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Coral community structure of reef flat-building corals in the intertidal zone of Sicogon Island, Philippines

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ABSTRACT

This study assessed genus-level coral community structure of reef flat-building corals in the intertidal zone of Brgy. Alipata, Sicogon Island, Carles, Iloilo, a coastal area within the Coral Triangle with limited published data on coral assemblages. Three 50-m transects were surveyed using 1 × 1 m photo-quadrats at 5-m intervals to characterize coral composition and relative abundance across the study site. A total of 15 genera were presumptively identified, including *Porites, Acropora, Dipsastrea, Platygyra, Goniastrea, Alveopora, Oculina, Psammocora, Stylophora, Pocillopora, Palythoa, Pavona, Seriatopora, Turbinaria, and Oulophyillia.* Community structure indices (Simpson, Shannon-Weiner, and Pielou's Evenness) indicated low to moderate genus-level diversity with strong dominance by *Porites*, a pattern characteristic of intertidal reef-flat environments. This study provides crucial initial characterization of coral community structure that can serve as ecological reference data for future monitoring and conservation planning in Sicogon Island.

KEYWORDS

baseline data, conservation management, spatial heterogeneity, marine biodiversity, Visayan Sea

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Corals are among the Earth's most diverse, productive, and extensively researched ecosystems (Brandl et al. 2019). Their complex three-dimensional structures, built by various benthic organisms like reef-building corals, sponges, bryozoans, and cnidarians, create diverse habitats that support an exceptional range of marine life from all kingdoms (Montano 2020). This inherent complexity makes coral reefs crucial for marine biodiversity.

Despite their immense ecological and economic value, intertidal coral reef communities worldwide face escalating pressures. These include localized impacts from coastal development and human activities (Lamb et al. 2018, as cited in Clemente et al. 2024), as well as broader threats such as global warming, severe storms, overfishing, and marine pollution (Zhao et al. 2019). Given these vulnerabilities, assessing coral community structure and diversity is crucial for evaluating the ecological condition of coral reefs (Lin et al. 2020). In the Philippines, coral reefs have unfortunately been in decline since the first periodic report in the 1970s by Gomez and Alcala, a trend further noted by Panga et al. (2021). From 1976 to 1981, a nationwide project evaluated 632 stations, revealing that only 5% were categorized as 'excellent,' with live coral cover (both soft and hard) exceeding 75% (Gomez et al. 1981, as cited in Licuanan et al. 2019). While the complex underwater landscape and geological evolution of the Philippine archipelago suggest the probable emergence of distinctive coral community structure, studies on coral community structure in the country remain limited, with scarce recent information on reef status (Feliciano et al. 2023). Such assessments are essential for understanding the current condition of

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coral communities at local scales and for informing site-specific conservation efforts. Sicogon Island, part of the Visayan Sea and a popular tourist destination in Carles, Iloilo, is known for its clear waters and white sand beaches, hosting a purportedly pristine marine environment. A previous study by Clarito (2017) assessed coral cover and fish abundance on the island, highlighting those fringing reefs offshore of Brgy. Alipata and Brgy. San Fernando exhibited good coral cover, while two sites in Brgy. Buaya (Timberland and Purok 2) were in fair condition. However, published studies describing the taxonomic composition and community structure of corals, particularly in intertidal reef-flat habitats of Sicogon Island, remain limited. This study was therefore undertaken to characterize the genus-level community structure of reef flat-building corals, including their composition, relative abundance, dominance, and evenness, in the intertidal zone of Sicogon Island.

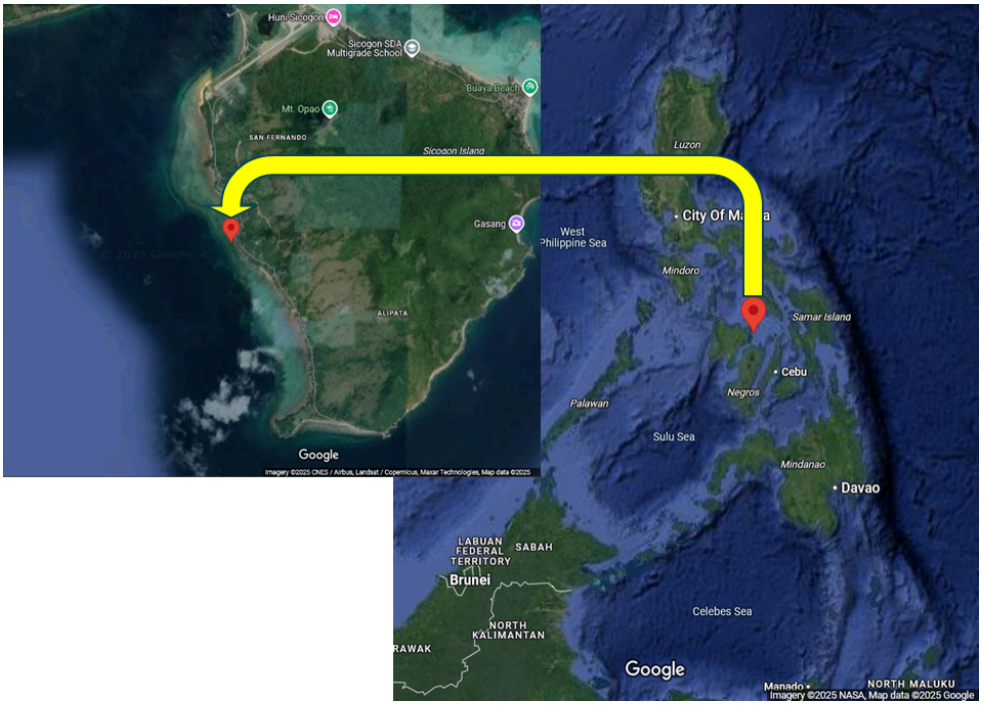

Figure 1. Overview map of the Philippines and Sicogon Island (Google Maps 2025).

Coral reef surveys were conducted on April 6, 2024, during low tide between 0400 and 0600 h to allow safe access to shallow intertidal reef-flat zones. Assessments were performed through snorkeling, with coral community structure evaluated using a combination of belt transects and photo-quadrats, following established reef monitoring protocols (Vito et al. 2019; Licuanan et al. 2020; Paz-Alberto et al. 2021; Urbina-Barreto et al., 2021; Rasher et al. 2024). Prior to the biological survey, in situ measurements of selected water quality parameters were recorded at the center of the study site to provide basic environmental context. Dissolved oxygen concentration was measured at 1.28 mg L^{-1}, and water temperature was recorded at 27.2 °C at the time of sampling. Three 50-m transect lines were randomly deployed parallel to the shoreline and spaced approximately 10 m apart within the intertidal reef flat. Along each transect, 1 m × 1 m quadrats were placed at 5-m intervals from 0 to 50 m, resulting in a total of 11 quadrats per transect. The transects were treated as replicate sampling units representing the intertidal coral community of the study site, rather than as independent treatments intended for comparative analysis. To document the presence and abundance of coral genera, high-resolution images of each quadrat were taken with a waterproof Samsung Galaxy A53 5G Android smartphone. The coordinates of the quadrats were recorded to allow for spatial referencing, data management, and future replication of this study (Licuanan et al. 2020) using a Garmin GPSMAP 64CSX device. The photographic quadrat data (from the photographs) were analyzed to provide a quantitative and qualitative summary of coral genera composition, relative abundance, dominance, and evenness within the study area that characterizes the structure of the coral community. Coral identification for this study was done from the photo-quadrat images taken as part of the

survey, with the photo-quadrat method being an established, widely accepted and non-destructive methodology for coral reef surveys (Rodriguez-Ramirez, et al., 2020). The coral genus level was determined based upon observable morphological characteristics such as the colony growth form, size, arrangement of corallites, structure of polyps, surface texture and colouration. The identification was done using commonly accepted field guides and online taxonomic databases (Veron, et al., 2016; WoRMS Editorial Board, 2024; Indo Ocean Project, 2022; Integrated Taxonomic Information System, 2024). Genus-level identification was adopted because photo-based surveys have limited resolution for distinguishing closely related coral species that require skeletal examination or microscopic analysis. Therefore, taxonomic assignments were restricted to genera that could be reliably differentiated from photographic records, ensuring consistency between identification methods and the level of analysis used in the study. As part of the data analysis, Simpson's Index of Dominance (D), Shannon–Wiener Diversity Index (H′), and Pielou's Evenness Index (J′) were calculated to quantify genus-level coral diversity, dominance, and community evenness in the intertidal reef-flat zone of Brgy. Alipata, Carles, Iloilo.

Where (Simpson 1949):

$$D = 1 - \left(\frac{\Sigma ni(ni-1)}{N(N-1)}\right)$$

D' - Simpson Dominance Index,

ni - number of individuals of species (i),

N - total number of individuals of all species

Diversity index will be calculated using the Shannon Wiener formula (Shannon 1948):

$$H' = -\left(\Sigma \frac{ni}{N} ln \frac{ni}{N}\right)$$

where:

H' – Shannon-Wiener Diversity Index,

ni – number of individuals of Type I,

N – number of total individuals.

The evenness of a community can be represented by Pielou's evenness index (Pielou 1966):

$$J' = \frac{H'}{H'_{max}}$$

Where:

J' - Pielou's Evenness Index,

H' - Shannon-Weiner Diversity Index

H'-{max}- maximum possible value of (H') for a community of the same richness.

Following the general concept of taxonomic richness described by Tekwa et al. (2023), genus richness in this study was quantified as the number of distinct coral genera directly observed within the surveyed quadrats across all transects, based on photo-quadrat data.

Table 1 summarizes the genus-level composition and richness of corals recorded in the intertidal reef-flat zone of Brgy. Alipata, Carles, Iloilo. A total of 15 coral genera were identified across all surveyed transects, with 63 coral colonies recorded. The coral assemblage was strongly

dominated by *Porites*, which accounted for 29 colonies (approximately 46%) of the total observed colonies. Several other genera occurred at moderate abundances, including *Dipsastraea* (7 colonies), *Acropora* (5 colonies), and *Platygyra* (5 colonies). In contrast, most recorded genera were represented by one or two colonies, indicating a skewed abundance distribution characterized by few dominant taxa and many rare genera. This pattern reflects a genus-level coral community structure typical of shallow intertidal reef-flat environments. The remaining genera occurred at comparatively low abundances, further emphasizing the skewed distribution of coral abundance across the study site. *Pavona* was represented by four colonies, while *Stylophora* and *Pocillopora* each accounted for two colonies. Most recorded genera, including *Goniastrea, Alveopora, Oculina, Psammocora, Palythoa, Seriatopora, Turbinaria,* and *Oulophyillia*—were each represented by a single colony. Collectively, these patterns indicate a coral assemblage characterized by strong dominance of a few genera and a high proportion of rare genera, reflecting uneven genus-level abundance within the intertidal reef-flat community (Aunkhongthonga et al., 2021).

Table 1. Genus-level diversity and richness of corals in the intertidal zone of Brgy. Alipata, Carles, Iloilo

Class	Order	Family	Genus	No. of Colonies
Anthrozoans	Scleractinia	Poritidae	*Porites*	29
Anthrozoans	Scleractinia	Acroporidae	*Acropora*	5
Anthrozoans	Scleractinia	Menilinidae	*Dipsastraea*	7
Anthrozoans	Scleractinia	Faviidae	*Platygyra*	5
Anthrozoans	Scleractinia	Agariciidae	*Pavona*	4
Anthrozoans	Scleractinia	Pocilloporidae	*Stylophora*	2
Anthrozoans	Scleractinia	Pocilloporidae	*Pocillopora*	2
Anthrozoans	Scleractinia	Merulinidae	*Goniastrea*	2
Anthrozoans	Scleractinia	Acroporidae	*Alveopora*	1
Anthrozoans	Scleractinia	Oculinidae	*Oculina*	1
Anthrozoans	Zoantharia	Sphenopidae	*Palythoa*	1
Anthrozoans	Scleractinia	Psammocoridae	*Psammocora*	1
Anthrozoans	Scleractinia	Pocilloporidae	*Seriatopora*	1
Anthrozoans	Scleractinia	Dendrophylliidae	*Turbinaria*	1
Anthrozoans	Scleractinia	Merulinidae	*Oulophyillia*	1
Total				**63**

Table 2 illustrates the spatial distribution of coral genera across the three transects established parallel to the shoreline. Four genera—*Dipsastraea, Porites, Acropora,* and *Platygyra*—were consistently recorded in all three transects, indicating a broad occurrence within the surveyed intertidal reef-flat area. *Pocillopora, Goniastrea,* and *Pavona* were present in two of the three transects, while the majority of recorded genera—*Oculina, Alveopora, Stylophora, Psammocora, Palythoa, Seriatopora, Turbinaria,* and *Oulophyillia*—were observed in only one transect. The distribution pattern observed across transects reflects within-site spatial heterogeneity in genus occurrence, a pattern that has also been reported for shallow intertidal and reef-flat coral assemblages in previous studies (Luo et al. 2022; Barott et al. 2024; Wang et al. 2023). It is noted that the transects were treated as replicate sampling units representing the study site, and no direct statistical comparison among transects was intended.

Table 2. Distribution of coral genera across transect lines

Family	Genus	Transect 1	Transect 2	Transect 3
Acroporidae	*Acropora*	+	+	+
Acroporidae	*Alveopora*	+	-	-
Merulinidae	*Dipsastraea*	+	+	+
Merulinidae	*Goniastrea*	+	+	-
Oculinidae	*Oculina*	+	-	-
Merulinidae	*Oulophyillia*	-	+	-
Sphenopidae	*Palythoa*	-	+	-
Agaricidae	*Pavona*	+	+	-
Faviidae	*Platygyra*	+	+	+
Pocilloporidae	*Pocillopora*	+	+	-
Poritidae	*Porites*	+	+	+
Psammocoridae	*Psammocora*	+	-	-
Pocilloporidae	*Seriatopora*	-	+	-
Pocilloporidae	*Stylophora*	+	-	-
Dendrophylliidae	*Turbinaria*	-	-	+
	Total	11	11	5

Note: Present (+), Absent (–)

Table 3 presents the calculated diversity indices for the surveyed transects, providing a quantitative description of genus-level coral community structure in Brgy. Alipata, Carles, Iloilo. Simpson's Index of Dominance (D), which reflects the probability that two randomly selected colonies belong to the same taxonomic group, yielded a value of D = 0.7665. Higher D values indicate stronger dominance by one or a few taxa and correspondingly lower community diversity (Vito et al. 2019). Based on the interpretative ranges presented in Table 3, this value indicates low genus-level diversity due to pronounced dominance within the coral assemblage. The Shannon–Wiener Diversity Index (H′), which incorporates both taxonomic richness and evenness, yielded a value of H′ = 1.967. According to established classification thresholds (Table 3), this value corresponds to very low genus-level diversity at the study site (Meng et al. 2024). Pielou's Evenness Index (J′), which measures the uniformity of colony distribution among taxa, produced a value of J′ = 0.7266. This value falls within the range interpreted as high evenness, indicating that colonies were relatively evenly distributed among the recorded coral genera despite overall low diversity (Meng et al. 2024).

Table 3. Diversity indices in all transects

Indices	Value	Interpretation
Simpson's Index of Dominance (D)	0.7665	Low Diversity
Shannon-Wiener Diversity Index (H')	1.967	Very Low
Pielou's Evenness Index (J')	0.7266	High Evenness

Note: **Simpson's Index of Dominance (D)**: Ranges from 0 to 1. A high value indicates high dominance (low diversity), while a low value indicates low dominance (high diversity). Interpretation: No diversity (1), Very Low diversity (0.81–0.99), Low diversity (0.61–0.80), Moderate diversity (0.41–0.60), High diversity (0.01–0.40), Very High diversity (0.00–0.009). **Shannon–Wiener Diversity Index (H')**: Genus-level diversity was interpreted as follows: very high (≥ 3.50), high (3.00–3.49), moderate (2.50–2.99), low (2.00–2.49), and very low (≤ 1.99); **Pielou's Evenness Index (J')** ranges from 0 to 1, where values closer to 1 indicate a more even distribution of colonies among coral genera, and values closer to 0 indicate dominance by one or a few genera. Evenness was interpreted as very high (0.90–1.00), high (0.70–0.89), moderate (0.50–0.69), low (0.25–0.49), and very low (0.00–0.24).

The combined results from the diversity indices, genus richness, and spatial distribution analyses indicate that the coral assemblage in Brgy. Alipata, Sicogon Island is characterized by low genus-level diversity and strong dominance by a limited number of taxa. The low Simpson's Index of Dominance (D = 0.7665) and very low Shannon–Wiener Diversity Index (H′ = 1.967) reflect a community structure in which a few genera, particularly *Porites*, accounted for a large proportion of observed colonies. Despite the identification of 15 coral genera, overall diversity remained low due to uneven contributions of colony genera to total abundance. The relatively high evenness value (J′ = 0.7266) indicates that, among the recorded genera, colonies were distributed fairly evenly; however, this pattern occurred within a community with limited taxonomic richness. Additionally, the restricted spatial occurrence of many genera to one or two transects suggests a patchy distribution at the site scale. Together, these patterns are consistent with coral communities in intertidal reef-flat environments, where environmental variability and physical exposure often favor a subset of stress-tolerant genera. While this study does not directly assess functional traits or environmental drivers, the observed dominance structure and spatial heterogeneity provide important insight into the current organization of the reef-flat coral community in Brgy. Alipata.

The coral assemblage in Brgy. Alipata, Sicogon Island was characterized by low genus-level diversity, strong dominance by a small number of taxa, and patchy spatial distribution, based on abundance patterns, diversity indices, and transect-level occurrence. Although 15 coral genera were recorded, nearly half of all observed colonies belonged to *Porites*, indicating a highly uneven contribution of colony genera to overall community structure. Similar dominance patterns have been reported in shallow reef-flat and nearshore coral communities across the Philippines and the broader Indo-Pacific, where environmental filtering favors stress-tolerant and morphologically robust genera (Licuanan et al. 2019; Luo et al. 2022; Barott et al. 2024). The low Simpson's Index of Dominance and very low Shannon–Wiener Diversity Index further support the interpretation that the coral community in the study area is structurally simplified at the genus level, despite moderate evenness among recorded taxa. High evenness values, such as those observed in this study, can occur in communities where a limited number of taxa are present but are relatively evenly represented in abundance (Magurran 2004). In intertidal reef-flat systems, such patterns are frequently associated with physical exposure, temperature variability, and periodic emersion, which constrain coral diversity and favor genera capable of tolerating fluctuating environmental conditions (Paz-Alberto et al. 2021; Rasher et al. 2024). Spatial distribution patterns across transects revealed that only four genera (*Porites, Dipsastraea, Acropora,* and *Platygyra*) were consistently present throughout the study site, while most genera occurred in one or two transects only. This patchy distribution is a common feature of intertidal reef-flat environments and reflects fine-scale habitat heterogeneity, including differences in substrate stability, water retention during low tide, and localized exposure (Wang et al. 2023). The absence of direct comparisons among transects in this study indicates that these patterns should be interpreted as within-site variability, rather than evidence of spatial gradients or zonation. Although this study was limited to genus-level identification and a single intertidal site, it contributes valuable baseline information for an understudied island system in the Visayan Sea. Genus-level assessments are widely used in coral reef monitoring, particularly in shallow or logistically constrained environments, and are effective for detecting shifts in dominance structure and community organization over time (Licuanan et al. 2020). The dominance of a few genera combined with low overall diversity highlights the importance of continued monitoring, especially in areas experiencing increasing coastal use and tourism development.

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AUTHOR CONTRIBUTIONS

- **Lhyra Amante**: Data collection, field assessment, and writing
- **Christian S. Apolinario**: Data collection, field assessment, and writing
- **Miles B. Chin**: Supervision, conceptualization, writing – original draft, data analysis, editing, data collection and field assessment
- **Ariette A. De Asis**: Data analysis, review, editing, and funding
- **Jomar Von R. Laforteza**: Data analysis, review and editing

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

ETHICS STATEMENT

The researchers affirm that this study was conducted in strict adherence to ethical guidelines for scientific research. Prior to the commencement of fieldwork, all necessary permissions and consents were obtained. Specifically, a Prior Informed Consent (PIC) was secured from the Barangay Captain of Alipata, Sicogon Island, Carles, Iloilo, to ensure community awareness and approval of the research activities. All data collection methods, including snorkeling surveys and photo quadrat sampling, were carried out with the utmost care to minimize any potential disturbance or impact on the marine environment and the coral ecosystems under investigation. The research team committed to non-invasive techniques to preserve the integrity of the natural habitat. Furthermore, data collected were handled with confidentiality and used solely for the academic purposes of this study.

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