How habitat destruction figures in long-term survival plans

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Some organisms might have an interesting strategy for long-term survival: switching between two unsustainable forms of behaviour that, when kept unchecked, can actually cause them to wipe out their own homes.

This discovery, published in the journal *eLife*, could provide insight into how some species, including humans, can survive and even thrive in harsh conditions and with limited environmental resources.

During their life cycles, organisms such as slime moulds switch between living as single, free-ranging individuals (known as 'nomads') and living communally in a colony. To explore the benefits of this adaptation, researchers from the Singapore Institute of Technology and Yale University created a mathematical model that can be applied to such behaviour-switching organisms. Their model suggests that the strategy can ensure survival, even when each behavior would independently result in extinction.

"This is an example of a counter-intuitive phenomenon called Parrondo's paradox, where two losing games, when played in a specific order, can surprisingly end in a victory," says first author Zong Xuan Tan, an undergraduate at Yale University.

"Previous studies have demonstrated that the paradox can occur when organisms are faced with unpredictable environments. However, our research shows that externally caused environmental variation is not

actually needed for organisms to display this behaviour - the paradox can also occur when they form colonies that destroy their own habitats."

The model considers a situation where nomads live relatively independently and are unaffected by competition and cooperation, but are subject to steady extinction under poor environmental conditions. Colonists, on the other hand, live in close proximity and are subject to both competitive and cooperative effects. They can also deplete the resources of their habitat over time, resulting in their own extinction.

"These two losing strategies can actually lead to survival because when the organisms switch from their destructive colonial form to live as nomads instead, this allows for habitat regeneration," says senior author Kang Hao Cheong, Assistant Professor in the Engineering Cluster at the Singapore Institute of Technology. "Once colonial population sizes are sufficiently small, environmental resources are allowed to recover. The nomads can then take advantage of the restored stocks by switching back to colonialism."

Cheong explains that a variety of mechanisms might trigger this switching behaviour. For example, highly mobile nomadic organisms could frequently re-enter their original colonial habitat, thereby detecting whether resource levels are high enough for recolonization. Switching behaviour could also be genetically programmed, such that 'involuntary' individual sacrifice ends up promoting the long-term survival of the species.

"The possibility of an ecological Parrondo's paradox could have wide-ranging applications across the fields of ecology and population biology," Cheong says.

Tan and Cheong are already exploring ways to adapt their model to specific organisms, and to investigate the possible evolutionary origins of

this behavioural phenomenon.

More information: Zong Xuan Tan et al, Nomadic-colonial life strategies enable paradoxical survival and growth despite habitat destruction, *eLife* (2017). DOI: 10.7554/eLife.21673

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