IH315: Resistance of tropical frogs to water loss and implications for distribution changes in the face of global warming trends, Indonesia

Evaporative water loss was first examined in frogs more than 200 years agoand continues to be the subject of inquiry to the present day. It now is clear that cutaneous resistance to evaporative water loss is present in many species,but completely absent in others (Wygoda, 1984). While most previous studies of skin resistance in frogs have focused on habitat aridity, none have considered salinity. This is most likely due to the fact that very few species (~ 1%) live in or can even tolerate brackish water (Hillman et al., 2009) and only a single species, the crab-eating frog (*Fejervarya cancrivora* [formerly *Rana cancrivora*]), is truly marine. *F. cancrivora* is a euryhaline species which inhabits mangrove swamps in Southeast Asia and is known to swim and feed in full-strength sea water (Schmidt-Nielsen and Lee, 1962). It is the most salt-tolerant of all frogs (Hillman et al., 2009) and has been found to tolerate salinities up to 40 ppt.

The adaptive advantage of evaporative water loss in *F. cancrivora* may be related to its euryhaline existence and the time-course of the mechanism by which it develops the ability to survive in waters of high salinity. Crab-eating frogs often move between freshwater and saltwater habitats but their establishment of elevated plasma solute levels is not accomplished immediately upon entry into high salinity water. Indeed, when freshwater-acclimated frogs were placed in 270 mosmol/L and higher solutions, they initially lose mass (presumably by osmotic water loss) which they did not recover for several days. Reduced evaporative water loss, therefore, would be beneficial in helping lower total water loss rates when frogs initially move from fresh to saltwater environments.

One of the questions repeatedly asked over the past century is whether evaporative water loss rates correlate with the aridity of the frogs'habitat. This projectwill study possible effects of climate change onthe crab-eating frog by measuring skin resistance to evaporative water loss over a series of temperatures and dehydration states. The results add another dimension to the continuing examination of evaporative water loss in frogs and how theymay be impacted by changes in habitat conditions.

Specific questions addressed:

1. Is skin resistance in crab-eating frogs influenced by temperaturedehydration state?
2. How might predicted changes in climate influence frog distribution and density?

3. Can the relationship between temperature, dehydration state and water loss be accurately modeled?
4. How might these models be used to improve conservation and survival of crab-eating frogs across their distributional range?

Methods:

Frogs will be collected from sites on Hoga Island and Kaladupa Island, southeast Sulawesi, Indonesia, and transported to the Hoga Island Research Laboratory. Frogs will be kept in bins containing moist compost and clean waterat field temperatures. For each trial frogs will be anesthetized with tricainemethanesulfonate and urinary bladders voided. The frog will bepositioned into a water-conserving posture and individually placed into a wind tunnel housed in the massing chamber of a Mettleranalytical balance. Airflow, air temperature and relative humidity will be measured during the trial. In a typical trial, body temperature will stabilize within 10 – 12 min and cumulative mass loss recorded during the final 6 min. After each frog trial, evaporative water loss rates and body temperatures of an exact agar model will be measured using the same procedures as for living frogs. Total, skin andboundary layer resistance will be calculated using the formula of Spotila and Berman, 1976.

Students participating in this research project will need the following:

1. sturdy pair of dive booties
2. waterproof field notebook and pencils
3. Good waterproof dive torch

All other necessary equipment and training will be provided by the field supervisor.

Reading List:

Hillman, S. S., P. C. Withers, R. C. Drewes, and S. D. Hillyard. 2009. Ecological and Environmental Physiology of Amphibians. Oxford University Press Inc., New York.

Spotila, J. R. and E. N. Berman. 1976. Determination of skin resistance and the role of the skin in controlling water loss in amphibians and reptiles. Comparative Biochemistry and Physiology 55A: 407-411.

Wygoda, M. L. 1984. Low cutaneous evaporative water loss in arboreal frogs. Physiological Zoology 57:329-337.