Thermoregulation in the American Alligator (Alligator mississippiensis)

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Background

Many ectothermic animals can tolerate long periods of fasting while maintaining normal functions, in other words they are not estivating or hibernating but remain alert and active during these periods. For example, some species of pythons are known to fast for 18 months between meals. Between fasts many of these animals consume extremely large meals, more than 15% of their own mass. It is hard for us even to imagine consuming such a meal. A 150 lb human would need to eat at one sitting 225 lbs. of food! In contrast, endothermic animals eat small but frequent meals. The regulatory responses to feeding and fasting are corresponding great in ectotherms compared to endotherms; thus ectotherms are very useful models for studies of the regulatory physiology of metabolism and energy balance. Our study aimed to understand body temperature regulation under fasting and feed (postprandial) conditions in an ectothermic vertebrate, the American alligator (Alligator mississippiensis). Like pythons, alligators naturally undergo long periods of fasting interspersed with large meals. We hypothesized that during the fast the animals would choose a cool body temperature to reduce metabolic rate and thus save energy. By selecting a warm basking area after feeding, the animals may be able to speed the rate of digestion of these large meals. If preferred body temperature varies in a predictable way in the fasting and in the postprandial state, we will then be able to seek to identify specific regulatory molecules that determine the set point for body temperature (e.g., leptin, gastrin releasing hormone, vasointestinal peptide, etc.).

Materials and Methods

Core body temperatures (Tc) were obtained from 10 juvenile female American alligators (Alligator mississippiensis) ranging in size from 2.3 to 4.1 kg. The alligators were housed in a greenhouse at an air temperature of approximately 23 °C. They were caged in two tanks, 1.2 x 2.4 m in size each, with a bridge connecting the tank (Figure 1). In one tank fresh water constantly flowed through the tank and maintained the temperature in the range of 17-19 °C. The other tank was dry and had heat lamps at one end providing both “cool” and warm basking areas ranging from 23-45 °C. The alligators were free to move about these thermal gradients.

Temperature data loggers (Button thermocroms, DS2422, Maxim Dallas Semiconductors) were used to measure Tc. The temperature sensors had a range of -40 to +85 °C and were accurate to ±0.5 °C. Each logger was 1.4 cm in diameter and 1 cm thick. The data loggers were programmed to record the temperature once every ten minutes until the buffer was full, which occurred after 2048 samples were obtained, 14.2 days after programming. The data loggers were inserted orally into the stomach. At the end of the experimental period the data loggers were retrieved by gastric lavage.

Figure 1. Schematic of the experimental set up. Two tanks were connected by a passageway. One tank held water that circulated through the tank and 17 °C. The other tank was dry. Heat lamps were attached to one end and provided a warm dry while the opposite end provided a cool dry basking area.

Protocol: Core body temperatures were recorded over a period of one week at the end of a one-month fast and during a subsequent period of feeding. During the period of feeding the animals were fed ad lib a diet of mice weighing approximately 25g/mice for 5 consecutive days. Each alligator ate from 2-5 mice per day. Only the first 3 days of the fasting period and of the feeding period were selected for analysis.

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