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Hybridisation in reef fishes

How did Stef end up working on hybridisation and evolution in butterflyfishes? After completing his undergraduate degree at JCU, he joined the university's Molecular Ecology and Evolution Laboratory as a research assistant, learning techniques that proved invaluable for the rest of his (so far brief) career. The samples he was charged with were hybrid butterflyfishes from Christmas Island provided by good friend and colleague JP Hobbs. The prospect of visiting Christmas Island was too good an opportunity to pass up and now Stef gets to research in a fantastic location, a reef fish hybridisation hotspot and a place where occasional whale sharks show up in his transect.

Historically, kings of ichthyology, Jack Randall and Jerry Allen reported reef fish hybrids in the literature as relatively rare oddities and gave accurate morphological descriptions of their intermediacy. More recently, reef fish hybridisation studies have focused on the genetic side of the story. Stef's approach combines in situ observations and molecular work to;

1. understand which ecological and behavioural processes are conducive to hybridisation;
2. explore the genetic mechanisms of hybridisation;
3. investigate its ramifications in adaptation and evolution.

This is important in the context of reef fish evolution studies because hybridisation can have consequences on adaptability to novel environments and increase (through speciation) or erode (through reverse speciation) biodiversity.

Stef's research is focused on the adaptive and evolutionary ramifications of natural (as opposed to anthropogenically mediated or artificial) hybridisation in tropical reef fishes. Just to briefly put this into context, natural hybridisation is the crossing of distinct genetic clusters leading to the production of viable offspring in the wild. Hybridisation is common in plants and animals and since Darwin's chapter on "Hybridism" has been under the radar of evolutionary biologists. Currently, the model organism of choice for his work are butterflyfishes of genus Chaetodon, for a number of reasons: i) these critters hybridise more frequently than any other plant or animal taxon; ii) strikingly colourful and with distinct patterns, they are a delight to ID underwater (even for a novice ichthyologist); iii) their hybrids display colour patterns that are different from, and intermediate to, those of their parental species, making them easy to spot; iv) and last but not least, butterflyfish are iconic and diver-friendly inhabitants of coral reefs that we know quite a bit about in terms of habitat preferences, foraging ecology and reproductive behaviour.

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Two allopatric sister species groups of butterflyfishes with different divergence times make secondary contact at Christmas Island (*Chaetodon guttatissimus* × *Chaetodon punctatofasciatus* and *Chaetodon trifasciatus* × *Chaetodon lunulatus*). In both groups: i) niche overlap between parent species increases the chances of heterospecific encounters; ii) low abundance of potential mates promotes heterospecific pair formation and the breakdown of assortative mating. Together with necessary genetic compatibility, these conditions set the scene for hybridisation. However, despite these similarities, the genetic consequences of hybridisation differ between the two groups. Hybridisation in *C. guttatissimus* × *C. punctatofasciatus* shows bidirectional maternal contributions and relatively high levels of introgression, both inside and outside the hybrid zone. *Chaetodon trifasciatus* × *C. lunulatus* in turn, exhibits unidirectional mitochondrial inheritance and no introgression. Further, *C. guttatissimus* × *C. punctatofasciatus* may reduce local species diversity through intermixing of hybrid and parental genotypes, whereas C. trifasciatus × C. lunulatus may generate sufficient genotypic novelty for the hybrids to remain distinct from the parents, thus increasing overall genetic diversity. These findings are consistent with hybridisation theory and show that the outcomes of hybridisation in reef fish are affected by the genetic distance between the hybridising parental species.

Understanding tropical marine ecosystems and processes is a key result area in National Research Plans to which both AIMS and JCU align. Hybridisation can have important consequences on biodiversity and its study allows deeper understanding of tropical marine processes that maintain or erode biodiversity. Stef's research also contributes to informing management of the Christmas Island National Park, which plans to extend its jurisdiction further out from shore.

Highlighting the importance of Christmas Island as a biodiversity hotspot therefore meets three important priorities: i) Baseline knowledge and monitoring for management; ii) Patterns and processes in tropical marine biodiversity; iii) Australia's tropical seas - past, present and future.

Publications

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