SOME ASPECTS OF THE THERMAL ECOLOGY OF THE GECKO *HEMIDACTYLUS FRENATUS*

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SOME ASPECTS OF THE THERMAL ECOLOGY OF THE GECKO *HEMIDACTYLUS FRENATUS*

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Abstract: The mean cloacal temperature for *Hemidactylus frenatus* was 27.2° ± 3.19°C. Mean cloacal temperatures were higher than mean air or substrate temperatures and significant differences were obtained between cloacal and the environmental temperatures. Correlation between cloacal and environmental temperatures is very high and statistically significant. From the literature and the present study speculations are made concerning the diel thermal cycle of *H. frenatus* and generalizations are made about the thermal relations of geckos.

The study of temperature relations of reptiles by Cowles and Bogert (1944) stimulated considerable work on reptile thermal ecology. Reviews of these investigations by Bogert (1949), Fitch (1956), Schmidt-Nielsen and Dawson (1964), Brattstrom (1965), Fry (1967), and Templeton (1970) demonstrate that the bulk of the work has been with basking heliothermic species from temperate regions. Recently Hertz

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TABLE 1.—Air, cloacal and substrate temperature data with *t*-values for the differences between the means for 138 captures of *Hemidactylus frenatus* from Cuidad Valles, San Luis Potosi, Mexico, March–May 1969. Asterisks indicate values that are significantly different at the .001 level.

Temperatures	$\bar{x} \pm$ SD	Range	CV (%)	*t-value*
Air	25.9 ± 3.65	16.0–33.4	13.6	3.43*
Cloacal	28.4 ± 3.61	19.0–34.3	12.7	3.69*
Substrate	26.8 ± 3.57	18.0–34.3	13.3	

(1974), Rand and Humphrey (1968), Ruibal (1961), Ruibal and Philiobosian (1970), and Schoener (1968) have begun to elucidate the thermal ecology of diurnal tropical lizards, but virtually nothing is known about the thermal requirements of tropical nocturnal reptiles. In this study some aspects of the thermal ecology of *H. frenatus* will be described, discussed, and compared to those of other lizard species.

MATERIALS AND METHODS

Data were collected as part of an etho-ecological study at the Hotel Valles in Ciudad Valles, San Luis Potosí, Mexico during March, April and May of 1969. Lizards were collected by hand capture and temperatures recorded with a Schultheis thermometer. Cloacal temperatures were taken immediately after capture, the lizard being held near the pectoral region while the thermometer reached equilibrium. Temperatures of animals < 40 mm in snout-vent length were not used and no temperatures were taken of lizards which had been chased more than 5 m prior to capture. Substrate temperatures were obtained by placing the bulb of the thermometer agaist the substrate at the place where the lizard had first been seen. It has been pointed out (Mayhew, 1963) that accurate substrate temperatures are difficult to record because the bulb of the thermometer cannot be placed in contact with the substrate over its entire surface. In spite of this criticism it was thought that these temperatures would be consistent and give an indication of the relationship between substrate and body temperature. Air temperatures were recorded 5 cm above the substrate at the place of first sighting. Data were collected at all hours of the night although a greater number of records were obtained before 0200 h.

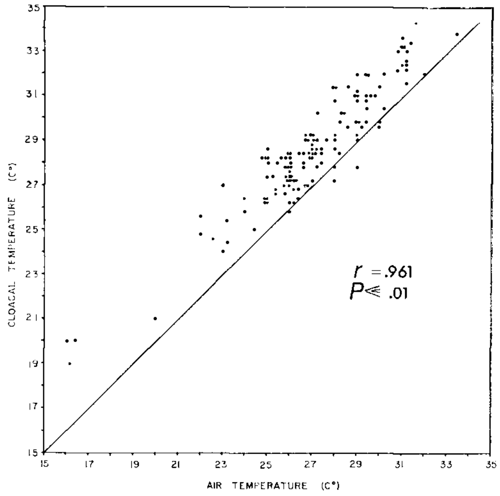

FIG. 1.—Scatter diagram of cloacal temperatures and substrate temperatures of *Hemidactylus frenatus* from Ciudad Valles, Mexico, March–May 1969. Line is isothermal axis; r = product moment correlation coefficient; P = probability correlation is not zero.

RESULTS

The mean cloacal temperature for 221 captures of *H. frenatus* was 27.2° ± 3.19°C with a range from 19.0 to 34.3°C. The lowest cloacal temperature was obtained from a 42.0 mm female. The air temperature and substrate temperature at the site of capture were 16.2 and 18.0°C, respectively. The highest cloacal temperature was from a 56.0 mm male. Air temperature and substrate temperature were 31.6 and 32.4°C. Geckos were active at the temperature extremes encountered during the 3-month study period and it is felt that work done throughout the year would greatly extend the activity range.

Air, substrate and cloacal temperatures were recorded concurrently for 138 captures. Average cloacal temperature was significantly higher than either average air or substrate temperatures (Table 1).

The degree of correlation between cloacal temperature and environmental temperatures can be seen in Figs. 1 and 2. In both cases the correlation coefficient is very high and the probability of correlation highly significant. In nearly every case the cloacal temperature is higher than either the substrate or the air temperature. Cloacal temperature varied as much as 4°C above air and substrate temperatures while varying only 1.2° and 0.8°C below air and substrate temperatures, respectively.

A visual comparison of the scatter diagrams and correlation coefficients seems to show a higher degree of correlation between cloacal temperature and substrate temperature. A test of homogeneity for the two correlation coefficients was nonsignificant and statistically the hypothesis that the r values differ must be rejected.

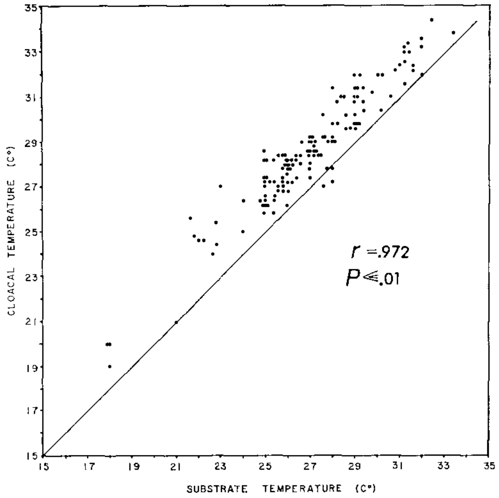

FIG. 2.—Scatter diagram of cloacal temperatures and air temperatures of *Hemidactylus frenatus* from Ciudad Valles, Mexico, March–May 1969. Line is isothermal axis; r = product moment correlation coefficient; P = probability correlation is not zero.

DISCUSSION

Hemidactylus frenatus are highly thigmotactic having at least the ventral surface of their bodies tightly pressed to the substrate and animals often wedge themselves in the juncture of wall and ceiling, thereby applying more body surface to the substrate. This behavior indicates that conduction from the substrate probably plays a greater part in maintaining cloacal temperatures than air temperatures. The higher correlation coefficient for cloacal-substrate temperatures as opposed to cloacal-air temperatures seems to bear out this hypothesis. The fact that the difference between the correlation coefficients was not statistically significant may be due to the difficulty in accurate measurement of substrate temperatures, because only a portion of the bulb of a thermometer is in contact with the substrate while the majority is in contact with air. Thus, the resultant temperature should be heavily biased in favor of air temperature. This bias might be expected to obscure a higher correlation between cloacal and substrate temperatures and the fact that a higher correlation persists is perhaps indicative of the importance of the substrate in regulating body temperatures in *H. frenatus*. The pronounced thigmotactic behavior described above, and the difficulty of accurate substrate temperature measurements indicate the nonsignificant statistical difference between correlation coefficients may be biologically significant.

The geckos may also control their body temperatures by utilizing warmer areas in the habitat for their nocturnal activity. Animals are commonly seen high on the walls or on ceilings. They also seem to prefer areas with little air movement such as stairwells and corners. These sites are presumably warmer than lower and more exposed areas. Movements into and out of these areas with higher environmental temperatures would aid the animals in maintaining higher body temperatures.

Literature dealing with temperature relations in nocturnal gekkonid lizards is limited. Work has been done using thermal gradients (Licht et al., 1966*a*) with geckos demonstrating lower preferred temperatures than most of the diurnal species studied. The heat resistance of geckos has been investigated (Licht et al., 1966*b*) and some species have shown remarkable resistance while others have much less resistance to heat than diurnal lizards. The sparse field data are restricted to a few reports of cloacal temperatures of geckos in their diurnal retreats and some temperatures of active individuals. Licht et al. (1966*a*) reported that the body temperatures of geckos collected in their diurnal retreats were often as high as those of diurnal, non-gekkonid lizards. Brattstrom (1965) reported a mean of 19.4°C for 17 active *Coleonyx variegatus* while Parker and Pianka (1974) showed a mean of 28.4° ± 3.4°C for 35 individuals of the same species. Stebbins (1961) recorded a mean temperature of 26.2°C for 13 active *Chondrodactylus angulifer*. The investigations above have been done on gecko species from arid regions with relatively cool nights, but the low means and high variability reported are similar to *H. frenatus*.

Soule (1963) summarized temperature data for seven groups of diurnal lizards. Means ranged from 31.3°C in *Anolis* to 40.7° for *Cnemidophorus* while standard deviations varied from 0.32°C in the *Callisaurus-Uma-Holbrookia* complex to 1.92°C in *Anolis*. *Hemidactylus frenatus* has a lower mean temperature than these lizards and the lower limits of the ranges of all seven groups does not even include the mean of *H. frenatus*. *Hemidactylus frenatus* also has a much greater range (15.3°C) and standard deviation (3.19°C) than all seven groups. The differences in variability are even more striking when it is realized that data for a single species are being compared to data from five genera.

Rubial and Philibosian (1970) accumulated data on *Anolis oculatus* that are comparable to those for *H. frenatus*. This anole has a broad activity range (10°C) and a great deal of variation around the mean (standard deviation 2.64°C). This broad range of body temperatures is shown to be related to a broad ecological niche. Temperature data for animals within a specific habitat had narrower ranges and less variation around the mean. Although *H. frenatus* has a broader range and more variation around the mean the parallels are apparent. In *A. occulatus* a number of populations occur in differing structural and climatic niches. In *H. frenatus* a single population exists in a single structural niche with a broadly variable climatic niche. In either case the result is a lizard species which does not demonstrate a preferred temperature but has broad temperature range within which it can be active.

The discussion above and the present study allows some speculations and generalizations concerning nocturnal gecko thermal relations and the thermal ecology of *H. frenatus*. The thermoregulatory behavior of *H. frenatus* appears to be composed of two different strategies; one which is operative while the animals are in their diurnal retreats, and a second which functions during the animals nocturnal activity period. No data are available for *H. frenatus* in diurnal retreats, but educated guesses can be made using results obtained by Bustard (1967) for *Gehyra variegata* and Licht et al. (1966*a*) for four species of Australian geckos. These animals were found to utilize behavioral thermoregulation during the daylight hours to raise their body temperatures to levels as high or higher than diurnal non-gekkonids. It is felt that *H. frenatus* operates in a similar manner. The result of such behavior would be a body temperature on emergence from diurnal retreats that is higher than most nocturnal environmental temperatures available to the animals. The geckos could then employ their second thermoregulatory strategy; that of conserving the heat gained during the day to support nocturnal activity. The means utilized are the previously discussed thigmotactic behavior and selection of warmer areas in the environment.

The limited thermoregulatory choices available to active nocturnal geckos results in temperature data such as those described in this paper. Nocturnal geckos demonstrate low mean activity temperatures, a wide activity range and a great deal of variation around the mean. The term "preferred temperature" is probably not applicable when discussing the thermal ecology of these eurythermic animals.

Literature Cited

Bogert, C. M. 1949. Thermoregulation in reptiles: a factor in evolution. Evolution 3:195–211.

Brattstrom, B. H. 1965. Body temperatures of reptiles. Am. Midl. Nat. 73:376–422.

Bustard, R. 1967. Activity cycle and thermoregulation in the Australian gecko *Gehyra variegata*. Copeia 1967:753–758.

Cowles, R. E., and C. M. Bogert. 1944. A preliminary study of the thermal requirements of desert reptiles. Bull. Am. Mus. Nat. Hist. 83:265–295.

Fitch, H. S. 1956. Temperature responses in free-living amphibians and reptiles of northeastern Kansas. Univ. Kansas Publ. Mus. Nat. Hist. 8:417–576.

Fry, F. E. 1967. Responses of vertebrate poikilotherms to temperature, p. 375–459. *In*: A. H. Rose [ed.] Thermobiology. Academic Press, New York.

Hertz, P. E. 1974. Thermal passivity of a tropical forest lizard, *Anolis polylepis*. J. Herpetol. 8:323–327.

Licht, P., W. R. Dawson, V. H. Shoemaker, and A. R. Main. 1966*a*. Observations on thermal relations of western Australian lizards. Copeia 1966:97–110.

———. 1966*b*. Heat resistance of some Australian lizards. Copeia 1966:162–169.

Mayhew, W. W. 1963. Temperature preference in *Sceloporus orcutti*. Herpetologica 18:217–233.

Parker, W. S., and E. R. Pianka. 1974. Further ecological observations on the western banded gecko, *Coleonyx variegatus*. Copeia 1974:528–531.

Rand, A. S., and S. S. Humphrey. 1968. Inter specific competition in the tropical rain forest: ecological distribution among lizards at Belem, Paraguay. Proc. U.S. Natl. Mus. (3658):1–17.

Ruibal, R. 1961. Thermal relations of five species of tropical lizards. Evolution 15:98–111.

———, and R. Philobosian. 1970. Eurythermy and niche expansion in lizards. Copeia 1970: 645–653.

Schmidt-Nielsen, K., and W. R. Dawson. 1964. Terrestrial animals in dry heat: desert reptiles, p. 465–492. *In*: D. B. Dill, E. F. Adolph, and C. C. Wilber [eds.] Handbook of physiology, sec. 4. Am. Physiol. Soc., Washington, D.C.

Schoener, T. W. 1968. The Anolis lizards of Bimini: resource partitioning in a complex fauna. Ecology 49:794–726.

Soule, M. 1963. Aspects of thermoregulation in nine species of lizards from Baja, California. Copeia 1963:107–115.

Stebbins, R. C. 1961. Body temperature studies in South African lizards. Koedoe 4:54–67.

Templeton, J. R. 1970. Reptiles, p. 1967–221. *In*: G. C. Whittow [ed.] Comparative physiology of thermoregulation, Vol. I. Academic Press, New York.

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