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OBSERVATIONS ON THE TEMPERATURE TOLERANCE OF LIZARDS IN THE CENTRAL NAMIB DESERT, SOUTH WEST AFRICA

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During February 1959, Professor R. C. Stebbins (of the University of California) assisted by the writer, did some determinations on the heat tolerance of lizards in the Kalahari National Park. The results of these investigations have been published by Stebbins (1961). In comparison with the coastal Namib, the Kalahari is a relatively mild and inactive desert, supporting a considerable amount of vegetation, although characterised by an absence of surface water. In view of the more severe conditions prevailing in the Namib desert, it seemed that some determinations on the heat tolerance of lizards from this region would be of interest. The Namib desert proper is a strip of moving sand, fringing the Atlantic coast of South West Africa and varying in width from a few miles in the north to about 100 in the south. The wide sand area terminates abruptly at the Kuiseb

River (at about the latitude of Walvis Bay) and on its north bank the dunes give way to extensive gravel plains, stretching inland from the narrow coastal sand strip. Rainfall over the whole area is low, seldom more than 5 inches per annum, although the development of nightly fogs, rising from the cold Benguella current, results in considerable precipitation of dew. Although the periodic rainfall allows the rapid growth of annual plants, larger vegetation is mostly restricted to the water courses, which make their way westward from the interior to the coast.

Perhaps the most characteristic elements of the reptile fauna of the Namib desert are the nocturnal and diurnal geckos, together with sand lizards of the family Lacertidae. Many of these show a preference for the sandy areas although a variety of species make use of the gravel plains as well. The sand lizards are exclusively diurnal and can be seen in the open during the hottest hours of the day. At such times the sand surface is clearly too hot for any lizard to remain upon and although the reptiles traverse it, they are completely dependent on the shade provided by vegetation or on the cooler depths of the subsurface sand. In view of the fact that it would be fatal for a lizard to remain exposed to full sun, even for a short while, on a normal day, it is interesting to know what temperature can be tolerated by the various lizards before the first signs of heat shock are exhibited. It was also planned to compare the heat tolerance of the robust-looking sand lizards and day geckos, with that of the nocturnal geckos which are so delicate in appearance.

In assessing the temperature which can be tolerated by a lizard, the most useful determination appears to be the Critical Maximum (Cowles and Bogert, 1944; Bogert, 1959).

This is the body temperature at which the first sign of heat shock or rigor is exhibited, usually taking the form of a loss of co-ordination between the limbs, impaired locomotion, followed by paralysis spreading inward from the extremities. Should the lizard be maintained at its Critical Maximum temperature for even a brief period, death will ensue. In all the determinations recorded below however, the lizards were cooled rapidly immediately the first signs of heat shock became apparent and all recovered completely.

Experimental procedure was briefly as follows: in each case the test was done on a recently caught individual and using a fast-registering rectal thermometer the lizard's body temperature was measured at the start of the test. Its temperature was then slowly raised, over a period of 10 to 15 minutes, until the Critical Maximum was reached. This can be done by tethering the lizard on the sand in full sun, but in the present instance cloudy and windy weather made this impracticable and an artificial heat source was employed. As each lizard was being warmed up, its body temperature was measured at the first signs of panting and again at the onset of loss of limb co-ordination. The animal was then rapidly cooled by being placed in the wind and sprinkled with cold water; in each case its activity was normal again within about 60 seconds. The tests were done on 3 species of nocturnal gecko (*Ptenopus garrulus*, *Ptenopus carpi* and *Palmatogecko rangei*); one species of diurnal gecko (*Rhoptropus afer*) and 3 species of diurnal lacertid (*Aporosaura anchietae*, *Meroles suborbitalis* and *Meroles cuneirostris*). Results are tabulated below:

Species	*Starting Temp.*	*Panting Starts*			*Critical Maximum*		
	Deg. C.	Deg. C.	Deg. F	Mean	Deg. C	Deg. F	Mean
Ptenopus garrulus	36.5	38.5	101.3		44.1	111.4	
	33.0	39.7	103.5		45.5	113.9	
	33.2	38.6	101.5	37.4	44.2	111.6	44.2
	18.5	37.2	99.0	99.4	43.6	110.5	111.6
	19.0	35.0	95.0		44.0	111.2	
	26.0	35.5	95.8		43.8	110.8	
Ptenopus carpi	31.3	33.5	92.3		42.7	108.9	
	30.5	33.9	93.0		42.4	108.3	
	29.5	38.2	100.8	34.8	43.5	110.3	42.7
	28.5	37.0	98.6	94.6	42.5	108.5	108.8
	28.6	31.0	87.8		43.0	109.4	
	29.5	35.0	95.0		42.0	107.6	
Palmatogecko rangei	30.9	32.0	89.6		43.0	109.4	
	32.8	37.7	99.9	36.2	43.5	110.3	43.5
	34.8	37.7	99.9	97.2	43.8	110.8	110.3
	35.2	37.5	99.5		43.6	110.5	
Rhoptropus afer	23.9	42.5	108.5		43.8	110.8	
	34.4	41.4	106.5	42.0	43.5	110.3	43.9
	35.0	42.0	107.6	107.6	43.9	111.0	111.0
	28.2	42.2	108.0		44.4	111.9	
Aporosaura anchietae	34.2	42.9	109.2		44.5	112.1	
	30.8	42.6	108.7	42.2	46.0	114.8	45.1
	31.4	41.0	105.8	107.9	44.7	112.5	113.1
Meroles suborbitalis	36.0	41.1	106.0		43.8	110.8	
	35.0	40.8	105.4	40.8	44.1	111.4	44.0
	33.5	40.6	105.1	105.5	44.0	111.2	111.1
Meroles cuneirostris	34.2	39.5	103.1		45.2	113.4	
	29.5	41.2	106.2		44.7	112.5	
	35.5	41.3	106.3	40.7	45.5	113.9	45.4
	35.0	39.5	103.1	105.3	46.3	115.3	113.8
	33.4	41.6	106.9		45.7	114.3	
	34.0	41.1	106.0		45.2	113.4	

It will be seen that panting occured in all the individuals tested; it is of interest however that this started at a very much lower temperature in the nocturnal geckos than it did in the diurnal lizards. Nevertheless, the Critical Maximum figures (giving an indication of the highest temperature tolerance) do not show an equivalent difference and it would appear that the delicate-looking night-geckos can stand approximately as much heat as can the diurnal lizards. This is in spite of the fact that (in May 1959) the day lizards were found to operate at body temperatures often 30 deg. F. higher than those of the night-geckos. Activity body-temperaures were measured on 52 individuals belonging to 4 species and details are set out below:

Species	*No. of specimens*	*Range of Body temperatures*	*Means*
Ptenopus garrulus	6	11.6 — 20.0 deg. C. 52.9 — 68.0 deg. F.	15.2 deg. C. 59.1 deg. F.
Ptenopus carpi	16	10.2 — 19.0 deg. C. 50.0 — 66.2 deg. F.	16.5 deg. C. 61.7 deg. F.
Rhoptropus afer	12	28.5 — 36.5 deg. C. 83.3 — 97.7 deg. F.	32.7 deg. C. 90.5 deg. F.
Meroles cuneirostris	18	24.2 — 39.1 deg. C. 75.2 — 102.2 deg. F.	35.0 deg. C. 95.0 deg. F.

These body temperature measurements were made rectally with a Schultheis quick-registering thermometer on lizards immediately after capture. Nocturnal geckos (*Ptenopus*) were picked up while they were found walking on the surface at night. Body temperatures of 10 and 11 deg. C. were most surprising as these are far lower than would be expected for gecko activity; they were observed on a cold May evening at Gobabeb with a bitter wind blowing off the sea. Although sluggish, the geckos had emerged from their burrows and were traversing the surface of the plain. Perhaps the scarcity of food had forced them out, but whatever the reason it seems clear that *Ptenopus* is capable of activity at temperatures lower than are normal for lizards generally. The temperatures measured on the day geckos and sand lizards were all taken immediately after the lizards had been shot with an elastic rubber band (see Brain, 1959).

In the course of the Critical Maximum tests it was repeatedly noticed that, among geckos particularly, liplicking invariably preceded panting. In many instances, the spectacle of the eye was also licked. This moistening of the head surface is doubtless aimed at cooling by evaporation and would pershaps result

in less liquid loss than is the case with panting. As the body temperatures continued to rise however, the lizards had no option but to pant.

Two other stereotyped responses to excessive heat were also shown by all individuals; in every case the lizards would attempt to burrow below the sand surface, but as the sand was being heated rather faster than was the air, they soon reappeared. In this respect, test conditions were unnatural and in normal circumstances, burrowing would certainly be an appropriate response to overheating on the surface. The other response was straightening of the legs so as to raise the body and tail high above the ground.

On being warmed up, the shovel-snouted lizards, *Aporosaura anchietae,* assumed an unexpected attitude. They would "dish" their bodies so that head, tail and limbs were raised well above the sand and the body was resting on a very small area of its ventral surface. This position was repeatedly taken up between spells of hurried digging.

In conclusion, the indications from this preliminary investigation are that both day- and night-lizards have an approximately equal temperature tolerance of 107—114 deg. F. Nocturnal geckos, however, attempt to reduce their body temperatures by panting well before this mechanism is resorted to by their diurnal counterparts. Stereotyped response to excessive heat on the ground surface consists of burrowing into the sand, or standing with the legs straightened so that the body and tail are well above the surface.

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REFERENCES:

Bogert, C. M., 1959. How reptiles regulate their body temperature. Scientific Amer., *200,* no. 4, 105—120.

Cowles, R. B. and Bogert, C. M., 1944. A preliminary study of the thermal requirements of desert reptiles. Bull. Amer. Mus. Nat. Hist., *83,* no. 5, 261—296.

Brain, C. K., 1959. On collecting lizards by means of a rubber band. Bull. Tvl. Mus. no. 3, 8.

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