Anuran species that inhabit areas with extreme and variable environmental conditions, such as extended periods of water limitation, tend to use several mechanisms to avoid body water loss (Cohen and Alford, 1996; Titon et al., 2010). These mechanisms include behavioral, ecological, and physiological modifications, in which organisms adjust their periods of activity, switch to alternate locations within their home ranges, and/or adapt their metabolisms according to the circumstances (Moore and Gatten, 1989; Zug, Vitt and Caldwell, 2001). Aestivation has been reported for many anuran species exposed to very dry environments; individuals conceal themselves with conspecifics in more humid shelters and enter a state of torpor (Zug, Vitt and Zug, 1979; Malvin and Wood, 1991; Hilje and Yglesias, 2010). For many species, even very small waterholes present during dry periods act as important refugia, where individuals frequently congregate (Vaughan et al., 1997; Hilje and Yglesias, 2010).

Low water availability is a recurrent scenario for terrestrial amphibians that inhabit dry areas, and for that reason, the implementation of adequate mechanisms to face this condition is critical for survival (Zug and Zug, 1979; Malvin and Wood, 1991; Hilje and Yglesias, 2010). In March 2007, during the peak of the dry season in Guanacaste, Costa Rica, we observed a group of the Cane Toad *Rhinella marina* aestivating in the tropical dry forest of Parque Nacional Palo Verde, Guanacaste (10°21’ N, 85°21’ W) (Organization for Tropical Studies 2012). At least 20 healthy adult individuals were grouped together in a single rock crevice immediately adjacent to a waterhole approximately 50 cm in diameter. These individuals were mainly clustered side by side where they remained motionless (without any activity) for a two-day period (Fig. 1). We suspect that this behavior continued for several days until the extreme dry conditions disappeared.

The fairly common *R. marina* is a solitary species, but it may congregate during the breeding season when males call together for female attraction, courtship, and egg-laying in temporary water bodies (Savage, 2002). This species is a broadly distributed toad and its range is from Texas, USA, to Brazil (Amphibiaweb 2012). It is also found outside of its native range in the Caribbean islands and countries where it was introduced by humans (Covacevich and Archer, 1975; Tyler, 1975; Zug, Lindgren and Pippet, 1975; Zug and Zug, 1979; Freeland, 1987; Savage, 2002, Amphibiaweb 2012). However, within this expansive range, aggregative behavior to avoid extreme dry conditions has only been reported from Australia, where the species was introduced decades ago (Cohen and Alford, 1996; Savage, 2002). Nevertheless, these aggregations reported from Australia were only witnessed during the day (Cohen and Alford, 1996), and here we observed individuals remaining completely motionless for extended periods in both day and night conditions, as is typical of aestivation.

Thus, this observation is showing an uncommon and probably extreme behavior to survive severe periods of dryness and to avoid water loss. It is possible that the success of this species during colonization, and in turn, becoming an invasive species worldwide is due to this kind of adaptation (Covacevich and Archer 1975; Urban et al., 2007, 2008; Kearney et al., 2008). In addition, this adaptation could potentially be beneficial to flourish worldwide in extremely dry environments generated by global warming, leading to further increases in its global and elevational ranges. An important question that remains is whether or not this is a common behavior of *R. marina* in habitats with extremely dry conditions throughout its range, and which specific environmental conditions trigger this behavior.

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References


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