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Mollusk diversity and richness in relation to moon phases in intertidal zone of Sawang, Sibutad, Zamboanga del Norte

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Abstract

The bulk of marine invertebrate molluscs in the intertidal zone are gastropods and bivalves. According to the study, the lunar cycle has an impact on animal biology and gatherer activities, and understanding the phases of the moon is critical for traditional coastal communities that rely on mangrove ecosystem resources to live. As a result, the researchers decided to test prior findings at Barangay Sawang in the municipality of Sibutad, Zamboanga del Norte's intertidal sample site. This study aimed to determine the population of mollusks found in the intertidal area. This study employed both qualitative and quantitative research methods. From November to December 2021 and January 2022, this was done during the four moon phases of the month where the species' intertidal population was assessed. At four sample stations, quadrant transects were employed to create permanent markers for onsite sampling of three substrates: rock, sand, and corals. The researchers utilized the Google Lens and Picture Shell software on their smartphones to differentiate traits among all Mollusk species for nomenclature. During the new moon phase, the highest peak population of Gastropods has been reported. In the monthly four moon phase, mollusk species with various lengths and dispersion can be seen. The mollusk population is very consistent across the four sampling sites, each of which has its own unique substrate. More research is needed in Zamboanga del Norte's unique mangrove habitats and estuary locations to learn more about the richness and species of mollusks. The government may strictly enforce legislation, rules, and regulations relevant to aquatic species protection and conservation.

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Introduction

Intertidal zones are areas where the sea meets the land, which during low tide is exposed to air while submerged during high tide (National Geographic Society, 2019). This zone is known to have harsh environments for it is a subject to rapid changes in temperature, salinity, hydrostatic pressure, food, and predation (Halim *et al.*, 2019). The area between the highest and lowest tides marks the transition from ocean to land conditions. Mollusks can be found in a variety of habitats, including the intertidal zone. Species appears to be more diverse at the intertidal zone than in other marine settings, owing to the abundance of microhabitats and the milder microclimatic conditions that support them. Molluscs are one of several species present in the intertidal zone; they are burying animals with slippery, thick shells.

With an estimated 80,000-100,000 species, Molluscs are the second biggest phylum after Arthropods (insects). Molluscs serve as algae feeders, detritivores, and deposit feeders in coastal ecosystems. Molluscs, according to Brown and Lydeard (2010), are "soft-bodied, unsegmented animals, with a body organized into a muscular foot, a head, a visceral mass containing most of the organ systems, and a fleshy mantle which secretes the calcareous shell" (Salvini-Plawen, 2020). They are not only diverse in terms of species, size, and anatomical structure, but also in terms of behavior and surroundings. Humans have relied heavily on mollusks as a food source. Mollusks are key suppliers of essential vitamins and minerals, in addition to having a pleasant taste (Khan and Liu, 2019). In the Philippines, there has not been much focus on evaluating the current state of molluscan diversity in the intertidal zone. There is currently only a limited amount of research on the state of molluscan biodiversity in southern Mindanao that has been published. A small investigation in Sarangani Bay revealed possible mollusc assessment locations (Jumawan *et al.,* 2015; Manzo *et al.,* 2014).

As seen from Earth, moon phases such as full moon, new moon, first quarter, and last quarter are shapes generated as the moon circles around the earth and the sun's light hits it. Moon phases are used by people living near intertidal zones to collect resources (Paujiah *et al.*, 2020). According to Nicola Davis of The Guardian, the oysters' lunar special link was uncovered after researchers tracked 12 Pacific oysters, *Crassostrea gigas*, which sunk along the French coast. They then monitored them for three lunar cycles, each lasting 29.5 days. Electrodes were used to measure the width of the oysters' shells every 1.6 seconds, and then compared the results to lunar cycle data. The oysters' shells narrowed as the moon waxed or became fuller, but they never entirely closed. As the moon began to decline, or recede to the new moon phase, they enlarged their shells again (Daley, 2019). Oysters are one of the species that keep track of the moon, according to a new study published in the journal Biology Letters, and the lunar cycle determines how wide their shells open. According to traditional fisherman knowledge, fishermen based the tide's amplitude from the moon phases (Alves *et al.*, 2019). Though there are studies regarding molluscs' degree of abundance depending on many factors (e. g. salinity), the investigation whether there are significant differences in abundance between each moon phase are still scarce.

The intertidal zones of Murcielagos Bay surround Barangay Sawang, located on the western shore of the municipality of Sibutad, Zamboanga del Norte. The majority of the residents of the stated barangay are fisherman, vendors, and a few farmers, with a population of 1,331 (PhilAtlas, 2015). They make a living by gathering mollusks for consumption, sell in markets, and export to other cities such as Dapitan and Dipolog City. Mollusks occurring in intertidal zones are easy to harvest, especially during low tides, making them a convenient source of both food and income. As a result, this study in Sawang, Sibutad, Zamboanga del Norte will determine the population of molluscs in the intertidal zone in relation to moon phase, in order to raise people's awareness of its importance and enhance its population for the benefit of the growing population. This information could be used to help make decisions about the management of aquatic resources at the site.

According to the research, the lunar cycle has an impact on animal biology and gatherer activities, and knowing the phases of the moon is an important element for traditional coastal communities that rely on mangrove ecosystem resources to survive. As a result, the goal of this research is to examine if the findings of past studies hold true in the Barangay Sawang intertidal sample site. Through its limited information on the population of mollusc in the Philippines, the researchers were prompted to conduct this first study on the investigation of the population of molluscs in the intertidal area of Sawang, Sibutad, Zamboanga Del Norte within a particular phase of the moon in a month of the calendar year December 2021 to January 2022. This would serve as the baseline information for further related research undertakings.

Specifically, it sought to answer

1. Determine the population of molluscs found in the intertidal area of Sawang, Sibutad, Zamboanga Del Norte.
2. Determine at what phase of the moon does mollusc population is most abundant in the intertidal area of the said barangay.
3. Determine the significant difference of molluscs population in the intertidal area of Sawang, Sibutad, Zamboanga Del Norte in relation to moon phase.

Hypothesis

Ha_1. Is there a significant difference on the diversity of mollusks in relation to moon phase?

Ha_2. Is there a significant difference on the richness of mollusks in relation to moon phase?

Time, atmosphere, and tidal cycles are all important factors in fishing. The cyclical movement of phenomena such as day and night, moon phases, and seasons has traditionally given a knowledge base for all communities. The lunar phase can have an impact on the unique makeup of ichtyo fauna in a given region, according to Bezerra *et al.* (2012), either through differences in nightlight or through its effect on tidal level variations. Aside from these factors, reproductive behaviors linked to the lunar cycle, such as spawning aggregation, can have a significant impact on fish population temporal variation.

The ebb and flow of tides governs the lives of some sea creatures, and moonlight is a crucial trigger for some species to mate or hunt. Oysters are one of the species that keep track of the moon, according to a new study published in the journal Biology Letters, and the lunar cycle determines how wide their shells open. That means the oysters may rely on an internal lunar clock rather than direct cues such as moonlight intensity. If that were the case, they would open their shells at the same rate during the first and last quarter moons because the light intensity would be comparable. The oysters, on the other hand, reacted differently to those phases, indicating that they are following an internal clock rather than reacting to the moonlight.

The marine invertebrate molluscs within the intertidal zone are predominantly comprised of gastropods and bivalves. Both of these classes have the delineating structure of the number of shells each mollusc synthesizes (Arombo, 2015). Studies concerning the diversity and variations of intertidal molluscs in the Philippines were done mostly in Luzon and Visayas shorelines areas. One of these was the study performed by Batomalaque *et al.* (2010) that focused on the spatial distribution of molluscs along the shoreline of Grande Island, Subic Bay. They have discovered that molluscs were distributed according to the substrate (composition and particle size) and concluded that the morphological adaptations of the different species enabled them to occur in specific habitat types. In the low intertidal zone, it is typically covered in water. Most animals that live in that zone can only tolerate exposure to air for short periods of time. Here the marine plants provide fish and other organism protection and food. The intertidal zone is constantly changing because of the constant motion of the waves and tides. It is never stable. Waves are always crashing and the tides are always changing. Survival is a challenge for the organisms that live there. The salinity is also always changing because of the rise and fall of the tides.

Studies on mollusc diversity in Mindanao Island, southern Philippines is considerably scarce. Recent studies in southern Mindanao are still not enough to suffice basic information in the inventory and community structure in the area. The study provided analysis in the diversity and spatial structure of shoreline molluscs found in Padada, Davao del Sur. The results identified a total of 31 species coming from class Gastropoda (17 species) and Bivalvia (14 species). Diversity indices and species importance values were determined. The data is the first attempt to provide baseline information on mollusk diversity and community structure in the study area. Likewise, Medrano (2015) also cited that most of the mollusks were found on the rocky and sandy-rocky substrates in the area. The edge of the intertidal zone is about 90% rocky where *Isognomon isognomon, Angaria species and Astraea species* were found. Much of the studies conducted about mollusc species in the Philippines were still based on the collections of mollusc species collections of Hugh Cummings from 1836 to 1840 (Batomalaque *et al.*, 2010).

Theoretical/Conceptual framework

This research is based on Chakraborty (2018), "Effects of Different Phases of the Lunar Month on Living Organisms." A large number of studies have linked lunar phases to various living organisms' activities, such as the activity patterns of marine and other animals, birds, insects, and people. These changes in activity pattern could be caused by changes in lunar gravitational force on the earth's surface, changes in "biological tide," or changes in the earth's electromagnetic field and lunar illumination.

The illumination and gravitational attraction of the moon on the earth vary depending on the prominent position of the moon during the lunar month, such as new moon (NM), first quarter (FQ), full moon (FM), and third quarter (TQ), and the amplitude of ocean tides fluctuates as well. A large number of studies have linked lunar phases to the activity patterns of marine and other creatures, birds, insects, and people. Variations in lunar gravitational force on the earth's surface, as well as changes in "biological tide" and shifts in the earth's electromagnetic field and lunar illumination, may be to account for these changes in activity patterns. The changes in activity of other living things are most likely caused by changes in autonomic neuronal activity and cardiovascular activity in higher vertebrates, as well as the light/dark cycle in different lunar phases.

The earth's tides are created by the gravitational pull of the moon and sun. While oceans and vast bodies of water are most often associated with tides, gravity also causes tides in the atmosphere and even the lithosphere (the surface of the earth). The tidal bulge of the atmosphere stretches far into space, although the lithosphere's tidal bulge is only around 12 inches (30 cm) twice a day. The tidal cycle lasts 24 hours and 52 minutes because of the cyclic rotation of the earth and moon. There are two high tides and two low tides at any point on the earth's surface during this time. Tides are more noticeable near oceanic coastlines and in bays where the tidal range (the height difference between low and high tide) is increased by terrain and other factors. Navigation, fishing, gleaning of shellfish and the development of coastal facilities all require a thorough understanding of tide heights, both low and high (Rosenberg, 2018).

The bulk of mollusk activity in the intertidal zone is highly reliant on local tide movements. The intertidal zone, in particular, can be a medium for the movement of many animals. The fluctuating tide in every site, especially in the intertidal area, allows nutrients and food particles to flow throughout. The active mollusks in the vicinity may gain access to the changing level of sea water. The active mollusks may be drawn to a location where there is no water during low tide by the high tide. In quest of food, the majority of active mollusks travel from one location to another. In another scenario, sedentary mollusks, particularly those clinging to rocks and other stationary structures, are just waiting for food particles and nutrients to be carried by the tide. These mollusks may get food from the water during high tide.

Materials and methods

The intertidal zone of Barangay Sawang in the municipality of Sibutad, Zamboanga del Norte, Philippines, was studied. According to the census of 2020, the population was 1,467. This was 8.41% of the entire population of Sibutad. Sawang is located at 8.6857, 123.5030 with respect to Mindanao's island. It's estimated that the elevation is 15.0 meters (49.2 feet) above sea level. It's the municipality of Sibutad's last barangay on the northwestern corner coast (Fig. 1).

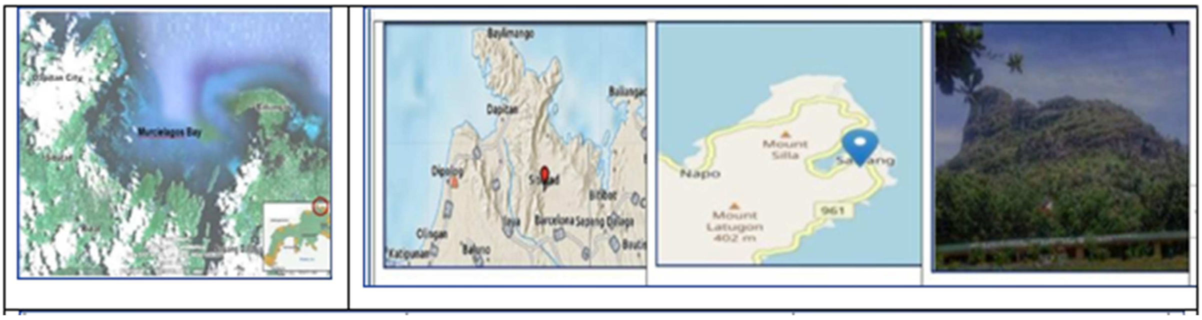

Fig. 1. A view of the Murcielagos Bay, with a map of Barangay Sawang and the mountain peak Punta Silla, showcasing the municipality of Sibutad, Zamboanga del Norte retrieved from https://www.philatlas.com/mindanao/r09/zamboanga-del-norte/sibutad/sawang.html

The research site is located in the Murcielagos Bay, which stretches from Dapitan City's eastern shore to the western part of the municipality of Baliangao, Misamis Occidental, in the Bohol Sea's south western section. Murcielagos Bay is situated in Zamboanga del Norte's northeastern region. It covers about 52 square kilometers, with a total water area of 7854.78 hectares (78.5 square kilometers) and 312.04 hectares of islands. Sea grass (2674.96 ha), mangroves (785.48 ha), and a marine sanctuary (27 ha) make up the three major marine ecosystems. The bay is shallow for three-quarters of its length, and its shoreline is dominated by a muddy bottom rimmed by patches of mangroves. In the shallow sea, water depths range from 0.5 to 30 meters, while in the deep sea, it can reach 120 meters as a collecting location, the study area has four components.

This was carried out during the four moon phases of the month from November to December 2021 and January 2022. The species' intertidal population was evaluated during the aforementioned date. For onsite sampling of three substrates of rock, sand, and corals, quadrant transects were employed at four sample stations where permanent landmarks were established (Fig. 2).

Fig. 2. Map of the sampling area

A transect line is 100 meters long, and each transect is divided into four plots with a distance of 5 meters between them. The samples were taken on a daily basis during the low tide period. The sample collections were handled by four gleaners, one for each collecting location. During low tide, the gleaners grabbed shellfish. They picked bivalves on the muddy substrate with their bare hands and feet. Another method to glean is to look for "smoke," which is actually silted that forms smoke-like particles when bivalves spurt water from their burrows. The gleaners then clinch or dig a section of the substrate and collect the bivalve.

Only the mollusks found in the collection site are collected, and they are separated into species and counted according to the number of pieces per species of mollusk. For the nomenclature of the mollusks, including the scientific name, English name, and local name, the researchers used the Google Lens and Picture Shell applications on their smartphones.

Molluscs diversity analysis

Diversity indices of molluscs such as Shannon diversity index (H'), and Margalef's species richness (S) were calculated based on the following formulae.

The Shannon diversity index: $H = - P1 \times \ln (P_1)$ (Shannon and Weaver, 1949)

Where, H = the diversity index, n_i = the relative abundance (S/N), S = the number of individuals for each species, N = total number of individuals.

Species richness (S): $D = (S - 1)/ \ln N$ (Margalef, 1969)

Where, D = Margalef's richness index, S = number of different species in the sample, N= total number of individual species in the sample.

Results and discussion

The highest peak recorded population of Gastropods during new moon phase dominated by the Maculated top shell (*Trochus maculatus*) locally known as Amomompong (1239 species out of 1806 or 68.60 percent), followed by second higher peak recorded during full moon is dominated by the Little bear conch (*Canarium urceus*) locally known as Aninikad (1236 species out of 1394 or 88.66 percent) , while during the first quarter is dominated by the Sunburst star turban/ circular saw shell (*Astraea heliotropiu*) locally known as Buta- buta (631 species out 933 or 67.63 percent). During the last quarter, the Geography Cone species (*Conus geographus*) locally known as Liswe (305 species out 681 or 44.78 percent) were prevalent (Fig. 3). The study of Pitogol *et al.* (2016) stressed that the dramatic variations in tides, lunar phases may have had an impact on individual dispersal. The availability of larger sizes under a new moon confirms the claim of intertidal gleaners in Sarangani Bay that collection is ideal during a new moon because of the abundance of larger sizes.

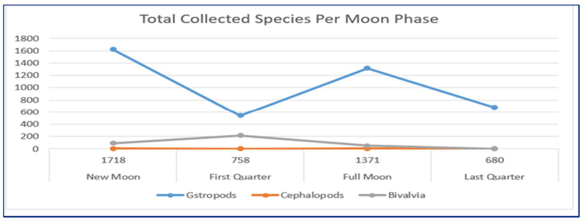

Fig. 3. The population distribution of the molluscs in the specified Barangay's intertidal area at four phases of the moon

The morphological shell features for sex differentiation of the 201 mature species of Scorpion or Spider conchs of the genus Lambis locally known as Sa-ang are noticeable, with 109 males (*Lambis scorpio* Linn.) and 92 females (*Lambis violacea scorpio* Lin.). Female specimens were on average 9.8 cm longer than male counterparts (5.9 cm).

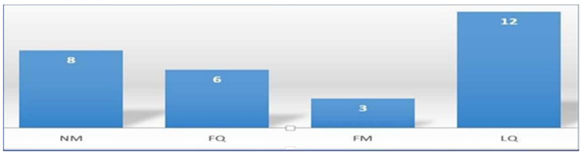

Fig. 4. The population distribution of the cephalopods in the specified Barangay's intertidal area at four phases of the moon

Fig. 4 shows that the highest peak recorded population of Cephalopods during the last quarter phase solely dominated by the Day octopus/ big blue octopus (*Octopus cyanea)* locally known as Tabugok (12 species out of 12 or 100 percent), then followed by the second higher peak recorded during new moon is dominated by the Octupos (*Octopus vulgaris*) locally known as Oktopus (6 species out of 8 or 75 percent), while during the first quarter is dominated by the Octupos (*Octopus vulgaris*) locally known as Oktopus (6 species out 6 or 100 percent) . During the full moon, there were only 3 species of 3 or 100 percent of octopus/ big blue octopus (*Octopus cyanea*) locally known as Tabugok.

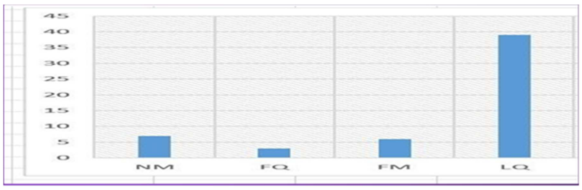

Fig. 5. The population distribution of the bivalves in the specified Barangay's intertidal area at four phases of the moon

In line with the study of Sandoval-Gío *et al.* (2020) findings revealed that the number of organisms per location was low: 22 in Ro Lagartos and 24 in San Felipe based on data collected before the commencement of the 2017 octopus fishing season. Only two organisms were found in Ro Lagartos and none in San Felipe in samplings taken after the commencement of the 2018 octopus fishing season. The number of live was found to be significantly reduced. Following the start of the octopus fishing season, polyphemus specimens showed a drop in average length of creatures, implying that mollusk fishing had a negative impact on horseshoe crab populations.

The species of octopus/ big blue octopus (*Octopus cyanea*) locally known as Tabugok were prevalent in the soft fine sand substrate, whereas Octupos (Octopus *vulgaris*) locally known as Oktupos were plentiful in the muddy sand substrate.

The highest peak recorded population of the Bivalves during the last quarter phase dominated by the Crocus/Crocea clam (*Tridacna crocea*) locally known as Suli-ot (21 species out of 39 or 53.84 percent), then followed by the second higher peak recorded during new moon is solely dominated by the Manila clam (*Mytilus edulis*) locally known as Tambayang (7 species out of 7 or 100 percent) , while during the first quarter and the full moon , there were only 3 and 6 species of Crocus/Crocea clam recorded (Fig. 5) .

Table 1. Diversity Indices of Molluscs

Diversity Indices	New Moon	First Quarter	Last Quarter	Full Moon	Average
Gastropods	1.83	1.71	1.85	2.12	1.8775
Bivalves	0.38	0.99	1.47	0.42	0.815
Cephalopods	0	0	0.95	0	0.2375
Total	1.98	1.79	2.01	2.27	2.0125

Table 2. Molluscs Richness

Richness Indices	New Moon	First Quarter	Last Quarter	Full Moon	Average
Gastropods	2.3	1.82	1.96	2.9	2.245
Bivalves	0.59	1.11	1.01	0.94	0.9125
Cephalopods	0	0	1.24	0	0.31
Total	2.94	2.41	3.06	3.67	3.02

Table 3. The Molluscs population in relation to moon phases

Indices	New Moon	First Quarter	Last Quarter	Full Moon	Average
Shannon-Wiener Diversity	1.98	1.79	2.01	2.27	2.0125
Margalef's Richness	2.94	2.41	3.06	3.67	3.02

Diversity indices

Indices are shown in Table 1, 2 and 3. The Shannon-Weaver diversity index varied from the four phases of the moon between the 1.98 (new moon) 1.79 (first quarter), 2.01 (last quarter) the total average diversity of mollusks. Margalef's richness varied from the four phases of the between 2.94 (new moon), to 32.42 (first quarter), 3.06 (last quarter) and 3.67(full moon) of mollusks found in the area study. The results showed an average richness index of 3.02. The molluscs population does not differ considerably between the four sampling locations with their own substrate, according to statistical test. The high frequency distribution of gastropod species during the new moon suggested that the increased pull on the tides allows nutrients and food particles to circulate throughout, enhancing the species' growth. Active mollusks may be drawn to a region where there is no water during low tide by the high tide during the last quarter phase, which is believed to reduce. The majority of active mollusks wander from one site to another in search of food. The population of mollusks can be observed during the four moon phases and may be influenced by the substrate and mangrove belt geographical location.

Conclusion

1. The bulk of the mollusks were Gastropoda, followed by Bivalvia with a small percentage, and Cephalopoda with the remaining percentage of the overall mollusk population. Gastropoda had the most genera, followed by Bivalvia, and Cephalopoda with only three genera.
2. The area's mollusc population is diverse. Mollusks are prevalent, particularly during the New Moon (NM) and Full Moon (FM), when the tide is much longer than during the First Quarter (FM) and Last Quarter (LQ) of the month.
3. The mollusc population in the intertidal area of Sawang, Sibutad, Zamboanga Del Norte does not differ much depending on moon phase. It also means that moon phasing has no effect on the number of mollusks in the intertidal zone.

Recommendations

1. The study will help increase people's understanding the significance of species and boost its population for the benefit of the increasing inhabitants.
2. More research is needed to better understand the richness and species of mollusks found in the diverse mangrove habitats and estuary areas in Zamboanga del Norte.
3. Gleaners may follow conservation measures and boost their earnings by only harvesting mature species.
4. Protecting habitat variability at local natural stock scales may be considered through the establishment of protected areas.

References

Barrientos-Luján NA, **Rodríguez-Zaragoza FA**, **López-Pérez A**. 2021. Richness, abundance, and spatial heterogeneity of gastropods and bivalves in coral ecosystems across the Mexican Tropical Pacific. Journal of Molluscan Studies **87**(2), eyab004. https://doi.org/10.1093/mollus/eyab004.

Castillo-Rodríguez ZG, **Naranjo-García E**, **Amezcua-Linare F**. 2018. A new record of *Huttonella bicolor* (Hutton, 1834) (Mollusca, Gastropoda, Streptaxidae) in Mexico. Acta Zoológica Mexicana **34**, Xalapa. Available at http://www.scielo.org.mx/scielo.php?pid=S0065-17372018000100115&script=sci_arttext.

Chakraborty U. 2020. Effects of different phases of the lunar month on living organisms. Biological Rhythm Research **51**(2), 254–282. DOI: 10.1080/09291016.2018.1526502.

Dahlhoff EP, **Buckley BB**, **Menge BA**. 2001. Physiology of the rocky intertidal predator *Nucella ostrina* along an environmental stress gradient. Ecology **82**, 2816–2829.

Denny M, **Wethey D**. 2001. Physical processes that generate patterns in marine communities. In Bertness MD, Gaines SD, Hay ME (eds.), Marine community ecology, pp. 3–37. Sinauer Associates, Sunderland.

Kulesza WA. 1988. Previsão astronômica através da observação das marés. Revista do Ensino de Física **10**, 3–11.

Maneschy MCA. 1993. Pescadores nos manguezais: estratégias técnicas e relações sociais de produção na captura de caranguejo. In Furtado LG, Leitão W, Fiúza A (eds.), Povos das Águas: Realidade e Perspectivas na Amazônia, MCT/CNPq, pp. 19–62.