IH313: Water loss resistance of intertidal crabs relative to intertidal distribution & inundation period

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The biggest threat to amphibious animals is desiccation. In animals with porous skin such as frogs, body water is lost at rates equal to that of a free water surface. In others, hard coverings can dramatically reduce the rate of water flux. Take the dessert snail, for example, during the high desert summer the snail will remain attached to boulders or shrubs for several months directly exposed to the sun. It thick shell, however, slows water loss to a rate one hundred and fifty thousand times slower than rates seen in aquatic frogs. Even within groups of animals it now is clear that significant cutaneous resistance to evaporative water loss is present in many, but completely absent in others (Wygoda, 1984). In addition to frogs and land snails, amphibious crustaceans, specifically crabs, have been the focus of many water loss studies. Typically these studies have looked at the percentage of body water that a species' might lose and still be viable, effects of temperature on desiccation or exposure time until loss of muscle control (Thurman, 1998). A few studies, however, have undertaken the more quantifiable (and comparative) approach of determining cutaneous resistance values (Wygoda, 1984).

The adaptive advantage of water loss resistance in amphibious crabs relates to the distribution pattern in their mangrove habitat, body morphology and presence or absence of shade. It is known, for example, that fiddler crabs from different intertidal regions have lethal temperatures, metabolic rates and water loss rates that correlate well with microhabitat conditions. Ironically few studies attempt to quantify resistance values in fiddler crab species. This project will look at three common species of fiddler crabs from Kaledupa Island, southeast Sulawesi, Indonesia living in different and distinct intertidal zones. *Ucavocans*, *Ucatetragonon*, and *Ucacrassipes* are all found in intertidal mangroves, but establish their burrows in different zones relative to tide and insolation exposure time. *Ucavocans* is found in the low intertidal zone where it is submerged for most of the tidal period, whereas *Ucacrassipes* resides in shaded upper mangal zones where it is emerged during all but the highest tides. *Ucatetragonon* is intermediate between the other two species. This project will determine exoskeleton/cutaneous resistance (E-CR) to evaporative water loss in the three fiddler crab species and evaluate these data relative to habitat selection and activity patterns in the in their environment.

Specific questions addressed:

1. What is the E-CR value for tropical fiddler crabs?
2. Do E-CR values differ between species?
3. Is there an obvious relationship between water loss resistance and habitat conditions?
4. Might resistance data be used to predict fiddler crab distributional shifts if climate changes occur?

Methods:

Crabs will be collected from mangal sites on Kaledupa Island, southeast Sulawesi, Indonesia, and transported to the Hoga Island Research Laboratory, and will be kept in bins with moist sand and clean seawater at ~26°. For each experimental trial a crab will be anesthetized with clove oil, blotted dry and positioned into a water-conserving posture in analytical wind tunnel. 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 crab trial, evaporative water loss rates and body temperatures of an exact agar model will be measured using the same procedures as for living crabs. Total, skin and boundary 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. three ordinary garden trowels
4. Good waterproof dive torch

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

Reading List:

Spotila, J. R. & 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 55: 407-411.

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

Thurman C.L. 1998. Evaporative water loss, corporal temperature and the distribution of sympatric fiddler crabs (Uca) from South Texas. Comparative Biochemistry and Physiology. 119A: 279–286.

Jimenez, A. G. & Bennett, W. A. 2005. Respiratory physiology of three indo-pacific fiddler crabs: Metabolic responses to intertidal zonation patterns. Crustaceana. 78(8):965-974.