THE UNIVERSITY OF HONG KONG
SCHOOL OF BIOLOGICAL SCIENCES

Postgraduate Student Public Seminar

"DELVING INTO THE AIR- WATER INTERFACE: ECOLOGICAL CONSEQUENCES OF THE INTERPLAY BETWEEN RESPIRATORY PHYSIOLOGY AND ENVIRONMENTAL STRESSORS IN BIMODAL BREATHING CRABS"

Mr. NG Ka Hei
PhD Student, School of Biological Sciences, HKU
(Supervisors: Prof. Gray A. Williams & Prof. Stefano Cannicci)

on Friday 10 November 2023 at 9:00 am
Room 6N-11, Kadoorie Biological Sciences Building

Abstract

The evolution of aerial respiration represents a key milestone in the development of terrestrialization, an ongoing process that has occurred recurrently in various lineages of brachyuran crabs. Owing to the much higher solubility and diffusivity of oxygen in air as compared to water, air breathing is hypothesized to facilitate a higher aerobic scope, which is reflected in various respiratory parameters such as internal oxygen availability and oxygen consumption rate. While a widened aerobic scope during aerial respiration has been observed in some bimodal breathing crustaceans like insects, it may not hold true in semi terrestrial crabs due to their family-specific respiratory strategies.

In order to adapt to the transition to terrestrial environment, semi terrestrial crabs have undergone several family-specific morphological and physiological modifications to their gills, giving rise to diverse aerially adapted breathing structures. Living at the air- water interface, these crabs face a multitude of environmental stressors, including fluctuations in temperature and oxygen availability. By transitioning between aerial and aquatic respiration using different respiratory mechanisms, the interplay between respiratory physiology and these environmental stressors may differ amongst the families of bimodal breathing crabs. To investigate how respiratory physiology, environmental temperature, and respiratory mediums interact at cellular, systemic and organismal levels, we tested key assumptions of the oxygen and capacity limited thermal tolerance (OCLTT) hypothesis and holobiont theory, by measuring proxies of respiratory performances in various families of semi terrestrial crabs in the Ocypodidae and Sesarmidae families.

At a systemic level, the confounding effect of temperature and respiratory medium had distinct effects on aerobic scope. Widening of aerobic scope, likely induced by air breathing, was only observed in ocypodid crabs which possess a lung-like respiratory structure. In contrast, sesarmid crabs displayed a restricted aerobic scope and thermal tolerance capacity owing to the high water dependency and ventilation cost of their extra- branchial recirculation system. The divergent respiratory performance of these two families successfully predicted their relative thermal niche in air, but their contrasting oxygen availability in blood did not result in varying aerobic capacity (mitochondrial output) at a cellular level. Regardless of respiratory medium and locomotory state, the most terrestrial species, *Chiromantes haematocheir* (Sesarmidae), displayed a drastic reduction in aerobic capacity despite its high oxygen availability in haemolymph. During rapid exercise, the contrasting respiratory performance in air and water among Ocypodidae, Sesarmidae and Grapsidae was mirrored by medium- specific activation of anaerobic metabolism. At an organismal level, species, and not respiratory strategy or gill position (anterior or posterior), was the most significant factor in influencing the gill microbiome, suggesting a non-random, host-microbe association that resembles a holobiont.

By employing bimodal breathing as an adaptation to an amphibious lifestyle, the species- and medium- specific patterns of respiratory performance differed across three hierarchical levels in semi terrestrial crabs. The differential expression of respiratory performance in semi terrestrial crabs observed in this study therefore calls for a more cautious and nuanced approach when extrapolating results from respiratory physiology to make generalized prediction of bimodal breathing ectotherms under warming scenarios.

--- ALL ARE WELCOME ---