

## IH312 Temperature preferences of intertidal fishes in Indonesia

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Over the last 20 years, increases in sea surface temperatures have been documented in many areas of the world. Of special interest are fishes from near-shore mangrove mud flats, seagrass beds, and tidepools (also known as marginal habitats) adjacent to coral reefs. These areas show considerable overlap with reef biota, because they serve as nursery areas for juvenile reef fishes, and are critical to coral reef health and biodiversity. Temperature change can be especially problematic in shallow nursery zones in that the shifts are rapid, unpredictable and of unusually high magnitude. For example, we have measured temperature increases in mangrove nurseries at Hoga Island of up to 15°C over the course of 2-3 hours. Unlike open ocean habitats, shallow nurseries will likely experience even more extreme spikes if average water temperatures increase by 1 to 2°C as predicted by most global warming models. The resulting increase in global thermal profiles is predicted to have profound effects on fish physiology, biodiversity and distribution.

Changes in fish biodiversity and distribution can be predicted from tolerance limits with relative ease. For example, high temperature tolerances determined for 450 individual fish from 65 species collected in a 2002 survey of Hoga Island marginal habitats had a mean tolerance value over 40°C – well above temperatures predicted by current global climate change models. It seems unlikely therefore, that nursery fishes will suffer any direct effects from a 2°C average increase in water temperature. Indirect effects on fish physiology and behavior, on the other hand, are more difficult to predict and therefore of greater concern. Perhaps a better benchmark of fish performance under the new thermal regimen may be the final temperature preference. Determinations of final preference are easily conducted in the laboratory and are a good indication of the optimum temperature for growth. Presumably it is at this temperature that fish have optimized their physiological efficiency. Therefore, the determination of the preference could be used as a rapid method for the estimating the effects of temperature change on physiology. Practical application of preference measurement include, determination of maximum growth temperature, assessing the effects of ontogenetic changes in temperature requirements, and predicting how fish nursery areas may shrink, grow or change location as area temperatures increase. Such investigation would be unrealistic using conventional methods for studying interactions between temperature and growth.

The purpose of this project is to estimate the final temperature preference of selected juvenile reef fishes from nursery areas around Hoga Island. Briefly, light traps will be used to capture juvenile reef fish at night in key nursery zones (e.g., seagrass beds, patch reefs or mangrove habitats). Fish will be transported to the Hoga Marine Research Center and held at ambient conditions (typically a cycling temperature regimen of 25 to 28°C) similar to those experienced in the field. Following a two-week holding period upper and lower thermal tolerance (measured using Critical Thermal Methodology, see Beitinger et al., 2000 in the reading list) will be determined for a subset of 10 fish. These values will be used to establish the high and low temperatures used in the preference trials.

Standard preference techniques (see Jobling 1981 and Wallman and Bennett 2004 on the reading list) will be used to estimate the preferred temperature of fish from each selected species. Briefly, replicates of either gregarious (n=5) or solitary (n=1) fish will be placed, into a temperature preference chamber and allowed to become accustomed to the apparatus overnight (at least 12 h). An increasing thermal gradient of between 0.5 to 1.0°C/30cm (depending on thermal tolerance scope, i.e.,

upper– lower thermal tolerance) will be established by introducing cold seawater into a 300cm long preference chamber. Seawater will be progressively heated by a series of heat lamps spaced along the chamber bottom. Seawater temperatures will be measured ( $\pm 0.1^{\circ}\text{C}$ ) at 15 cm intervals using iButton temperature loggers set to record temperature every 5 minutes. Fish will be photographed at 20 minute intervals and the temperature of the nearest iButton recorded. The population thermal preference for each species will then be taken as the median temperature from the resulting data set.

Temperature profiles will be estimated for each of the three nursery zone types by placing a series of 10 to 15 iButtons along a transect line traversing the nursery's long axis and collecting temperatures at 30 minute intervals over one complete lunar tidal cycle. The temperature dataset will be plotted over time as well as input to a spatial map to better quantify thermal profiles of each nursery type. Data will be interpreted relative to thermal preference of the fish species collected. By better understanding the thermal physiology of nursery fishes it becomes possible to more accurately predict future changes in reef fish diversity as well as potential spatial shifts in nurseries, and perhaps implement more effective management strategies to protect reef and nursery areas.

Students participating in this research project will need the following:

1. sturdy pair of dive booties
2. wetsuit
3. Snorkel gear
4. Waterproof dive torch
5. waterproof field notebook and pencils
6. polarized sunglasses

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

### **Reading List**

Beitinger, T.L., Bennett, W.A., McCauley, R.W., 2000. Temperature tolerances of North American freshwater fishes exposed to dynamic changes in temperature. *Environmental Biology of Fishes*. 58, 237–275.

Jobling, M. 1981. Temperature tolerance and the final preference-rapid methods for the assessment of optimum growth temperatures. *Journal of Fish Biology*. 19, 439–455.

Wallman, H. L. and Bennett, W. A. 2006 Effects of parturition and feeding on thermal preference of Atlantic stingray, *Dasyatis sabina* (Lesueur). *Environmental Biology of Fishes*. 75, 259–267.