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**THE REDISCOVERY AND PRECARIOUS STATUS
OF CHIHUAHUAN DWARF CRAYFISH
*CAMBARELLUS CHIHUAHUAE***

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ABSTRACT: We report rediscovery of the Chihuahuan Dwarf Crayfish *Cambarellus chihuahuae* at the desert spring Ojo Solo in Ejido Rancho Nuevo in Chihuahua, México. This species was reported to be extinct. Morphological evaluation of 12 voucher specimens confirmed the population as *C. chihuahuae*. Crayfish were abundant upon rediscovery in September 2012 and remained so throughout bimonthly monitoring from February 2014 to April 2015. Despite abundance at Ojo Solo, the species is critically imperiled, with four of its five native habitats dry and the remaining one in decline; however, a population was established at Ojo Caliente, a nearby natural refuge habitat we created in Ejido Villa Ahumada y Anexos in late 2013. Conservation management of *C. chihuahuae* and associated endemic species is discussed.

RESUMEN: Reportamos el redescubrimiento del acocil enano chihuahuense *Cambarellus chihuahuae* en el manantial del Ojo Solo, Ejido Rancho Nuevo, en Chihuahua, México. Esta especie se encontraba reportada como extinta. Identificamos una población de dicha especie, con base en la morfología de 12 ejemplares colectados. Los acociles fueron abundantes en el sitio a partir de su redescubrimiento en septiembre de 2012, y permanecieron así durante los ejercicios de monitoreo bimensuales, que llevamos a cabo entre febrero de 2014 y abril de 2015. A pesar de la abundancia de la especie en el Ojo Solo, esta se encuentra en peligro crítico de extinción, al encontrarse totalmente desecados cuatro de los cinco hábitats nativos, y el Ojo Solo en franca decadencia; sin embargo, una población fue establecido en Ojo Caliente, en un hábitat que creamos, un refugio natural cercano al Ejido Villa Ahumada y Anexas a finales de 2013. Discutimos el manejo para la conservación de la especie *C. chihuahuae* y especies endémicas asociadas.

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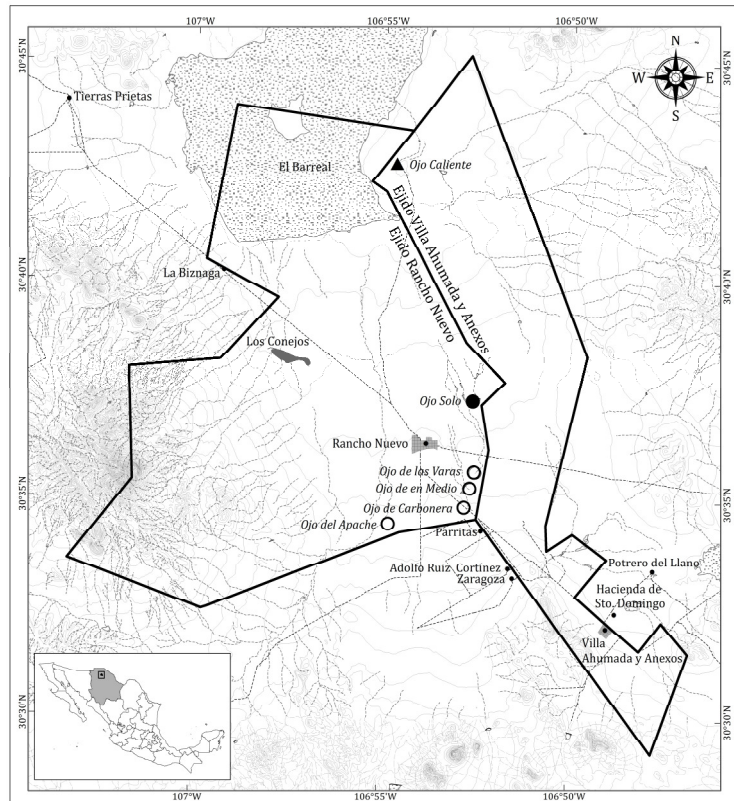
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We report rediscovery of the Chihuahuan Dwarf Crayfish *Cambarellus chihuahuae* Hobbs 1980, a species recently declared extinct (International Union for Conservation of Nature [IUCN], 2014). *Cambarellus chihuahuae* is endemic to a complex of five desert springs at Ejido Rancho Nuevo in the Samalayuca basin of Chihuahua, México (Hobbs, 1980; Fig. 1). This species is one of 17 dwarf crayfish (Cambaridae: Cambarellinae), a scarcely studied group represented by nine species in México and eight in the United States (Fitzpatrick, 1983). Several are of conservation concern, especially in México, where three are recognized as threatened or endangered and two are classified as extinct (IUCN, 2014).

Extinction of *C. chihuahuae* was reported by Alvarez et al. (2010) after an unsuccessful attempt in 2009 to locate the crayfish in its last remaining habitat, Ojo Solo. In September 2012, during an unrelated survey of the co-endemic Carbonera Pupfish – cachorrito de Carbonera, *Cyprinodon fontinalis* (Smith and Miller, 1980), EWC, MDMB, and MLLV documented *C. chihuahuae* at Ojo Solo. Crayfish of various life stages were abundant (Fig. 2) and, much as described by Hobbs (1980), were associated primarily with sediments around emergent (*Cyperus* and *Typha* spp.) and submergent (*Chara* and *Najas* spp.) vegetation of headspring, outflow, and pool habitats (Fig. 3). *Cambarellus chihuahuae* remained abundant throughout the period of bimonthly monitoring surveys conducted from February 2014 through April 2015.

Figure 1. Map of the distribution of *Cambarellus chihuahuae*. The crayfish is endemic to five springs in Ejido Rancho Nuevo: Ojo Solo (filled large circle; site of the rediscovery) and the recently dried Ojo de las Varas, Ojo de en Medio (= Ojo en Medio of Smith and Miller 1980), Ojo de Carbonera, and Ojo del Apache (open circles). The refuge population is located at Ojo Caliente (filled triangle) in the adjacent Ejido Villa Ahumada y Anexos. Contour lines (gray) represent changes in elevation; broken lines denote intermittent streams (gray) and unimproved roads (black); small filled circles are towns; and thick, black lines delineate boundaries of the ejidos.



We confirmed the crayfish population at Ojo Solo to be *C. chihuahuae* by evaluation of diagnostic morphological characters (Hobbs, 1980) in a representative sample of 12 specimens (2 male form I, 3 male form II, 4 females, and 2 juvenile males and 1 juvenile female); the specimens were collected on 6 February 2015 and deposited in the Colección Carcinológica at the Universidad Autónoma de Nuevo León (accession numbers UANL-FCB-C32-07082). Affinity to Mexican congeners was indicated by the structure of the first pleopod of first form males. The specimens from Ojo Solo differed from the most-geographically proximate species, *Cambarellus areolatus* and *Cambarellus alvarezii*, by possession of a shorter, more-distally pointed mesial process of the first pleopod of first form males and by the presence of spines on the carpus and merus of the cheliped. Distinction from other dwarf crayfish of México was evident from the broad areola (<3 times as long as wide).



Figure 2. *Cambarellus chihuahuae*. Adults and juveniles (upper left); defensive posture (upper right); mature, ovigerous female (lower left); and close-up of fertilized eggs (lower right).

Rediscovery of *C. chihuahuae* is encouraging but should be considered with caution. The designation of *C. chihuahuae* as extinct was based on limited survey data (a single survey trip; Alvarez, et al., 2010) and an understanding of the severity of local environmental degradation (loss of desert springs from intensive groundwater extraction; Echelle et al., 2003); such incomplete information is common with assessments of the status of imperiled species from remote areas. While our findings suggest that other such species may remain extant, the prospects for the long-term survival of aquatic biota of the North American Southwest are diminishing. Desert spring and other wetland habitats in the region are threatened by a variety of human activities, especially the unsustainable exploitation of water resources (Williams et al., 1985; Edwards et al., 2002; Barrios et al., 2009; De la Maza-Benignos, 2009; De la Maza-Benignos et al., 2014a,b). Further, climate change exacerbates these effects (Liverman and O'Brien, 1991; Magaña and Conde, 2000;

Christensen et al., 2004; Barrios et al., 2009; Falkenmark, 2013; De la Maza-Benignos et al., 2014a; Cook et al., 2015). For *C. chihuahuae* and associated endemic species, including the Largemouth Shiner – sardinita bocagrande, *Cyprinella bocagrande* (Chernoff and Miller 1982), and *Cyprinodon fontinalis*, four of five native springs are dry and the remaining one, Ojo Solo, is in decline. This fauna is at high risk of joining the list of northern Mexico’s well-documented extinctions, which include the endemic fishes and invertebrates of the Potosí and Sandia basins in Nuevo León (Contreras-Balderas and Lozano-Vilano, 1996) and a variety of microendemic springsnails in Chihuahua (Hershler et al., 2011, 2014a,b).



Figure 3. Habitats at Ojo Solo, including the headspring in winter (upper left) and summer (upper right) and the outflow and terminal pool in winter (lower left). Decline of this desert spring is indicated by the expansive areas that previously were inundated (impounded) year-round but now are dry (lower right).



Figure 4. The refuge at Ojo Caliente is located in a modified, desert-spring ecosystem surrounded by Chihuahuan Desert grassland (upper left). The site contains shallow pool (upper right, foreground) and deeper laguna (upper right background) habitats as well as marshes (lower left). A surrounding fence excludes livestock (lower right).

Our conservation efforts for *C. chihuahuae* are conducted as part of a larger program that includes management of *Cyprinella bocagrande* and *Cyprinodon fontinalis* (Carson and De la Maza-Benignos, 2014). Under this program, in late 2013 we created a natural refuge habitat in a nearby desert spring, Ojo Caliente (Fig. 4), in Ejido Villa Ahumada y Anexos, and in February 2014 began translocation of crayfish, pupfish, and shiners to the new habitat (Carson and De la Maza-Benignos, 2014). In conjunction with monitoring trips conducted bimonthly from February 2014 to April 2015, we transferred a total of 750 crayfish from Ojo Solo to Ojo Caliente and

also started a captive population at the Universidad Autónoma de Nuevo León. Although these three species are established at Ojo Caliente, this success is tempered by the continued decline of Ojo Solo and the broader threats to desert springs throughout the Samalayuca basin.

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