Cryptic species and unique lineages in a number of reef fish species in the Western Indian Ocean revealed by broad-scale phylogeographic studies

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Background
Numerous broad-scale and coarse-grained phylogeographic studies of putatively-widespread, reef-associated species have been conducted across the Western Indian Ocean (WIO) portion of their distributions, under the ambit of a large research programme initiated in 2008. The broader programme has used a multi-taxon approach and the analysis of data from multiple molecular markers to examine patterns of contemporary and historical connectivity among the regions of the WIO in order to elucidate the biogeography, historical ecology of the region and the evolutionary origins of its diversity and endemism. Individual species, representing the Aporogonidae, Holocentridae, Labridae, Lutjanidae, Mullidae, Pomacentridae, Scaridae and Serranidae, have shown patterns varying from genetic homogeneity and panmixia to marked regional intraspecific genetic structure. However, several species have demonstrated substantial and deep genetic structure, suggesting the presence of hidden taxonomic diversity.

Abudelful vaigiensis
The sergeant major (Abudelful vaigiensis) is widespread throughout the tropical Indo-West Pacific occurring on reefs and rocky shores at depths up to 15 m.

Analyses of two mitochondrial gene regions (cytochrome b and ATPase 6) and a nuclear marker (57 intron I) revealed three distinct and divergent lineages across the WIO. One lineage was widespread and demonstrated little spatial genetic structure. Two lineages were restricted in distribution, but occurred sympatrically with the widespread lineage. Sequence divergences within lineages were low (<1.3%), but divergences among lineages were high (cytochrome b: 1.0 – 8.5%; ATPase 6: 1.2 – 9.4%) and approached values seen among the outgroup taxa.

Cheilodipterus quinquelineatus
The sharptooth cardinal (Cheilodipterus quinquelineatus) is relatively common in reef habitats up to 40 m depth and is widespread throughout the tropical Indo-Pacific.

A coarse-grained mtDNA phylogeographic study of this species in the WIO provided evidence of two distinct clades. Sequence divergence among these clades was high (ATPase 6: 11.20%; cytochrome b: 8.2%). Clades were largely restricted to the northern and southern portions of the WIO, respectively, but both occurred at the Kenyan sampling locality. Nuclear DNA (57 intron I) data substantiated the divergence of the two clades, but also provided evidence of hybridization where these lineages occur sympatrically. Here, a single individual from Kenya possessed alleles characteristic of each of the lineages.

Lethrinus nebulosus
Similar investigations have revealed the presence of two lineages in the widespread Indo-West Pacific spangled emperor. This has been supported by mtDNA (control region) and microsatellite data from 14 polymorphic loci.

Conclusion
While the divergence observed in these examples suggests hidden taxonomic diversity, the taxonomic status of the lineages is currently being investigated further, through morphological and morphometric studies, the analysis of additional genetic data and material, and parallel taxonomic comparisons.

The identification of unique lineages and possible cryptic species diversity has been ancillary to the original aims of this programme, but this does suggest that more diversity remains to be discovered in the WIO through studies such as this.