The radiocarbon date is 940±70 (UCLA: 1640B) calibrated to 1050 AD, in agreement with previous considerations.

On balance, the calibrated radiocarbon dates agree well with lowland Maya Middle Preclassic and Terminal Late Classic estimates. The latter are consistent with an 11.16.0.0.0 correlation of Maya and Christian calendars. Two dates, one from the earlier late Classic Period, the other from what would appear to be the equivalents of a Tepeu 1 or 2 context, are a little more difficult to reconcile with the 11.16.0.0.0 correlation, suggesting, instead a 12.9.0.0.0 correlation. The latter of these two dates does harmonise with Tepeu 1, as dated in the 11.16.0.0.0 correlation, however, while the statistical error of the former still allows for the same interpretation.

Unfortunately, the Early Classic Period (Tzakol ceramic sphere) is very poorly represented at Seibal and no samples from such a context could be obtained. The Late Preclassic (Chicanel ceramic sphere) is, on the other hand, well represented by structures and pottery at the site although we were unable to find appropriate materials for radiocarbon dating.

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Fever in the lizard *Dipsosaurus dorsalis*

FEVER is considered to be a universal response of warm-blooded animals to endotoxins[1]. Although during a fever a mammal uses behavioural as well as physiological means to increase its body temperature[2], it is not known whether fever develops in an animal such as a lizard which regulates its body temperature largely by behaviour. For example, the desert iguana (*Dipsosaurus dorsalis*) regulates its body temperature close to 38.5° C if placed in a chamber with a temperature gradient[3]. If this lizard is placed in a temperature chamber in which one end is heated to above the animal's lethal body temperature (50° C) and the other end is maintained at room temperature, the lizard regulates its temperature by moving back and forth between the two sides[4]. Under these conditions, one can determine its high and low set-points (Fig. 1). The central nervous control of temperature in an ectotherm, such as a lizard, and an endotherm, such as the rabbit, appears to be quite similar. For example, both possess a hypothalamus which is thermally sensitive[5,6], and lesions in the posterior hypothalamus in both lizards[4] and mammals[7] lead to an inability to maintain a high body temperature.

Because of the similarities in the central nervous control of thermoregulation in reptiles and mammals, and because fever in mammals is accompanied by major behavioural adjustments, we suspected that fever could be produced in a reptile. We now report that bacteria that produce fever in a rabbit will produce a similar fever in the lizard *Dipsosaurus dorsalis*.

Lizards weighing 25–60 g (Hermosa Reptile Farm, Hermosa, California) were housed in circular cages and fed meal worms, lettuce and water *ad libitum*. The cages and experimental chambers were kept on a 12-h light and 12-h dark photoperiod. The chamber was heated by a 250 W heat lamp which was also on a 12:12 cycle.

Experiments were carried out in a temperature-controlled room. Each lizard was placed in a wooden box (30 cm × 140 cm × 30 cm) of which one end was at the room temperature of 30° C and the other end at 50° C. This high temperature was provided by heating coils taped to the undersurface of the floor of one end of the box. The two sides of the box were separated by a small wire mesh bridge to provide a clear boundary between the two temperature extremes. A copper–constantan thermocouple covered with polyethylene tubing (PE 100) was placed about 3 cm into each lizard's cloaca and taped to its tail; this did not noticeably impair the movement of the lizards. Thermocouples were connected to a Honeywell Electronik 112 multipoint recorder which recorded the temperature of each lizard (±0.1° C) every 30 s.

Aeromonas hydrophila, Gram-negative bacteria pathogenic to reptiles and amphibians[8], were grown on blood agar and killed by washing in 70% ethyl alcohol. They were then centrifuged and resuspended in physiological saline. The concentration of bacteria was determined by a turbidity test.

Lizards were allowed 1 d to adapt to the wooden box, and on the second day control data were recorded. On the third day either 0.2 ml of a solution containing 2×10^{10} bacteria per ml of saline or 0.2 ml of sterile physiological saline alone was injected into the heart using a 1.5-inch 26-gauge needle. Blood

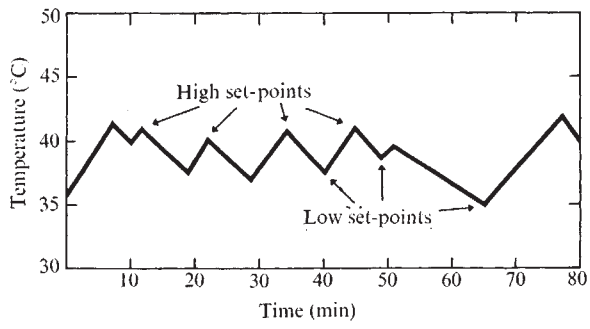

Fig. 1 Record of the cloacal temperature of *Dipsosaurus dorsalis* regulating its temperature in the wooden box in which the substrate at one end was maintained at 30° C and the other end at 50° C. At the high set-point, the lizard moved from the warm side of the chamber to the cool side. At the low set-point the lizard moved back to the warm side of the chamber. Data were recorded every 30 s. The high and low set-points, for any time period, represent the average of these points over that time period.

was redrawn into the syringe to ensure that the needle was in the heart. All injections were done at the same time of day to avoid possible effects of diurnal variations.

To determine whether increases in body temperature were due entirely to behavioural modifications, or whether an increased internal production of heat was part of the response, three lizards were given injections of bacteria identical to the above. They were then placed in a wooden chamber (14 cm × 30 cm × 30 cm) which was held at 30° C. Cloacal temperatures were measured as before.

Four New Zealand white rabbits (*Oryctolagus cuniculus*) were used to determine whether *A. hydrophila* could also produce fever in mammals. The rabbits' tails were shaved and a thermocouple was inserted 10 cm into the rectum and taped to the tail. The rabbits were placed in a restrainer and allowed 1 h to acclimatise to room temperature (22° C). Then 0.2 ml of saline was injected into the marginal ear vein. After 1 h (control period), 1 ml of 3×10^9 bacteria per ml saline was injected into the marginal vein of the other ear.

In 10 lizards, given free choice of either the 50° C or 30° C environment, injection of 4×10^9 bacteria produced little increase in temperature during the first few hours. Body temperature increased approximately 2° C between the fourth and sixth hours (Fig. 2). The increases of the average high (41.1° C to 42.7° C) and low (37.4° C to 39.7° C) set-points were highly statistically significant ($P < 0.001$ using paired sample analysis).

When the same concentration of bacteria was injected into three lizards maintained in a constant temperature chamber at 30° C, their temperatures did not change throughout the control and experimental periods. Injection of saline into nine lizards, given free choice of the warm or cool environment, produced no changes in high or low set-points (Fig. 2). Comparison of lizards injected with saline to those with *A. hydrophila* revealed a statistically significant increase in the high ($P < 0.02$) and low ($P < 0.003$) set-points during the second 3 h (Student's *t* test). Injection of saline into the four rabbits produced no increase in rectal temperature. Injection of the bacteria produced a fever with a latency of about 20 min and a mean maximum rise of 2.2° C within 3 h.

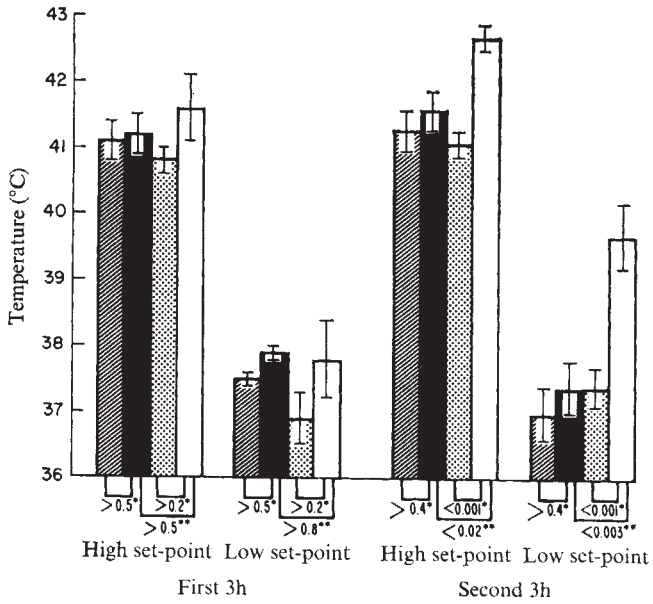

Fig. 2 Average high and low set-points (±s.e.m.) during control periods (day 2) and after intracardiac injection of 0.2 ml isotonic saline or 0.2 ml of 2×10^{10} *Aeromonas hydrophila* ml^{1-} (day 3) into *Dipsosaurus dorsalis*. *, Level of significance using paired sample analysis; †, level of significance using Student's *t* test. Hatched columns, control period before saline injections; solid columns, period after saline injections; stippled columns, control period before *Aeromonas* injections; open columns, period after *Aeromonas* injections.

These data indicate that a bacterium that causes fever in a rabbit has a similar effect in a lizard. Since the lizards could not increase their temperature in response to the bacteria when the ambient temperature was held constant, fever in these lizards cannot be developed by increased internal production of heat. The relatively long latency before the onset of fever in the lizards might be due to the lower metabolic rate of an ectotherm in comparison with that of an endotherm.

These results demonstrate that fever can be sustained by behavioural regulation in an ectotherm. Also, since the hypothalamic control over thermal responses in reptiles and mammals are similar[4–6] and as we have shown, a similar concentration of bacteria will produce a similar increase in temperature in both a reptile and a mammal, we suspect a common origin for reptilian and mammalian fever. If this is true, then the ability to develop a fever existed before the time when evolutionary lines for mammals and reptiles diverged. This suggests that at least the behavioural component of fever had evolved by the late Palaeozoic or early Mesozoic, or perhaps even earlier. We cannot rule out the possibility, however, that fever might have independently and perhaps recently evolved in reptiles and mammals.

These findings also open new possibilities for ascertaining the adaptive value of fever. The question of whether fever is beneficial or harmful to the host has been difficult to resolve in mammals. Since the increase in body temperature in response to bacterial infection might have evolved in primitive reptiles, or even in amphibians, the adaptive value of fever might be revealed by a careful study of the role of the febrile response in these classes of vertebrates.

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Dependence of juvenile hormone release from corpus allatum on intraglandular content

THE corpus allatum has been shown to be the source of chemically defined juvenile hormones in five different species of insect[1–5]. The release of juvenile hormone from active corpora allata is known to be a prerequisite for the rapid induction and promotion of vitellogenesis in adult female insects of several orders, including all tested members of the Orthoptera[6,7]. It is generally believed that temporal patterns of activity in the adult female corpus allatum are of prime importance in initiating and maintaining oocyte growth[6,8].

Up to now the activity of the corpus allatum has been inferred from indirect observations such as glandular activity