# Threat of Fast-Growing Corallimopharian to Health of Corals Reef at Bawe and Changuu Islands, Zanzibar

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## ABSTRACT

Coral reefs globally face degradation from anthropogenic stressors, often shifting toward dominance by non-reef building organisms like Corallimorpharia. This study investigated 0distribution and competitive dynamics on the reefs of Bawe and Changuu Islands, Zanzibar, which experience differing human pressures. Benthic surveys using line intercept transects were conducted across reef zones in December 2023 and January 2024. Results showed hard coral dominance at both sites (Bawe: 62.1%; Changuu: 58.3%), with Porites as the predominant genus. Corallimorpharia cover was statistically similar between sites (Bawe: 12.4%; Changuu: 12.1%; p=0.45), with four species recorded*: Discosoma rhodostoma, D. nummiforme, D. unguja,* and *Ricordea yuma*. Spatial adjacency modeling revealed Corallimorpharia as disproportionately aggressive competitors, engaging in 34-37% of competitive encounters despite moderate cover. Direct contact with Corallimorpharia caused visible coral tissue mortality and bleaching. Correlation analysis identified *Physogyra* and *Plerogyra* as particularly vulnerable genera. Changuu exhibited significantly higher macroalgae cover (p = 0.0109), adding competitive pressure absent at Bawe. Although Corallimorpharia do not currently dominate these reefs, their persistent presence and competitive impacts on scleractinian corals suggest increasing pressure on reef-building communities. Management of land-based pollution and long-term monitoring are essential to prevent potential coral–Corallimorpharia phase shifts.

**Keywords:** Corallimorpharia, coral competition, reef health,

## INTRODUCTION

Coral reefs are among the most biologically diverse and productive ecosystems on the planet (Hoegh-Guldberg, 2011), providing essential ecological services including shoreline protection, fisheries support, and biodiversity conservation (Elliff and Silva, 2017). However, these ecosystems are increasingly threatened by a combination of local and global anthropogenic stressors such as overfishing, coastal development, eutrophication, sedimentation, and climate induced coral bleaching (Harrison, and Booth, D. J. 2007: Imran *et al*, 2025). As reef-building scleractinian corals decline under these pressures, many reefs are undergoing shifts toward alternative benthic states dominated by non-reef-building organisms (Reverter, *et al*., 2024).

Corallimorpharia are anthozoan cnidarians closely related to scleractinian corals but lack a calcareous skeleton (Fautin, Guinotte, and Orr, 2009). Although traditionally considered minor components of reef benthic communities, Corallimorpharia have increasingly been reported to expand in abundance and spatial dominance on degraded reefs (Kuguru, *et al*., 2004; Muhando, *et al*., 2002). In several reef systems worldwide, they have been observed to overgrow and displace hard corals, thereby altering reef structure, reducing habitat complexity, and potentially compromising ecosystem function (Sebens, 1994).The ecological success of Corallimorpharia has been attributed to a suite of biological traits, including rapid growth rates, clonal propagation (Chadwick and Adams, 1991), high tolerance to environmental stressors such as elevated nutrient levels and turbidity, and potential chemical or allelopathic defenses against competitors and predators (Parr, 2019). Corallimorpharia frequently colonize dead coral substrates, rubble, and rocky surfaces (Vroom, 2016). Corallimorpharia are capable of adapting to global climate changes (Kuguru, Fine and Tchernov, 2012), and they can withstand high

temperatures, sedimentation and low pH (oceanic acidification) (Wall *et al.*, 2015). Corallimorpharia can withstand high temperatures for an extended time while protecting their zooxanthellae from extreme irradiation (Kuguru *et al.*, 2007; Kuguru *et al.*, 2008)

**Ideal conditions for Corallimorpharia growth**

Disturbances on coral reefs caused by both natural and anthropogenic stressors often lead to declines in hard coral cover and the proliferation of Corallimorpharia. Natural disturbances such as predator outbreaks, tropical storms, cold fronts, warming events, disease outbreaks and hurricanes can damage coral colonies and create open substrate that favours Corallimorpharia expansion (Chadwick and Morrow, 2010). Anthropogenic pressures further intensify these impacts by altering water quality and ecosystem structure. Elevated nutrient levels from terrestrial runoff, agricultural fertilizers, and urban pollution enhance Corallimorpharia growth by increasing food availability and reducing competition from nutrient-sensitive hard corals (Muhando *et al.,* 2021). Poor land-use practices, destructive fishing techniques, and pollution contribute to changes in reef biota, including the reduction of herbivorous grazers that normally limit benthic overgrowth, thereby indirectly promoting Corallimorpharia dominance (Bruno *et al.,* 2009; Work, Aeby and Maragos, 2008). In addition, reduced water visibility and increases in nutrient concentrations influence the growth, distribution, and competitive success of Corallimorpharia on degraded reefs (Muhando *et al.,* 2002; Kuguru *et al.,* 2004).

Climate change further amplifies conditions that favor Corallimorpharia over reef-building corals. Corallimorpharia exhibit a high capacity to tolerate and adapt to climate-related stressors, including elevated temperatures, increased sedimentation, and decreased pH associated with ocean acidification (Kuguru, Fine and Tchernov, 2012; Wall *et al.,* 2015). They can withstand prolonged thermal stress while maintaining functional symbioses with their zooxanthellae and protecting them from extreme solar irradiation (Kuguru *et al.,* 2007; Kuguru *et al.,* 2008). As climate change increases the frequency and intensity of coral bleaching and mortality, Corallimorpharia are able to rapidly occupy available space and outcompete recovering corals. Although their resilience allows them to persist under harsh environmental conditions, the dominance of Corallimorpharia is typically associated with declining reef health, reduced structural complexity, and lower overall biodiversity

**Effect of Corallimorpharia on coral reefs**

Corallimorpharia are strong competitors among benthic organisms for space, potentially encroaching on coral habitats. (Muhando *et al.*, 2021), Inhibits the fecundity, recruitment, and survival of coral, this implies that Corallimorpharia may disrupt the natural reproductive and population dynamics of corals, potentially leading to declines in coral abundance and diversity. (Chadwick and Morrow, 2010) unfortunately causing the death of corals, this is likely due to the competition for space, as well as potential allelopathic effects or physical damage caused by Corallimorpharia (Chadwick and Adams, 1991) Bawe and Changuu Islands, located off the coast of Zanzibar, provide an opportunity to examine Corallimorpharia dynamics across reefs exposed to differing levels of human pressure while Bawe Island experiences relatively lower direct anthropogenic influence, Changuu Island is subject to higher levels of tourism, fishing activity, and coastal runoff. Comparing these two sites allows for an assessment of how varying degrees of human disturbance influence

This study aims to investigate the distribution and abundance of Corallimorpharia on the reefs of Bawe and Changuu Islands, characterize species composition, examine interactions with scleractinian corals, and assess the potential competitive pressure exerted by Corallimorpharia on coral reef communities. By improving understanding of Corallimorpharia ecology in the context of anthropogenic stress, this research contributes to broader efforts to predict and manage reef community shifts in a rapidly changing marine environment.

## MATERIALS AND METHODS

**Study Area**

The study was conducted at two reef sites in Unguja Island, Zanzibar. The data was collected at three points at each study site. Bawe (6°09’72.3"S, 39°08’19.2"E, 6°09’07.2"S, 39°08’24.3"E, 6°09’30.8"S, 39°08’08.8"E) and Changuu (6°06’55.1"S, 39°10’02.0"E, 6°07'01.9"S 39°10'04.8"E, 6°07'09.1"S 39°10'12.5"E). Changuu Island

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is situated close to Stone Town and is exposed to urban runoff and tourism activities, while Bawe Island is located further offshore with relatively lower anthropogenic influence.

### Sampling design and Data Collection

Three randomly selected stations were marked at each study site. 18 line intercept transects (LITs) with 20m in length used in each study area, which were randomly laid across the three reef zones i.e. reef slope, reef crest, and reef flat. Sampling was conducted in December 2023 and January 2024. LIT technique for measuring *p*ercentage cover of benthic categories and the frequency of competitive interactions was estimated from the LIT cover data through the application of a spatial adjacency probability model. This analytical method serves as a statistical inference, with the total and relative numbers of competitive encounters being derived from the observed benthic community composition.

### Statistical Analysis

Coral and Corallimorpharia species were identified. Percentage cover for benthic categories, coral genera, and competitor taxa was calculated. Statistical tests (t-tests) were used to compare cover between sites, and correlation analyses examined relationships between coral genera and competitors.

## RESULTS

### Benthic categories

The benthic categories in both study sites takes into consideration the all that touched on transect.

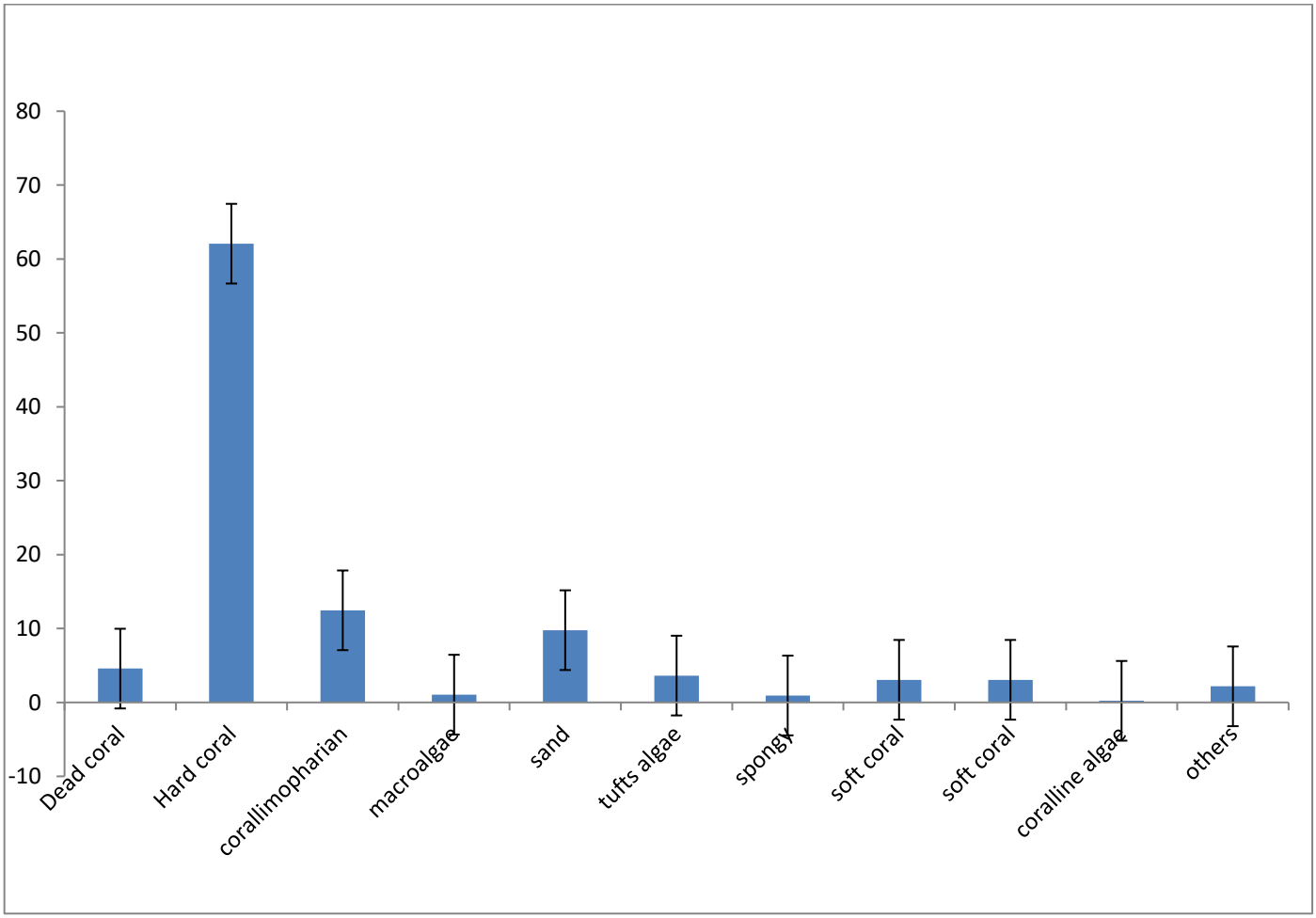


**Figure 1 Benthic cover of Bawe**

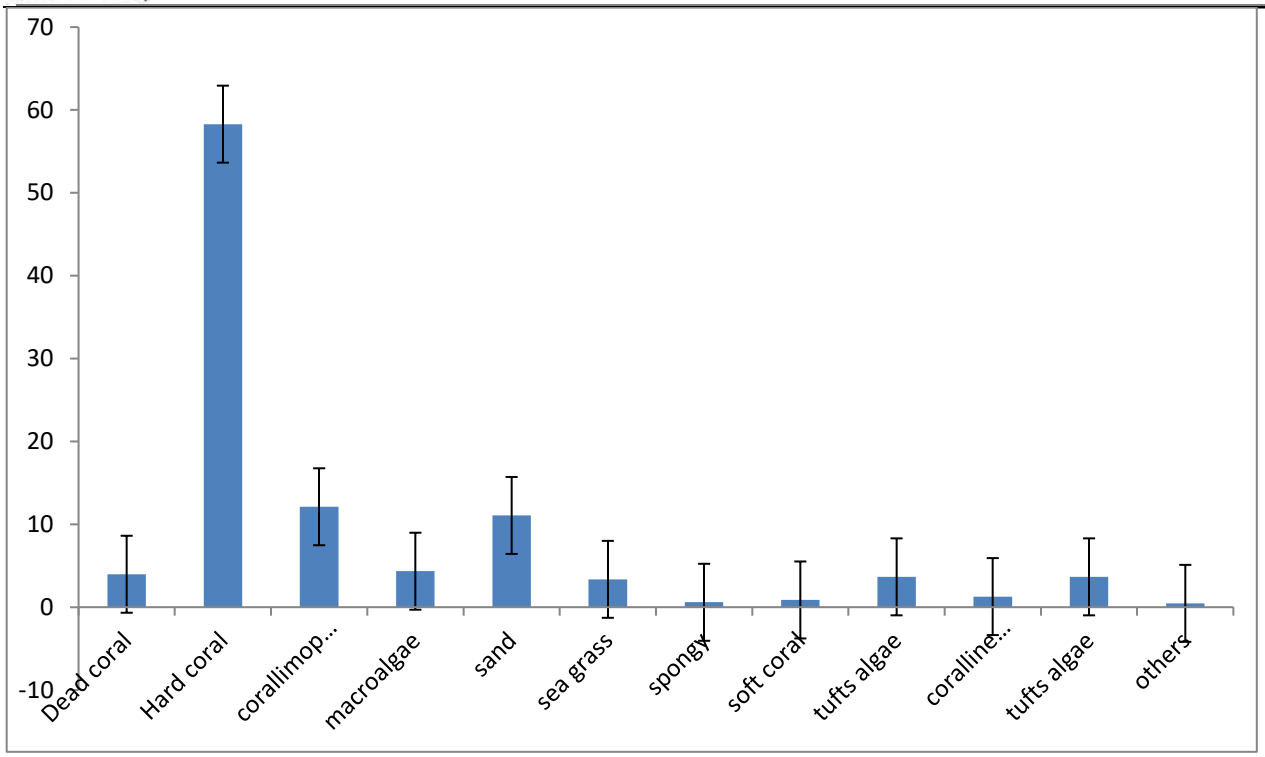


**Figure 2 Benthic cover of Changuu**

Dominance of Hard Corals: Hard corals represent the most dominant benthic category at both sites, with a slightly higher percentage at Bawe 62.1% compared to Changuu 58.3% (Figure 1 and Figure 2). This indicates that both sites are coral-dominated reefs, emphasizing their significance as critical habitats for marine biodiversity.

Corallimorpharia cover was slightly higher at Bawe Island (12.4%) than at Changuu Island (12.1%); however, this difference was not statistically significant ($p = 0.45$, $p > 0.05$). Overall, Corallimorpharia cover remained relatively low at both study sites, have a comparable level of Corallimorpharia presence across the reefs**.**

Macroalgae Cover; Changuu had significantly higher macroalgal abundance ($p = 0.0109$), caused by nutrient pollution from Stone Town's sewage and intensive tourism, which fuels macroalgal growth (Simba, 2026). Sand Cover; Changuu had higher sand cover (11.06%) than Bawe (9.78%) the contributed by sediment input from urban runoff and sewage. Seagrass Cover; Changuu had recorded seagrass cover (3.36%). Bawe had no seagrass observed in the surveyed transects. Sponge abundance was low at both islands.

**Coral Community**

A total of 24 coral genera were recorded across Bawe and Changuu, representing 12 families. Of these, 11 families were found on both islands, indicating a shared baseline of coral diversity between the sites, one unique ***Dendrophylliidae*** was recorded exclusively at Changuu. *Porites* was overwhelmingly dominant at both sites, accounting for 60% of coral cover at Bawe and 45.7% at Changuu (Figures 3 and Figures 4). This dominance likely reflects the high tolerance of *Porites*.

**Table 1 Families and genera recorded during the reef survey**

| **Family** | **Genera** |
|---|---|
| Acroporidae | Acropora[1] , Montipora[1] |
| Agariciidae | Leptoseris[2] , Pavona[1] |
| Dendrophyliidae | Turbinaria[3] |
| Euphyllidae | Euphyllia[1] |
| Faviidae | Favia[1] , Favite[2] , |

| | |
|---|---|
| Fungiidae | Diaseris[2], Fungia[1], Halomitra[1], Heliofungia[1], Herpolitha[1] |
| Merulinidae | Echinopora[1] , Oulphyllia[3],Platygra[1], Goniastrea[3], Mycedium[2] |
| Lobophylliidae | Lobophyllia[1] , |
| Oculinidae | Galaxea[1] |
| Pocilloporidae | Pocillopora[1] |
| Plerogyridae | Plerogyra[1], Physogyra[1] |
| Poritidae | Porites[1] |

**Note: 1 = both (Bawe and Changuu) , 2 = in Bawe and 3 = Changuu**

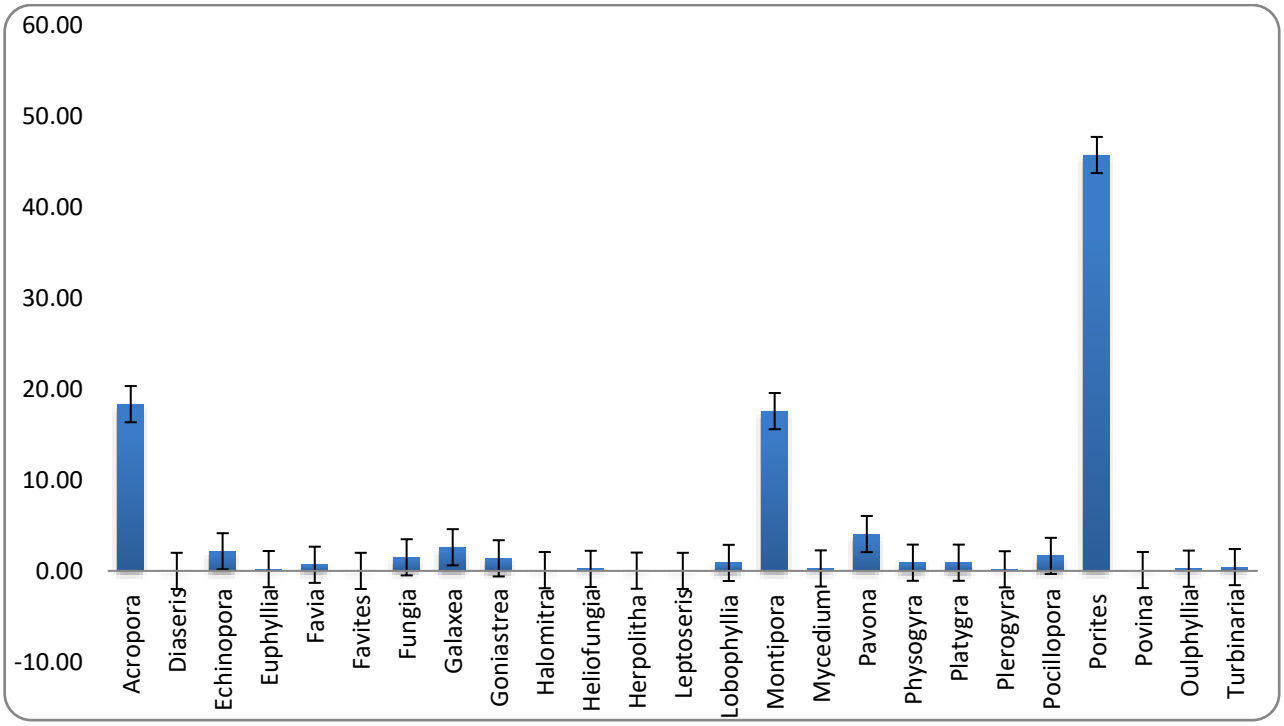


**Figure 3. Percentage cover of coral genera found in Changuu.**

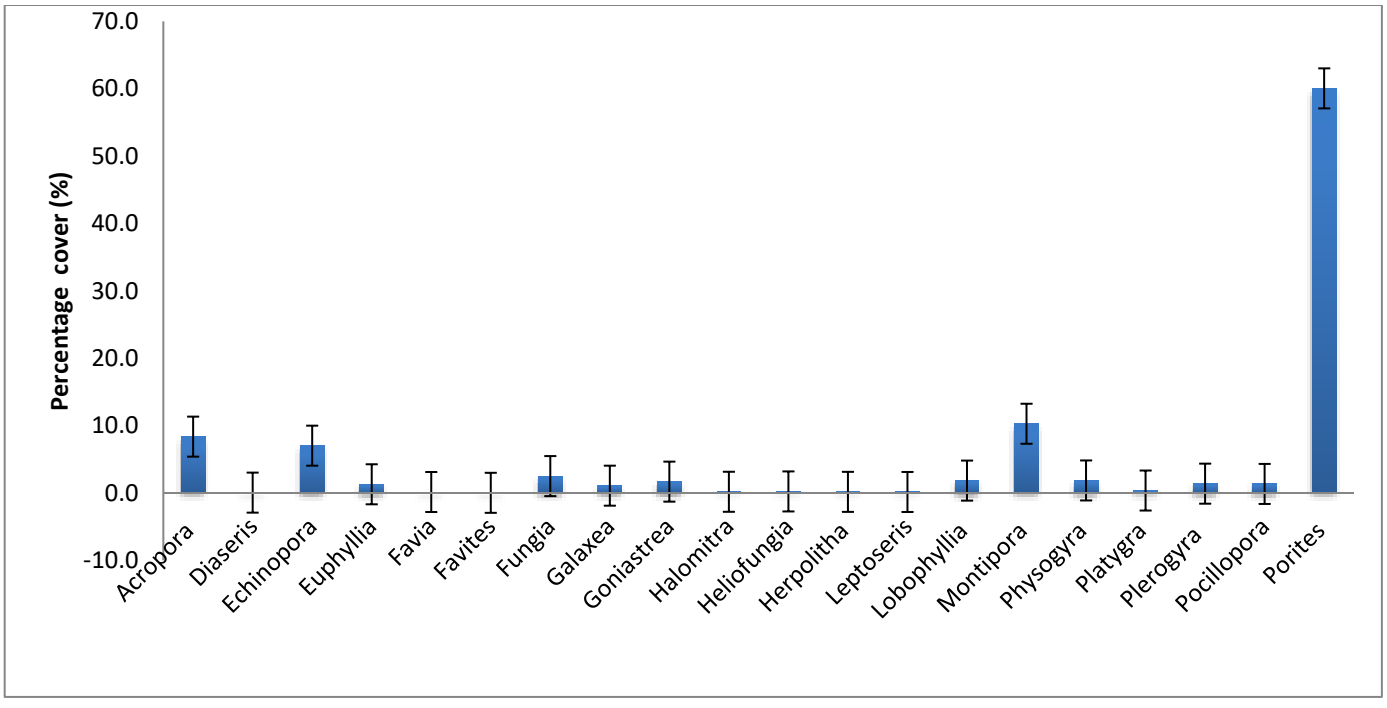


**Figure 4. Percentage cover of coral genera found in Bawe**

**Corallimorpharia Diversity and Distribution**

Corallimorpharia; Four Corallimorpharia species were recorded at both Changuu and Bawe Islands: *Discosoma rhodostoma* (Rhodactis), *D. nummiforme*, *D. unguja*, and *Ricordea yuma*. These species were observed across surveyed reef habitats at both sites

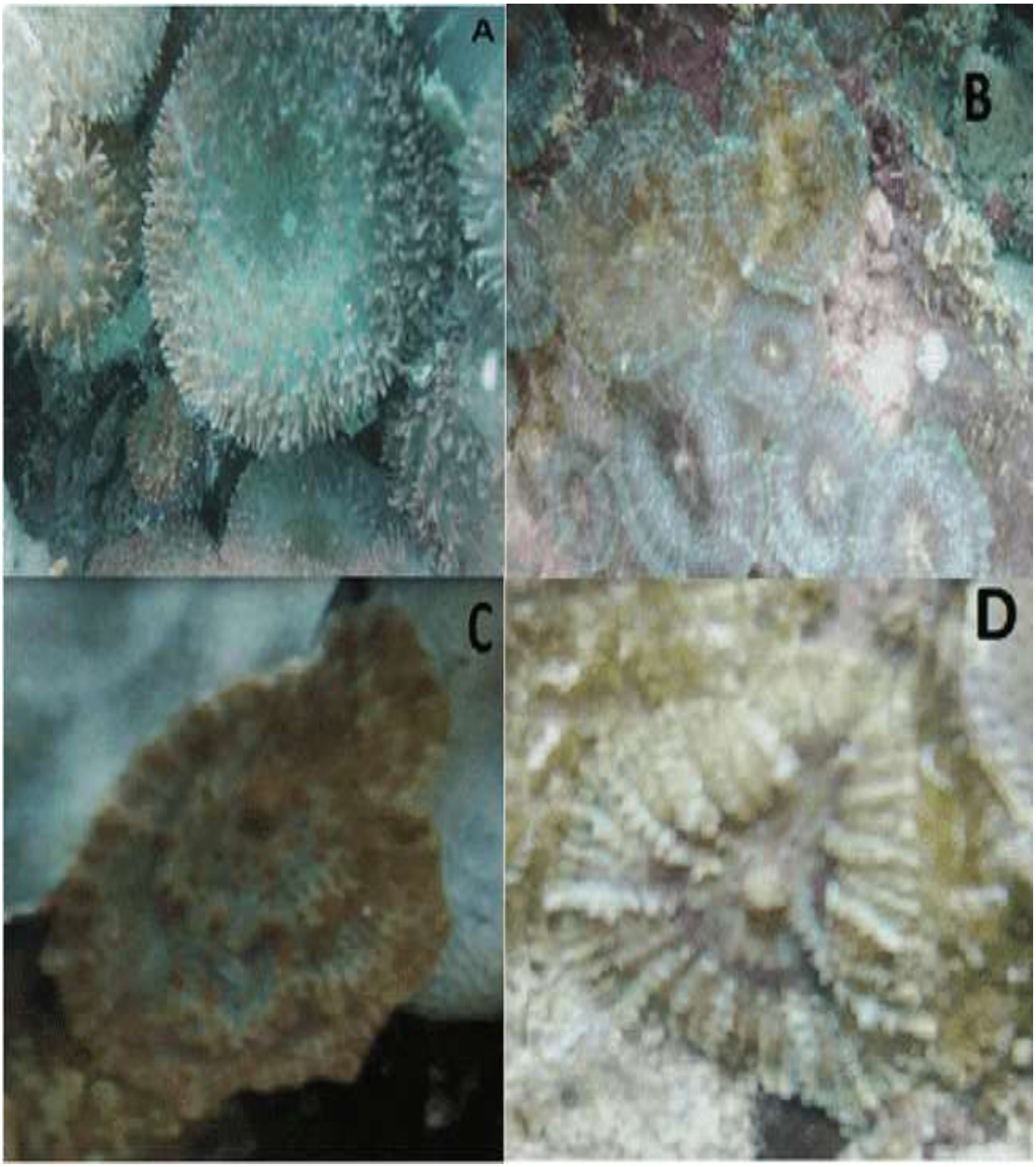


Plate 1 (A) *Discosoma rhodostoma (rhodactis),* (B) *D. nummiforme,* (C) *D. unguja* and (D) *Ricordea yuma*.

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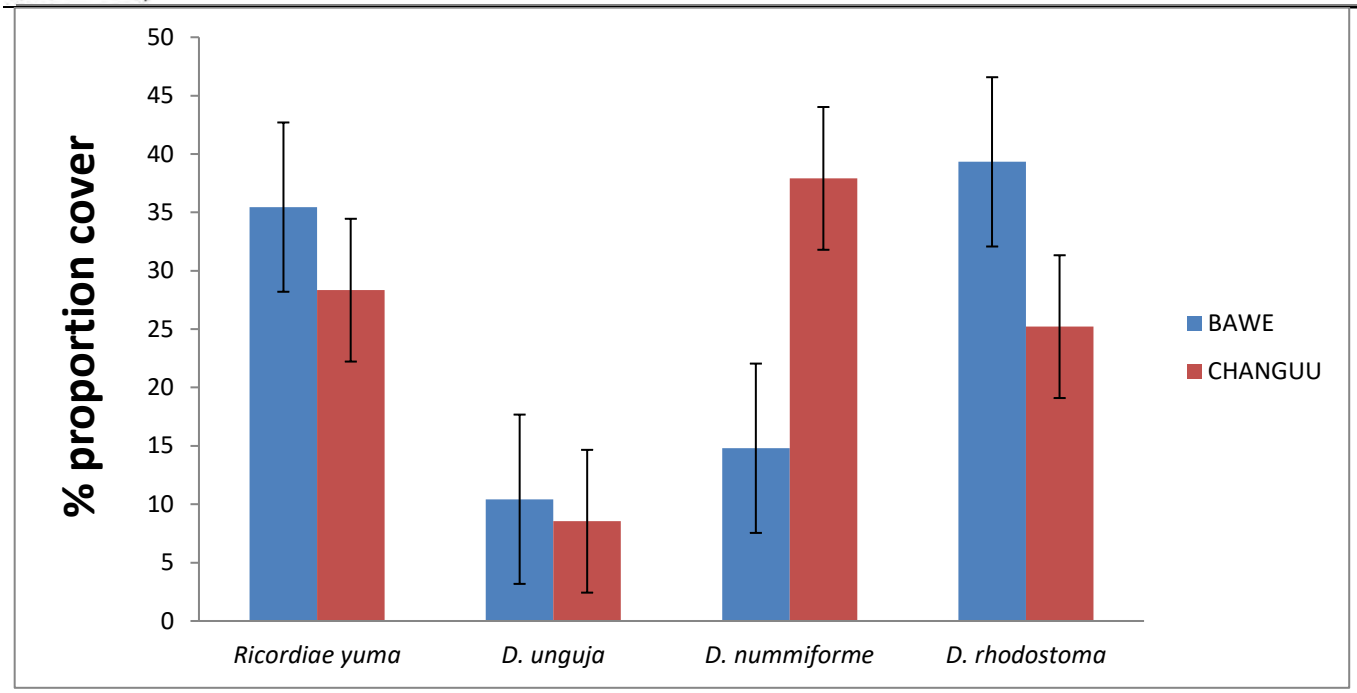


**Figure 5 Percentage cover of Corallimorpharia in the study site.**

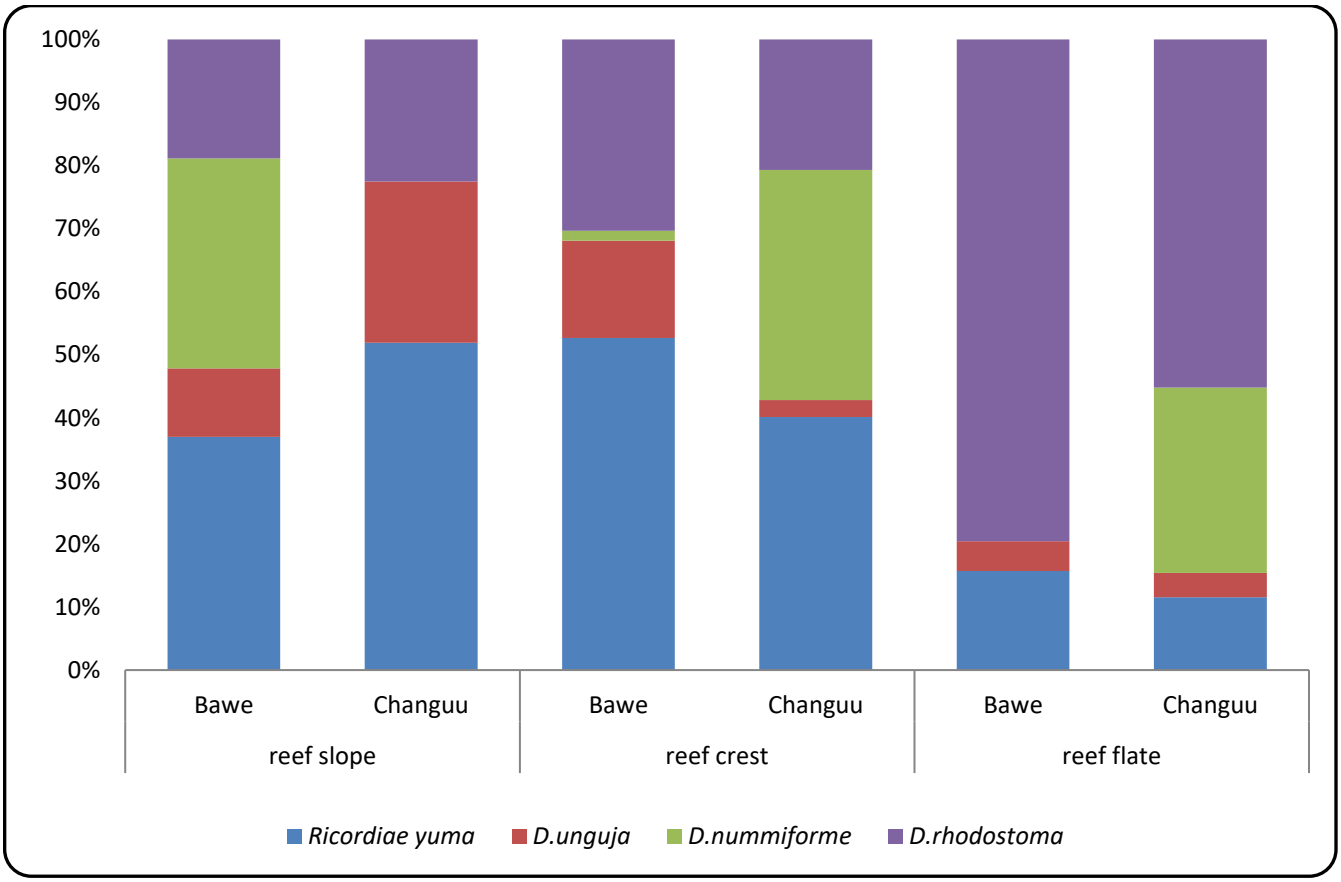


**Figure 6. Percentage covers of Corallimorpharia in reef**

Bawe has a higher proportion cover of *Ricordea yuma* and *D.rhodostoma*, while Changuu dominated by *D.nummiforme* whereas *D.unguja* has minimal presence in both locations. Corallimorpharia cover was 12.4% at Bawe and 12.1% at Changuu, with no significant difference between sites ($p = 0.45$). The findings show that with time, the percentage cover of Corallimorpharia at Changuu and Bawe changed, at Changuu decreased slightly, from 13.2% to 12.1% and Bawe increased from 10.2% to 12.4% as reported by (Kuguru *et al.*, 2004).

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**Coral– Corallimorpharia Interactions**

Coral tissue mortality and bleaching were observed at direct contact zones between corals and Corallimorpharia (Plate 2). Affected corals exhibited localized tissue loss, partial bleaching, and in some cases complete colony mortality at points of contact. These impacts were recorded where Corallimorpharia directly met or touched coral colonies, resulting in visible damage along the contact margins.


**Plate 2.** Effect of Corallimorpharia on coral tissue; coral tissue damaged along contact zones.(Changuu)

**Competitive interactions on Coral reef Ecosystem**

Table 3 Comparative Competitive Interactions (Bawe vs. Changuu)

| Metric | Bawe Island | Changuu Island |
|---|---|---|
| Total Competitive Interactions | 42,087 | 45,150 |
| Hard Coral Encounters | 33,896 (80.5%) | 35,007 (77.6%) |
| Corallimorpharia Encounters | 15,712 (37.3%) | 15,337 (34.0%) |
| Macroalgae Encounters | 1,504 (3.6%) | 5,979 (13.2%) |
| Tufts Algae Encounters | 5,045 (12.0%) | 5,075 (11.2%) |
| Spongy Encounters | 1,340 (3.2%) | 843 (1.9%) |

A spatial adjacency analysis of benthic cover data (n = 36,000 points) at Bawe Island, Hard coral as the dominant benthic group, it is the primary space holder followed by Corallimorpharia with disproportionately high rate given its 12.4% cover, confirming its role as the most aggressive and impactful competitor, then Tuft Alga whereas Microalgae and Sponges < 4%

The spatial adjacency model applied to Changuu Island's benthic data (n = 36,000 points) the competitive interactions**,** a higher overall frequency of encounters compared to Bawe. While hard corals remained the most competitive for landscape. Corallimorpharia were again a dominant force, but their relative impact was slightly lower than at Bawe. The most striking contrast was the role of macroalgae, a value over three times greater than at Bawe. Tuft algae maintained a consistent role (about 11-12% of interactions at both sites), while sponges played a minor part. This comparative analysis reveals that while both reefs are characterized by intense

competition involving Corallimorpharia, Changuu experiences a more diffuse competitive regime where macroalgae pose a significant additional pressure, likely driven by localized eutrophication

**Relationship between Corallimorpharia and Coral Genera**

Coral Genera at Bawe: Correlation analysis at Bawe Island identified variation in r-values among coral genera. The highest correlation coefficients were recorded for Physogyra ($r = 0.5748$, $p = 0.013$), Porites ($r = 0.457$, $p = 0.057$), and Plerogyra ($r = 0.339$, $p = 0.168$). Intermediate R-values were observed for Fungia ($r = 0.239$, $p = 0.340$), Echinopora ($r = 0.227$, $p = 0.365$), Euphyllia ($r = 0.209$, $p = 0.311$), Diaseris ($r = 0.207$, $p = 0.408$), Favites ($r = 0.207$, $p = 0.408$), Halomitra ($r = 0.192$, $p = 0.444$), and Lobophyllia ($r = 0.187$, $p = 0.881$). Lower correlation coefficients were associated with Montipora ($r = 0.171$, $p = 0.497$), Platygyra ($r = 0.169$, $p = 0.502$), Galaxea ($r = 0.143$, $p = 0.138$), Favia ($r = 0.132$, $p = 0.599$), Heliofungia ($r = 0.106$, $p = 0.675$), Leptoseris ($r = 0.067$, $p = 0.791$), Herpolitha ($r = 0.065$, $p = 0.798$), Goniastrea ($r = 0.059$, $p = 0.814$), Pocillopora ($r = 0.0875$, $p = 0.73$), and Acropora ($r = 0.046$, $p = 0.855$) and at Changuu the highest correlation coefficients were recorded for Physogyra ($r = 0.596$, $p = 0.009$), Plerogyra ($r = 0.514$, $p = 0.029$), Acropora ($r = 0.416$, $p = 0.086$), and Pavona ($r = 0.34$, $p = 0.167$). Intermediate r-values were observed for Fungia ($r = 0.261$, $p = 0.295$), Heliofungia ($r = 0.261$, $p = 0.296$), Halomitra ($r = 0.252$, $p = 0.314$), Galaxea ($r = 0.203$, $p = 0.419$), Montipora ($r = 0.172$, $p = 0.494$), Echinopora ($r = 0.155$, $p = 0.538$), Goniastrea ($r = 0.153$, $p = 0.544$), and Platygyra ($r = 0.152$, $p = 0.547$). Lower correlation coefficients were associated with Porites ($r = 0.135$, $p = 0.593$), Povina ($r = 0.132$, $p = 0.602$), Turbinaria ($r = 0.132$, $p = 0.602$), Favia ($r = 0.1001$, $p = 0.693$), Pocillopora ($r = 0.087$, $p = 0.73$), Lobophyllia ($r = 0.056$, $p = 0.823$), Herpolitha ($r = 0.042$, $p = 0.870$), Euphyllia ($r = 0.034$, $p = 0.894$), Mycedium ($r = 0.008$, $p = 0.974$), and Oulophyllia ($r = 0.008$, $p = 0.974$).

# DISCUSSION

**Reef condition and benthic dominance**

The dominance of hard corals, particularly *Porites*, at both sites is a proof to their resilience. *Porites* constituted 60% of coral cover at Bawe and 45.7% at Changuu, these reefs remain structurally function as coral-dominated ecosystems. Slightly higher coral cover at Bawe suggests comparatively lower disturbance levels

**Corallimorpharia expansion and ecological implications**

The comparable and persistent cover of Corallimorpharia at both Bawe and Changuu confirms their established role in the reef ecosystem, with a temporal increase at Bawe, expansion due to under favourable conditions. Direct evidence of coral tissue mortality and bleaching at contact zones demonstrates their potent competitive impact, which is likely driven by a suite of aggressive strategies including rapid growth, allelopathy, and morphological advantages. Crucially, spatial adjacency modelling quantified that Corallimorpharia are a stronger spatial competitor than macroalgae at both sites, implicating them as a primary agent of biotic interaction capable of driving long-term shifts in benthic community composition, particularly if their expansion is further facilitated by environmental stressors like elevated nutrients and turbidity. CCorallimorpharia are highly prevalent than other competitors can grow quickly, overcoming macroalgae and sponges. The capacity of Corallimorpharia to outcompete and outgrow nearby organisms may be influenced by their morphology of extended tentacles and polyps, may contribute better access to light and nutrients compared to other reef organisms.

# CONCLUSION

Corallimorpharia are established competitors on the reefs of Bawe and Changuu Islands. Although they do not currently dominate benthic communities, frequent direct-contact interactions with scleractinian corals were observed, resulting in tissue mortality and localized colony loss. These interactions indicate increasing competitive pressure on reef-building corals. Continued proliferation of Corallimorpharia, particularly under conditions of elevated nutrient input, sedimentation, or reduced herbivory, may enhance their competitive advantage and increase the risk of coral–Corallimorpharia phase shifts. Long-term ecological monitoring,

together with effective management of land-based stressors, is therefore essential to limit further expansion and maintain reef community structure.

**Conflict of interest**

There is no any kind of engagement interest in this study.

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