

Patterns in the diversity of coral reef fishes in the Western Indian Ocean

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and David Obura¹

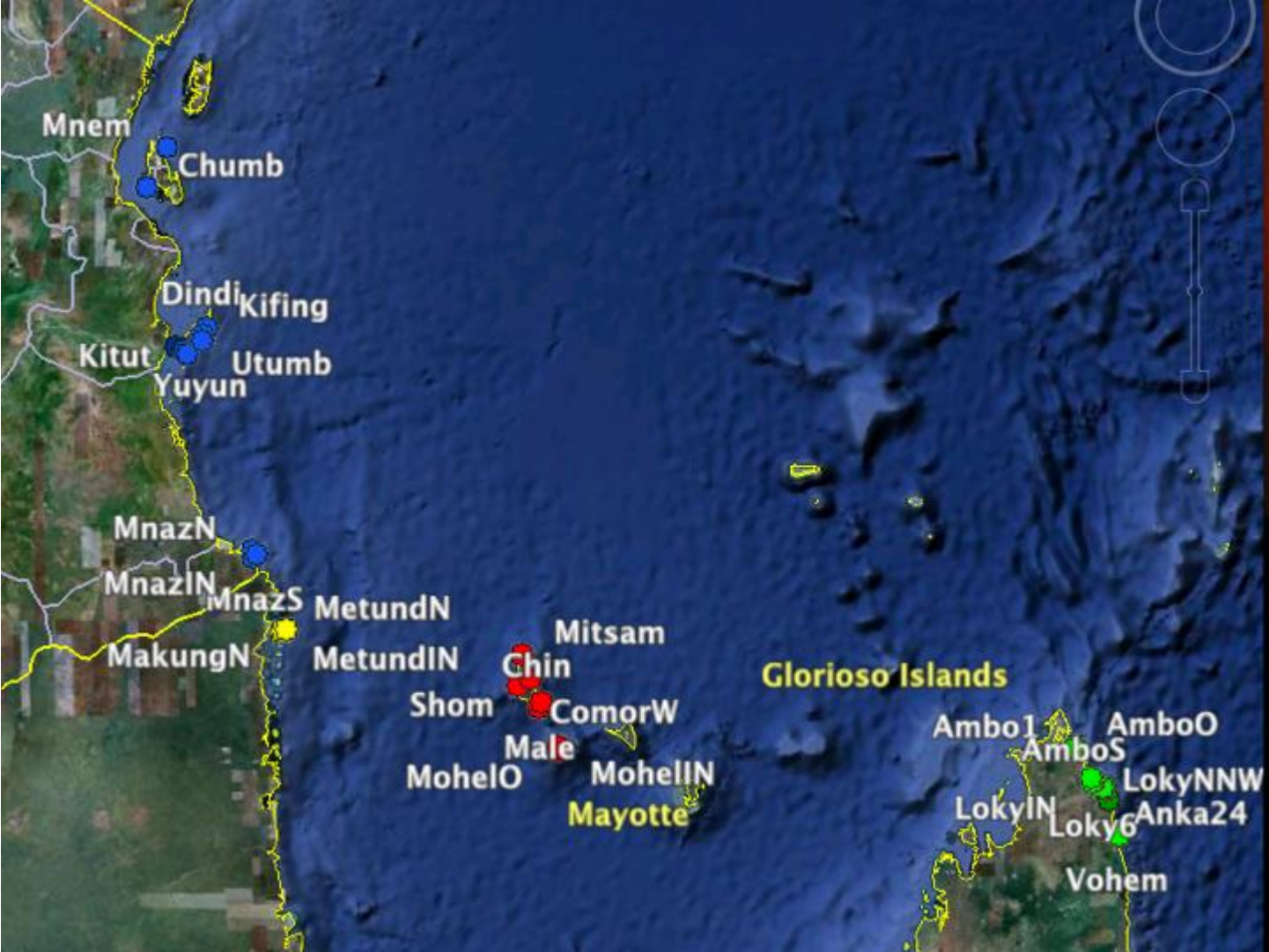
1. CORDIO East Africa

2. Simon Fraser University

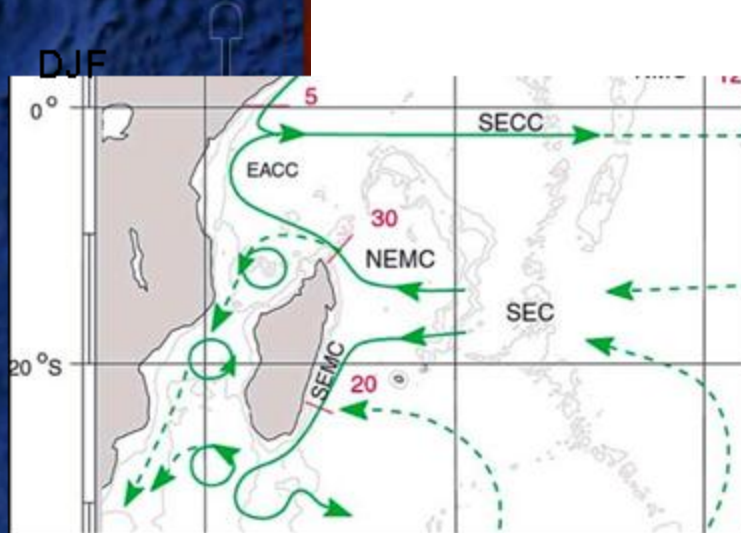
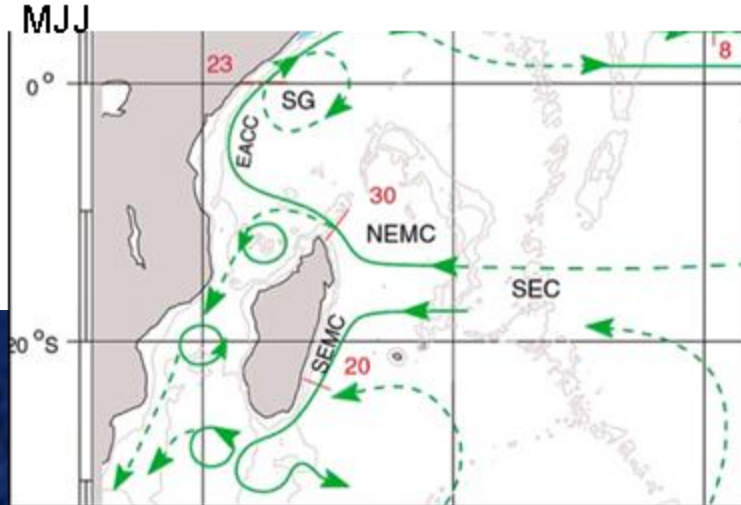
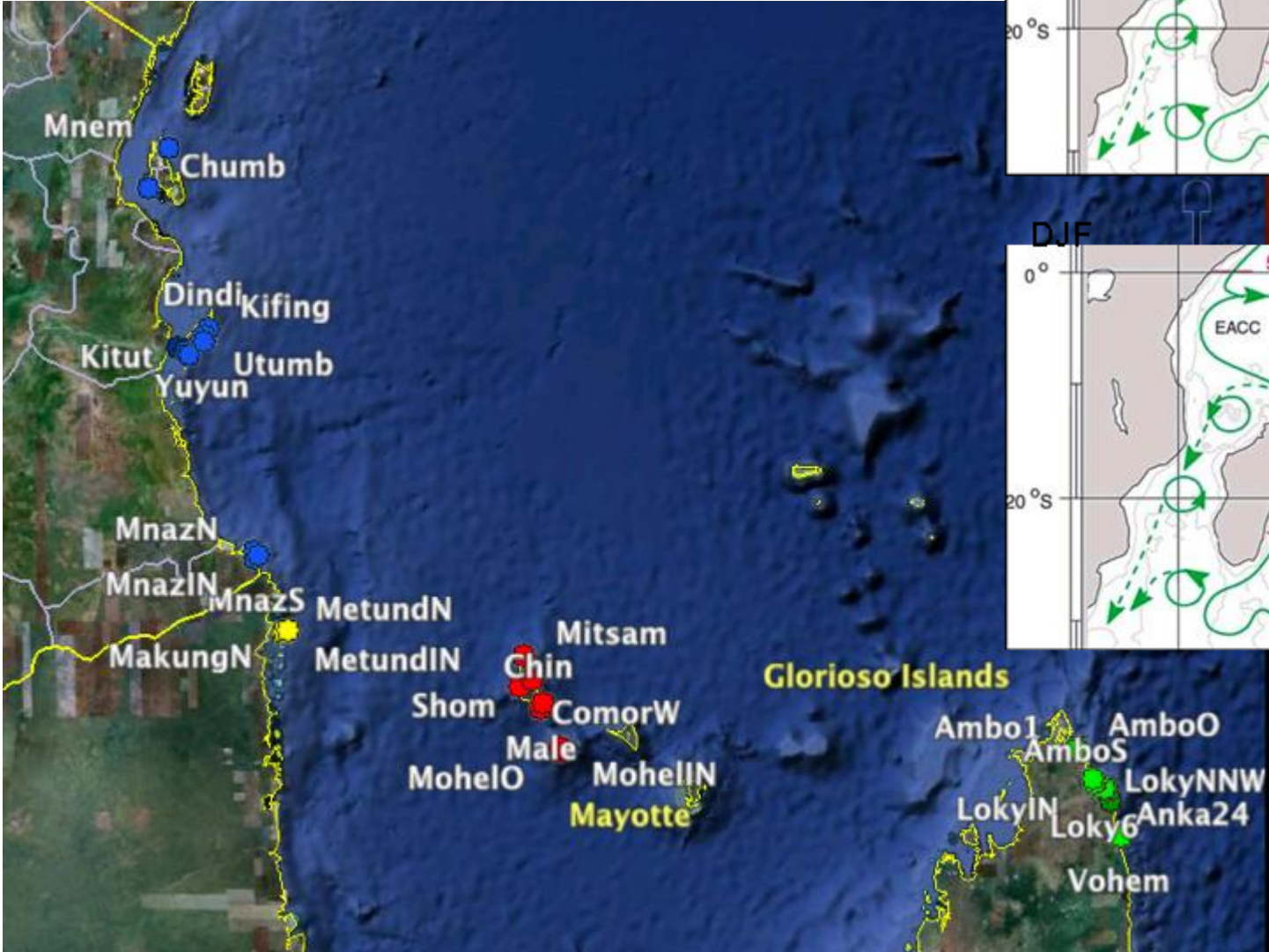
Objectives

- To measure the species diversity of coral reef fishes across a range of locations in the WIO for biogeographic and other analyses
- To test the hypothesis that there is a high diversity core region centred around the Northern Mozambique channel
- To explore underlying causes of differences in reef fish species assemblages in the WIO
- To inform conservation & management action

Study sites, main ocean currents



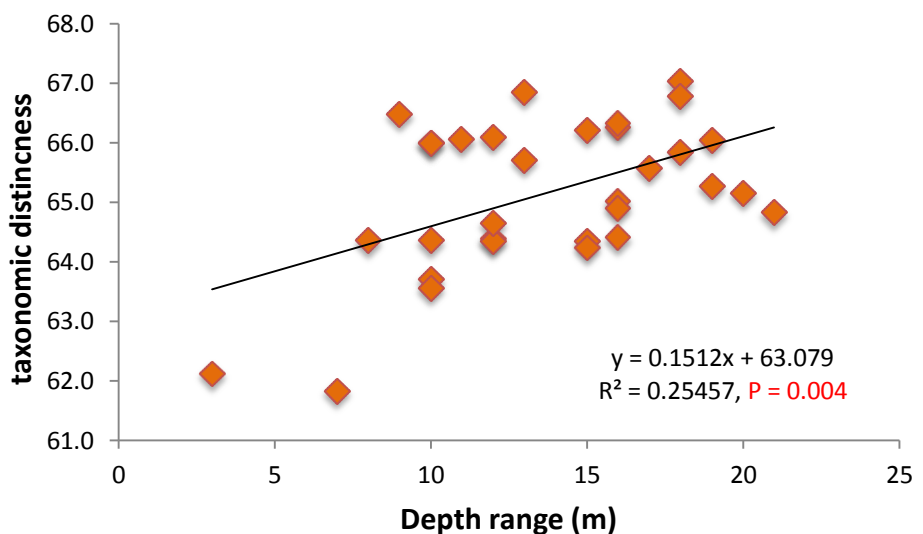
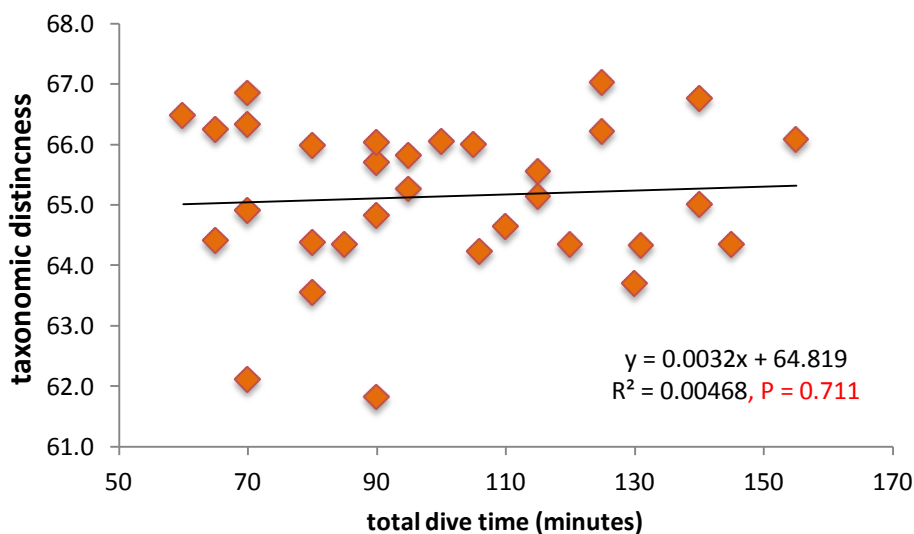
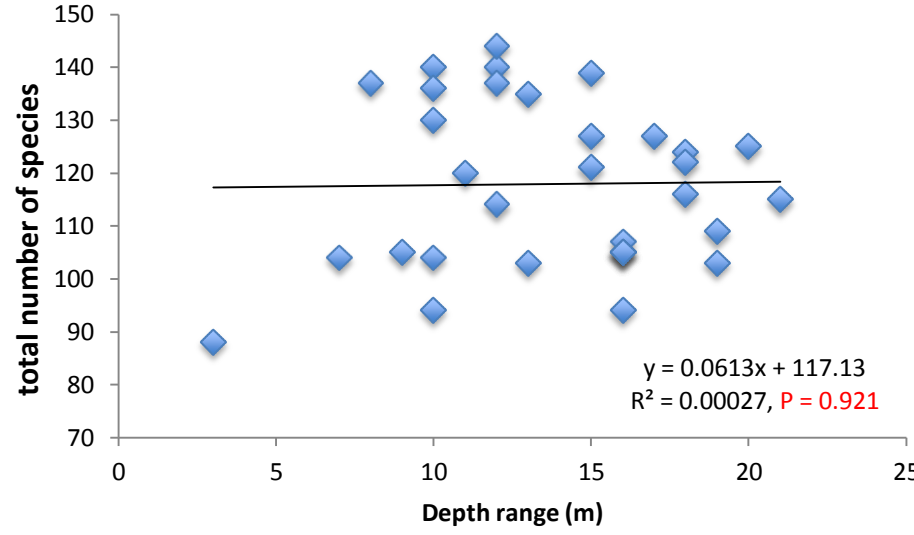
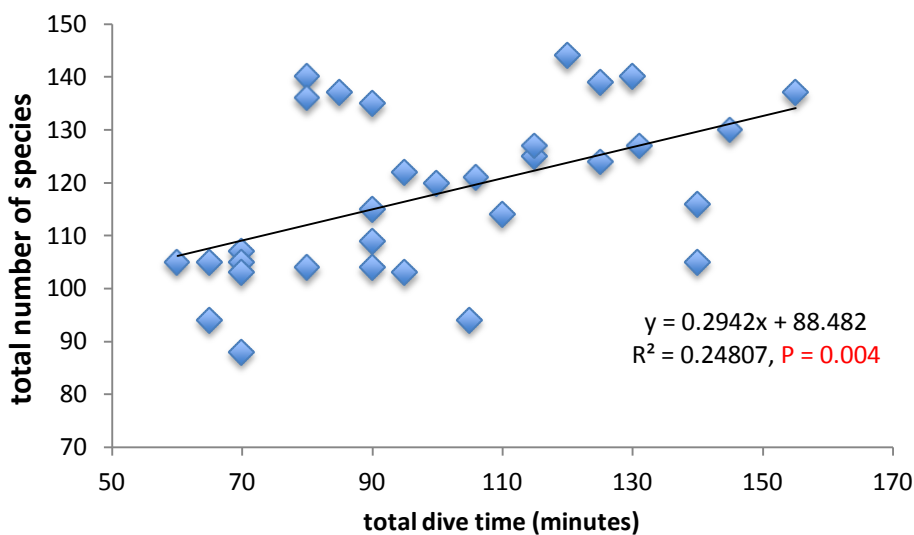
Study sites, main ocean currents



source: Schott

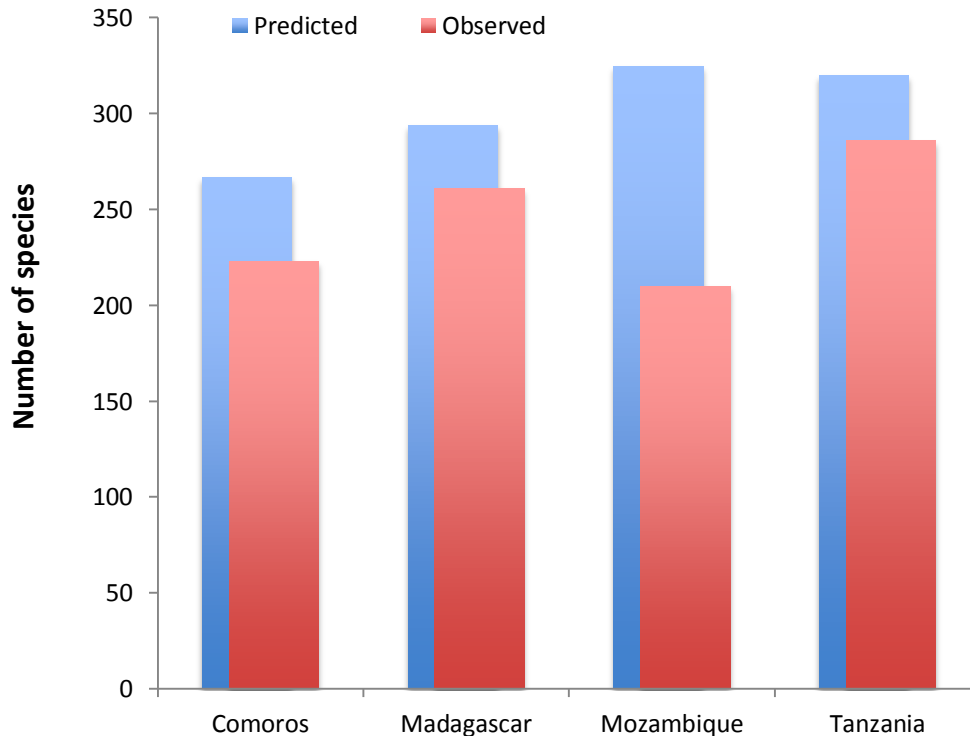
Order	Sub – Order	Families		CFDI	No.	10 coral reef	Spec -iose
Perciformes	Labroidei	Labridae (wrasse)	1	X	X	X	1
	Percoidei	Serranidae (groupers)	2				3
	Labroidei	Pomacentridae (damselfishes)	3	X	X	X	2
Perciformes	Percoidei	Chaetodontidae (butterfly fishes)	4	X	X	X	6
	Labroidei	Scarinae (parrot fishes)*	5	X		X	8
	Acanthuroidei	Acanthuridae (surgeon fishes)	6	X	X	X	7
	Percoidei	Lutjanidae (snappers)	7				10
	Percoidei	Pomacanthidae (angel fishes)	8	X			11
Perciformes	Percoidei	Lethrinidae (emperors)	9				13
	Percoidei	Haemulidae (grunts)	10				23
	Percoidei	Mullidae (goat fishes)	11			X	19
	Acanthuroidei	Siganidae (rabbit fishes)	12				21
	Percoidei	Nemipteridae (bream)	13				24
	Percoidei	Carangidae (trevally)	14			X	N/A
Perciformes	Percoidei	Caesionidae (fusiliers)	15				28
Tetraodontiformes	Tetraodontiformes	Balistidae (trigger fishes)	16				16
		Monacanthidae (file fishes)	17				14
ditto	ditto	Ostraciidae (box fishes)	18				25
		Tetraodontidae (puffer fishes)	19				18

Total number of species and taxonomic diversity VS TIME & DEPTH



Observed vs predicted number of species at Country level

Predicted number of species calculated using the Michaelis Menton index (Species accumulation curves were calculated using 9999 permutations)



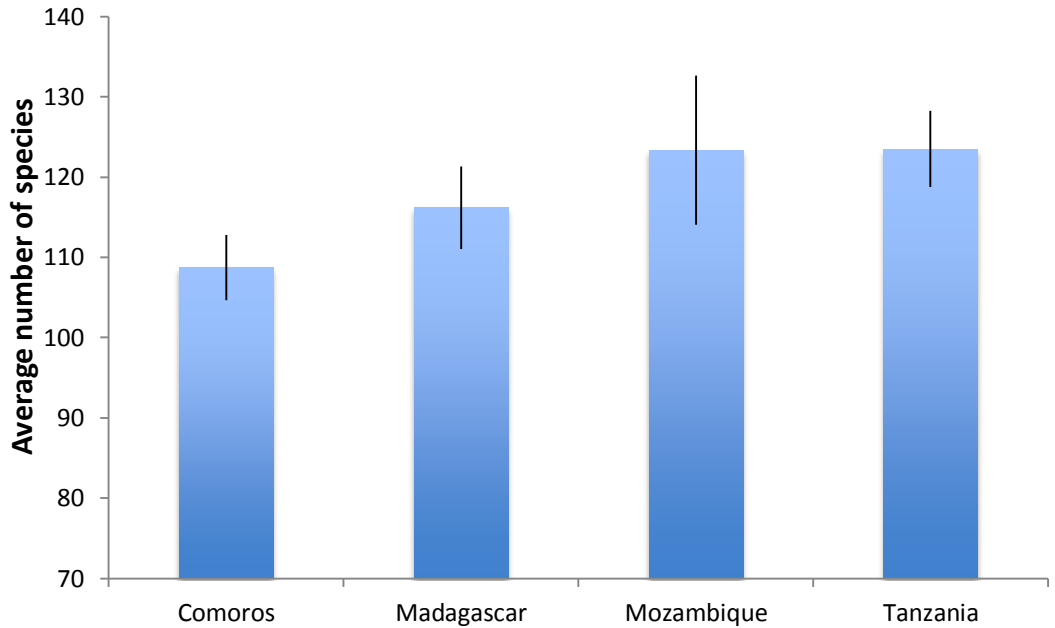
Marginal differences for Comoros (Chi-square = 3.9; df = 1; p = 0.049)

NO differences for Madagascar (Chi-square = 1.9; df = 1; p = 0.163)

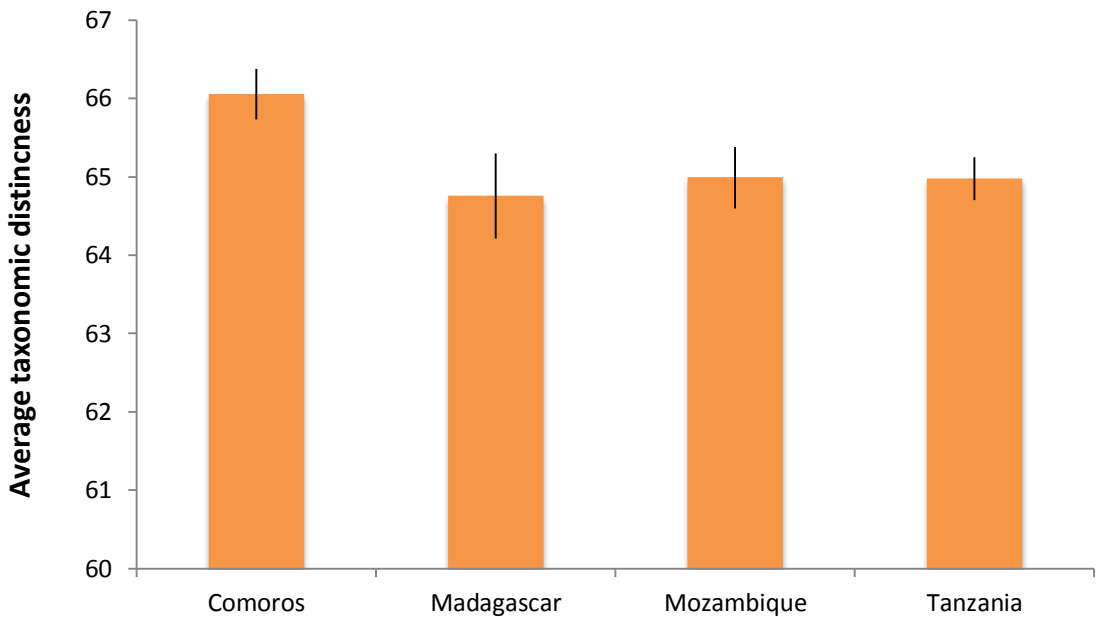
NO differences for Tanzania (Chi=1.8; df=1, p=.179)

VERY different for Mozambique: Chi= 24.56; df = 1; p = 7.2x10⁻⁷)

Mean no. species and taxonomic diversity by Country



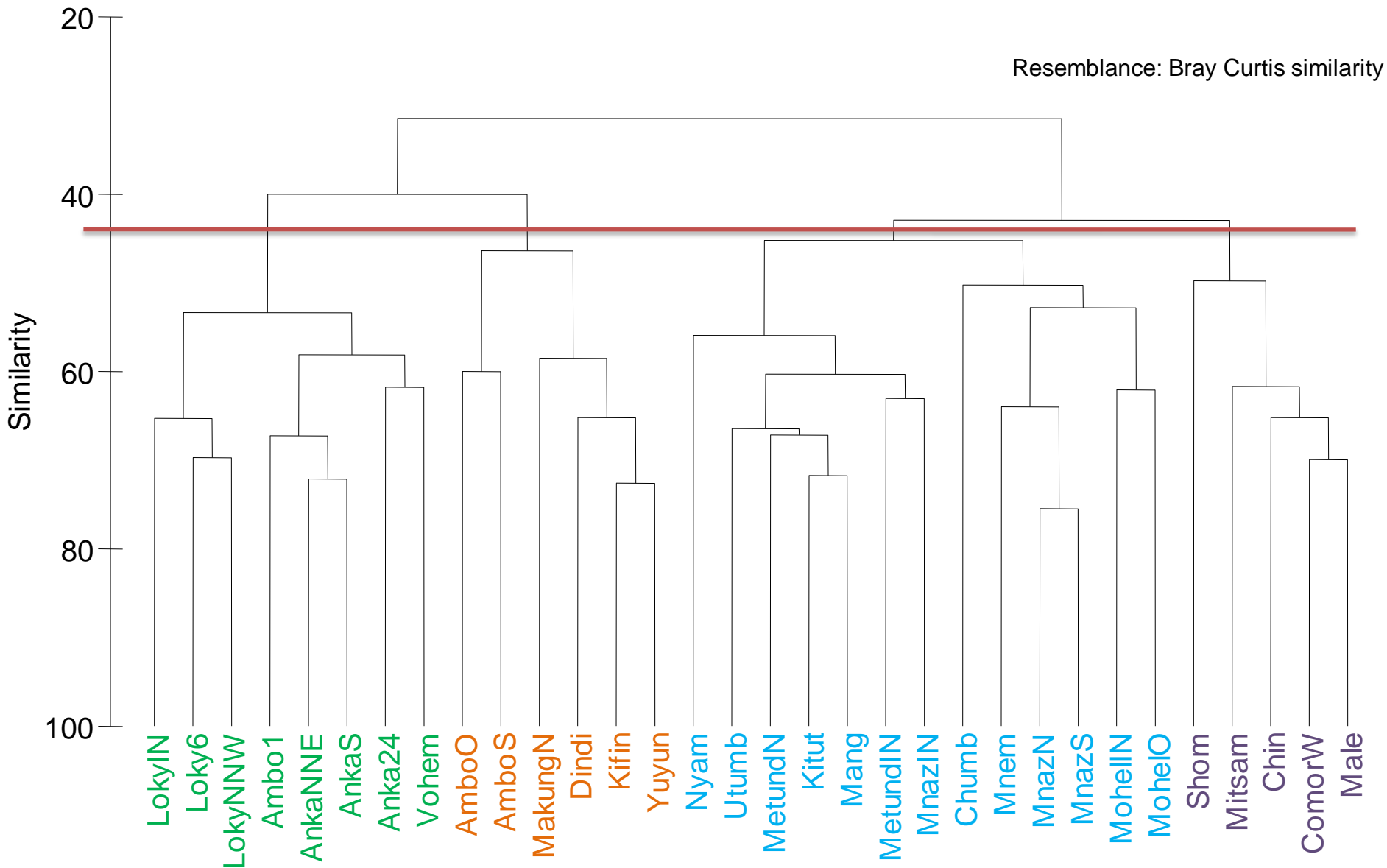
Spp diversity = no significant differences (Kruskal-Wallis test; $H = 4.34$; $p = 0.227$)



Taxonomic diversity = no significant differences (Kruskal-wallis test; $H = 4.99$; $p = 0.172$)



Dendrogram (cluster analysis) for all locations



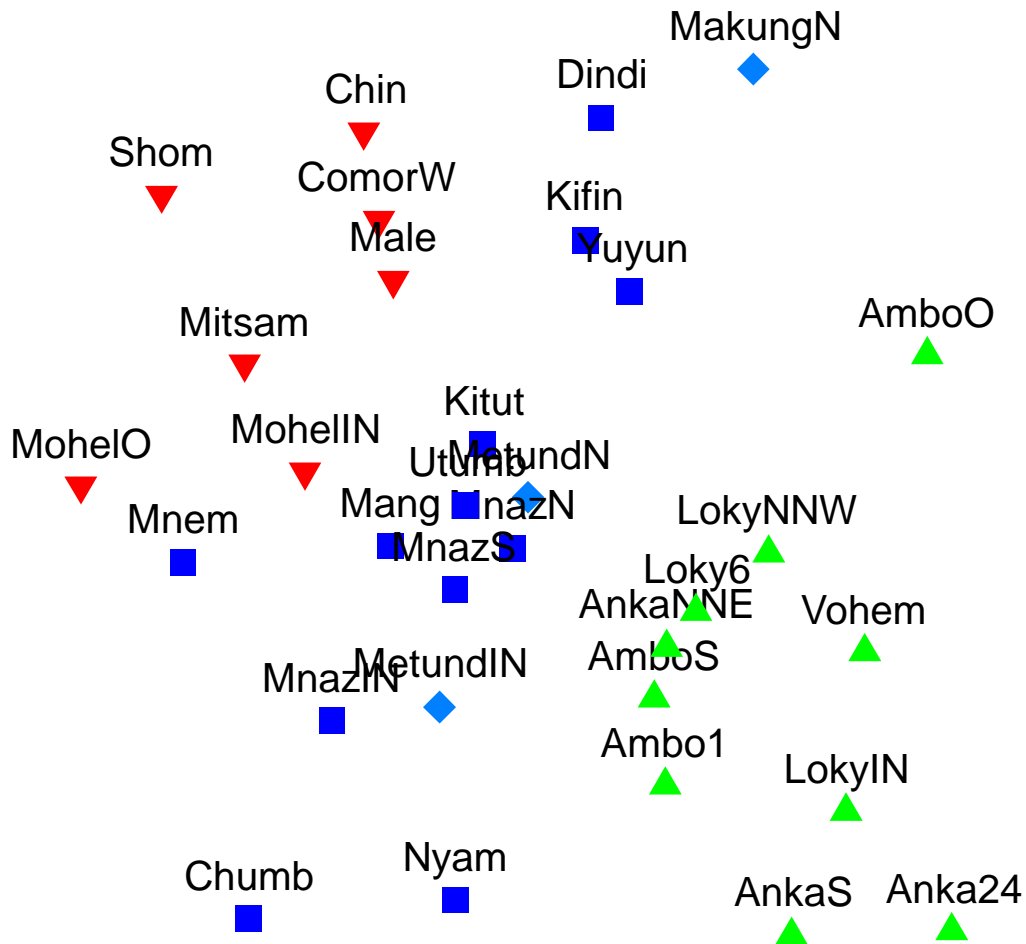
MDS for all diversity sites

Resemblance: Bray Curtis similarity

2D Stress: 0.18

Country

- ▲ Madagascar
- ▼ Comoros
- Tanzania
- ◆ Mozambique



ANOSIM by Country

there are no differences between Mozambique and Tanzania, therefore valid to group these sites into one single group – which we called ‘Mainland’

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Global Test
Sample statistic (Global R): 0.533
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)
Number of permuted statistics greater than or equal to Global R: 0

Pairwise Tests
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Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Madagascar, Comoros	0.864	0.1	19448	999	0
Madagascar, Tanzania	0.592	0.1	646646	999	0
Madagascar, Mozambique	0.545	1.4	286	286	4
Comoros, Tanzania	0.397	0.1	50388	999	0
Comoros, Mozambique	0.403	5	120	120	6
Tanzania, Mozambique	0.048	37.4	455	455	170

MDS for MAINLAND sites

Resemblance: S17 Bray Curtis similarity

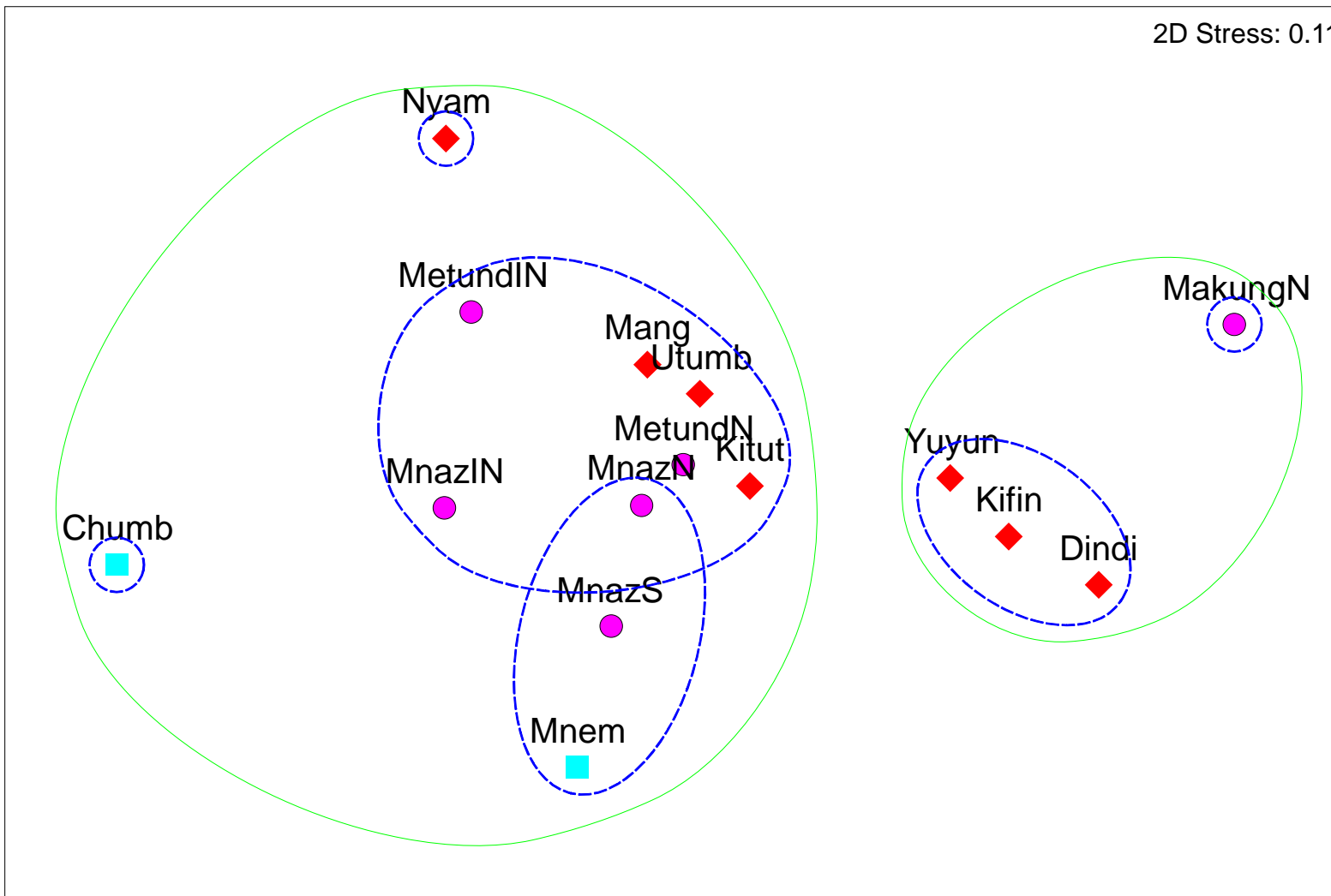
2D Stress: 0.11

Group4

- Chumbe
- Mafia
- Mnazi-Moza

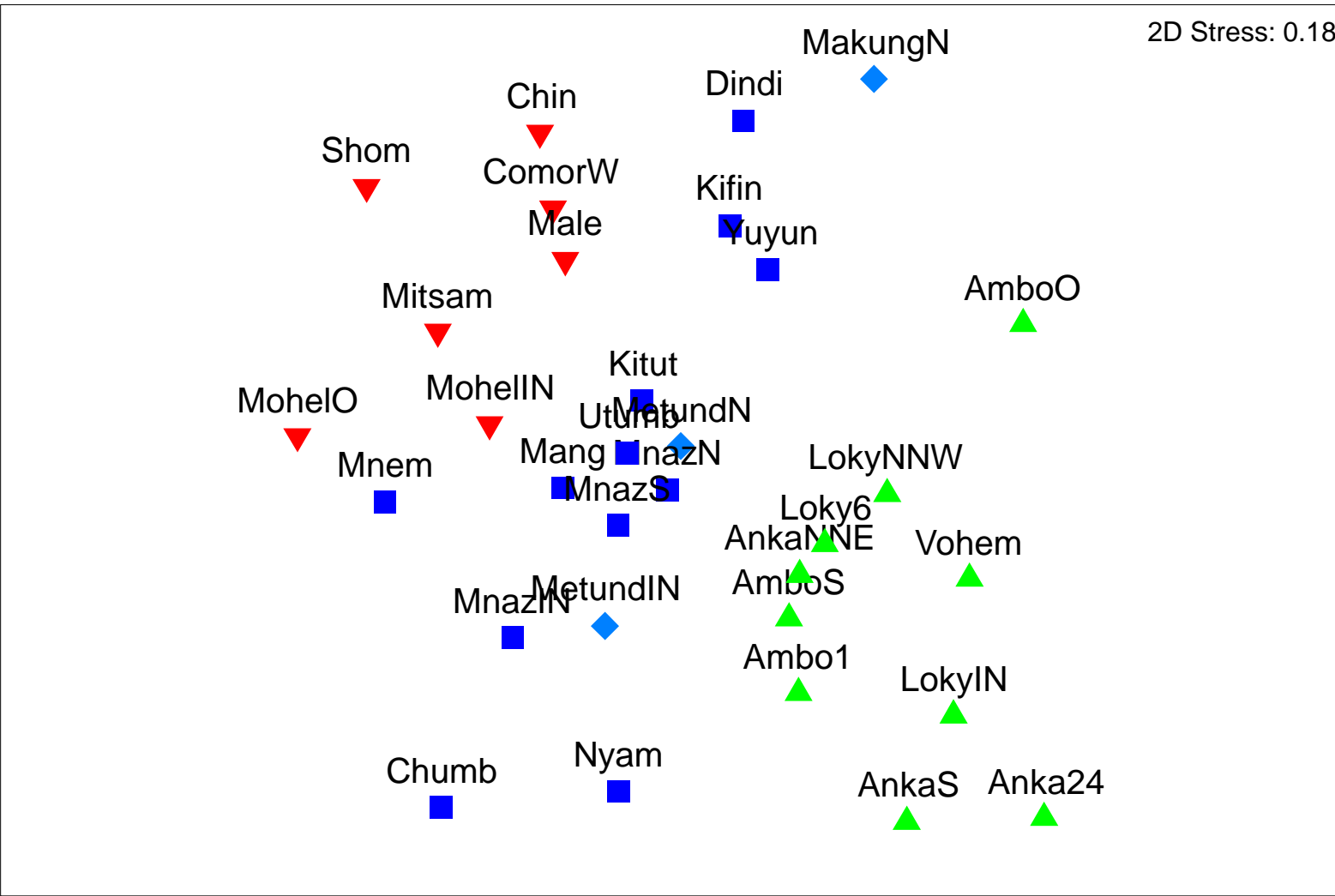
Similarity

- 40
- 60



MDS for all 33 sites

Resemblance: Bray Curtis similarity



Country

- ▲ Madagascar
- ▼ Comoros
- Tanzania
- ◆ Mozambique

ANOSIM (R):
 Significant differences between Madagascar, Comoros and Mainland (p<0.01-0.02)

Species driving the differences in diversity (SIMPER analysis)

Rank	Species	Average Dissimilarity (%)		
		Madagasc - Comoros	Madagasc - Mainland	Comoros – Mainland
1	<i>Plectropomus punctatus</i>	0.45		
2	<i>Plectorhinchus gaterinus</i>	0.41		
3	<i>Epibulus insidiator</i>	0.4		0.34
4	<i>Hipposcarus harid</i>	0.4		0.31
5	<i>Chaetodon vagabundus</i>	0.4	0.36	
6	<i>Anampses twistii</i>	0.39	0.39	
7	<i>Neoglyphidodon melas</i>	0.38		
8	<i>Scarus ghobban</i>	0.38		
9	<i>Chaetodon falcula</i>		0.38	
10	<i>Pygoplites diacanthus</i>	0.32	0.37	

Average abundance – proportion of sites present

Rank	Species	Range	COMOROS	MAINLAND	MADAGASCAR
1	<i>Plectropomus punctatus</i>	WIO	0	0.4	1
2	<i>Plectorhinchus gaterinus</i>	Red-WIO	0	0.47	0.9
3	<i>Epibulus insidiator</i>	Red-I-P	0	0.8	0.9
4	<i>Hipposcarus harid</i>	Red-WIO	0	0.73	0.9
5	<i>Chaetodon vagabundus</i>	Red - Pac	0	0.07	0.9
6	<i>Anampses twistii</i>	Red-I-P	0.86	0.93	0
7	<i>Neoglyphidodon melas</i>	Red - Pac	0.14	0.6	1
8	<i>Scarus ghobban</i>	Red - Pac	0.14	0.73	1
9	<i>Chaetodon falcula</i>	WIO	0.43	1	0.1
10	<i>Pygoplites diacanthus</i>	Red - Pac	0.71	0.87	0

Average abundance – proportion of sites sp. present

Rank	Species	Range	COMOROS	MAINLAND	MADAGASCAR
1	<i>Plectropomus punctatus</i>	WIO	0	0.4	1
2	<i>Plectorhinchus gaterinus</i>	Red-WIO	0	0.47	0.9
3	<i>Epibulus insidiator</i>	Red-I-P	0	0.8	0.9
4	<i>Hipposcarus harid</i>	Red-WIO	0	0.73	0.9
5	<i>Chaetodon vagabundus</i>	Red - Pac	0	0.07	0.9
6	<i>Anampses twistii</i>	Red-I-P	0.86	0.93	0
7	<i>Neoglyphidodon melas</i>	Red-I-P	0.14	0.6	1
8	<i>Scarus ghobban</i>	Red-I-P	0.14	0.73	1
9	<i>Chaetodon falcula</i>	WIO	0.43	1	0.1
10	<i>Pygoplites diacanthus</i>	Red-I-P	0.71	0.87	0

Example 1 – disappearance of reef associated species in Madagascar



Anampses twistii (wrasse) and *Pygoplites diacanthus* (angel fish) are both common and ubiquitous in the WIO (0.86 -0.93, and 0.71 - 0.87, respectively) yet not seen in NE Madagascar. But both listed by Gerry Allen as occurring in NW Madagascar in 2005.... Is this a recent disappearance? Is it related to coral degradation / bleaching? Or distribution does not include NE Madagascar? Is “near threatened” in Reunion (Fricke et al 2009)

Example 2 – disappearance of fishery species in Comoros



Plectropomus punctatus (grouper) and *Plectorhinchus gaterinus* (sweetlip) known to occur in Comoros yet not seen. These are fishery species. Are they going locally extinct due to overfishing? *P. gaterinus* reported as extinct from Reunion by Fricke.

Summary

- provides a significant dataset on presence/absence of > 350 species from 79 sites spread across 33 locations in 4 countries (13 more locations now from Mozambique)
- cannot yet test the hypothesis of a core region of high diversity centred around the northern Mozambique channel – data from more “peripheral” sites required

Summary

- underlying causes for differences in species diversity in this WIO region requires further analysis but results so far point to:
 - evolutionary history of species distributions is no doubt a driving factor - need proper analysis on range data; integrate info on currents (larval flow); connectivity (genetics)
 - significant fishing pressure in places, e.g. Comoros is masking natural differences in species assemblages
- Results will be useful to inform conservation action

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