

CORAL DIVERSITY AND EVOLUTION OF THE MOZAMBIQUE REEFAL MARGIN

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KEY FINDINGS

- The offshore Mozambique reef cores provide a unique opportunity to investigate coral diversity and reef development in association with sea-level and environmental changes over the past three glacial-interglacial cycles (~260 kyr).
- A total of 2,625 corals were identified in nine Mozambique cores (five drilled at ~94 m bsl, and four drilled at ~35 m bsl).
- Fifty distinct morpho-taxonomic groups, including 43 genera, were identified in the cores.
- Vertical variations in coral composition and reef facies reflect changes in sea level and environmental conditions over the past ~260 kyr.

INTRODUCTION

Coral reef systems serve as important natural archives for tracking historical sea-level shifts and environmental conditions. Because tropical coral reefs are highly responsive to changes in water chemistry and physical surroundings, they provide valuable insights into past climate and environmental variations. Shifts in factors like light availability and nutrient concentrations are often mirrored in the structure and composition of reef communities, as many reef-dwelling species are sensitive to even slight ecological disturbances.



Figure 1: Examples of well-preserved corals collected from the Mozambique cores. Over forty genera have been identified in the cores, mirroring the diversity of modern reefs in the Indian Ocean.

The last deglaciation has proven to be particularly interesting regarding coral reef development in response to sea-level and environmental change. Previous drilling projects have been conducted in Barbados (Fairbanks, 1989; Peltier and Fairbanks, 2006), around Tahiti (IODP Expedition 310; Camoin et al., 2007a, b, 2012), and off the Australian Great Barrier Reef (IODP Expedition 325; Webster et al., 2011; Yokoyama et al., 2011).

For example, the Tahiti sea-level record is based on the taxonomy and morphology of dominant and secondary coral colonies (branching, robust branching, massive, tabular, foliaceous, and encrusting) and associated biota including coralline algae, gastropods, and foraminifera (Camoin et al., 2007a). These authors use a robust branching *Acropora* and/or *Pocillopora* assemblage associated with mastophoroid coralline algae to constrain paleowater depths to within 6 m. Community transitions within a core may therefore represent reef response to changing paleoenvironmental conditions, but similar patterns may also be produced by ecological succession and vertical reef accretion, or lateral growth during sea-level stillstands. Homogeneous composition of framework facies within a given sequence may indicate the persistence of uniform environmental conditions, whereas repeated abrupt facies changes are interpreted to indicate lateral displacements of coral communities.

The reef cores recently obtained from offshore Mozambique provide another unique opportunity to investigate the nature of reef development and faunal change in association with sea-level and environmental fluctuations during past glacial to interglacial cycles.

DATA SET AND METHODS

A total of nine cores were drilled offshore Mozambique. Five cores (ES-101, ES-103, ES-107, ES-104 and ES-102) were drilled on the lower and more distal terrace at a depth of ~94 m. Core ES-101 was the deepest core and penetrated to a depth of 120.5 m. Four cores were drilled on the upper terrace at a depth of ~35 m. The deepest

Upper Terrace ~ 35 m bsl

- ES-10 (20 m)
- ES-11 (20.3 m)
- ES-5 (15.1 m)
- ES-4 (21.0 m)

Lower Terrace ~ 94 m bsl

- ES-101 (120.5 m)
- ES-102 (80.5 m)
- ES-103 (65 m)
- ES-104 (22.8 m)
- ES-107 (25.9 m)

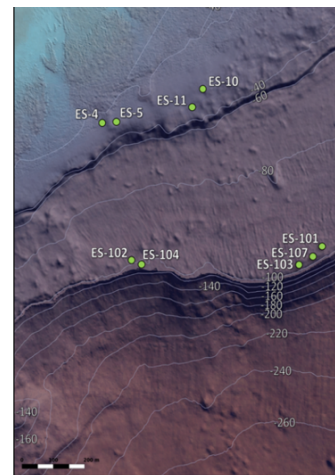
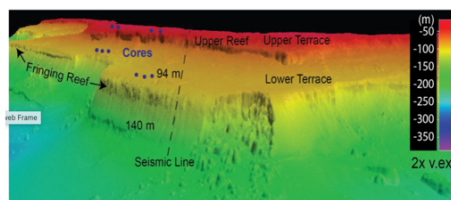


Figure 2: Map and digital elevation model showing the position of the nine cores drilled on the Mozambique shelf.

core on the upper terrace penetrated to a depth of 21 m (Figure 2). Visual inspection of the core material allowed for 2,625 corals to be identified to broad taxonomic groups (typically genera) and assigned growth form characteristics (branching, tabular, massive, free-living). Future petrographic analysis will help refine taxonomic identifications.

MAIN RESULTS

Reef Diversity

Preliminary assessments have identified 50 distinct morpho-taxonomic groups including 43 distinct genera (Figure 1, 3). The genera *Acropora*, *Porites*, and *Montipora* were divided into tabular, branching and robust growth forms. The cores were extracted in 1.5 m coring intervals, and when assessed by coring interval, diversity ranged from zero to seven taxa with an average of four taxa per 1.5 m coring interval. The dominant taxa identified in the cores including branching and robust *Acropora*, branching and massive *Porites*, and tabular *Montipora*. Vertical changes in coral composition can be recognized and likely reflect changes in sea level and reef environmental conditions.

Modern-day reefs from offshore Mozambique are extremely diverse. When assessed across all reef environments, modern surveys have identified 59 distinct genera. These genera show distinct zonation patterns and reflect clear environmental preferences of the diverse taxa. The documented diversity of the Mozambique cores is on par with modern diversity and provides important insight into the dominant reef-building taxa present in the region during the last three deglaciations.

Preliminary ages for Core ES-101 (120.5 m) range from 258 to 12 ka. The core shows an overall shallowing-upward succession with deeper forereef slope sands overlain by shallower forereef and reef crest deposits. The core is capped by a drowning succession where shallow reef deposits are unable to keep up with the pace of sea-level rise. The forereef slope sands are characterized by fluctuations in coral debris associated with the rise and fall of sea level from MIS 8 to MIS 2. Coral debris is higher during lowstands but decreases during highstands when the shallow reef deposits backstep inland. The overlying forereef deposits are characterized by abundant platy corals dominated by the genus *Montipora*. The reef crest deposits are dominated by robust growth forms of the genus *Acropora*. The overlying drowning succession is characterized by a transition from shallow backreef coral to overlying sediments with fewer corals.

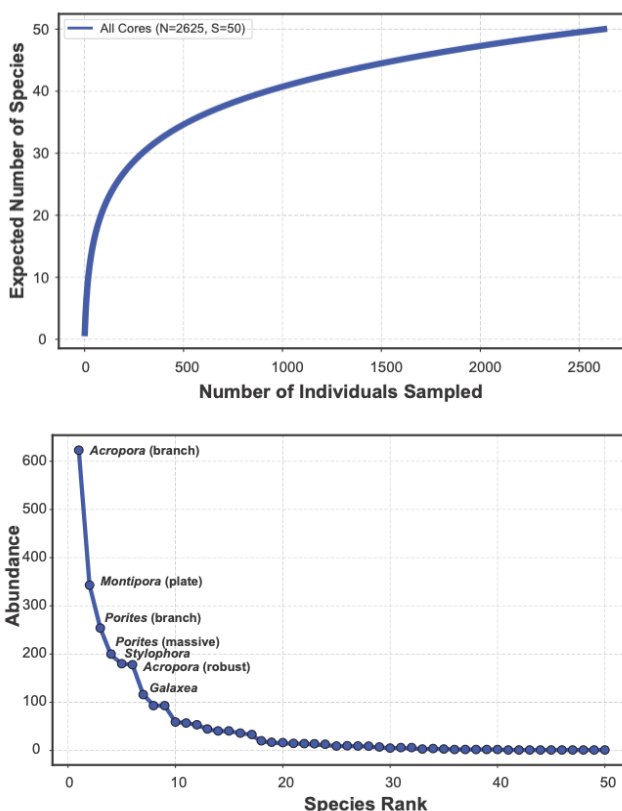


Figure 3: (top) Rarefaction curve showing the relationship of coral diversity to the number of individual corals sampled. (bottom) Rank-abundance plot for the entire coral dataset highlighting the dominant coral taxa.

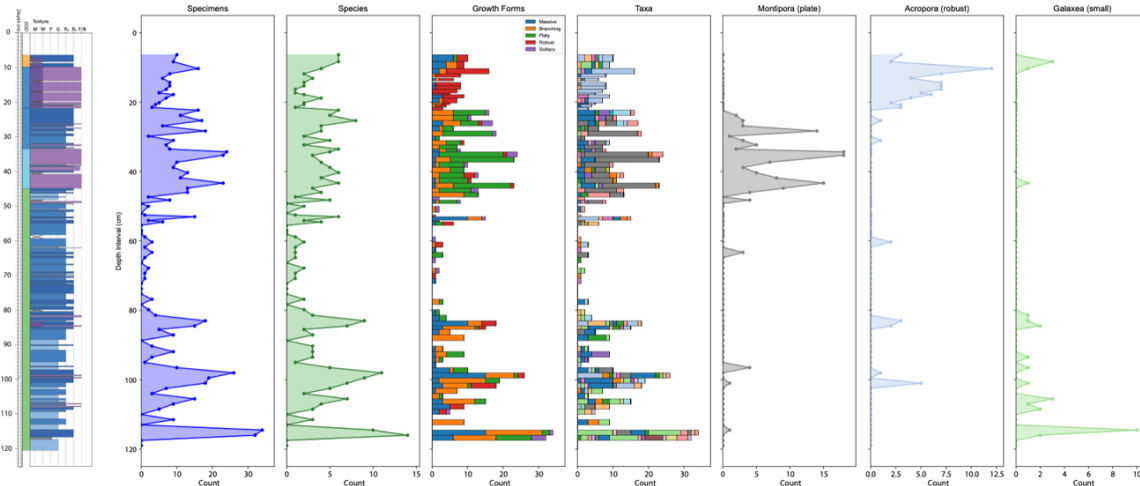


Figure 4: Summary plot of coral data from Core ES-101 showing the number of specimens counted, the number of taxa identified, the relative growth morphologies, and the distribution of the key indicator taxa *Montipora*, *Acropora*, and *Galaxea*.

REFERENCES

- Camoin, G.F., Iryu, Y., McInroy, D. and the Expedition 310 scientists (2007a) Proc. IODP, 310. Integrated Ocean Drilling Program Management International, Inc., College Station, TX. doi:10.2204/iodp.proc.310.101.2007.
- Camoin, G.F., Iryu, Y., McInroy, D. and the Expedition 310 scientists (2007b) IODP Expedition 310 reconstructs sea-level, climatic and environmental changes in the South Pacific during the Last Deglaciation. *Sci. Drill.*, 5, 4–12.
- Camoin, G.F., Seard, C., Deschamps, P., Webster, J.M., Abbey, E., Braga, J.C., Iryu, Y., Durand, N., Bard, E., Hamelin, B., Yokoyama, Y., Thomas, A.L., Henderson, G.M. and Dussouillez, P. (2012) Reef response to sea-level and environmental changes during the last deglaciation: Integrated Ocean Drilling Program Expedition 310, Tahiti Sea Level. *Geology*, 40, 643–646.
- Fairbanks, R.G. (1989) A 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the Younger Dryas event and deep-ocean circulation. *Nature*, 342, 637–642.
- Peltier, W.R. and Fairbanks, R.G. (2006) Global glacial ice volume and Last Glacial Maximum duration from an extended Barbados sea level record. *Quatern. Sci. Rev.*, 25, 3322–3337.
- Webster, J.M., Yokoyama, Y., Cotterill, C. and the Expedition 325 Scientists (2011) Proceedings of the Integrated Ocean Drilling Program Volume 325 Expedition Reports Great Barrier Reef Environmental Changes, Integrated Ocean Drilling Program Management International, Inc., for the Integrated Ocean Drilling Program.
- Yokoyama, Y., Webster, J.M., Cotterill, C., Braga, J.C., Jovane, L., Mills, H., Morgan, S., Suzuki, A. and Expedition 325 Scientists. (2011) IODP Expedition 325: Great Barrier Reefs reveals past sea-level, climate and environmental changes during the end of the last Ice age. *Sci. Drill.*, 12, 32–45.