Title: How does the snakehead, Channa Asistcica, survive during aerial exposure?

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up study to examine the long-term effects in terms of other crucial time-related indicators such as education placement factors. The study shawed the importance of a child's early environment and preschool experience. Some of our children in Singapore are more vulnerable to being at risk of failure sooner or more easily than their peers when they join P1, for example children who come from non-English speaking backgrounds or low SES. These at-risk groups require more nurturing and stimulating environments in the early years to develop optimally. To this end, the findings seem to indicate that there is a need to judge the study on the basis of its success in narrowing the gap among children of different backgrounds. The research study provides evidence that pupils from the low SES and non-English speaking pupils in the experimental groups have better gains for Phase 1 of the research study. From this perspective, the interventions of the new curriculum delivered by trained teachers have made an impact on the preschool pupils.

Team Members: Carolyn Tan-Niam and MOE officers from Psychological Assessment & Research Branch, and Research and Evaluation Services.

This was an MOE PSE project, in collaboration with NIE.

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**How does the Snakehead, *Channa Asistica*, Survive During Aerial Exposure?**

**Chew Shit Fun**

Introduction

Some teleostean fish actively lead an amphibious life (e.g. mudskippers) while others occasionally get trapped in puddles of water (e.g. marble goby) or in the intertidal zone in their natural habitats. Without the buoyancy of water, gills would collapse and lamellae would coalesce. Branchial ammonia excretion would be inefficient when no external water current is available to irrigate the gills during aerial exposure. Consequently, endogenously produced ammonia would accumulate and these fish must deal with the problem of ammonia intoxication in the absence of water.

Three different major nitrogenous products are found to accumulate in the tissues of some tropical teleostean fishes during aerial exposure. These are alanine, glutamine and urea. The weather loach and the mangrove killifish accumulate both alanine and glutamine, although to a lower extent than the mudskipper and the sleeper, respectively, when exposed to terrestrial conditions. These two fish have the unique capability of excreting ammonia through volatilizing NH₃ during aerial exposure.

Urea production does not appear to be a common strategy adopted by teleosts to detoxify endogenous ammonia during aerial exposure, probably because it is energy expensive. Glutamine formation is also energy dependent and appears to be adopted mainly by fishes that remain completely motionless and remain quiescent, with only occasional eel-like movements, for an extended period.

From this information, we hypothesized that *C. asiatica* was capable of undergoing partial amino acid catabolism leading to the formation of alanine to reduce the rate of ammonia accumulation in its tissues during aerial exposure.

Objective and research

This study was undertaken to investigate the effects of aerial exposure on the snakehead *Channa asiatica*, which is an obligatory air-breather.

Experiments were thus performed to study the effects of aerial exposure on (1) the concentration of free amino acids (FAAs) in the muscle, liver and blood plasma, (2) the ammonia and urea excreted by, and accumulated in the various tissues, (3) the activities of alanine aminotransferase (ALT), glutamine synthetase and glutamate dehydrogenase (GDH) and (4) the activities of the ornithine-urea cycle enzymes.

Results and discussion

Results obtained showed that aerial exposure significantly decreased the rates of ammonia excretion by *C. asiatica*. Upon re-submergence, the rates returned to the initial...
control values. Similar observations were made on the rates of urea excretion.

There were significant increases in concentrations of ammonia in the muscle, liver and plasma after exposure to terrestrial conditions for 48 h. The urea level increased slightly after 12 h of aerial exposure and returned to normal value thereafter. Aerial exposure had no effect on the urea content in the liver. There was a significant increase in the urea concentration in the plasma of specimens exposed to 24 or 48 h of terrestrial conditions, but the change was minor compared to that for ammonia.

No significant changes in the activities of the arginine urea cycle enzymes were detected after aerial exposure. The alanine level (3.7 pmol g⁻¹) in the muscle rose to 6.4 and 12.6 pmol g⁻¹ after 24 h and 48 h of exposure to terrestrial conditions, respectively. There were significant changes to some of the FAAs in the liver of specimens exposed to terrestrial conditions for 48 h. Aerial exposure induced only minor changes to some of the amino acids in the plasma of *C. asiatica*.

Activities of ALT in the cytosolic and mitochondrial fractions of the muscle and liver were unaffected by aerial exposure. However, there were significant decreases in the aminating activity of GDH from the muscle and liver of specimens exposed to terrestrial conditions, leading to significant decreases in the amination:deamination ratio. Malic enzyme is also present in the muscle of *C. asiatica*.

From the results obtained, the first strategy adopted by this fish to survive aerial exposure is to tolerate the build up of ammonia level in its body. However, in order to prevent ammonia from building up to an intolerable level, other strategies must be subsequently involved to maintain the new steady state level of internal ammonia. It has been suggested that fishes, like the mudskipper *P. schlosseri*, which are active on land with impeded excretion of ammonia would partially catabolize certain amino acids to alanine. This would allow amino acids to be used as an energy source without polluting the internal environment. Partial amino acid catabolism coupled with a reduction in amino acid catabolism in general constitutes the most cost-effective way to minimize endogenous ammonia build-up. Alanine may be more suitable for accumulation because it has less effects on kinetics of many enzymes than other amino acids. Indeed, alanine increased 4-fold from 3.7 to 12.6 pmol g⁻¹ in the muscle of *C. asiatica* after 48 h of aerial exposure.

The accumulated alanine accounted for 70% of the deficit in ammonia excretion during that period. This would allow the utilization of certain amino acids as energy sources and, at the same time, minimize ammonia accumulation. However, different from the mudskippers, the reduction in nitrogenous excretion during 48 h of aerial exposure was completely balanced by nitrogenous accumulation in the tissues. Hence, it is unlikely that the rates of proteolysis and amino acid catabolism were reduced during aerial exposure, as in the case of mudskippers. This implies that *C. asiatica* cannot measure up to the mudskippers’ capability of surviving on land.

For details of this report please refer to: Chew, S F M Y Wong, Tam W L and Y K Ip. The Snakehead *Channa asiatica* accumulates alanine during aerial exposure, but is incapable of sustaining locomotory activities on land through partial amino acid catabolism. Journal of Experimental Biology, United Kingdom, 2003. 206 (5): 693-704.

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**Summary of the strategy utilised by *C. asiatica* during aerial exposure**

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**Detection of Colorectal Diseased Tissues Using Laser Induced Autofluorescence Spectroscopy**

Colorectal cancer is currently the second leading cause of cancer mortality in Singapore after lung cancer for males and after breast cancer for females. The possibility of survival from colorectal cancer is closely related to the clinical and pathological stages of the disease during diagnosis. However, most deaths can be prevented by early detection. Thus, further research and development of novel strategies for early, noninvasive or micro-invasive detection can greatly