maryland.

Garrett, G. P., R. J. Edwards, and C. Hubbs. 2004. Discovery of a new population of Devils River minnow (*Dionda diaboli*), with implications for conservation of the species. Southwestern Naturalist 49:435–441.

Garrett, G. P., R. J. Edwards, and A. H. Price. 1992. Distribution and status of the Devils River minnow, *Dionda diaboli*. Southwestern Naturalist 37: 259–267.

Garrett, G. P., C. Hubbs, and R. J. Edwards. 2002. Threatened fishes of the world: *Dionda diaboli* Hubbs & Brown, 1956 (Cyprinidae). Environmental Biology of Fishes 65:478.

Gu, B., C. L. Schelske, and M. V. Hoyer. 1997. Intrapopulation feeding diversity in blue tilapia: evidence from stable isotope analysis. Ecology 78: 2263–2266.

Howells, R. G. 2001. Introduced non-native fishes and shellfishes in Texas waters: an updated list and discussion. Management Data Series Number 188. Texas Parks and Wildlife, Austin.

HUBBS, C. 2003. Spring-endemic *Gambusia* of the Chihuahuan Desert. In: G. P. Garrett and N. L. Allan, editors. Aquatic fauna of the northern Chihuahuan Desert. Museum of Texas Tech University, Special Publications 46:128–133.

HUBBS, C., AND G. P. GARRETT. 1990. Reestablishment of *Cyprinodon eximius* (Cyprinodontidae) and status of *Dionda diaboli* (Cyprinidae) in the vicinity of Dolan Creek, Val Verde Co., Texas. Southwestern Naturalist 35:446–478.

NICO, L. G., AND R. T. MARTIN. 2001. The South American suckermouth armored catfish, *Pterygoplichthys anisitsi* (Pisces: Loricariidae), in Texas, with comments on foreign fish introductions in the American Southwest. Southwestern Naturalist 46:98–104.

POWER, M. E., T. L. DUDLEY, AND S. D. COOPER. 1989. Grazing catfish, fishing birds, and attached algae in a Panamanian stream. Environmental Biology of Fishes 26:285–294.

SHAFLAND, P., AND J. PESTRAK. 1982. Lower lethal temperatures for fourteen non-native species in Florida. Environmental Biology of Fishes 7:149–156.

URBANCZYK, K. 2003. Contemporary water supply in Texas as an example for the northern Chihuahuan Desert. In: G. P. Garrett and N. L. Allan, editors. Aquatic fauna of the northern Chihuahuan Desert. Museum of Texas Tech University, Special Publications 46:13–23.

Submitted 14 October 2003. Accepted 18 October 2004. Associate Editor was Kevin Bestgen.

HELMINTH PARASITES OF FOUR SPECIES OF ANURANS FROM NUEVO LEON, MEXICO

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ABSTRACT—We examined 50 amphibians of 4 species (*Bufo marinus, B. nebulifer, Rana berlandieri,* and *Scaphiopus couchii*) from 4 localities in the state of Nuevo León, Mexico. We collected 7 species of digeneans (*Cephalogonimus americanus, Clinostomum* sp. (metacercariae), *Haematoloechus complexus, Halipegus occidualis, Langeronia* cf. *macrocirra, L.* cf. *jimenezi,* and *Megalodiscus americanus*) and 1 monogenean (*Pseudodiplorchis americana*), 3 cestodes (*Distoichometra bufonis, Ophiotaenia filaroides,* and larvae of 1 proteocephalidean), and 4 nematodes (*Cosmocercoides* sp., *Chabaudgolvania* sp., *Rhabdias fülleborni,* and *R. savagei*). Eleven host records are new, and the geographic ranges of *C. americanus, H. occidualis, P. americana, O. filaroides, Chabaudgolvania* sp., *Cosmocercoides* sp., *R. fülleborni,* and *R. savagei* are expanded by these records.

RESUMEN—Examinamos 50 anfibios de 4 especies (*Bufo marinus, B. nebulifer, Rana berlandieri,* y *Scaphiopus couchii*) de 4 localidades en el estado de Nuevo Léon, Mexico. Se recolectaron 7 especies de digéneos (*Cephalogonimus americanus, Clinostomum* sp. (metacercarias), *Haematoloechus complexus, Halipegus occidualis, Langeronia* cf. *macrocirra, L.* cf. *jimenezi* y *Megalodiscus americanus*), 1 monogéneo (*Pseudodiplorchis americana*), 3 céstodos (*Distoichometra bufonis, Ophiotaenia filaroides* y larvas de un Proteocephalidea) y 4 nemátodos (*Cosmocercoides* sp., *Chabaudgolvania* sp., *Rhabdias fülleborni* y *R. savagei*). Once de los registros de hospedero son nuevos y se amplía la distribución geográfica de *C. americanus, H. occidualis, P. americana, O. filaroides, Chabaudgolvania* sp., *Cosmocercoides* sp., *R. fülleborni* y *R. savagei.*

Because parasites can provide information about ecological interactions, patterns of distribution, and evolutionary history of their hosts and their ecosystems, they should be an