



Some Ecological Aspects and Conservation Efforts on Honeycomb Oysters in Rakhine Coastal Region of Myanmar

Naung Naung Oo^{1*}

¹Department of Marine Science, Patheingyi University, 10014, Patheingyi, Ayeyarwady Region, Myanmar

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Contact

*Naung Naung Oo

naungnaungoomarine@gmail.com (NNO)

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Abstract

A total of four distinct species of "honeycomb oysters" belonging to the family Gryphaeidae (Order: Ostreida) within the class Bivalvia. The specimens categorized represent two primary genera: *Hyotissa* (Stenzel, 1971) and *Neopycnodonte* (Stenzel, 1971). Among the genus *Hyotissa*, three species were recorded: *H. hyotis* (Giant honeycomb oyster), *H. inermis* (Saddle-shaped honeycomb oyster), and *H. sinensis* (Foam honeycomb oyster), with shell lengths ranging from 40.4 mm to a maximum of 75.5 mm. Additionally, the genus *Neopycnodonte* is represented by *N. cochlear* (Deepsea honeycomb oyster), measuring 58 mm in length. This compilation provides essential morphometric and classification data for these bivalve molluscs, highlighting the diversity of honeycomb oysters within their respective ecological niches. This study also examines the ecological significance, environmental requirements, and management frameworks for honeycomb oysters (Family: Gryphaeidae) within the Rakhine Coastal Region, Myanmar. Analysis of the region reveals that habitat suitability is strictly governed by tidal regimes, substrate stability, and seasonal salinity fluctuations—factors increasingly threatened by sedimentation and mangrove deforestation. To address pressures from overharvesting and coastal development, this paper evaluates potential Community-Based Fisheries Management (CBFM) and sustainable harvesting protocols, including size-based limits and seasonal closures. While documented conservation initiatives in Rakhine remain sparse, the integration of local stewardship with habitat restoration is identified as a vital pathway for maintaining population recruitment. The findings emphasize that a shift toward co-management and selective, low-impact harvesting gear is essential for the long-term resilience of Rakhine's bivalve resources and the coastal livelihoods dependent upon them.

Keywords

Ecological resilience, Honeycomb oysters (Gryphaeidae), Marine biodiversity, Myanmar, Rakhine Coastal Region

1. Introduction

Honeycomb oysters (Family: Gryphaeidae) play a vital ecological role as reef-forming organisms, providing habitat and shelter for marine species (Harry, 1985). Their calcareous shells contribute to coastal stability and carbon sequestration. Despite their importance, they face threats from habitat destruction, pollution, and overharvesting. Conservation efforts are limited but include habitat protection, monitoring

of populations, and research into sustainable management practices. These oysters are often overlooked in conservation planning, highlighting the need for increased awareness and targeted initiatives.

In the Rakhine Coastal Region, the honeycomb oyster is a marine bivalve known for its distinctive, interlocking shell pattern resembling a honeycomb. It thrives in shallow, rocky



intertidal zones and plays a role in coastal ecosystem stability by providing habitat for other organisms. Its presence indicates relatively healthy marine environments, though specific ecological data on population dynamics, conservation status, or human impacts in this region remain limited. Further research is needed to assess threats such as habitat degradation, overharvesting, or climate change effects.

Intertidal habitats in Myanmar are dynamic and subject to human pressures such as harvesting, boat traffic, and sedimentation from land-use changes. Sustainable management of oyster populations often benefits from protecting settlement substrates (rocks, reefs), regulating harvest, and monitoring water quality. Precise ecological roles can vary locally due to factors like salinity, temperature, sediment type, and associated species; targeted field studies in the Rakhine region would help quantify the relative importance of their ecosystem services there.

The objectives of studying the ecological aspects and conservation efforts of the honeycomb oysters in the Rakhine Coastal Region of Myanmar include assessing their habitat requirements, population dynamics, and role in coastal ecosystem stability. Conservation efforts aim to mitigate threats such as overharvesting, habitat degradation, and climate change impacts. Promoting sustainable harvesting practices, establishing protected areas, and raising local community awareness are key strategies. These initiatives support biodiversity conservation, enhance fishery resilience, and contribute to livelihoods through eco-friendly aquaculture.

2. Materials and Methods

2.1. Sampling Sites and Period

The Rakhine Coastal Region exhibits variable salinity due to monsoonal influences and riverine inputs, with substrate types ranging from sandy to muddy deposits influenced by tidal dynamics. Wave exposure varies from low in sheltered lagoons to moderate to high along open shorelines, affecting habitat distribution. These factors collectively shape coastal ecosystems, influencing biodiversity and ecosystem resilience.

Honeycomb oysters were collected across six coastal sites as Western Bo Ron Ga Island (Lat. 19° 47' N, and Long. 92° 54' E), Kyauk Phyu (Lat. 19° 25' N, and Long. 93° 31' E), Andrew Bay (Lat. 18° 18' N, and Long. 94° 19' E), Gwa Aw (Lat. 17° 35' N, and Long. 94° 33' E), Chaung Tha (Lat. 16° 57' N, and Long. 94° 25' E), and Mawtin Point (Lat. 15° 57' N, and Long. 94° 14' E) in the Rakhine Coastal Region of Myanmar between January 2019 and March 2026 (Fig. 1). These locations include islands and bays along the western coast, indicating a broad distribution pattern.

2.2. Sampling Methods

Specimens were randomly collected from shallow intertidal to subtidal depths, cleaned in situ, measured for shell length, and preserved in 10% formalin seawater. Voucher specimens are housed at Patheingyi University's Museum of Marine Science (PMS). Taxonomic identification followed established references by Thomson (1954), Torigoe (1981)

and Harry (1985), ensuring reliable classification. This standardized protocol supports reproducibility and long-term study of marine molluscs. The extensive sampling period observed ongoing ecological or survey efforts, possibly related to biodiversity monitoring, marine resource assessment, or cultural/artisanal use of these shells.

2.3. Conservation Assessment Methods

The present study conducted semi-structured interviews and distributed questionnaires to local fishing communities and oyster harvesters. Focus on harvesting intensity, market demand, and traditional ecological knowledge. Use a Likert scale (1–5) to rank observed threats such as habitat destruction (from destructive fishing), sedimentation, and over-harvesting. Review local Department of Fisheries (DoF) records and consult with local NGOs (Rakhine Coastal Region Conservation Association) to evaluate the enforcement of existing Marine Protected Areas (MPAs).

3. Results

3.1. Identification and Shell Morphologies

The family Gryphaeidae, commonly known as honeycomb shells, is characterized by thick, robust shells with a distinctive honeycomb-like pattern of raised ridges and deep pits. The valves are typically unequal in size, with the left valves being larger and more convex. They possess a strong hinge and a well-developed ligament. The shell surface often displays radial ribs and growth lines, and the interior is usually nacreous or smooth. These features distinguish them from other bivalves and reflect their adaptation to firm substrates in marine environments. The present study recorded 3 species of *Hyotissa* and a single species of *Neopycnodonte* along the Rakhine coast (Table 1).

Shell morphologies of *Hyotissa* species play a key role in habitat adaptation (Figs. 2A–C). These bivalves are ecologically significant as reef-forming organisms and serve as habitat for marine life. Their taxonomic classification reflects evolutionary adaptations to hard substrates and varied depths.

Shell shape and ribbing: The ribbed, honeycomb-like sculpture provides added structural strength without a heavy increase in weight. This helps the shell resist predation and physical abrasion from wave action and sediment transport in shallow, rocky, or coral-reef habitats where *Hyotissa* often occurs. The irregular, arched profiles can reduce wave drag and help the clam anchor more securely to hard substrates such as limestone, coral, and compacted sediments.

Size and shell thickness: Large species *Hyotissa hyotis* with relatively thick but lightweight shells, balance protection with buoyancy and maneuverability. This is advantageous in open, dynamic environments with strong currents, where a heavy but sturdy shell reduces the risk of dislodgement.

Hinge and valve morphology: *Hyotissa* species typically have strong, robust hinges and thick pallial tissue that support a wide gape. This allows them to seal tightly against the substrate under variable hydrodynamic conditions, preventing desiccation during low tides and protecting against sediment influx and predation. A broad, convex

exterior can help shed sediment and resist burial by shifting sands, which is beneficial in habitats subject to currents or bottom disturbance.

Shell coloration and texture: Surface texture and coloration can provide camouflage against the substrate and background to avoid visual predators. In sessile or slow-moving bivalves, cryptic coloration reduces detection by predators and can also mitigate overheating in shallow, sunlit waters.

Internal anatomy and shell performance: The microstructure of the shell's inner layers can influence durability and repair efficiency after mechanical damage. A resilient microstructure supports longer lifespans in environments with frequent abrasion from abrasive sediments or life on rocky bases.

Habitat-specific implications: In reef or hard-substrate

zones, the rugged shells are well-suited to resist wave action and provide stable microhabitats for associated organisms, contributing to reef resilience. In deeper or softer substrates, shell robustness still offers protection against sediment storms and helps maintain position in nutrient-rich upwelling areas where currents can scour the seafloor.

The shell morphologies of *Neopycnodonte* species exhibit distinct features such as a moderately inflated, sub-ovate shape with a rounded umbo and a smooth, glossy surface. These bivalves typically display radial ribs and a well-developed hinge with a complex ligament structure (Fig. 2D).

Variations in ribbing density, shell thickness, and ornamentation patterns can differentiate species like *Neopycnodonte cochlear* and *N. johanna*, often linked to ecological adaptations or geographic distribution. Such morphological traits are crucial for taxonomic identification and understanding evolutionary trends within the genus.

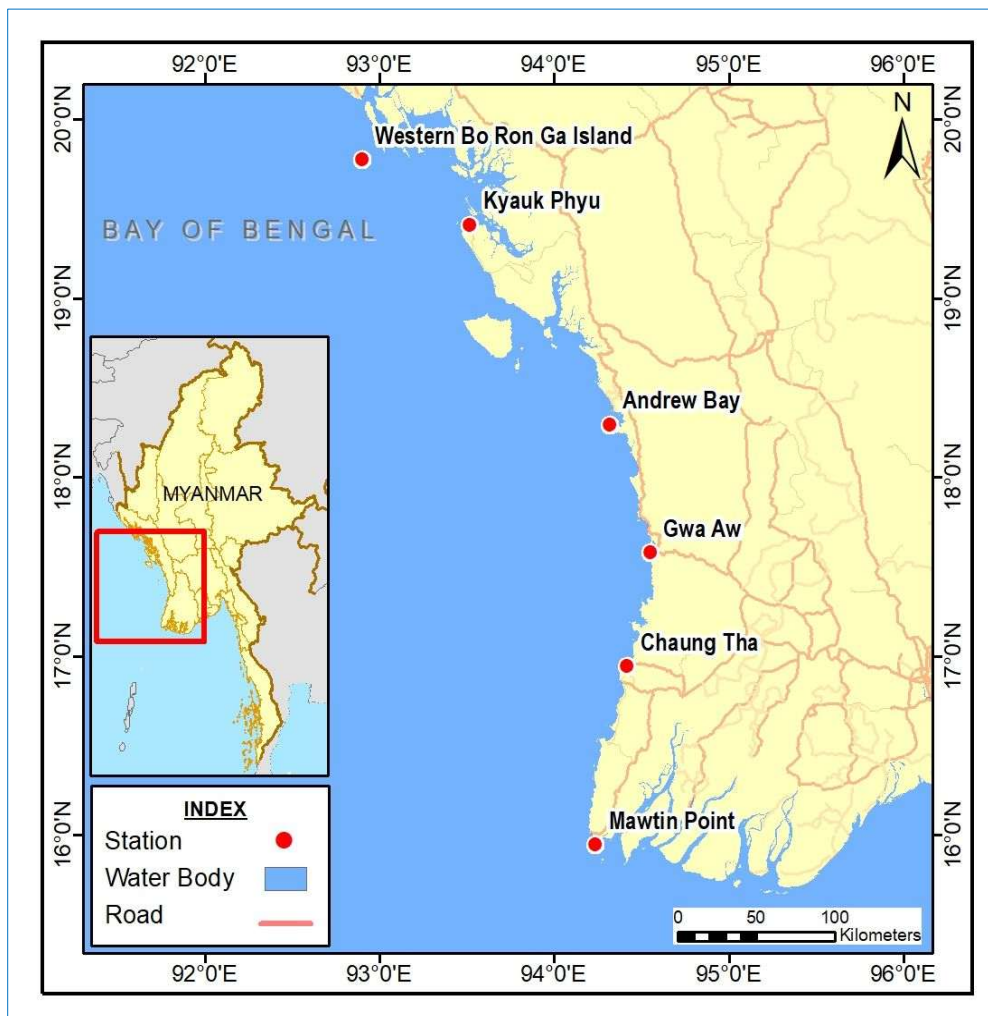


Fig 1. Collection sites of honeycomb oysters in the Rakhine Coastal Region of Myanmar

3.2. Ecological Role

The honeycomb shells occupy a shallow to moderately deepwater marine niche, typically on firm substrates such as rocky bottoms, reefs, or shell beds. Key aspects of their ecological role in study areas include:

Substrate specialization: They are cemented or anchored to hard, stable surfaces rather than free-lying in sediments, which helps them withstand currents and wave action.

Filter feeding: Like many bivalves, Gryphaeidae are

suspension feeders, drawing in water to capture plankton and organic particles.

Burrow- and bed-attached behavior: Their thick, heavy shells and strong byssal attachments (where present) reduce mobility, making them relatively sessile and dependent on local water quality and food supply.

Habitat structure contributors: Their rugged, horned shell morphology can add complexity to the substrate, potentially providing microhabitats for epibionts or small invertebrates.

Tolerances: They often tolerate fluctuating salinity and turbidity better than some more delicate bivalves, but they generally prefer stable marine conditions with adequate nutrient flow.

3.3. Key Environmental Factors Affecting Shell Habitats

The following key environmental factors influenced shell habitats in the study areas.

Salinity and tides: Oysters are euryhaline but have optimal salinity ranges. In estuarine and mangrove-influenced areas of Rakhine, freshwater input from rivers lowers salinity seasonally. Prolonged low salinity or excessively high salinity can stress oysters and affect growth, reproduction, and larval survival. Tidal regimes affect feeding, larval settlement, and

desiccation risk during exposure. Intertidal zones with stable, moderate immersion periods support better juvenile survival.

Substrate and substrate stability: Oyster larvae require suitable hard or consolidated substrata for settlement (e.g., rocky, compact shell, or hard-packed mud with sufficient biofilm). Siltation, sedimentation from land-use change, and mangrove deforestation can smother larvae and juvenile oysters, reducing recruitment.

Temperature: Growth and spawning are temperature-dependent. Warmer surface waters can accelerate metabolism and reproduction, but extreme temperatures or thermal stress can reduce survival. The Rakhine coast experiences seasonal temperature variation that may influence breeding cycles.

Practical implications for Rakhine Coastal Region: Favorable oyster habitats are likely in sheltered, mangrove-adjacent estuaries with stable sediment, moderate salinity, and good flushing to prevent hypoxia and detrital buildup. Protection of mangrove belts and maintaining estuarine hydrology are critical to sustain settlement habitats and recruitment. Monitoring should focus on salinity and temperature ranges, sedimentation rates, dissolved oxygen, nutrient levels, and pollution indicators to infer habitat suitability and health.

Table 1 Identification of honeycomb oyster in the Rakhine Coastal Region

Taxonomic scheme			
Phylum: Mollusca (Cuvier, 1795)			
Class: Bivalvia (Linnaeus, 1758)			
Order: Ostreida (Férussac, 1822)			
Family: Gryphaeidae (Vialov, 1936)			
Genus: <i>Hyotissa</i> (Stenzel, 1971)			
Sr. No	Species	Common name	Length (mm)
1	<i>H. hyotis</i> (Linnaeus, 1758)	Giant honeycomb oyster	75.5
2	<i>H. inermis</i> (Sowerby II, 1871)	Saddle-shaped honeycomb oyster	64.8
3	<i>H. sinensis</i> (Gmelin, 1791)	Foam honeycomb oyster	40.4
Genus: <i>Neopycnodonte</i> (Stenzel, 1971)			
4	<i>N. cochlear</i> (Poli, 1795)	Deepsea honeycomb oyster	58

3. Results

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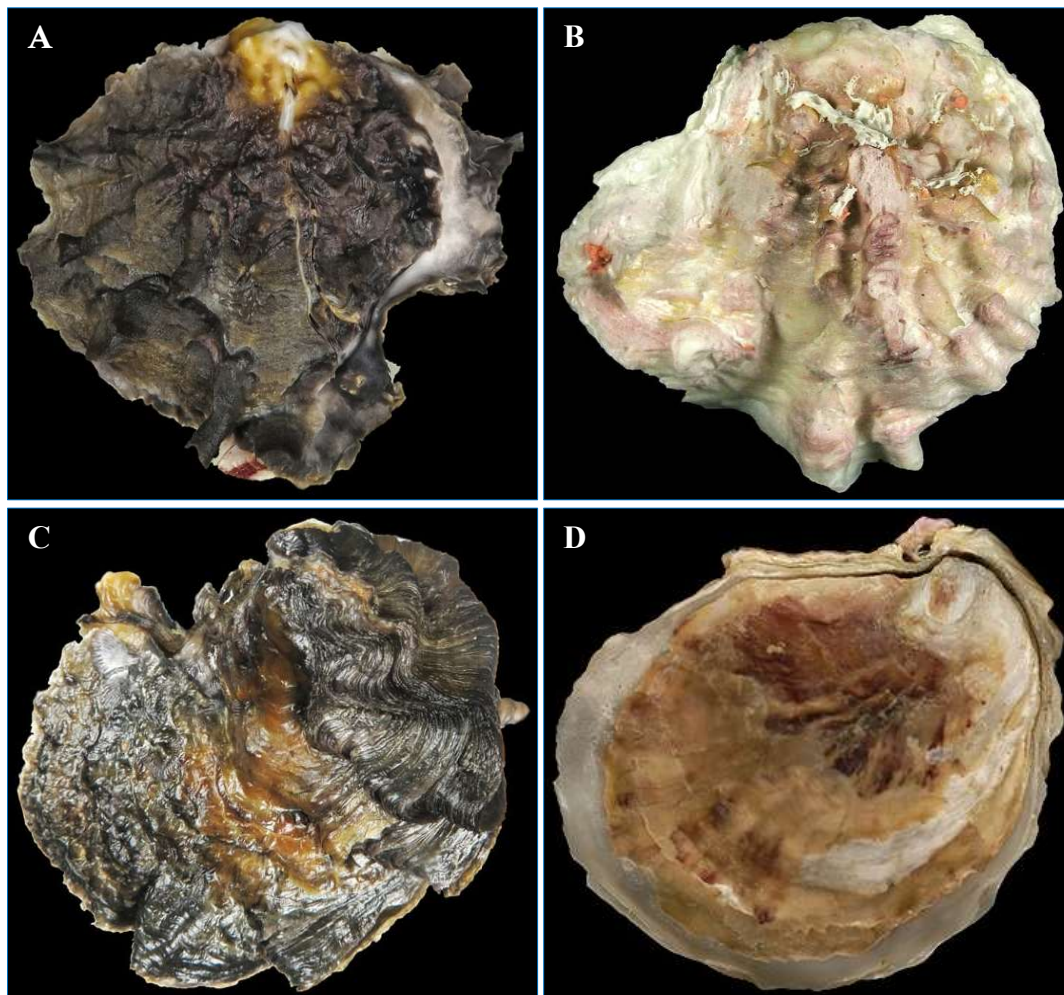


Fig. 2. Honeycomb oyster of Rakhine Coastal Region (A-D): A) *Hyotissa hyotis* (Linnaeus, 1758), B) *H. inermis* (Sowerby II, 1871), C) *H. sinensis* (Gmelin, 1791), D) *Neopycnodonte cochlear* (Poli, 1795)

Variations in ribbing density, shell thickness, and ornamentation patterns can differentiate species like *Neopycnodonte cochlear* and *N. johanna*, often linked to ecological adaptations or geographic distribution. Such morphological traits are crucial for taxonomic identification and understanding evolutionary trends within the genus.

3.4. Community-based Conservation Efforts for Oysters in Rakhine

Based on available information up to research knowledge cutoff, there is limited publicly documented detail on community-based oyster conservation programs specifically in the Rakhine Coastal Region of Myanmar. That region has

faced pressures from coastal development, overharvesting, and environmental change, which can complicate such initiatives. However, there are a few general possibilities and avenues to explore:

- Community-based fisheries management (CBFM): Some coastal communities in Myanmar participate in locally led management of shellfish resources, including setting seasonal harvesting rules, protected zones, or co-management with authorities. These efforts are often informal or mixed with broader livelihood programs.
- Small-scale hatchery or aquaculture initiatives: Community groups may collaborate to culture native or introduced oyster species for a sustainable supply while reducing pressure on wild stocks.
- Conservation and education programs: Local NGOs, fisher associations, or school/community groups sometimes run awareness campaigns about habitat protection (mangroves, intertidal zones) and the importance of sustainable harvesting.
- Government and NGO partnerships: There can be pilot projects or concessions involving community co-management, though documentation specific to Rakhine is scarce in accessible sources.

There are five practical steps to gather up-to-date information on a project or current research.

- Check recent field reports or NGO project summaries focusing on Rakhine's coastal resources or shellfish fisheries.
- Reach out to local fisheries departments or district authorities in Sittwe, Kyauk Phyu, or other Rakhine coastal towns for any community groups involved with oysters.
- Connect with regional NGOs focused on marine resource governance, livelihood development, or mangrove/coastal habitat protection.
- Look for academic theses or reports from universities in Myanmar or Southeast Asian institutions that document community initiatives in the region.
- Consider on-the-ground reconnaissance: talking with fisherwomen and fishers in village clusters along the coast to identify any grassroots organizations or ongoing stewardship activities.

3.5. Sustainable Harvesting Methods are Being Promoted Locally

The following key sustainable harvesting approaches are often promoted locally for honeycomb oysters and similar oyster fisheries in the Rakhine Coastal Region of Myanmar.

Size-based harvesting rules: Allowing oysters to reach reproductive maturity before harvesting, typically by setting minimum legal sizes to protect juveniles and ensure spawning cycles.

Open-season and catch limits: Establishing seasonal closures or daily/weekly quotas to prevent overharvesting during peak breeding periods and stock rebuilding.

Harvest gear restrictions: Limiting gear types and mesh sizes to reduce bycatch and avoid damaging habitats; promoting

selective, low-impact tools (e.g., hand-picking, smaller dredges with defined parameters).

Rotational harvesting and no-take zones: Designating small-scale protected or no-take patches to preserve brood stock and habitat, with surrounding areas open for regulated harvest.

Habitat-friendly collection practices: Avoiding uprooting reef substrates, minimizing damage to oyster reefs, and refraining from collecting oysters during spawning to protect reproductive output.

Community-based management and co-management: Involving local fishers, communities, and authorities in setting rules, monitoring compliance, and sharing benefits to improve stewardship.

Traceability and compliance measures: Recording harvest dates, locations, and quantities to discourage illegal harvesting and enable stock assessments.

Restoration and enhancement initiatives: Restocking depleted beds, deploying substrate structures or oyster culturing technologies in degraded areas to boost habitat complexity and recruitment.

Alternative livelihood and value addition: Encouraging sustainable aquaculture or mariculture as an alternative to wild harvest, along with processing and certification to add value without increasing pressure on wild stocks.

Education and awareness campaigns: Providing fishers with training on sustainable practices, ecological importance, and the long-term benefits of managed harvesting.

4. Discussion

The study covers approximately from Mawtin Point to Western Bo Ron Ga Island. Northern sites of Western Bo Ron Ga Island and Kyauk Phyu areas are characterized by complex estuarine systems and higher turbidity. The presence of honeycomb oysters here suggests a high tolerance for varying salinity levels and suspended sediments. In central and southern sites, from Andrew Bay to Mawtin Point, moving south toward Gwa and Chaung Tha, the coastline becomes more influenced by open-ocean transitions. This broad range determines if there is a "clinal variation" (gradual change) in shell morphology or population density as environmental conditions shift.

The presence of three *Hyotissa* species (*H. hyotis*, *H. inermis*, *H. sinensis*) and one *Neopycnodonte* species (*N. cochlear*) confirms that the Rakhine coast serves as a significant biodiversity hotspot for the family Gryphaeidae. The morphological data in Table 1 highlights a clear size gradient, with *H. hyotis* reaching a maximum length of 75.5 mm, nearly double that of *H. sinensis* (40.4 mm).

The "honeycomb" vesicular structure and radial ribbing observed in *Hyotissa* provide a high strength-to-weight ratio. This is ecologically essential for resisting the high-energy wave action and physical abrasion characteristic of the rocky

intertidal zones and coral reef flats found at sites like Mawtin Point and Western Bo Ron Ga Island. The unequal valve size and convex left valve allow these oysters to cement securely to hard substrates. This sessile lifestyle, while providing stability against currents, makes them highly vulnerable to localized environmental changes, as they cannot migrate to escape stressors.

The Andrew Bay and Gwa Aw areas are typically lower-energy environments that may act as "nurseries" or stable recruitment grounds for oyster larvae. Western Bo Ron Ga Island and Mawtin Point are likely exposed to stronger wave action and oceanic currents. Comparing data from these sites can reveal how honeycomb oysters adapt their shell thickness or attachment strength to survive high-wave energy.

The honeycomb oyster populations in the Rakhine Coastal Region are governed by cyclical recruitment patterns observed over multi-year trends. The sustained presence of these bivalves over the 2019–2026 period underscores a significant level of population resilience, likely facilitated by larval connectivity across the six coastal study sites. Both Chaung Tha and Andrew Bay (Ngapali/Thandwe area) are critical from a conservation standpoint. These areas are high-traffic tourist zones. Data from these sites can be compared against the more remote Bo Ron Ga Island to assess the impact of human disturbance, pollution, and physical habitat trampling on oyster beds. Understanding that honeycomb oysters are present at all six sites suggests that the Rakhine coast may function as a single large corridor. If one site (like Gwa Aw) is degraded, larvae from Mawtin Point or Andrew Bay might help "reseed" the area, provided the currents are favorable.

While honeycomb oysters tolerate moderate turbidity, the "Practical Implications" section notes that excessive sedimentation, often caused by mangrove deforestation and coastal development in areas like Kyauk Phyu, can smother larvae. The euryhaline nature of these species is tested by the seasonal freshwater influx from the massive river systems of the Rakhine coast. The stability of these populations is likely dependent on the "flushing" effect of tidal regimes, which prevents hypoxia and maintains the nutrient flow necessary for suspension feeding.

The limited documentation of formal community-based oyster conservation in Rakhine presents both a challenge and an opportunity. The proposed transition from wild harvesting to Sustainable Harvesting Methods is critical for long-term population resilience.

- a. **Livelihood vs. Sustainability:** The promotion of size-based harvesting rules (protecting individuals under the 40–75 mm range) is essential to ensure that oysters reach reproductive maturity.
- b. **The Kyauk Phyu Case Study:** Given the intense coastal development in Kyauk Phyu, this area should serve as a priority zone for co-management initiatives. Implementing "no-take" zones in areas identified as high-recruitment hotspots could provide a "larval bank" to reseed nearby degraded habitats.
- c. **Integrated Coastal Management:** The survival of the

honeycomb oyster is inextricably linked to the health of the mangrove belts. As noted, mangroves stabilize sediments and regulate nutrient flow. Therefore, oyster conservation in Myanmar cannot be successful in isolation; it must be part of a broader strategy that includes mangrove protection and regulated industrial runoff.

5. Conclusion

The study of the family Gryphaeidae along the Rakhine Coastal Region underscores the critical intersection between specialized shell morphology and ecological resilience. The four species identified—*Hyotissa hyotis*, *H. inermis*, *H. sinensis*, and *Neopycnodonte cochlear*—exhibit distinct structural adaptations, such as honeycomb-like ridges and robust hinge mechanisms, which enable them to function as essential ecosystem engineers in dynamic marine environments. By providing complex habitat structures and improving water quality through suspension feeding, these bivalves support broader regional biodiversity. However, the stability of these populations is increasingly threatened by environmental stressors, including fluctuating salinity, sedimentation, and habitat loss from mangrove deforestation. To ensure the long-term survival of honeycomb oysters in Rakhine, it is imperative to bridge the gap between scientific knowledge and local management. Future efforts must prioritize community-based fisheries management (CBFM), the implementation of sustainable harvesting protocols (such as size-based limits and no-take zones), and the preservation of estuarine hydrology. Strengthening local stewardship and monitoring environmental thresholds will be the cornerstone of maintaining these valuable bivalve resources for both ecological health and community livelihoods.

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