



Research note

Selected body temperature of nine species of Mexican horned lizards (*Phrynosoma*)

Temperatura corporal seleccionada de nueve especies mexicanas de lagartijas cornudas (Phrynosoma)

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Abstract

Temperature plays an important role in the behavior, ecology, physiology, and evolution of reptiles. Herein, we present selected body temperatures on 9 species of *Phrynosoma* under laboratory conditions, and note congeneric differences related to altitude and reproductive mode. The results are discussed with those of other phrynosomatid lizards.

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Keywords: Thermal gradient; Phrynosomatids; Laboratory conditions; Preferred temperature; Reproductive mode; Altitude

Resumen

La temperatura juega un rol importante en el comportamiento, ecología, fisiología y evolución de reptiles. Aquí, se presentan las temperaturas corporales seleccionadas de nueve especies de *Phrynosoma* bajo condiciones de laboratorio, tomando en cuenta la relación con la altitud y el modo reproductor. Se discuten los resultados con las temperaturas corporales de otros phrynosomátidos.

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Palabras clave: Gradiente térmico; Phrynosomátidos; Condiciones de laboratorio; Temperatura preferida; Modo reproductor; Altitud

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In ectotherms most physiological mechanisms are affected by temperature, therefore they carefully regulate body temperature (T_b) within a relatively narrow range by using behavioral adjustments (Cowles & Bogert, 1944). T_b data collected in the field form the basis of most thermal biology reports in the literature (Avery, 1982). In contrast, selected body temperatures (T_{sel}) in laboratory conditions are rarely reported. T_{sel} , also known as preferred body temperature, represents the range of body temperatures at which an ectothermic animal seeks to maintain itself by behavioral means in order to carry on their normal activities (Brattstrom, 1965a). This temperature is commonly measured in laboratory conditions that provide an array of thermal environments free of physical and biotic constraints (e. g., predation, costs of thermoregulation; Clusella-Trullas, Terblanche, van Wyk, & Spotila, 2007). T_{sel} had been recorded for a wide range of diurnal lizard families, mostly in Scincidae, Agamidae, Lacertidae, Liolaemidae, and Phrynosomatidae (Clusella-Trullas & Chown, 2014), nonetheless, within this last family the T_{sel} of horned lizards (genus *Phrynosoma*) is actually quite rare in the literature (Lara-Reséndiz, Jezkova, Rosen, & Méndez-de la Cruz, 2014).

Horned lizards are one of the most distinctive lizards in North America. Most horned lizards have diets consisting primarily of native ants, dorsoventrally compressed bodies, cranial horns and body fringes, camouflaging coloration and sedentary habits, a constellation of unusual and interrelated traits including “relaxed” thermoregulation (Pianka & Parker, 1975). According to the latest taxonomic revision, this genus comprises 17 species distributed from Canada to Guatemala (Nieto-Montes de Oca, Arenas-Moreno, Beltrán-Sánchez, & Leaché, 2014). Among lizards, this genus has one of the largest altitudinal distributions (–200 to 3,440 m elev.) and 2 groups have evolved viviparity, apparently a characteristic associated with montane habitats (Hodges, 2004). There have been several reports on T_b in the field and critical temperatures in *Phrynosoma* (Cowles & Bogert, 1944; Heath, 1962; Lemos-Espinal, Smith, & Ballinger, 1997; Pianka & Parker, 1975;

Woolrich-Piña, Smith, & Lemos-Espinal, 2012, and others) and various other reports detailing aspects of its thermal ecology (Brattstrom, 1965b; Christian, 1998; Guyer & Linder, 1985; Powell & Russell, 1985; Prieto & Whitford, 1971, and others). Nevertheless T_{sel} of horned lizards has attracted relatively little study even though it is essential to understanding behavior, natural history, ecophysiology (Huey, 1982; Sherbrooke, 1997; Sherbrooke & Frost, 1989), and responses to the effects of global warming (Sinervo et al., 2010). Therefore, our principal objective was to determine the selected body temperatures of *Phrynosoma* in a laboratory thermal gradient and to discuss the results with those of other phrynosomatid lizards.

We conducted fieldwork during 4 years (2010-2013) in 9 localities from Mexico, A) Zumpago de Neri, Guerrero (*P. asio* and *P. taurus*; 17°36'11.73" N, 99°31'19.74" W, 1,130-1,400 m elev.) in a deciduous tropical forest; B) Ensenada, Baja California (*P. blainvilli*; 31°55'14.94" N, 116°36'32.6" W, 235 m elev.) in a chaparral community; C) volcán La Malinche, Tlaxcala (*P. orbiculare*; 19°14'38.49" N, 97°59'26.48" W, 3,140 m elev.) in a montane woodland and grassland; D) Chilapa de Álvarez, Guerrero (*P. sherbrookei*; 17°33'10.85" N, 99°16'15.01" W, 2,020 m elev.) in an oak forest with patches of grassland and scrub; E) Zapotitlán de las Salinas, Puebla (*P. taurus*; 18°19'39.68" N, 97°27'16.17" W, 1,400 m elev.) in a desert scrub with cacti and xerophilous plants; F) Hermosillo, Sonora (*P. solare*; 28°57'49.82" N, 111°4'1.2" W, 160 m elev.) in a desert scrub habitat, some with large, columnar cacti and small trees; G) Altamirano, Janos, Chihuahua (*P. hernandesii*; 30°20'58.24" N, 108°29'26.3" W, 1,830 m elev.) in an oak forest with patches of grassland and scrub; H) Samalayuca, Ciudad Juárez, Chihuahua (*P. modestum*; 31°28'33.1" N, 106°28'33.6" W, 1,260 m elev.) in sand dunes and semi stabilized dunes; I) Janos, Chihuahua (*P. cornutum*; 30°49'31.6" N, 108°28'26.6" W, 1,435 m elev.) in grasslands and scrublands.

All animals were captured by hand. Snout-vent length (SVL) was measured to the nearest 0.1 mm, and sex was determined

Table 1
Selected body temperature (T_{sel}) of horned lizards (*Phrynosoma*) and T_{sel} range (quartiles 25 and 75%) in °C. Localities description in text. SVL= snout-vent length, ND= not determined. *= Viviparous, **= oviparous

| Species | n (♀:♂) | Adult body size (SVL; mm) | T_{sel} | T_{sel} 25% | T_{sel} 75% | Elevation (m asl) | References |
|---|------------|---------------------------|-----------|---------------|---------------|-------------------|--|
| <i>P. asio</i> ** | 67 (33:34) | ≥90 | 35.9±0.13 | 34.3 | 38.0 | 1,260 | Hodges, 2002; present study |
| <i>P. blainvilli</i> ** | 5 (3:2) | ≥62 | 37.6±0.39 | 35.9 | 39.2 | 235 | Goldberg, 1983; present study |
| <i>P. braconieri</i> * | 78 (56:22) | ≥49 | 35.9±ND | 33.9 | 37.4 | 2,470 | Zamudio and Parra-Olea, 2000; Hernández-Ríos, not published data |
| <i>P. cornutum</i> ** | 10 | ND | 38.5±ND | 37.5 | 39.0 | 1,230 | Prieto and Whitford, 1971 |
| <i>P. cornutum</i> ** | 97 (61:36) | ≥69 | 34.2±0.1 | 32.5 | 36.0 | 1,435 | Lemos-Espinal and Smith, 2009; present study |
| <i>P. goodei</i> ** | 40 (16:24) | ≥66 | 34.9±0.18 | 32.5 | 37.3 | 60 | Lara-Reséndiz et al., 2014 |
| <i>P. hernandesii</i> * (Chihuahua) | 7 (6:1) | ≥50 | 33.0±0.18 | 30.9 | 35.5 | 1,830 | James, 2002; present study |
| <i>P. hernandesii</i> * (= <i>dougllassii</i>) | 10 | ND | 35.0±ND | 33.0 | 36.0 | 2,620 | Prieto and Whitford, 1971 |
| <i>P. modestum</i> ** | 8 (6:2) | ≥37 | 33.6±0.51 | 31.1 | 36.5 | 1,260 | Goldberg, 2012; present study |
| <i>P. orbiculare</i> * (Tlaxcala) | 10 (5:5) | ≥67 | 31.4±0.22 | 30.8 | 33.7 | 3,140 | Hodges, 2002; present study |
| <i>P. orbiculare</i> * (State of México) | 57 | ≥67 | 33.1±0.19 | 30.5 | 33.3 | 2,600 | Hodges, 2002; Arias-Balderas, 2011 |
| <i>P. platyrhinos</i> ** | 1 | ND | 36.0±0.14 | ND | ND | 1,440 | Pianka and Parker, 1975 |
| <i>P. sherbrookei</i> * | 45 (26:19) | ≥54 | 33.4±0.14 | 31.1 | 36.2 | 2,020 | Nieto-Montes de et al., 2014; present study |
| <i>P. solare</i> ** | 26 (15:11) | ≥69 | 37.5±0.12 | 36.8 | 38.5 | 160 | Howard, 1974; present study) |
| <i>P. taurus</i> * (Puebla) | 11 (8:3) | ≥55.5 | 35.9±0.24 | 34.9 | 37.5 | 1,400 | Zamudio and Parra-Olea, 2000; present study |
| <i>P. taurus</i> * (Guerrero) | 23 (12:11) | ≥55.5 | 34.3±0.23 | 32.4 | 36.6 | 1,130 | Zamudio and Parra-Olea, 2000; present study |

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