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Leptodactylus pustulatus Peters, 1870 (Amphibia: Leptodactylidae): Notes on Habitat, Ecology, and Color in Life

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The Brazilian Cerrado remains one of the most poorly understood habitats in that country. Among the little known anurans from the Cerrado is a reclusive member of the genus *Leptodactylus* which Peters (1870) described as *Entomoglossus pustulatus*, collected from Ceará, Brazil (Bokermann 1966). Boulenger (1882) reassigned the species to the genus *Leptodactylus*. A number of subsequent publications briefly mention the species by either including it in faunal, distributional, or nomenclatural listings, or by providing short physical descriptions of preserved specimens (Bokermann 1962, 1966; Duellman 1999; Frank and Ramus 1995; Frost 1985; Heyer and Pyburn 1983; Liner 1992; Lutz 1926, 1930; Miranda Ribeiro 1926, 1927; Vanzolini and Heyer 1988), but little else has been reported. The holotype was long believed lost, leading Heyer (1970) to designate a neotype (MCZ 373). Subsequently, the original type has been relocated in Berlin, Germany (ZMB 6951) (Bauer et al. 1995).

Habitat associations.—Little is known of the biology or ecology of this species. These frogs have been primarily associated with Amazon, Cerrado, and Caatinga habitats south of the Amazon River; the four drainage systems for which reliable locality records exist are the Xingu, the Paranaíba, the Araguaia, and the Tocantins in Central Brazil (Heyer 1970). The majority of the locality records associate the species with Cerrado (Heyer 1994). The type specimen was collected in Ceará, Brazil (Peters 1870), an area dominated by Caatinga habitat. Bokermann (1962) reported finding individuals beneath an old boat along the Xingu River. The locality, Posto Jacaré, is located in transitional forest between Cerrado and Amazonian biomes (as are the localities for the new specimens reported herein). Aside from association with riparian habitat, frogs have also been found in patches of marsh-like wetlands within the outlined habitat types, known in Brazil as "vereda." No other habitat information for *L. pustulatus* has been published (Heyer 1994, Heyer, pers. comm.), except for male calling sites (Brandão and Heyer, *in press*).

Habitat description (Locality 1).—In August 2000, we collected two specimens and observed a third along the upper Tocantins River in the state of Tocantins, Brazil. Vereda in the vicinity of the city of Tocantinópolis ranges from mildly disturbed to completely cleared for cattle grazing. We found our specimens in a heavily disturbed clearing with a natural spring that maintains the small wetland area, even in the dry season. During the wet season, the entire cleared area, ca. 50 ha^2, is inundated with water ranging from 0.2–1 m in depth. During the dry season, the wetland is reduced to small patches roughly one tenth the size of the wet season habitat. Tall grass covers the clearing at roughly 0.6 m in height. The ground is uneven and is arranged in a random series of slightly elevated mounds. These mounds become small, soggy "islands" in the wet season and are separated by shallow water. All *L. pustulatus* from this locality were found on these mounds at night. When approached, individuals crawl in a bufonid-like fashion rather than hopping away in a typical leptodactylid fashion. The following anurans were found syntopically: *Leptodactylus ocellatus*, *L. podicipinus*, *Hypsiboas raniceps*, *Dendropsophus minutus*, *Scinax* sp., and *Pseudis tocantins*.

Habitat description (Locality 2).—The city of Peixe, Tocantins State, is connected to the "Peixe Angical" hydroelectric impoundment of the Tocantins River by a road that crosses the Tocantins River before reaching the dam. That road is fringed by area cleared for the grazing of cattle. Patches of vereda are common along the road. On the right bank of the Tocantins River, immediately after the road crosses it, is a patch of vereda. We examined the habitat on 25 April 2005 at 2000 h and 17 June 2005 at 1900 h. The wetland is ca. 6 ha^2 with water depths ranging from .01 to 2.1 m depth. The vereda is maintained throughout the year by springs and aquatic vegetation is present. The edges of the wetland, and small islands within, are covered by grass 0.4 m in height. All *L. pustulatus* at this locality were found on muddy banks of the wetland, among clumps of grass. The following anurans were found syntopically: *Pseudis tocantins*, *Dendropsophus anataliasiasi*, *D. minutus*, *D. cruzi*, *D. nanus*, *Hypsiboas raniceps*, *Leptodactylus ocellatus*, *L. fuscus*, *L. labrynthicus*, *L. podicipinus*, *L. troglodytes*, *Physalaemus cuvieri*, and *P. nattereri*. We observed Cuvier's Dwarf Caiman (*Paleosuchus palpebrosus*), a potential predator, in the wetland.

Color in life.—The dorsal coloration of individuals range from a dark, forest green, to dark brown, with darker brown or black irregularly shaped and spaced spots. In contrast to other *L. pustulatus* without dorsolateral ridges (Heyer and Pyburn 1983), these specimens have six small, elevated dorsolateral ridges extending along the dorsum to the vent with an uneven surface. A maroon V-shaped pattern extends from behind each eye to the nasal openings. A faint black line also extends from the base of each eye to the nasal openings. The pupils are horizontal and black. The iris is a faded copper color marked by irregularly spaced black reticulations that extend to the edge of the eye. The ventral pattern and coloration of *L. pustulatus* is a distinguishing character from other anurans, save for *L. podicipinus*. The ventral ground color ranges from charcoal gray to black and can change within 20 minutes from gray to jet black or vice versa. Circular and ovoid spots cover the ventral surface extending from the throat covering to the groin and undersides of the legs and arms, as well as onto the flanks. The spots wrap around the throat and onto the lower lip. Syntopic *L. ocellatus* and "*L. podicipinus*" also have white spots of similar proportion on their lower lip which confuses visual iden-

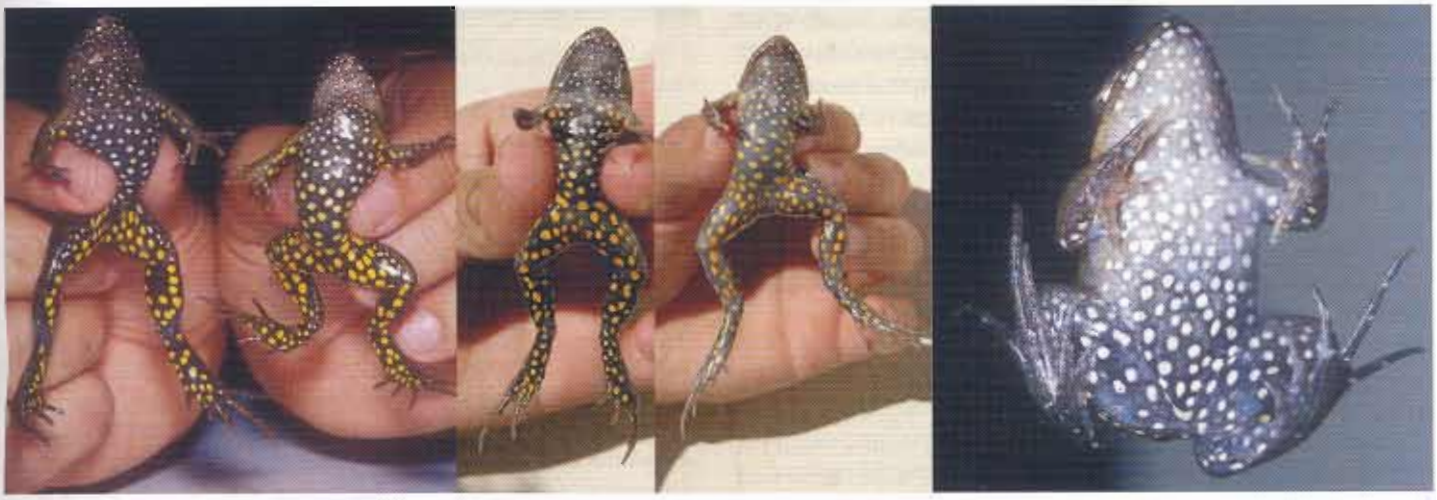

FIG. 1. The ventral surface of *Leptodactylus pustulatus* demonstrating ventral color in life and variation in color and pattern. From left to right: HLR20 and HLR21 from outside "Paudo Chapinha:" wetland on the left bank of the Tocantins River: Tocantins State: Brazil; NAT1222, NAT1223, and NAT1228 from the road connecting the town of Peixe, and "Peixe Angical" hydroelectric impoundment: wetland on the right bank of the Tocantins River: Tocantins State: Brazil. Note, NAT1228 is a juvenile with only faint traces of the orange coloration filling spots on the outer thighs and arms.

tification when facing an individual from a distance. The ventral spots on *L. pustulatus* do not connect and are white in the throat and chin region. All of the spots near the groin and lower abdomen range from a brilliant orange to canary yellow in adults. Individual variation exists in the relative number of colored versus white spots, and in the progression of the orange spots up the ventral surface toward the animal's head (Fig. 1). In most individuals, orange colored spots can be found on the underside of the upper arms, even if the orange spots don't extend far up the ventral surface. In a resting position, the spots are visible on the chest and lower lip when approaching the animal from the front. Two juvenile frogs were collected at the Peixe locality. The spots on their ventral surface were primarily white. The orange coloration of the spots on the thighs and groin area was faint (see Fig. 1). This observation suggests that either 1) juveniles do not have well defined orange colored spots early in life, or 2) that some individuals never develop well defined orange or yellow spots. Because all adults observed from this locality and elsewhere have had well defined orange or yellow colored ventral spots, the first hypothesis is the likely condition. Accordingly, this increases the likelihood of confused identifications between juvenile *L. pustulatus* and *L. podicipinus* (similarly sized and colored dorsally—also with white spots on the ventral surface). One discriminating character is that in *L. pustulatus*, the ventral surface of the tarsal units have distinct white spots, whereas in *L. podicipinus* the surfaces are mottled rather than clearly spotted (W. R. Heyer, pers. comm.).

TABLE 1. Morphometric measurements for specimens of *Leptodactylus pustulatus* from (1) outside "Paudo Chapinha": wetland on the left bank of the Tocantins River: Tocantins State: Brazil, and from (2) the road connecting the town of Peixe, and "Peixe Angical" hydroelectric impoundment: wetland on the right bank of the Tocantins River: Tocantins State: Brazil. All measurements taken using digital calipers, in mm: SVL = snout to vent length, HW = head width, HL = head length, IOD = inter-ocular distance, END = eye to nostril distance, TD = tympanum diameter, FeL = femur length, TL = tibia length, FL = foot length, Juv. = juvenile. All specimens deposited in the collection at the Universidade Católica de Goiás, Goiás, Brazil.

Locality	Field Number	SVL	HW	HL	IOD	END	TD	FeL	TL	FL	Sex
Tocantinópolis Locality											
	HLR20	56.3	17.0	22.4	5.5	4.8	3.8	21.5	21.6	26.0	Female
	HLR21	49.0	16.7	20.2	5.3	5.0	2.8	14.1	16.9	24.7	Female
Peixe Locality											
	NAT1222	35.9	13.9	17.3	6.3	3.8	3.6	10.5	16.1	18.3	Male
	NAT1223	47.0	15.9	18.3	5.1	4.1	3.9	17.3	20.6	25.6	Female
	NAT1224	34.7	13.3	16.3	4.6	3.2	3.4	11.7	16.0	20.8	Male
	NAT1225	33.9	12.9	16.4	4.4	3.8	3.5	12.8	15.9	20.9	Male
	NAT1226	40.0	13.3	19.2	4.9	4.3	3.3	13.4	17.3	22.3	Male
	NAT1227	32.5	13.0	14.5	5.7	3.7	2.8	13.3	16.0	19.9	Male
	NAT1228	24.8	9.6	10.3	5.5	3.1	1.8	9.5	11.5	15.0	Juv. Male
	NAT1229	24.4	9.3	9.9	4.7	2.6	2.1	10.0	12.4	14.1	Juv.

Reproductive output.—We collected one gravid female (field number NAT1223) at the Peixe locality. She had 1480 unyolked, black eggs in her abdomen. All eggs were 1 mm in diameter. She had a noticeably greater girth to her body relative to two non-gravid females collected at the Tocantopolis locality.

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Rain-Harvesting in a Wild Population of *Crotalus s. scutulatus* (Serpentes: Viperidae)

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Mohave Rattlesnakes (*Crotalus s. scutulatus*) inhabit many of the desert regions of the southwestern United States and northcentral Mexico. Throughout much of the range of *C. s. scutulatus*, the dominant plant is Creosote Bush (*Larrea tridentata*), which is widely spaced, and the terrain is mostly devoid of rock outcroppings and other significant topographic features. This habitat is also characterized by dry, porous soils that rapidly absorb rainfall, creating little opportunity for surface water to accumulate. Most precipitation in the Mohave Desert, where this study was conducted, occurs during the winter. Summer monsoon rains are less predictable and less significant than in the more southern Sonoran and Chihuahuan Deserts (Jaeger 1957), where *C. s. scutulatus* also occurs.

Several authors have described viperid snakes drinking water from the external surfaces of their own skin. Bogert (1927) describes a technique for captive husbandry of "rattlesnakes taken on the desert miles from water" as requiring water to be "sprayed upon them, as well as upon the rocks in their cage." He goes on to describe the snakes "sucking the water off the rocks and sometimes off their own backs." Also referring to captive animals, Hediger (1964) describes "some rattlesnakes" as preferring to "drink drops from the scales on their own bodies." Greene (1997) describes watching a wild Terciopelo (*Bothrops asper*) "drinking rain droplets off her own skin" in a Costa Rican rainforest. Andrade and Abe (2000) report captive juvenile Brazilian Lanceheads (*Bothrops moojeni*) coiling when sprayed with water, which was trapped between body loops and ingested. Captive Peringuey's Adders (*Bitis peringueyi*) from the Namib Desert have twice been reported to flatten their bodies when sprayed with water, which they then "drink" (Robinson and Hughes 1978) or "lick" (Louw 1972) from their own skin. Aird and Aird (1990) reported a captive adult female Great Basin Rattlesnake (*Crotalus oreganus lutosus*) in an outdoor enclosure flattening her body, forming concentric coils, and drinking rainwater trapped between the coils. A single observation of a wild xeric rattlesnake, *Crotalus oreganus concolor*, drinking rainwater from its skin was reported by Ashton and Johnson (1998).

Body posturing has been reported to enhance the collection of water from the skin by some desert lizards, including *Phrynocephalus helioscopus* (Schwenk and Greene 1987), *Phrynosoma cornutum* (Sherbrooke 1990), *P. platyrhinos* (Peterson 1998), *P. modestum* (Sherbrooke 2002), and *Trapelus pallidus*, *T. mutabilis*, and *T. flavimaculatus* (Vesely and Modry 2002). The term "rain-harvesting" was first used by Sherbrooke (1990) to describe the combination of integumental microstructure that enhances capillary movement of water and associated stereotypical posturing by *Phrynosoma cornutum* to collect and ingest rainwater.