cells were added; in all other respects similar to the transformation tests, these controls were uniformly negative in all tests reported.

Sterile solutions of purified DNA preparations were examined for capacity to transform cells of *N. meningitidis* 15 *str-s*, a strain inhibited by less than 1 $\mu$g of *str* per milliliter which had been isolated from spinal fluid of a fatal non-epidemic case of meningitis. Representative results are compiled in Table 1 (experiments A and B). Meningococci were transformed to *str*-resistance by as little as $10^{-3}$ $\mu$g of DNA per milliliter of the preparation extracted from *N. sicca* 12 *str-r*, and the number of transformants was a function of the quantity of DNA employed. Transformation ratios for this meningococcus strain ranged from 17 to 26 times greater with corresponding concentrations of a DNA preparation from meningococcus (a strain resistant to both erythromycin and to *str*) than with one from *N. sicca* (compare with *8, 9*).

To investigate the transforming activity of *N. sicca* culture slime, carbomycin (*car, 16*) was used to eliminate the growth of viable slime-donor cells, without affecting the slime DNA or growth of the recipient cells (in this case, a mutant of *N. meningitidis* 15 resistant to 50 $\mu$g of *car* per milliliter). Recipient cells were exposed to the DNA-containing material in the usual antibiotic-free medium; thereafter, they were plated in agar containing 12.5 to 25 $\mu$g of *car* per milliliter, which did not interfere with the selective action of *str* added later. With this strain, also, preparations of purified DNA, which were examined for comparative purposes, elicited both intraspecific and interspecific transformations (Table 1, experiments C and D).

Transforming activity was exhibited by crude slimes removed from cultures ranging in age from 2 to 16 days. Viable cells numbering over $10^8$/ml were present in all slimes from *N. sicca* 12 *str-r* cultures in brain heart infusion broth sampled during the first 5 days of incubation. Indeed, the slime harvested at 44 hours (and tested for transforming activity, Table 1, experiment C) contained $1.3 \times 10^9$ colony-forming units per milliliter; the culture incubated for 16 days (Table 1, experiment D), on the other hand, was essentially sterile. An inverse correlation was observed between transforming activity and number of viable cells present in the culture slime. This would be anticipated if increased cellular lysis associated with aging of cultures released more DNA. In addition, intact *N. sicca* cells, which could undergo some metabolic activities but could not form colonies in the presence of *car*, appeared to exert an adverse effect on *str-r* transformation or on colony formation by meningococcus transformants. Thus, slimes obtained from cultures incubated for periods of 44 to 116 hours were more effective as transforming agents when diluted 1:100 immediately before use, than when used in final dilutions of 1:5 to 1:25. On the other hand, no increase of transformation ratio with dilution was observed with the sterile (16-day) culture slime. A dilution of 1:500 examined for one culture slime (not shown) resulted in fewer transformants than were obtained with the 1:250 dilution of the same slime, as would be expected from results with decreasing concentrations of purified DNA preparations.

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11. It will be of special interest if transformation of streptococci by DNA extracted from staphylococci (*10*), whose relation with streptococci is unclear, can be repeated by a quantitative method and with controls adequate to reveal possible selective effects of the DNA preparation or of DNA split products. When the character change examined in a transformation test occurs, also, by mutation at an ordinary frequency, it is possible that a selective increase of the proportion of mutant to parental type may occur in the transformation test broth during the hours of incubation *before* the cells are confined in agar. A test performed in the absence of DNA, or of DNA degraded with nuclease, does not provide an adequate control for a transformation test, for these environments are not the same.
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15. The plating medium, HIY-1 agar, was heart infusion broth with 0.3 percent Bacto yeast extract and agar (0.7 percent for "soft agar," or 1.4 percent for "hard agar," all Difco), further supplemented aseptically with 250 $\mu$g of sodium ribonucleate per milliliter, 0.00005*M* sodium glutamate, and 0.0005*M* $CaCl_2$.
16. Magnamycin, a gift of Chas. Pfizer & Co., Inc.

28 September 1959

## Effect of Acclimation on the Preferred Body Temperature of the Lizard, Sceloporus occidentalis

*Abstract.* The preferred body temperature was determined for several groups of *Sceloporus occidentalis* previously acclimated to several constant temperature levels. Acclimation to a high temperature (35°C) resulted in the selection of a lowered mean preferred body temperature, whereas acclimation to lower temperatures (12°C and 25°C) produced no change in the preferred body temperature.

In recent years considerable interest has been directed towards the controlling mechanism of thermoregulation in poikilotherms. Current interest in reptilian thermoregulation was initiated by Cowles (*1*), and the entire subject has been reviewed recently by Saint-Girons and Saint-Girons (*2*). Concerning the control of thermoregulation, Rodbard (*3*) described a temperature-sensitive area in the brain of the turtle, and some other aspects of control, especially behavioral, have been reviewed by Bogert (*4*). More recently, Stebbins and Eakin (*5*) have reported on the parietal eye of lizards as influencing over-all exposure to heat.

Of equal importance is the role of acclimation in modifying temperature tolerances and preferred body temperature of certain poikilotherms. Lowe and Vance (*6*) demonstrated a direct relationship between acclimation and the critical thermal maximum of lizards, and Dawson and Bartholomew (*7*) have shown a relationship between acclimation and oxygen consumption. Garside and Tait (*8*) have reported results of acclimation on preferred temperatures in fish. This paper is a discussion of experiments designed to ascertain the effects of acclimation on thermoregulatory behavior and the preferred body temperatures of lizards.

Fifty-three fence lizards, *Sceloporus occidentalis*, collected in Berkeley, California, were used in the experiments, which were conducted in two stages, the first during September and October of 1958, and the second during March and April of 1959. Fall and spring groups were treated equally, except that during the fall no controls were utilized. The spring group was divided between control and experimental animals of approximately equal size, weight, and

sex distribution. Each experimental group was treated in the following manner. The freshly collected animals were first kept for 5 days at room temperature (21° to 26°C) and supplied with a surplus of food and water. They were then placed in a constant temperature environment for 14 days. Each group of animals was acclimated to 35°, 25°, and 12°C, in that order. After 14 days at the constant temperature they were placed in separate runways within a photothermal gradient. After allowing 2 hours for the animals to become familiar with their surroundings, we recorded body temperatures at hourly intervals over an 8-hour period with a quick-recording Schultheis, 0° to 50°C thermometer inserted into the cloaca.

The photothermal gradient used was described by Stebbins and Eakin (*5*). The temperature range during the period of observation remained from about 25°C at the cool end to 55°C at the heated end. As pointed out previously (*5*), these temperatures were well above the upper and lower extremes of body temperatures recorded in these lizards during periods of activity in the wild. The animals were not fed while in the gradient, but water was supplied. The shelter provided by Stebbins and Eakin was removed.

In the fall (1958) experiments, animals were left in the runways for 24 hours at 20° to 25°C, then tested again when the gradient was established. We noted no difference in the group over the 24-hour "rest period." This indicated that the results probably were not attributable to a fatigue effect and that acclimation persists for at least this time interval. The spring (1959) groups were tested only once. After the desired body temperatures were secured, the animals were placed in cages and provided with food and water. They were kept at room temperature (21° to 26°C) for 7 days, then reintroduced into a constant temperature environment for acclimation to one of the other experimental temperatures.

Table 1. Influence of the previous thermal experience on mean preferred body temperature in *Sceloporus occidentalis*. Numbers after temperature are one standard error of the mean. C, control; E, experimental.

| Groups | No. of animals | No. of readings | Combined means (°C) |
|---|---|---|---|
| | *Previously acclimated to 12°C* | | |
| C | 14 | 112 | 33.8 ± 0.10 |
| E | 43 | 344 | 33.7 ± 0.43 |
| | *Previously acclimated to 25°C* | | |
| E | 25 | 220 | 33.2 ± 0.60 |
| | *Previously acclimated to 35°C* | | |
| C | 21 | 163 | 33.6 ± 0.27 |
| E | 52 | 382 | 30.1 ± 0.65 |

In the spring a control group was treated exactly as the experimentals, except that during the 14-day acclimation period they were maintained at room temperature (21° to 26°C). Controls and experimental animals were placed within the gradient, and marked so that they could be returned to the same runway each time. Body temperatures of animals buried in the sand substrate were recorded along with those on the surface.

The results of the experiments are given in Table 1. The data show a valid statistical difference ($P = < 0.01$) between the mean preferred body temperature of animals acclimated to 35°C (30.6° ± 0.48°C) and the controls (33.8° ± 0.10°C). However, there is no significant difference between the 12° group and the controls. The 25° group, run only in the fall, did not differ statistically from the 12° group in preferred body temperature, but the mean of this group does fall between the 12° and 35°C groups.

Neither the 12° nor the 35° group differed between fall and spring; thus we could compare data from spring controls with all data on experimentals.

Since there were no sexual differences in preferred body temperatures within any of the groups, none of the data are separated on the basis of sex. Comparisons of the means for buried animals and those on the surface revealed no difference. Therefore, body temperatures of animals buried in the runways are included in both control and experimental groups.

Garside and Tait (*8*) did not attempt to interpret their findings other than to mention that the inverse relationship between acclimation temperature and preferred temperature was an unexpected phenomenon, since most studies with fish have shown a direct relationship between preferred temperature and acclimation temperature.

All work to date has shown the ability of lizards to thermoregulate, and some species show marked stenothermism during periods of activity. This suggests that there is a narrow thermal optimal range for the physiological processes of such species. However, when lizards are exposed to temperatures at or near the mean of this so-called optimal range for an extended period, a deleterious effect occurs. Wilhoft (*9*) found thyroid hypertrophy and decreased viability in *S. occidentalis* kept at 35°C. Dawson and Bartholomew (*7*) reported that *Sceloporus* that were acclimated at a temperature near the "optimal" (33°C) consumed oxygen at a lower rate than those acclimated to lower temperatures when tested at several temperature levels (16°, 28°, and 33°C).

Lizards exposed to constant high temperatures are forced into metabolic excesses; thus, the thyroid hypertrophy observed by Wilhoft (*9*) might represent a response to the increased oxidative processes, whereas the decrease in oxygen consumption demonstrated by Dawson and Bartholomew (*7*) might be considered a homeostatic response, probably one of many which function to prevent the animal from physiologically "burning itself out." Our results indicate a behavioral thermoregulatory response that probably accompanies, and perhaps is responsible for, the reduced rate of oxygen consumption. The desirability of a combined thermoregulatory and metabolism study is evident.

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## Simple Telemetering System for Signaling High Rumen Pressures

*Abstract.* The construction of a modified Hartley oscillator transmitter activated through a pressure switch is described. When this device is placed within the rumen of a cow which is allowed unrestricted movement in the pasture, frequency-modulation signals are transmitted to a recording receiver whenever a preselected pressure is exceeded. The pressure at which transmission begins is determined by the capacitance across the coil of the circuit.

One of the difficulties encountered in studying bloat is the need for making intermittent or continuous visual observations of experimental animals. One or more individuals must watch the animals, and such observations are normally limited to daylight hours. Any method of recording intraruminal pressure which involves the use of tubes or wires connected to the animal limits its movement. Therefore it is desirable to have an instrument which will signal such pressures and yet allow unrestricted movement within the