



New Dams May Flush Bottom-Breathers Out

Some freshwater turtles can extract oxygen from the water via their bottoms, but oxygen-poor water in dams can compromise their ability to do this. Natalie Mathie says hatchlings that need to surface may be at greater risk of predation.

Most diving animals, like whales and dolphins, can only stay submerged underwater for around 30 minutes. However, a freshwater turtle can last underwater for days or even weeks in the right conditions.

Animals such as whales that live in the water, but breathe air, are limited in the amount of time they can spend underwater as they must frequently return to the water surface to take a breath. The record for the longest time spent underwater is currently held by the sperm whale, which can stay submerged for 3 hours. However, a recent study at The University of Queensland has shattered this record by discovering that certain species of freshwater turtles can stay submerged underwater for at least 45 times longer than any other air-breathing animal.

The reason these animals can stay submerged for such a long time is because they are able to obtain oxygen from the water. Certain species of Australian freshwater turtle have evolved the ability to breathe aquatically like fish do but, instead of gills, the turtles have specialised sacs inside their cloaca, or bottom, called cloaca bursae. The turtles actively pump water

into their cloaca, where the high surface area of the cloacal bursae allows oxygen to move into the blood.

Being able to extract oxygen directly from the water means the turtles can remain submerged underwater for longer periods. The record for the longest time spent underwater is held by a Fitzroy River turtle that remained submerged for more than 3 weeks!

Freshwater turtles are highly aquatic animals that only come onto land occasionally to bask in the sun and dig nests for their eggs. Maximising the amount of time spent underwater is therefore thought to be beneficial as it allows the turtles more time for activities like finding food. Reducing the number of times the turtle must travel to the surface also conserves energy and reduces the risk of predation.

Hatchling turtles are prone to extremely high levels of predation from birds and fish. Extracting oxygen from the water reduces the number of times the hatchlings must leave the safety of their hiding place and venture up through the water column to the surface, where they expose themselves to predators.

Hatchling turtles can extract a

larger amount of oxygen from the water than adults. This supports the theory that aquatic respiration may have evolved as a "predator avoidance" strategy.

Being able to extract oxygen through the cloaca is an adaptation found only in some species of Australian turtles. Recent population surveys have discovered that these unique turtles are in decline while the air-breathing species are flourishing.

One possible cause for this decline is river damming, which can significantly change the ecological properties of rivers by converting narrow flowing systems into large stagnant reservoirs. The environmental costs of damming include loss of shallow rocky zones, reduced water flow, decreased aquatic oxygen levels, decreased temperature and increased water depth. Many of these environmental properties can influence aquatic respiration and diving behaviour in adult turtles.

Changes in environmental conditions, such as water flow, can affect the amount of oxygen the turtles are able to extract from the water. A fast-



flowing stream will have high levels of oxygen that enable aquatic respiration, whereas a stagnate pool that has low levels of oxygen will inhibit aquatic respiration. Turtles inhabiting stagnant pools must therefore surface more frequently for air, exposing themselves to high levels of predation.

With recent announcements of more dam developments, research into the effect of environmental conditions on aquatic respiration and diving behaviour in these turtle species is critical.

I have recently completed a study investigating whether the endangered Mary River turtle can adapt to these changing environmental conditions. The Mary River turtle is found only in the Mary River in Queensland. The population of this species was diminished in the 1960s due to the pet trade. This species is now protected from this industry, but high nest predation from foxes, cats and dogs is keeping populations numbers low.

The Mary River turtle can extract up to 50% of its oxygen requirements from the water, allowing it to stay submerged for at least 5 hours. The time this species spends underwater is dependent upon the temperature of the water. At high temperatures, the turtles are much more active so they use up oxygen more quickly. As a result, the amount of time the turtles can stay submerged is reduced at higher temperatures.

The turtles are less active at cold temperatures. There is also more oxygen in the water at cold temperatures so the turtles can stay underwater for longer.

My research investigated how the Mary River turtle could adapt to long-term changes in water temperature.

Many animals, including humans, can acclimatise when they spend long periods of time in a different environment. For example, somebody who lives in a cold environment will be able

to perform better in that environment than somebody who lives in a warm

environment. Being able to acclimatise means that animals can maintain their ability to swim or run despite changes in environmental conditions.

My research has discovered that the Mary River turtle is unable to acclimatise to warm temperatures but does have the ability to increase its dive duration in cold conditions. By increasing the amount of oxygen it can extract from the water, a Mary River turtle that is acclimatised to a cold temperature can stay submerged underwater for six times longer than a turtle acclimatised to warm temperatures.

Without high oxygen levels in the water, however, the turtles will be unable to increase their dive duration and may face increased predation rates, as at cold temperatures their ability to escape predators is reduced because they can't swim as fast.

These results suggest that any changes in environmental conditions may have a significant effect on the survival of this species of turtle.

Australia is extremely lucky to have such unique and fascinating creatures living in our waters, and we must do everything in our power to ensure their survival. Preservation of the natural river systems in Australia is critical to the conservation of turtle habitat.

Research into turtle ecology and behaviour is also required to ascertain the natural requirements of these species. Further investigations into the influence of changing environmental



conditions on species survival will allow us to predict the ecological costs of future change.

Natalie Mathie is a PhD student at The University of Queensland's School of Integrative Biology.



Left: a Mary River turtle hatchling



The natural habitat of the Mary River turtle