sent potential sources of experimental error and efforts should be taken to control these in future experimental designs. These factors must also be considered in using rates of evacuation as an indirect estimation of rates of food consumption in nature.

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CHANGES IN O_2 CONSUMPTION, BODY WATER AND LIPID IN BURROWED DESERT JUVENILE ANURANS

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Abstract: Juvenile *Scaphiopus hammondi*, *Bufo debilis* and *Bufo cognatus* (1–6 weeks post-metamorphosis) were allowed to burrow in soil containers in an environment chamber adjusted to simulate soil temperature conditions in the field. Approximately 50% of the *S. hammondi* survived 6 months during which time body H_2O changed from 86% to 75% and body lipid from 3.2% to 2.0%. *Bufo cognatus* did not burrow and died within 1 month. *Bufo debilis* made shallow burrows after the soil was mechanically broken and survived 3 months. O_2 consumption of burrowed juvenile *S. hammondi* was 25% of nonburrowed. O_2 consumption of *S. hammondi* and the bufonid juveniles was higher than that of adults proportionate to the body size differences.

Creusere and Whitford (1976) suggested that overwinter mortality was significant in dormant juvenile desert anurans. In this study, we studied changes in lipid and H_2O content in burrowed, juvenile toads and O_2 consumption in juveniles burrowed in the soil in comparison to juveniles which had not burrowed. These

data, together with the data in Creusere and Whitford (1976) provide some basis for understanding the population changes and physiology of desert anuran juveniles.

Methods

The juvenile (1–6 weeks post-metamorphosis) toads were collected at the US/IBP Jornada Site 40 km NNE of Las Cruces, Doña Ana County, New Mexico, during October, 1972.

Oxygen consumption measurements were made with a Gilson Respirometer™ using specially designed 100-ml flasks and standard 15-ml flasks. Juvenile *Scaphiopus hammondi* were allowed to burrow in 100-ml flasks containing 80 g of water-saturated sandy loam. Flasks containing soil but no toads were paired with each experimental flask to obtain control data. Toads burrowed in flasks and toads held in plastic containers with moist paper towelling were acclimated at 15°C, 12 h light:dark regime, for 1 week prior to O_2 consumption measurements.

Groups of 25 juveniles of *S. hammondi*, *Bufo cognatus* and *Bufo debilis* were placed in plastic waste cans filled with water-saturated sandy loam from the Jornada Site. The containers were placed in a controlled environment chamber which was adjusted to provide soil temperatures equivalent to those measured at 45 cm depth in the same soil at the Jornada Site. One container was removed each month and the position and appearance of toads in the soil was recorded. The water content of the soil from around the burrowed toads was measured gravimetrically. Each juvenile was weighed after the bladder had been emptied by abdominal pressure. The toads were then killed and body composition determined.

Gross body composition was obtained by a modification of the technique of Rose (1967; F. Rose, *personal communication*). Toads were dried at 60°C to a constant weight, the carcasses broken and placed in a 3 : 2 mixture of chloroform and methanol. After 3 days the extract was decanted and this procedure was repeated two more times. The difference between dry weight and lean dry weight is the extractable lipid.

Results and Discussion

During the course of the experiments, soil temperatures were reduced from 20°C in October to almost 0°C in December and January, and gradually increased to 20°C in April. During this period soil water potential in the containers changed from 0 to –60 bars. In April the soil water potential on the Jornada Site in the same soil was –53 bars.

None of the *B. debilis* or *B. cognatus* burrowed in the soil containers. *Bufo cognatus* did not enter burrows we made in the soil and all died within 1 month. *Bufo debilis* dug into the soil after we broke up the soil surface but then only to 15 cm. Data from these laboratory experiments and field observations (Creusere and Whitford, 1976) suggest that juvenile bufonids do not excavate their own burrows but use other excavations such as ant nests in which to overwinter.

Scaphiopus hammondi juveniles burrowing behavior was similar to that described in adults of the same species (McClanahan, 1967). They dug with the rear legs with digging bouts of 10–15 min followed by equivalent rest periods.

When the containers were emptied, we found no aggregations. The minimal distance between *S. hammondi* was 3–4 cm. The surfaces of the snout were covered with a thick, black layer of waxy appearing material. When picked up the toads excreted $\cong$ 0.1 ml of clear urine. Juvenile *S. hammondi* remained inactive for about 15 min after being dug up.

In *S. hammondi* the mean monthly weight loss was 0.08 g (Table 1). There was no difference between the mean weight of juveniles collected on the Jornada Site at the end of April, 1973, and the juveniles removed from a container in the lab in early May ($\bar{x}$ = 1.35 g and 1.35 g, respectively). No other data were taken on the animals removed in May. *Scaphiopus ham-*

TABLE 1.—Changes in water content and lipid in two species of anurans during hibernation in burrows in soil.

Month	N	Mean wet wt (g)	Mean dry wt (g)	H_2O (%)	Lipid (%)
		Scaphiopus hammondi			
October	25	1.55	0.21	86.4	3.2
November	16	1.54	0.22	85.7	3.2
December	14	1.54	0.22	85.1	2.6
January	10	1.53	0.21	86.3	2.6
February	11	1.53	0.31	85.6	2.6
March	15	1.50	0.28	74.7	2.0
May	14	1.35	—	—	—
		Bufo debilis			
October	25	0.66	0.06	90.0	3.0
December	14	0.42	0.05	88.1	2.4

mondi juveniles exhibited a gradual H_2O loss and decrease in body lipid over the study period (Table 1).

Juvenile S. *hammondi* tolerated a loss of 16% of their initial body water without apparent detriment. They also used 40% of their total fat reserves in 6 months. Assuming similar rates of water loss and fat depletion, we suggest that some could survive an additional 6 months. Thorson and Svihla (1943) showed that adult *Scaphiopus* could lose 60% of their body water before reaching the vital limit of desiccation. Although acute laboratory experiments on adult frogs are not comparable to natural situations, they do indicate the general range of tolerance of a species. While it is impossible to determine the cause of death, it seems most likely that the juvenile mortality in the experiment was due to dehydration and/or depletion of fat reserves. Since only approximately 50% of the juveniles of S. *hammondi* survived the simulated overwinter conditions the suggestion of Creusere and Whitford (1976) that death of hibernating juveniles is an important factor in the dynamics and success of juvenile desert frogs is supported by this study.

The mean O_2 consumption ± SE in burrowed S. *hammondi* at 15°C was 44 ± 16 μl/(g·h) and for nonburrowed animals was 172 ± 62 μl/(g·h). The O_2 consumption of juvenile *B. debilis* and *B. cognatus* at 15°C was 128 ± 61 μl/(g·h) and 131 ± 38 μl/(g·h), respectively. Seymour (1973) presented O_2 consumption values at 15°C of dormant adult S. *hammondi* of 15 μl/(g·h) and of adults resting on the surface of 60 μl/(g·h). The differences in metabolic rate between juvenile and adult S. *hammondi* are undoubtedly due to body size differences (Whitford, 1973). Oxygen consumption rates in the juvenile bufonids was proportionately higher than those reported for adult bufonids (Whitford, 1973).

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