

## The Influence of Photoperiod and Position of a Light Source on Behavioral Thermoregulation in *Crotaphytus collaris* (Squamata: Iguanidae)

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Temperature selection of male *Crotaphytus collaris* acclimated to  $25 \pm 1$  C was measured over a 24 h period in a thermal gradient with either uniform light over the entire gradient, a point source of light over the hot end of the gradient, or a point source of light over the cold end of the gradient and an 16L/8D, 12L/12D or 8L/16D photoperiod. Both photoperiod and the position of the light source over the gradient significantly influenced the diel cycle of thermal selection. The position of the light also significantly affected mean selected body temperatures. Photoperiod and light position were important both as separate and conjunctual factors influencing behavioral thermoregulation. We concluded that light position, heat, and photoperiod are used as separate cues in behavioral thermoregulation.

PHOTOPERIOD changes throughout a reptile's activity season provide reliable seasonal cues. Reptiles often thermoregulate within narrow limits when provided the opportunity, and some show seasonal differences in temperature preference (Patterson and Davies, 1978; Sievert and Hutchison, 1989a; Van Damme et al., 1986). Photoperiod affects many behavioral and physiological responses including repro-

duction (Licht, 1971a, 1971b), DNA synthesis in the testis (Noeske and Meier, 1983), temperature selection (Graham and Hutchison, 1979; Rismiller and Heldmaier, 1982, 1988), diel patterns of temperature selection (Rismiller and Heldmaier, 1982; Spellerberg, 1974), and thermal tolerance (Hutchison and Kosh, 1964; Licht, 1968).

Photoperiods with a longer photophase (16L/

8D) caused an elevation of preferred temperatures in painted turtles (*Chrysemys picta*) acclimated at 15 or 25 C and spotted turtles (*Clemmys guttata*) acclimated at 25 C (Graham and Hutchison, 1979). Similar results were found in European green lizards (*Lacerta viridis*) (Rismiller and Heldmaier, 1988) and fence lizards (*Sceloporus undulatus*) in May, but not July (Ballinger et al., 1969). In constant light (LL), blotched water snakes (*Nerodia erythrogaster*) chose higher body temperatures ( $T_b$ ) than snakes kept on an 12L/12D photoperiod (Gehrmann, 1971).

Light and heat are often treated synonymously in thermal gradient studies, especially in the case of photothermal gradients where a lamp is the source of both heat and light for the gradient. The position of the light source is an important factor in temperature selection in both nocturnal geckonids (Sievert and Hutchison, 1988) and diurnal iguanids (Sievert and Hutchison, 1989a). The position of the light source influences the temporal pattern of thermal selection and in some cases the actual temperatures selected by lizards. The purpose of this study was to examine the effect of both the position of the light source and duration of the light phase of the photoperiod on temperature selection of *Crotaphytus collaris* over diel (24 h) periods. We chose *C. collaris* as a study animal because we had background information on the effects of time of day, sex, season, nutritional status, and the parietal eye on temperature selection in this species (Sievert and Hutchison, 1989a, 1989b; Sievert, 1989).

Because *C. collaris* selects higher  $T_b$ s during photophase than during scotophase (Sievert and Hutchison, 1989a) we hypothesized that lizards maintained on long photoperiods would select significantly higher mean  $T_b$ s over a 24 h period than lizards maintained on short photoperiods. To test this hypothesis, we monitored  $T_b$ s of lizards maintained on 16L/8D, 12L/12D, and 8L/16D photoperiods and determined the effect of photoperiod on: 1) mean  $T_b$  selected over a 24 h period; and 2) temporal patterns of temperature selection. We repeated this work with three combinations of light and heat to determine how light position and photoperiod interact to influence behavioral thermoregulation.

#### MATERIALS AND METHODS

Male *Crotaphytus collaris* were captured in central Oklahoma and maintained in the labora-

tory (Sievert, 1987) for at least 6 mo prior to use. After emergence from hibernation in Jan. the lizards were divided into three groups and maintained on either an 8L/16D, 12L/12D, or 16L/8D photoperiod for at least 4 wk before experimentation. In all three groups the photoperiod was centered at 1200 Central Standard Time and air temperature was maintained at  $25 \pm 1$  C. Photophase of the 8L/16D group lasted from 0800–1600 h, of the 12L/12D group from 0600–1800 h, and of the 16L/8D group from 0400–2000 h. Prior to acclimation each lizard was able to elevate  $T_b$  by basking under a 60 W incandescent light bulb during photophase. Five days before experimentation each lizard was acclimated to a constant  $25 \pm 1$  C and kept on the same photoperiod on which it had been maintained prior to acclimation. Lizards were provided water ad lib but no food during acclimation to eliminate the possibility of postprandial thermophily (Sievert, 1989).

Late during the photophase of the day before experimentation a single lizard was placed into one of three linear thigmothermal gradients with an aluminum plate (0.3 cm) floor. Each gradient was approx. 210 cm long and had floor temperatures ranging from  $10 \pm 0.2$ – $50 \pm 2$  C. Each gradient was covered with a clear acrylic plastic heat shield that prevented heat from the lights from entering the gradient.

One gradient had broad spectrum fluorescent lights (General Electric) suspended over its entire length, which provided uniform light (UL). The second had a point source of light over the hot end (LH) and the third had a point source of light over the cold end (LC). The point source of light was a 60 W broad spectrum incandescent bulb (Westinghouse) with a narrow reflector shade.

Each lizard was allowed to habituate to the gradient overnight. Cloacal temperatures were recorded at 10 min intervals from 0900 h one day until 0900 h the next day with a flexible copper-constantan thermocouple placed in the cloaca with the exiting wire taped to the tail. Details of the gradient and experimental protocol were described by Sievert and Hutchison (1988).

We gathered all data between mid-Feb.–late May. All animals were healthy and alert during the experimental period. We used nine different lizards within each light treatment group in each of the three photoperiod groups.

Data were analyzed with two-way repeated measures ANOVA. Time and either photoperiod or light treatment were the two factors.

