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A 27MHz TELEMETER FOR THE FIELD MEASUREMENT OF TEMPERATURE FROM A DUNE LIZARD, *Angolosaurus skoogi*.

M.J.M Nijland[1], D. Mitchell[1] and M.K. Seely[2]
[1]Department of Physiology, University of the Witwatersrand Medical School, Johannesburg 2001, South Africa.
[2]Desert Ecological Research Unit, P.O. Box 1592, Swakopmund 9000, South West Africa/Namibia.

Desert lizards are among the most conspicuous of desert fauna because of their great number and diurnal habits. Being exothermic they utilise external heat sources such as solar radiation to realise a high body temperature. Exposure to the intense solar radiation of a desert environment poses the threat of overheating, making the study of the thermal biology of these animals of particular interest.

To this end attempts have been made to implant temperature telemeters within the body cavity of the dune lizard *Angolosaurus skoogi* (Andersson) for the measurement of body temperature from free-ranging individuals. Poor wound healing as a consequence of the low metabolic rate of these animals interfered with their activities and prevented successful measurement of body temperature. In many cases lack of wound healing was such that sand entered the wound during burrowing and threatened animal survival. To solve this problem a temperature telemeter has been designed that is carried by the animals much like a back-pack. A similar design has been employed by Muth *et al.* (1978), although for tracking rather than the measurement of body temperature.

The telemeter circuit is based on that of Mini-Mitter Inc. (USA) and is shown as both a wiring diagram and component layout in Figure 1a. Modifications to the original specifications include the use of a 2N3904 transistor (T), replacement of the reed switch with a 1.8pF capacitance (C4) and reforming the coil (L) to 20 turns on a 4mm coil former. The thermistor (Th) forms the tip of a 100mm probe made of 0.2mm gauge flexible wire. The last

20mm of the probe was covered with 3mm heat-shrink tubing and an epoxy glue (Pratley) to seal it against fluid leakage and give it rigidity.

Investigations of the power supply requirements of the circuitry showed that the transmitter requires a minimum voltage of 1.8 volts for reliable temperature transmission. The battery most suited to the design specifications was found to be the 3 volt Duracell DL2430, which is both flat and light weight. The only drawback of this choice is that the battery capacity is only 185 mAh, although seven days of recordings were obtained from the lizards and the transmitters continued to function at room temperature (±22°C) for a further 35 days.

Each transmitter was constructed on a cast of a male *Angolosaurus* so that it could be contoured to the body shape of the animals as closely as possible. Careful contouring during construction minimises the amount of drag the telemeter creates while the lizard sand dives. The completed transmitters, excluding the batteries, were double coated with coating wax (Mini-Mitter) ready for on-site battery attachment. The batteries were coated with the same wax when attached to the transmitters to prevent battery failure while the animals are below the sand surface. The completed telemeter with power supply weights 10.5g and measures 55mm (l) x 20mm (w) x 7mm (h). A transmitter of these dimensions is easily carried by adult male *Angolosaurus* which range in size from 80 to 120g. Line of sight transmission distance with the telemeter on the surface and buried at a depth of approximately 50cm was 90m and 55m respectively. These distances were measured as the point from the telemeter at which the signal could still be counted, although the audible range was some 50m further. These distances were well above the 30 meters required for this particular study. Further increases in range can be obtained by tapping the coil (L) 4 turns from negative side and attaching a trailing piece of piano wire.

The receiver used was a modified, 6 channel, Realistic Citizen Band Transceiver (Mini-Mitter Inc., USA). Transmitted pulse tone was adjusted for clarity using a beat frequency oscil-

lator installed by the distributors.

Calibration of the telemeters was carried out in the field using the time taken for 30 pulses to calculate the pulse rate (pulses per second - pps). Three measurements were taken at each calibration temperature; the drift in temperature and pps for each calibration point remained within 0.2°C and 0.5pps respectively. Each transmitter was calibrated by hanging the thermistor probe in a flask of heated water. The temperature within the flask at the level of the probe was measured using a calibrated T-type thermocouple and Bailey Instruments BAT-12 digital thermometer. The calibration curves proved accurate over the range 25°C to 45°C and in the example given in Figure 1b, the best fit curve $Y_{est}=179.89 \times X^{-0.701}$ has a standard error of the estimate (SEY_{est}) of 7.587×10^{-3} and coefficient of determination (R^2) of 0.998. Temperatures as low as 5°C were recorded with the transmitters while the upper limit was found to be 57°C, at which point a pure tone is transmitted. For ease of use in experiments where the telemetry pulses are counted manually, however, the maximum expected temperature should not exceed 50°C, as at this temperature the pulse rate is in the order of 5 pulses per second.

Angolosuarus skoogi is the largest Namib Desert dune lizard inhabiting the northern Namib Desert of southern Angola and Namibia. The study area on the Unjab River of the northern Namib (20°09' S, 13°14' E) was the same as described by Pietruszka *et al.* (1986). The inhabited concentric slipfaces form ideal study sites as the animals remained with a localised area. This factor enhanced the recordings from the telemeters as ground antennae could be deployed vertically on the slipface of the study dune. A further benefit of this recording method was that the approximate horizontal location of the various individuals could be determined from an otherwise directionless system. Such a technique would prove useful for studies on any animals that have a localised range.

Telemeters were attached to the lizards using elastoplast

tape and positioned on the dorsal surface slightly anterior to the back legs. The temperature probe was placed in the cloaca and taped to the tail to prevent it from moving. The cloacal temperatures recorded from a single lizard on the 19th January 1987 are shown in Figure 2a for the period 09h00 to 24h00. Temperatures were recorded hourly from 17h00 to 10h00 and half hourly from 10h00 to 17h00, except when an individual was active on the sand surface during which time measurements were made every two minutes (Figure 2b). These figures clearly indicate that while gross daily temperature trends can be obtained using the transmitters, detailed measurements during periods of activity can also be derived for the investigation of thermoregulatory strategies during exposure to a heat load.

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FIGURE 1. (A) Circuit and component diagrams of the 27MHz temperature telemeter. **B** 3 V battery (Duracell); **T** 2N3904 switching transistor; **R** 1 kΩ resistance (5%); **C1** 1.5 μF; **C2** 0.1 nF; **C3** 40 pF; **L** 20 turn (4mm) inductance; **Th** 1 MΩ (21°C) thermistor (Radio Spares). (B) Calibration curve for channel #3. Temperature (°C) is plotted against Time for 30 telemetry pulses (secs). Regression analysis reveals a best fit power curve $Y_{est}=179.89 \times X^{-0.701}$ (SEY_{est} 7.587×10^{-3}; R^2 0.998).

FIGURE 2. (A) Cloacal temperature of lizard #3 on 19-01-87 over the period 09h00 to 24h00. (B) Detailed recording of cloacal temperature from lizard #3 during a period of surface activity between 14h00 and 15h00. Measurements were made at 2 minute intervals and are the average of 3 readings.

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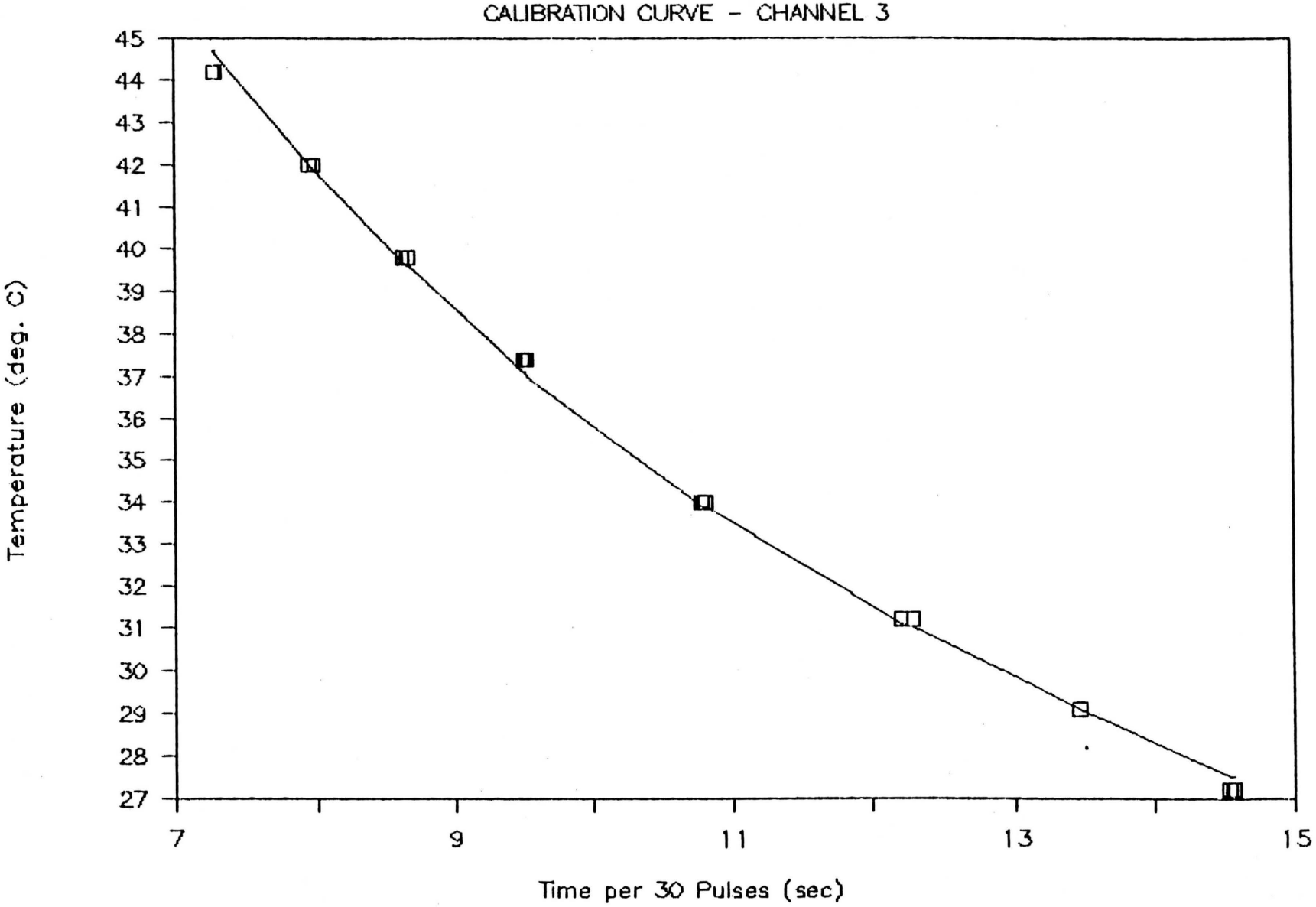

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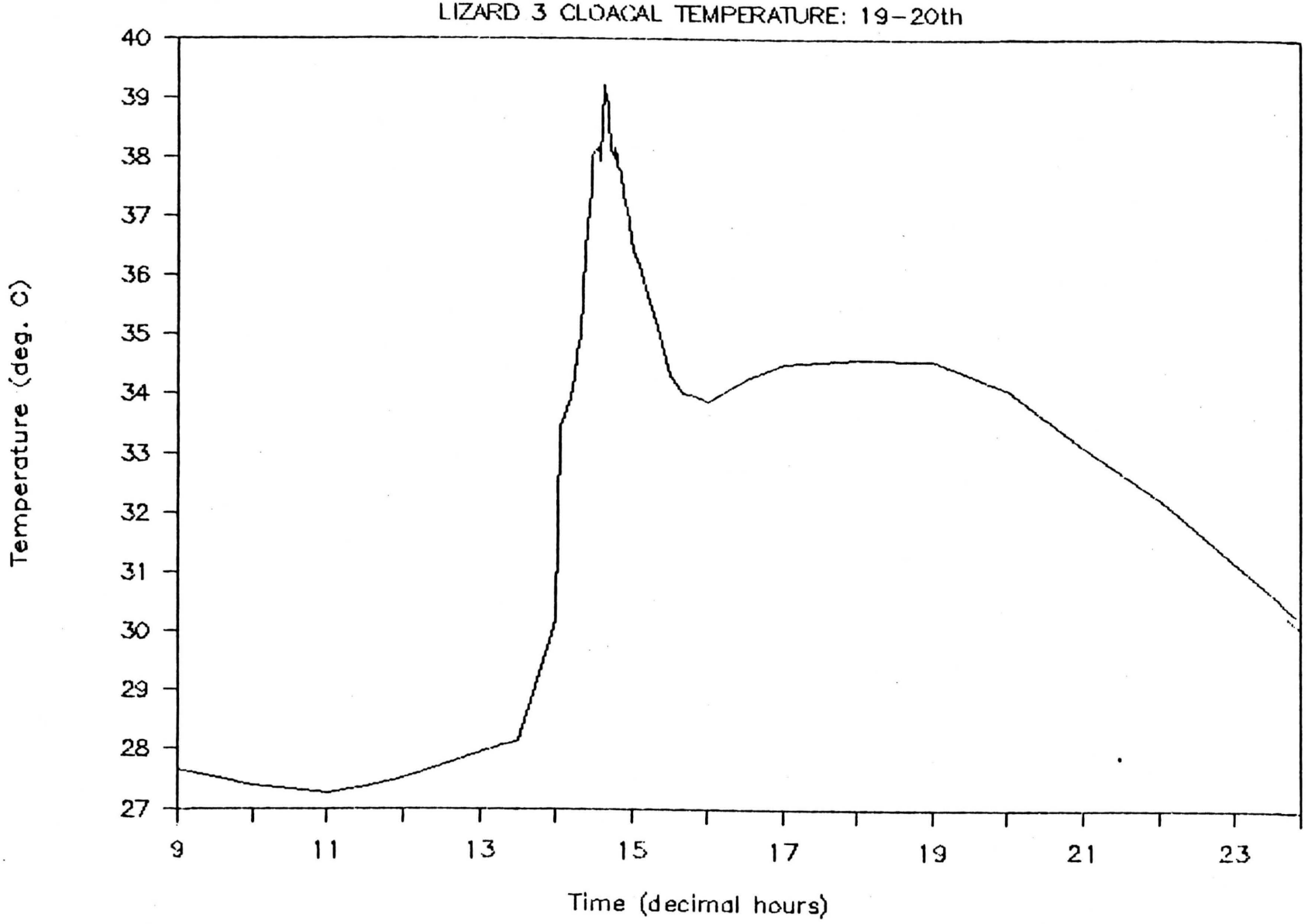

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