containing more than a male and female have been reported for *L. bufonius* (Philibosian et al. 1974. Herpetologica 30:381–386; Pisanó et al. 1993. Rev. Fr. Aquariol. 19:125–126; Reading and Jofré 2003, *op. cit.*). Philibosian et al. (1974, *op. cit.*) suggested that *L. bufonius* may exhibit polyandrous behavior or males may use chambers of other males. The second scenario seems more plausible for the population studied in Argentina by Reading and Jofré (2003, *op. cit.*). These authors stated that the available evidence did not support polyandry. Given that *L. bufonius* individuals occur in high densities at our study site, and that the region is subjected to floods which may shorten the reproductive period because of lack of suitable sites to construct the chambers, we suggest that the occurrence of multimale and perhaps multifemale spawning behavior seems plausible for this population. Polyandry has rarely been reported for South American frogs (Prado and Haddad 2003. J. Herpetol. 37:354–362; Prado et al. 2006. Herpetol. Rev. 37:206–207). In species with external fertilization, as most anurans, one of the ways to increase fertilization success is increasing quantity of sperm released (Gross 1985. Nature 313:47–48). Thus, selection may favor males with larger testes (Prado and Haddad 2003, *op. cit.*). Studies on the reproductive effort (gonad mass relative to body mass) of *L. bufonius* males, as well as studies addressing offspring paternity, are needed to help understand the behaviors described herein.

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***LIMNONECTES PALAVANENSIS* (Smooth Guardian Frog). ALTITUDE.** *Limnonectes palavanensis* is a small (to 40 mm SVL) raniform anuran with conspicuous tympanum and supratympanic folds, smooth reddish to chocolate brown on top of the head and dorsum except for a distinctive inverted V-shaped ridge between the shoulders and two unbroken folds from behind the eyes to the lower back, several posterior dorsolateral dark spots, immaculate orange yellow venter, and half-webbed toes with faintly dilated tips (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.). *Limnonectes palavanensis* occurs in Palawan of the Philippines, and Borneo (Sabah and Sarawak of Malaysia, Brunei Darussalam, and Kalimantan of Indonesia) (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 200 pp.; Inger 2005, *op. cit.*; Inger 2007. Systematics and Zoogeography of Philippine Amphibia. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. vi + 370 pp.). Previous publications reported the altitudinal range for the species to be from near sea level to 1300 m elev. (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo, 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 201 pp.; Malkmus et al. 2002, *op. cit.*). Herein we report a new altitude limit for *L. palavanensis*.

On 11 Dec 2008, between 1900 and 2200 h, an adult *L. palavanensis* (26 mm SVL, 1.7 g) was sampled via opportunistic examination at Geludu Trail on Geludu Hill (6°N, 116.5375°E; 1502 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. The male anuran was found on the forest floor among dead leaves, and was not guarding eggs or carrying tadpoles. Air temperature was 16.2°C, and relative humidity was 88.1%. Geludu Hill is densely forested with elevation of 1200–1550 m. The hill houses other anuran species associated with forest floor such as *Ansonia longidigita*, *Leptobrachella baluensis*, *Leptobrachium montanum*, *Leptolalax dringi*, and *Chaperina fusca*, as well as with primary forest: *Philautus aurantium*, *P. bunitus*, *P. petersi*, and *Rhacophorus angulirostris*. The locality represents an extension of habitat for *L. palavanensis* from submontane to the montane zone. The specimen (HEP00913) was deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah. On the same night, an additional *L. palavanensis* was sampled at Geludu Hill at 1478 m elev. (HEP00912: SVL 37 mm, mass 5.1 g).

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***LITHOBATES AREOLATUS CIRCULOSUS* (Northern Crawfish Frog). WINTERKILL.** Herein we report the first documented instance of winterkill in *Lithobates areolatus*, a state endangered species in Indiana and a species thought to be threatened throughout its range (Parris and Redmer 2005. *In* Lannoo [ed.] Amphibian Declines: Conservation Status of United States Species, pp. 526–528. Univ. California Press, Berkeley, California.). Our study population is located at the Hillenbrand Fish and Wildlife Area, in Greene Co. in southwestern Indiana (Lannoo et al. 2009. Diversity 1:118–132). This population is about 40 km SSE of the northernmost known extant population in Indiana, and probably at this point in time, the species. At this latitude, Crawfish Frogs overwinter obligately in burrows—one frog per burrow—excavated by crayfish (*Cambarus diogenes*, *C. polychromatus*, or *Fallicambarus fodiens*; Heemeyer and Lannoo 2010. Herpetol. Rev. 41:168–179). These burrows are small-bore—about the width of the frog—and long, extending a meter, perhaps more, down into the water table (Thompson 1915. Occ. Pap. Mus. Zool. Univ. Michigan 9:1–7). Crawfish Frogs spend the

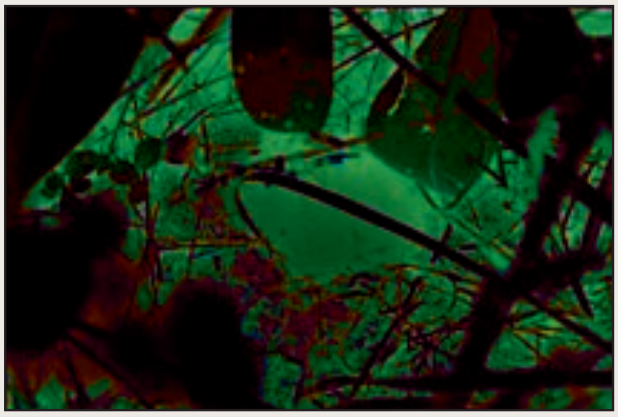

FIG. 1. Flooded Crawfish Frog burrow; feeding platform is the muddy area immediately to the left and below the entrance in this photograph. Photo taken on 14 October 2009, after several days of heavy rains. Burrow entrance is about 8 cm in diameter.

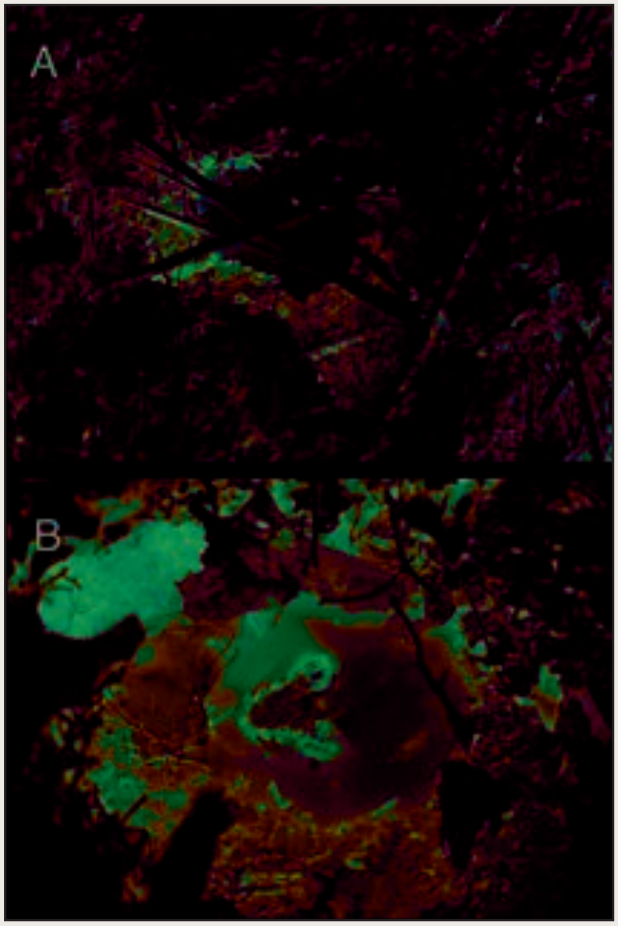

FIG. 2. A) A thin incomplete ice cap covering the burrow of Crawfish Frog 9. Burrow entrance about 14 cm across. B) A magnified view of Frog 538 (headwidth 40 mm) partially submerged sitting in the water of her burrow after the ice cap had been broken and cleared. Distance from ice cap to the water was approximately 10 cm. Photos taken on 10 Dec 2009.

winter in or near the water at the bottom of their burrow, either partially submerged with their nostrils above the water or completely submerged with occasional emergence (especially under warm conditions). Crawfish Frogs will drown if submerged for extended periods of time (Heemeyer and Lannoo 2010, *op. cit.*).

During the winter of 2009–2010 we monitored 14 Crawfish Frogs on a weekly basis until 1 March, when we resumed daily monitoring. We observed frogs at the entrance or out of their burrows during every month of the winter. Temperature and precipitation data were recorded every 10 min throughout the winter using a HoboWare weather station located at a secure site 4.4 km NW of our study area. October 2009 was unusually wet (114 mm of rain, 28.7 mm above the 10-yr monthly average), with heavy rains coming on the 8th, 9th, and 14th. These rains raised the water table to the soil surface and inundated Crawfish Frog burrows (Fig. 1). For much of the winter (December was also wet) the water table remained near the soil surface. Throughout the winter we noticed a general pattern of rain leading a cold front, which led to burrow inundation with ice formation over the burrow entrance, followed by a fast or slow percolation of water out of burrows. This drainage created an air pocket between the ice and the water surface (Fig. 2). Burrows did not drain evenly in the clay-capped mine spoil soils of our study site (Lannoo et al. 2009, *op. cit.*). Later warming produced thawing and open burrow entrances. At no time during the winter was there enough persistent snow to provide insulation to retain ground heat.

January and February were cold, with a minimum recorded temperature of –20.4°C. On 21–22 February it rained 2.6 cm, and from 23–25 February a cold snap froze the entrances to many burrows, and in particular the burrow of Crawfish Frog number 9. Frog 9 was a large male (119 mm SUL, 152 g minus the transmitter [3.8 g]) whose burrow was situated on a south-facing hillside, in deep clay, in a pocket shaded by several large clusters of Big Bluestem (*Andropogon gerardii*). As a consequence of being sheltered and in thick clay, the ice at the entrance to this burrow was thick (centimeters), the water in the burrow did not drain to form an air pocket, and the ice over the burrow did not thaw quickly. When it did, on 7 March, we saw Frog 9 below the water level, something that is not unusual and typically not cause for alarm. On 9 March we realized Frog 9 had not moved and JLH extracted him. The carcass was fresh, and necropsy followed by consultation with Alan Pessier, D.V.M., suggested death by either drowning or asphyxiation. Among all (14) burrows surveyed, Frog 9's burrow had the thickest ice, was the last to thaw, and had the highest water table relative to the ground surface.

Frog 9 was the only monitored frog to die over the winter, and over the course of this study (16 months to date) has been only the second Crawfish Frog in a burrow to die (Engbrecht and Heemeyer 2010. Herpetol. Rev. 41:197). In the absence of heavy fall rains, we expect the winter water table to be close to or below the frost line (76 cm), and for Crawfish Frogs sheltered (water has a higher thermal inertia than air) in the water at the bottom of crayfish burrows to be relatively protected from the several potential consequences of freezing temperatures.

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