

Measurement System for Body Temperature during Transition Period of Hibernating Animal

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ABSTRACT

A measurement system for body temperature of a hibernating animal has been designed to detect a transition period of hibernation. A *Tamias sibiricus* was bred in a cage kept in a refrigerator at four degrees centigrade. The surface temperature of the squirrel was measured telemetrically every fifteen minutes with a radiation thermometer. The cage was designed to keep the animal hibernating in the same place after the periodic arousal. The measurement system in the present study is simple compared with the multi-channel thermography, but effective to detect the transition period of hibernation.

Keywords: Bio-measurement, Hibernation, Body temperature, Thermometer, Squirrel

1. INTRODUCTION

During a cardiovascular surgical operation, the heart is iced and its beating is stopped (Fig. 1). The suspended period causes harmful effects to the heart after re-circulation of the blood. Several kinds of preconditioning have been applied to protect myocardial function during the heart surgery [1]. Hibernation is a mysterious period, when every metabolic level is minimized: the body temperature, the heart rate, and the breathing rate [2].

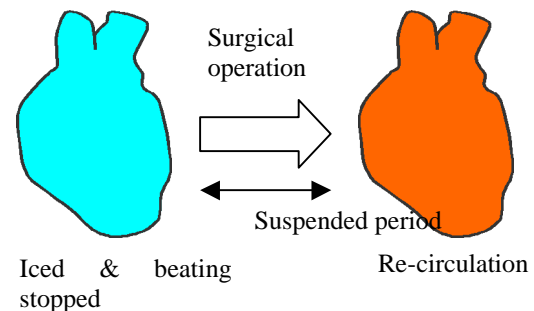


Fig. 1: Heart surgery.

For designing an animal surgical experiment on blood circulation during hibernation, it is necessary to detect whether the condition of the animal is stable [3].

Two periods, "bout" and "periodic arousal", repeat alternately during hibernation. Each period consists of a transition period and a stable period (Fig. 2).

Previous studies show that the body temperature changes between five and thirty-seven degrees centigrade during the transition period [2].

The temperature of the body surface has been measured continuously with a non-invasive method to distinguish hibernation from death and to detect the transition period of hibernation in the present study.

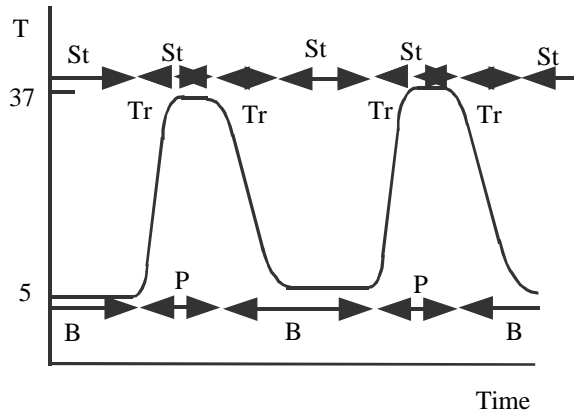


Fig. 2: Body temperature (T, centigrade) during hibernation: bout (B), periodic arousal (P), stable period (St), transition period (Tr).

2. METHODS

A *Tamias sibiricus* was bred in a cage kept in a refrigerator at four degrees centigrade (Fig. 3).

The surface temperature of the squirrel was measured telemetrically (sensor, Keyence, IT2-80; multifunction data acquisition, National Instruments, SUB-68, DAQPad -6020E) every fifteen minutes with a radiation thermometer (Figs. 4, 5).

The thermocouple of the radiation thermometer detects infrared radiation from an object (Fig. 6).

A cage was designed to keep an animal hibernating in the same place after periodic arousal (Fig. 7).

The space was sectioned into two parts: for sleeping and evacuating, respectively. These parts were connected with a narrow paths each other. The pile of woodchips was limited so that the back of the squirrel is exposed above the pile during sleep to be targeted for the measurement of temperature.



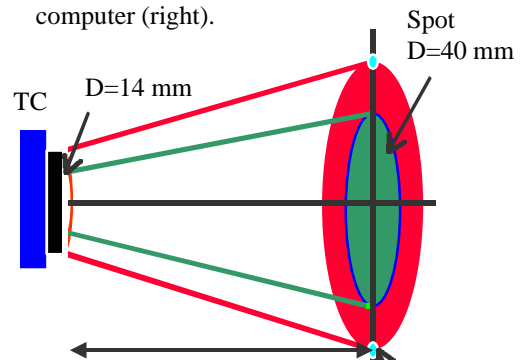
Fig. 3: Telemetric measurement of surface temperature of the squirrel in a refrigerator (right): recorder (left).



Fig. 4: Telemetric measurement of surface temperature of the squirrel with radiation thermometer (upper left): cage (right).



Fig. 5: Radiation thermometer sensor (left), multifunction data acquisition (middle), computer (right).



The spot of measurement was stable at the back of the squirrel during sleep. The tracings show that the surface temperature is around five degrees centigrade during bout (Fig. 8). The temperature fluctuates above ten degrees during periodic arousal, because the squirrel is moving around and the temperature of woodchips in the animal's bed is measured.

The tracings also show that the transition periods of periodic arousal and of bout are one hour and 4.5 hours, respectively, and that the stable period of periodic arousal continues for 16 hours.

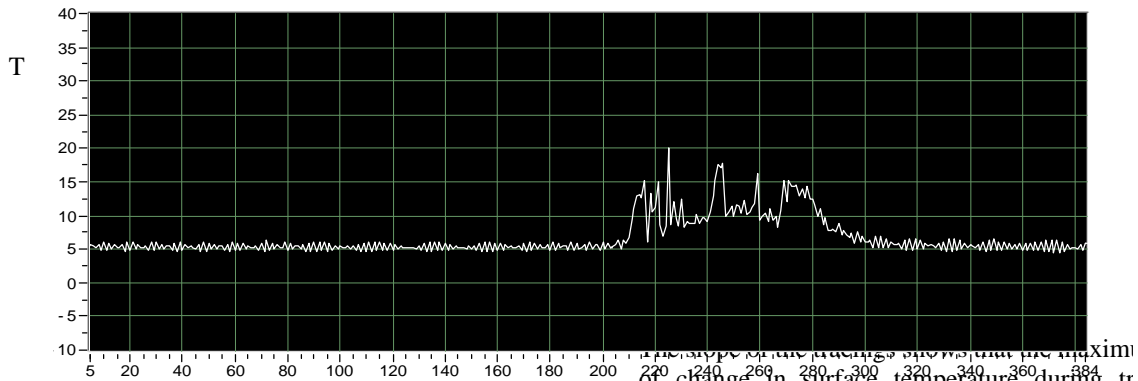


Fig. 8: Temperature (T, centigrade) tracings.

The slope of the tracings shows that the maximum rate of change in surface temperature during transition period of periodic arousal and of bout are 0.5 and 0.2 degrees per minute, respectively.



Fig. 7: Cage: space for sleeping (left) and evacuating (right).

The interval of fifteen-minutes was short enough to measure the rate of change in body temperature during hibernation.

4. DISCUSSION AND CONCLUSION

The design of cage is important, because a squirrel would kill itself kept in a narrow space. The place for urination should be separated from the bed to prevent death from cold.

There are several methods to detect body temperature: thermograph, recto-thermometer. The measurement system in the present study is simple compared with the multi-channel thermography, but effective to detect the transition period of hibernation. With this system, the animal experiment model would be designed to study about myocardial protection during the cardiovascular surgical operation,

3. RESULTS

5. ACKNOWLEDGMENT

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