Amphibian optimum temperatures

Dr Robert K. Browne, Royal Zoological Society of Antwerp, Belgium, robert.browne@gmail.com

Thermal and metabolic studies investigate the interaction of temperature and food intake with growth and development (Browne and Edwards, 2003; Hutchison and Duprle, 1992). Exposure of amphibians to higher temperatures – up to an optimum - increase growth rates and decreases maturation times (Hadfield, 1966; Smith, 1976; Lillywhite, 1970). Successful reproduction in females requires both maturity and a high condition index (Smith, 1976).

As amphibians produce little heat through metabolism they are dependent on the ambient temperature or through sun basking to regulate their body temperature. Basking is widespread in anurans and increases body temperature from 3-10ºC above ambient air temperature (Lillywhite, 1970; Hutchison and Duprle, 1992).

Besides biological information, the study of themal biology of amphibians is important to conservation. The advantages of the increased temperature on growth and development through basking must be balanced against increased predation risk (Duellman, 1978). Therefore, in conservation programs for anurans the provision of optimum basking microhabitats requires a sound knowledge of each species thermal physiology and their thermoregulatory behaviour.

The studies listed below through using varying temperatures and irradiance can provide information on the optimum physiological temperature, the preferred temperature, and the lapse time to reach the preferred temperature (Hutchison and Duprle, 1992). If food intake is measured, and growth and development the effect of temperature on anuran metabolism can also be assessed (Larsen, 1992).

The exact mechanisms of temperature and food assimilation of anuran growth and development are complex and depend on (seasonal) hormonal responses (Emerson et al., 1997; Pasanen and Koskela, 1974; Duellman and Trueb, 1986), increases with food ingestion and digestion rates, and reproductive responses (Lofts et al., 1972; Kanamadi and Jirankali, 1993; Licht et al., 1983).

The simplest way to measure temperature is with noncontact temperature measurement using a portable Handheld Infrared Thermometer. As Handheld Infrared Thermometers also measure reflected infrared the heat lamps should be off during measurements.

Resource: A list of articles relating to thermal biology of amphibians and reptiles
http://www.nal.usda.gov/awic/pubs/Amphibians/amp_thermal.shtml

The optimum temperature for growth and associated metabolism

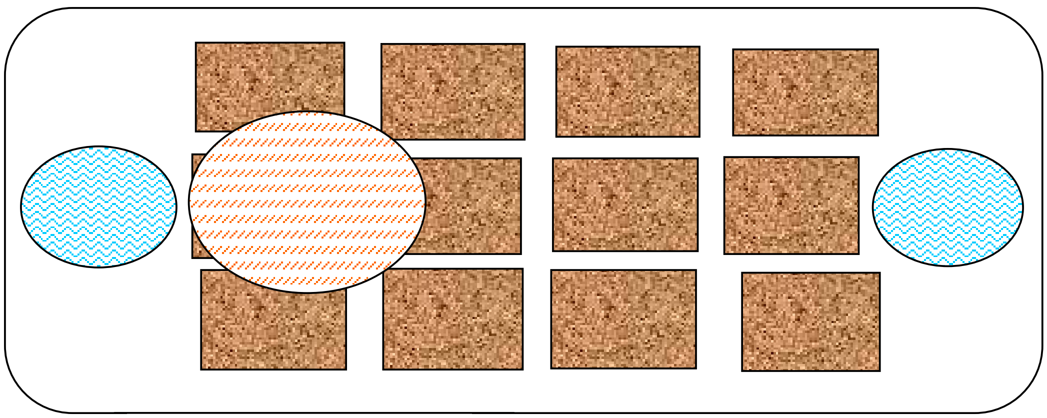
The optimum temperature for growth, associated food intake, and consequently metabolism, of anurans and terrestrial salamanders can be studied through raising them from juvenile to sub-adult at three temperatures in 4 boxes at each temperature with 6-10 frogs per box. Temperatures should be chosen dependent on the temperatures that occur naturally in the environment. They should be selected as a predicted low temperature, optimum, and a high temperature. The boxes can be kept in selected rooms to provide the required temperatures.

Species should be selected that have high growth rates and can eat reasonably size feed such as crickets or mealworms. In the case of salamanders feed such as earthworms or inert food should be used. The boxes should be provided with a substrate that enables good hygiene and the easy collection of uneaten food. A water bowl should be provided. Anurans should be randomly selected for each box. They should all then be measured for weight and for snout-urostyle length. Twice weekly the anurans should be fed with a counted and weighed number of food items and uneaten food items counted and weighed. Depending on growth rates, either once weekly, or perhaps fortnightly or longer individual anuran weight or lengths should be measured. The responses for growth can be taken as the averages of weights and lengths of individuals in each box as a replicate and food intake taken as the amount consumed over the life of the study compared to weight will give a measure of metabolic efficiency.

Thermal micro-habitat selection for cryptic species

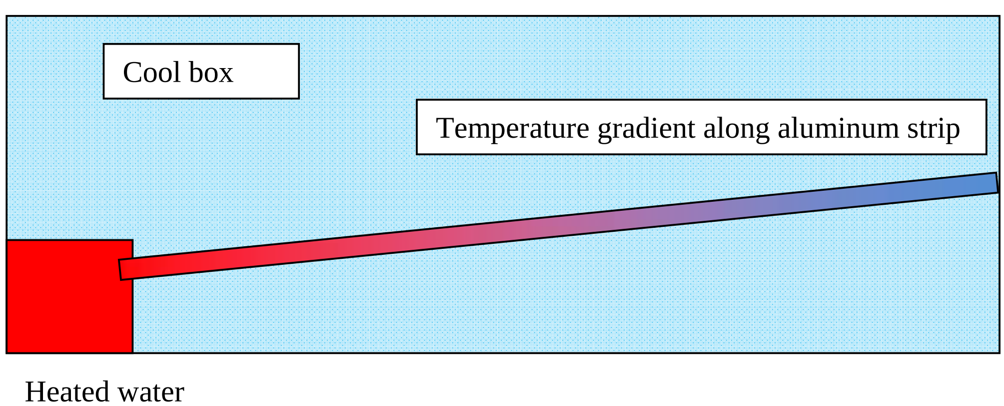
A simple method to test thermal micro-habitat selection and preference of all terrestrial amphibians is to use a box with an array of pieces of cork bark for shelter. If frogs are cryptic and nocturnal they will found under the bark during the light period. A heat lamp of appropriate power is then placed toward one end of the box. This produces a range of different temperatures, and the temperature of the frog and substrate under the bark - where the frogs most shelter - will show the frogs preferred diurnal temperature. At least 4 frogs can be kept in each box for social species.

The terrarium layout. A1-D3 cork bark shelters ; water dish ; sunlamp .



Short-term assessment of thermal preference

Another method (below) for short term studies with frogs and toad species is the use of an aluminium strip – the width of the container that is heated at one end by immersion in a water bath heated by an aquarium heater. The bath must be covered to prevent frogs entering. If kept in a room with a low temperature the frogs will select their preferred position on the aluminium strip. Shelter and a thin layer of substrate for comfort and moisture can be provided along the aluminium strip (Witters and Sievert, 2001).



Sun basking

For assessment of sun basking a terrarium should be provided with an incandescent lamp to provide heat and suitable branches to enable them to bask at a range of heights and temperatures. The ambient temperature of the terrarium should be kept lower than their preferred temperature to enable the frogs to select their preferred temperature. The range of temperatures they prefer should be recorded. There may also be diurnal patterns in the thermal behaviour of frogs and these may also be recorded. Preferably three terrariums should be used to give a statistical significance.

References:

Browne R.K., Edwards D.L. 2003. The effect of temperature on the growth and development of green and golden bell frogs (*Litoria aurea*). Journal of Thermal Biology. 28: 295-299. http://www.anu.edu.au/BoZo/Scott/PDF

Duellman WE. 1978. The biology of an equatorial herpetofauna in Amazonoan Ecuador. Misc. Publ. Mus. Natl. Hist. Univ. Kansas 65: 1-352.

Duellman WE, Trueb L. 1986. Biology of Amphibians. The Johns Hopkins University Press, Baltimore, MD, 217pp.

Emerson SB, Carroll L, Hess D. 1997. Hormonal induction of thumb pads and the evolution of secondary sexual characteristics of the South East Asian Fanged frog, *Rana blythii*. Exp. Zool. 279: 587-596.

Freed AN. 1980. An adaptive advantage of basking behavior in an anuran amphibian. Physiol. Zool. 53, pp. 433-444.

Hadfield S. 1966. Observations on body temperature and activity in the toad *Bufo woodhousei fowleri*. Copeia, 581-582.

Hutchison VH, Duprle RK. 1992. Thermoregulation. In: Feder, M.E., Burggren, W.W. (Eds.), Physiology of Amphibians. University of Chicago Press, Chicago, pp. 207-215.

Kanamadi RD, Jirankali CS. 1993. Role of temperature and light in regulation of ovarian cycle of tree frog *Polypedates maculatus*. Ind. J. Exp. Biol. 31: 732–737.

Larsen LO. 1992. Feeding and digestion. In: Feder, M.E., Burggren, W.W. (Eds.), Physiology of Amphibians. University of Chicago Press, Chicago, pp. 378-380.

Licht P, Mc Creery BR, Barnes R, Pang R. 1983. Seasonal and stress related changes in plasma gonadotrophins, sex steroids, and corticosterone in the Bullfrog, *Rana catesbeiana*. Gen. Comp. Endocrinol. 18: 344-364.

Lillywhite HB. 1970. Behavioural thermoregulation in the Bullfrog *Rana catesbeiana*. Copeia, 158–168.

Lofts B, Wellen JJ, Benraad TS. 1972. Seasonal changes in endocrine organs of the male Common Frog, *Rana temporaria* III. The gonads and cholesterol cycle. Gen. Comp. Endocrinol. 18: 344-363.

Pasanen S, Koskela P. 1974. Seasonal and age variation in the metabolism of the common frog, *Rana temporaria* L. In northern Finland. Comp. Biochem. Physiol. 47: 635-654.

Smith GC. 1976. Ecological energetics of three species of ectothermic vertebrates. Ecology 57: 252-264.

Witters LR, Sievert L. 2001. Feeding causes thermophily in the woodhouse's toad (*Bufo woodhousii)*. Journal of Thermal Biology 26(3): 205-208.