Optimum egg temperatures

A temperature survival curve is a graphic representation of the relationship between egg survival to hatch and temperature. Similarly, a temperature development curve related temperature to the time to hatch. Both studies can be conducted simultaneously (Figure 1, image from Goncharov et al. 1989.

The establishment of a temperature survival curve for the incubation of amphibian's eggs; 1) guides the optimal temperature range within which to conduct studies, 2) assists predicting the effects of climate variation on egg survival and hatch time, and 3) can be incorporated into phylogenetic, toxiciological or other multispecies studies.

Previous investigators have suggested that 20°C is the best temperature for all amphibian species. However, accumulating evidence indicates that this is not the case (Goncharov et al 1989). Figure 1 shows that the median optimal temperature for *Bufo viridus* is beyond the optimal range for *B*. *verrucosissimus*. In contrast, with a range of acidity (pH) at an optimal temperature most species survive best at a neutral pH of 7 (not shown).

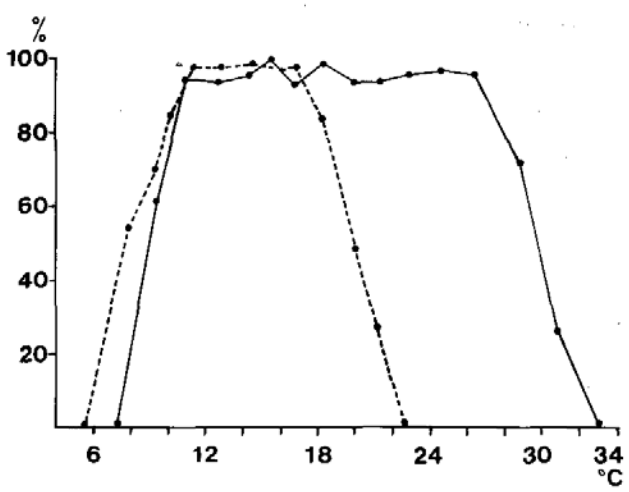


Fig. 1. Effect of temperature on the survival of embryos of *Bufo viridis* (solid line) and *B. verrucosissimus* (broken line).

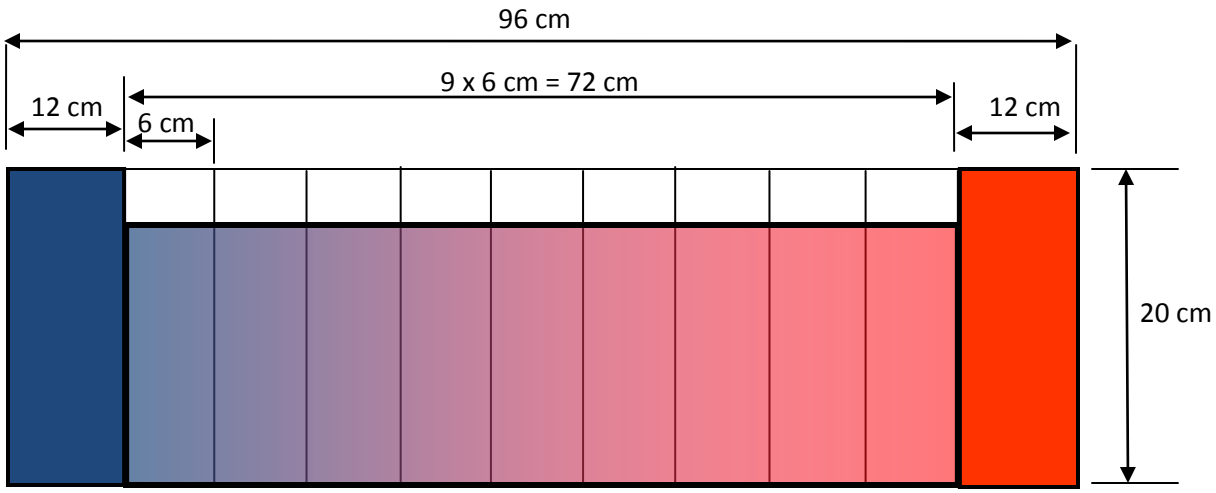
Temperature influences eggs size, hatch rate and development time to hatch. There are two main consequences of high temperature on egg physiology. The metabolic rates of eggs increase rapidly with increasing temperature with a Q10 of 1.5-4.0. However, the Q10 for oxygen diffusion is less than 1.4 (see footnote). Consequently, in general in a variety of invertebrates and vertebrates the largest eggs are found from cooler climate species.

In warmer conditions in nature eggs on the inside of large egg masses because of low oxygen have been observed to develop slowly or to die (Woods 1999).

When incubating the eggs of urodelians a problem can be high mortality from infection with *Saprolegnia.* Goncharov et al. (1989) found that 0.025ml of 30% H_2O_2 per. liter every two days was an effective prophylactic.

Q 10. The Q10 coefficient is the rate of increase of a biological activity with a 10˚C increase in temperature. The greater the Q10 the greater the rate of increase with temperature.
http://en.wikipedia.org/wiki/Q10_(temperature_coefficient)

A simple piece of equipment to create a temperature gradient can be used to study the relationship between egg hatch, development rate and temperature.



A thermostatically controlled aquarium can be constructed from glass or acrylic plastic (above). The height is 20 cm, the length 96 cm and the depth 20 cm. The depth can vary dependent on the provision of side panels and whether the apparatus may be used for tadpole studies. One is heated with an aquarium heater and the other end cooled with a chiller or ice slurry. The array should be insulated with foam sheets around the outsides. To achieve more uniform heat compartments may be also be located along the sides. The required highest and lowest temperatures are automatically maintained in the two extreme compartments thus creating an almost linear gradient between them. Each compartment is supplied with an airstone ensuring constant intermingling of water and full oxygenation. Eggs are kept in baskets hanging from the edge.

Goncharov BF, Shubravy OI, Serbinova IA, Uteshev VK. 1989. The USSR programme for breeding amphibians, including rare and endangered species. International Zoo Yearbook. 28:10-21.

Woods HA. 1999. Egg-mass size and cell size: Effects of temperature on oxygen distribution. American Zoologist 39(2): 244-252.