differences between killers and mate-killers is suggested by a recent demonstration by Preer *et al.* (*8*) that showed that a small proportion of the kappa particles in killers contains one or more refractile areas. These kappas are called "brights," and they are the bearers of paramecin activity. Brights are found only in animals that can produce paramecin, never in those unable to produce this toxin. Bright particles have never been found among the mu particles of mate-killers (*8*). The increased metabolic activity of killers may be a direct consequence of the production of paramecin, and the site of this altered metabolic activity may rest in the bright kappa particles or in their influence on the metabolism of the whole cell.

In this connection, it would be of interest to examine the respiratory activity of paramecia carrying a third type of particle that is neither involved in a toxic effect nor produces paramecin. This particle, called *pi*, was first discovered by Hanson (*9*) in animals that had once been killers and are in all probability mutants of kappa particles. If the higher oxygen consumption of killer animals is indeed a consequence of paramecin production and is correlated with the presence of brights, paramecia containing pi should respire at the same rate as isogenic paramecia devoid of these particles.

### References and Notes


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# Thermistor Electronic Thermometer


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Electronics is receiving increasing attention and finding many applications in the tools of medical research. One of our problems in instrumentation led to a solution that should find application wherever research using small animals is in progress. A research worker in physiology needed to take a record of the rectal, subcutaneous, and skin-surface temperature of experimental groups of six mice each and to observe the variation in these several temperatures over a period of time.

The temperature-measuring units need (i) to remain *in situ*; (ii) to be able to be calibrated to give comparable readings; (iii) to be fairly quick reading; (iv) to be sensitive enough to measure to 1 percent; (v) to be small enough physically so that an animal as small as a mouse does not experience insuperable discomfort; (vi) to be well insulated, both electrically and against moisture, and to give reproducible results.

We tried both thermocouples and thermistors and settled for the latter as being best suited to our requirements, using the W. E. No. 14B thermistor in a bridge circuit. The voltage divider can be adjusted to give the same voltage across the bridge over the life of the battery. This voltage is checked by the same vacuum-tube voltmeter that serves as the temperature indicator by substituting a voltage divider in place of the thermistor bridge (Fig. 1).

The 19 thermistor bridges (one for measuring the ambient temperature plus six sets of three for the six animals being tested) are identical (Fig. 2), each with a balancing control for setting the minimum temperature reading (in our case, 0°C) and a maximum setting control (in our case, 50°C).

This gives a 2-point adjustment of comparability between bridges. We have found this degree of comparability satisfactory, since the several thermistors that we are using track within the limits of experimental error.

These 19 bridges and the voltage-check divider are connected to the switch points of a three-bank 20-position rotary switch, making it possible to select and measure any temperature by a turn of the dial.

It is necessary to match the sensitivity of the

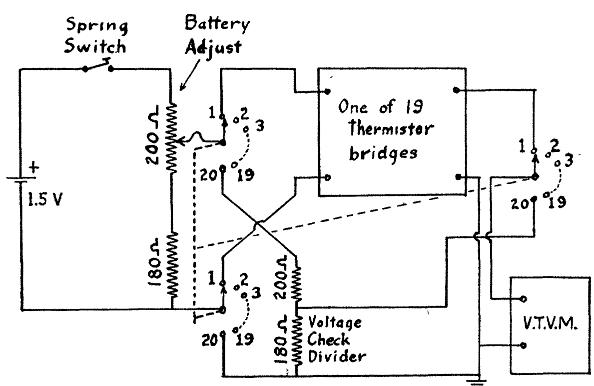


Fig. 1. Thermistor thermometer. Block diagram with supply and check-voltage source.

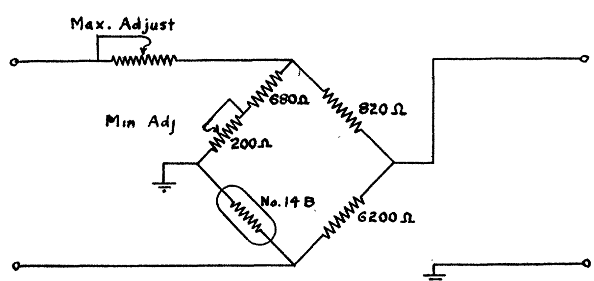


Fig. 2. Thermistor bridge. Nineteen bridges are required in the complete instrument.

V.T.V.M. to that of the thermistor bridge. The lowest temperature is set on the zero of the scale by balancing the bridge, but the highest temperature is set at the full scale reading by adjusting the sensitivity of the V.T.V.M. The maximum setting control of the bridge serves to make the several bridges compare, but serves only as a fine control in matching the bridge to the V.T.V.M.

*Calibration.* (i) With the 20-point switch in the voltage-check position but with the battery voltage not applied, adjust the balance control of the V.T.V.M. so that the meter reads zero. (ii) With the 20-point switch in the check position and with the battery voltage applied, adjust the battery-adjust control to provide a predetermined reading on the V.T.V.M. This adjustment is important as a means of assuring reproducibility with changes in the age of the battery. The particular reading of the V.T.V.M. is not important as long as it allows adjustment when the battery ages, and providing the maximum adjust on the thermistor bridge can actually adjust for the maximum temperature desired. (iii) With the thermistors in a bath at the lower temperature limit, switch each of the thermistor bridges into the circuit in turn and adjust the minimum control of that bridge so that the meter reads zero. The bridge is now balanced. This adjustment is not disturbed by changes in the maximum control. (iv) With the thermistors in a bath at the upper temperature limit, switch each of the thermistor bridges in turn into the circuit and adjust the maximum control of that bridge so that the meter reads full scale. The scale of this thermometer is not linear, and either a special scale on the meter must be provided or a conversion graph must be prepared between the temperature and the meter reading. The instrument should now be in adjustment and ready for use.

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## Prolongation of Molting Period in the Canary by Long Days

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The stimulating effect on avian gonads of lengthening daily light periods has been studied by many investigators, but little is known about its effect on molting periods. This paper describes the results of studies (*1*) of the effects of long days on the molting periods of the canary.

Beginning on 10 Sept. 1953, eight female canaries were subjected to 20-hr daily light periods. Artificial light was produced by a 100-w electric bulb, which was placed 1.5 m from the bird cages and was turned on from 4 A.M. until 12 P.M. every day. In addition, the birds received natural sunlight in daytime. Eight other female birds exposed to natural daily light periods served as controls. Four birds were kept in a cage. The structure of the cage used for the experiment has been described elsewhere (*2*).

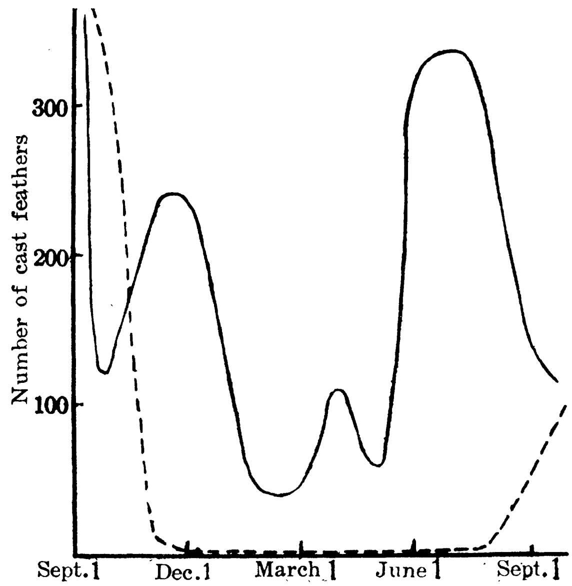


Fig. 1. Curves showing numbers of feathers cast off every 4 days by eight experimental canaries exposed to 20-hr daily light periods (solid line) and by eight control birds exposed to natural daily light periods (broken line).

All the birds were allowed to take water and food *ad libitum*. In order to examine the molting process of the birds, the feathers cast off on the floor of the cages were counted every 4 days, and at intervals the body and wing feathers that were being renewed were carefully observed in each bird.

The results of our experiment are summarized in Fig. 1. The molting of experimental birds was inhibited for about the first 20 days of the experiment. It has already been reported that the pituitary body and thyroid gland are concerned in the inhibition of molting following lengthening of the daily light periods (*3*). The molting became severe again toward December. During January and February 1954 the rate of refeathering was slowed. From March on, the loss of feathers was increased until the beginning of July; after this, a decrease again occurred. However, the birds continued to molt until 9 Nov., when the observation was stopped.

During the experimental period these birds were refractory to the stimulus of long days and did not show any sign of ovarian development. The cloacal region did not swell, and fat was not deposited subdermally. We had already observed that, in the canary, the cloacal region swells and the subdermal fat increases remarkably during the beginning of ovarian development (*4*). This refractoriness of the ovaries to long days observed in the experimental birds is in accordance with observations made by several investigators (*5*).

In control birds, the molting period was terminated