Natural Resources, 2025, 16(13), 694-706
https://www.scirp.org/journal/nr
ISSN Online: 2158-7086
ISSN Print: 2158-706X

Impact of Habitat and the Rock-Boring Sea Urchin on the White Sea Urchin Population: The Case of Martinique

Coralie Borelva[1,2*], **Philippe Joseph**[1,2]

[1]UMR Espace Dev-BIORECA, University of the Antilles, Schœlcher, France
[2]Institute of Biodiversity and Ecology, Fort-de-France, France
Email: *coralieborelva5@gmail.com

How to cite this paper: Borelva, C. and Joseph, P. (2025) Impact of Habitat and the Rock-Boring Sea Urchin on the White Sea Urchin Population: The Case of Martinique. *Natural Resources*, **16**, 694-706.
https://doi.org/10.4236/nr.2025.1613034

Received: January 22, 2025
Accepted: December 26, 2025
Published: December 29, 2025

Abstract

Tripneustes ventricosus and *Echinometra lucunter* are two species of sea urchins that live in the oceanic waters of Martinique. Both species live in the same habitat and have common food preferences. Martinique is an island with a particular geomorphology with coral reefs in the east (Atlantic part) and slopes of volcanic origin in the west (Caribbean part). The aim of this study is to identify the habitats where white sea urchins are distributed according to the type of substrate and the geomorphology of the seabed. The other part is to assess whether these two species (white sea urchin and rock-boring sea urchin) can compete. Thirty-three sites were sampled in Martinique. Of these sites, four were selected to determine the density of rock-boring sea urchins. The transect method was used to count the number of sea urchins. Other elements were noted: type of substrate, geomorphology, benthic biocenoses, state of health. The results showed that white sea urchins are more numerous in the soft substrate, in the mixed seagrass beds of *Thalassia testudinum* and *Syringodium filiforme*. They also live in the hard substrate of coral origin, in fringing reefs (flats and back reef depressions), cays, coral patches and generally in coastal reef platforms. They are rare on the volcanic hard bottoms between Anses d'Arlet and Prêcheur. The population of rock-boring sea urchins is higher than that of white sea urchins between April and December 2024. It appears that the rock-boring sea urchins appear to be taking advantage of the decline in the white sea urchin population to grow.

Keywords

Echinometra lucunter, *Tripneustes ventricosus*, Marine Environment, Geomorphology, Habitat, Competition, Martinique

1. Introduction

The white sea urchin or *Tripneustes ventricosus* is an echinoidea. It is characterized by a reddish-brown, rarely white test that is surrounded by small white spines [1] [2]. It consumes seagrass beds (*Thalassia testudinum, Syringodium filiforme*) and algae such as the algae *Dictyota sp* [3]-[6]. In some Caribbean islands (Barbados, Puerto Rico, Saint Lucia, Jamaica, Bahamas, Virgin Islands), white sea urchins live in a wide variety of biological communities. They thrive in the beds of *Thalassia testudinum* or mixed seagrass beds *Thalassia testudinum* and *Syringodium filiforme* [5]-[8], in *dictyota*, *padina*, *halimeda* algae [9]-[11]. The type of substrate was also indicated: sand, rubble, rocks, corals (debris, living or dead) [3] [4] [10] [12]. Some authors have specified their location based on the reef. White Sea Urchins may colonize fore-reefs, back-reefs, behind the reef front, reef flats, and lagoons [7] [8] [13]-[15]. These habitats are located in shallow waters, usually less than 10 metres deep [16]. In Martinique, there are very few studies on this subject. Daniel [16] explains that white sea urchins live in a bay, in mixed grass beds, on cays and not in bare sand.

The sea urchin *Echinometra lucunter*, commonly known as the rock-boring sea urchin, is a black to red sea urchin [17]. It is not part of the same family as the white sea urchins (family Echinometridae) and is smaller. In fact, the maximum size for the rock-boring sea urchin is 7 cm, while for *Tripneustes ventricosus* it is 15 cm [16] [17]. They are distributed in Florida, Bermuda, the Caribbean, Brazil, Venezuela as is the white sea urchin [18] [19]. They are found in the same habitat as *Tripneustes ventricosus*, in rocky areas, coral reefs, holes, and very little in *Thalassia testudinum* meadows [17]. The particularity with the rock-boring sea urchin is that it is able to dig crevices in the rock of biogenic origin [20]. They live in shallow areas but have previously been observed at depths of up to 45 metres. Their breeding season is in late summer and early fall [17]. It consumes invertebrates such as sponges, bivalves, macroalgae such as the algae *Dictyota spp* [21].

The aim of this study on the one hand is to determine all the habitats where white sea urchins live in Martinique and whether the geomorphology of the seabed and the type of substrate can influence their distribution. And on the other hand, how the population of white sea urchins and rock-boring sea urchins evolves and whether they are in competition.

2. Materials and Methods

2.1. Study Sites

Martinique is a volcanic island in the Caribbean that is part of the Lesser Antilles. It is located between 14˚23' and 14˚53' north latitude, and between 60˚50' and 61˚15' west longitude, between Dominica to the north and Saint Lucia to the south. It is surrounded by the Caribbean Sea to the west and the Atlantic Ocean to the east. Martinique has a geomorphology of the seabed that depends on its geological history [22]. It is characterized by coral reefs in the Atlantic part (from Sainte-Anne to Sainte-Marie). Barrier reefs are located from the Caravelle to Vauclin, covering 25 km and encompassing the Loup Garou cay, the Pinsonnelle cay and the Pariadis cay [23]. Inside this area, many fringing reefs and islets have formed such as the Eau islet, the Boisseau islet, Rats islet. In the south of Martinique, in Sainte-Anne, there are micro-lagoons at Cap Chevalier [23]. The Caribbean area (from Prêcheur to Anses d'Arlet) has slopes of volcanic origin. Formations of gorgonians, corals, sponges on rocks are present and are called non-bio-constructive reefs, *i.e.* they do not come from the formation of limestone skeletons. Generally, this area consists of boulder fields, then a rock slope, a rock platform and finally a wall (sub-vertical slopes). The further north you go, the steeper the slopes. The bay of Fort-de-France is not of volcanic origin and is composed of many coral structures such as the Vache caye [23]. It is certainly protected, but very much anthropized. The Diamant/Sainte-Anne zone, located in the Caribbean zone, is called the southern zone. It is made up of coastal reef platforms (structures that do not form a lagoon) and cayes (shoal) such as the Cherry Cay or the Trois Rivières Cays. The depth of the seabed is influenced by these different geological constructions, which explains why the Atlantic zone is flatter than the Caribbean zone. In Martinique, there is a great diversity of benthic biocenotic composition [24]: coral community, seagrass beds, algal community, bare soft bottom community, mixed community. Marine phanerogams are almost everywhere in Martinique and very little represented in the northern Caribbean area [24]. The dominant species are *Thalassia testudinum* and *Syringodium filiforme*. Other marine phanerogams are present such as *Halophila stipulacea* and *Halophila decipiens* [24] [25]. The type of substrate that is mainly found in Martinique is sand. Other substrates are present on this island: rocks, mud, muddy sand, coral, detrital (pebbles, coral debris) [24].

The sites sampled are located throughout Martinique and are thirty-three in number (**Figure 1**). They are spread over different municipalities:

- North Caribbean Zone: Prêcheur (Pointe Lamarre), Case-Pilote (Fond Bellemare, Vétiver);
- Bay of Fort de France (2 sites);
- Southern Caribbean zone: Anses d'Arlet (La Baleine, Grand Anse, Petite Anse, Town);

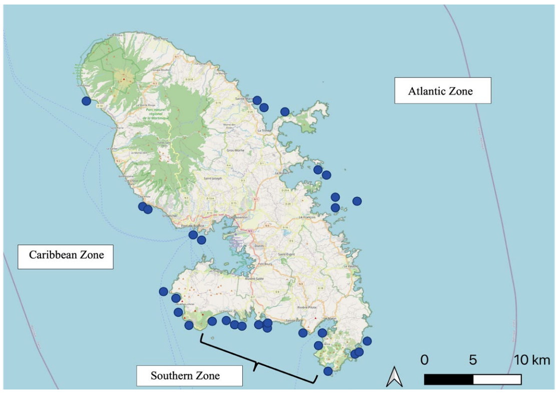

Figure 1. Map of sampled sites in Martinique.

- Southern Zone: Diamant (Anse Cafard, La Cherry, Tête de Singe, Town), Sainte-Luce (Kaye Baré, Trois Rivières, Anse Mabouya, Anse Mabouya beach), Marin (Pointe Borgnese), Sainte-Anne (Pointe du Marin, Anse Caritan, Cabrits islet);
- Atlantic zone: Sainte-Anne (Hardy islet, Chevalier islet, Anse Michel), François (Caye Pinsonelle, Grande Basse 1, Grande Basse 2), Robert (Rats islet, Eau islet, Boisseau islet), Trinité, Sainte-Marie (Anse Azérot, Saint Aubin islet).

2.2. Sampling

The study ran from January 2023 to November 2024. These sites were located at depths between 0 and 24 metres. The method used is the transect method. On a 60 m^2 transect with a length of 30 metres, the white sea urchins on both sides of the line (1 metre on each side) were counted. The type of substrate (soft, hard), the geomorphology of the seabed (barrier reefs, rocky slopes, cays, etc.), the benthic floristic species present and their state of health were also inventoried. The health of reefs and seagrass beds was assessed according to the principles of Bouchon *et al.* [26]. A macroscopic analysis of the sand was carried out in order to classify them into several classes: fine sand, medium sand and coarse sand. The density of white sea urchins was calculated over several months and for each habitat type. Concerning the rock-boring sea urchin, four sites that are part of the sites sampled for the white sea urchin were considered, two in the Caribbean zone (Diamant, Trois Rivières) and two in the Atlantic zone (Trinité, Robert). The study ran from March to December 2024. The number of white sea urchins and rock-boring sea urchins was counted on a 60 m^2 transect over three periods of April-June, July-September and October-December.

2.3. Statistical Analyses

The Shapiro-Wilk test was used using the XLSTAT software to test the normality of the sample. As the data did not follow the normal distribution, nonparametric statistical tests were used. Differences in white sea urchin densities according to substrate type (soft, hard of biogenic origin and hard of volcanic origin) were analyzed using the nonparametric Kruskal-Wallis test (XLSTAT®). If the null hypothesis was rejected, a Dunn's pairwise multiple comparison was used to determine which substrate types differed from each other. Density was expressed as an average ± standard error. For this test, the significance level was set at $p < 0.05$. The Mann-Whitney U test was tested using XLSTAT software to compare the densities of rock-boring sea urchins and white sea urchins for each period (April-June, July-September and October-December).

3. Results

3.1. Habitat of White Sea Urchins

First, white sea urchins are located in various seagrass communities (**Figure 2**). They lived in the exclusive beds of *Thalassia testudinum* and in the exclusive beds of the invasive *Halophila stipulacea* seagrass beds on both muddy sand and sand. Also, they were present in mixed seagrass communities (*Thalassia testudinum*/*Halophila stipulacea* or *Syringodium filiforme*/*Halophila stipulacea* or *Thalassia testudinum*/*Syringodium filiforme*) on sand with low to medium grains. No white sea urchins were observed in the bare loose substrate (mud, muddy sand, sand) and in the meadows of halophila (*Halophila stipulacea*, *Halophila decipiens*) on coarse sand. This plain of Halophila seagrass beds was located after the rocky slopes in the Caribbean coast (Case-Pilote, Anses d'Arlet) at depths greater than 15 metres. White sea urchins were more numerous in mixed meadows of *Thalassia testudinum* and *Syringodium filiforme* on sand and less in invasive meadows of *Halophila stipulacea*, alone or with *Syringodium filiforme*. However, at Pointe Borgnese, when this invasive species is associated with the *Thalassia testudinum* seagrass, the number of sea urchins was close to that observed in mixed seagrass beds. *Tripneustes ventricosus* generally preferred sand as a substrate than muddy sand. Pointe Borgnese was the site with the most white sea urchins and a greater diversity of marine phanerogams.

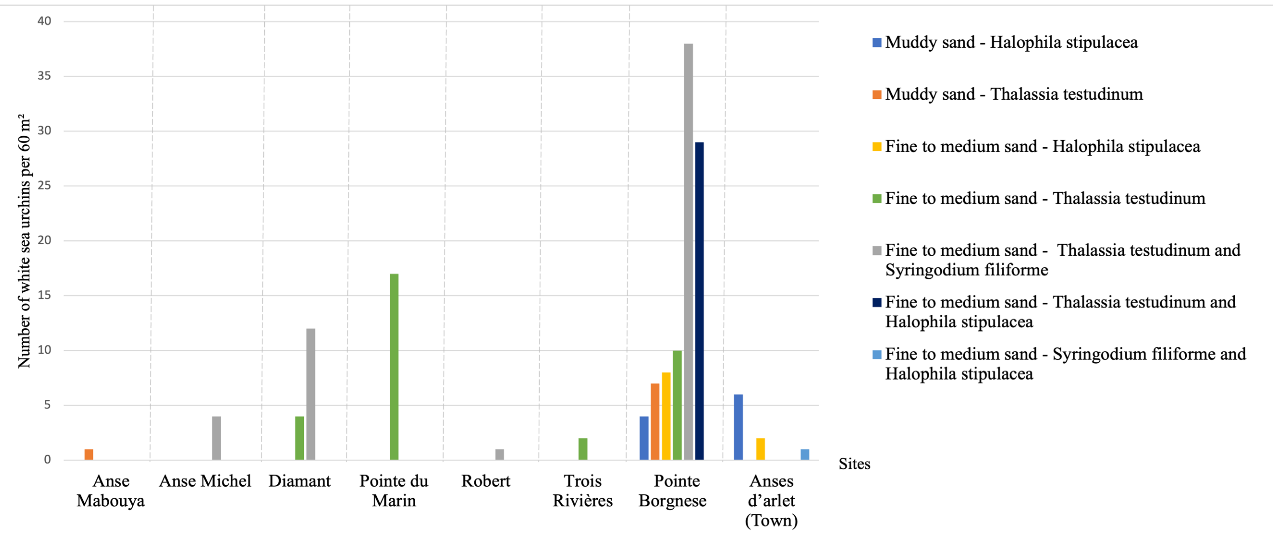

Figure 2. Number of white sea urchins per site according to the type of substrate and their biocenotic composition in marine phanerogams.

In Fort-de-France, Anses d'Arlet (Grande and Petite Anse) and Sainte-Anne (Cabrits islet, Hardy islet and Chevalier islet), despite the presence of meadows of *Halophila stipulacea* on muddy sand or mixed meadows of *Thalassia testudinum* and *Syringodium filiforme*, they were devoid of sea urchins (Table 1).

Concerning the hard substrate of volcanic origin, white sea urchins have been found at Anses d'Arlet, in the fields of boulders with brown algae and only one in the rocky slope. This slope was composed of corals, sponges, gorgonians, turf and was very degraded with the presence of *Sargassum sp*. In the North Caribbean zone (Prêcheur, Case-Pilote), they were absent. It was composed of rock block fields with encrusting corals and turfs, slopes and rock platforms with mixed populations (corals, sponges, gorgonians, turfs).

Table 1. Characteristics of sampled sites with no white sea urchins.

Site	Substrate type	Species	State of health	Zone
Bay of Fort-de-France	Muddy sand	*Halophila stipulacea*	Very degraded	Bay of Fort-de-France
Cabrits islet	Fine to medium sand	*Thalassia testudinum* et *Syringodium filiforme*	Degraded	Southern
Hardy islet	Fine to medium sand	*Thalassia testudinum* et *Syringodium filiforme*	Good condition	Atlantic
Chevalier islet	Fine to medium sand	*Thalassia testudinum* et *Syringodium filiforme*	Good condition	Atlantic
Anses d'Arlet (Petite Anse)	Fine to medium sand	*Thalassia testudinum* et *Syringodium filiforme*	Good condition	Caribbean
Anses d'Arlet (Grande Anse)	Muddy sand	*Halophila stipulacea*	Very degraded	Caribbean

Finally, in hard substrates of biogenic origin (of coral origin), white sea urchins generally lived on coastal reef platforms, composed of coral debris, dead and/or live corals. At the level of the Chéry Caye located in Diamant, the white sea urchins were particularly visible on the shoal and less so in the meadows of *Thalassia testudinum* located between the cay and the coast. The seagrass area after the cay was devoid of *Tripneustes ventricosus*. In addition, at the level of the barrier reef, the Pinsonnelle Caye had no white sea urchins. The sea urchins thrived in the reef flats of the fringing reefs in François and Robert. On the other hand, none were observed in Trinité and Sainte-Marie. The particularity with the Eau islet in Robert compared to the nearby islet Boisseau is that the Eau islet has a more marked back-reef depression. In addition, it is in this area that there were the most white sea urchins. And when we head out to sea, and therefore towards the reef front, the more the number of sea urchins decreased (**Figure 3**). The back-reef depression was composed of mixed populations of gorgonians, coral patches, seagrass beds, rocks, brown algae while the reef flat had *Sargassum polyceratium*. The reef front was made up of degraded corals and gorgonians.

In the end, white sea urchins significantly prefer the soft substrate, unlike the hard substrate of volcanic origin ($P = 0.0002$) and the hard substrate of biogenic origin ($P = 0.015$) (**Figure 4**). When comparing the two types of hard substrate, it flourished particularly in hard substrates of coral origin ($P = 0.028$).

3.2. Rock-Boring Sea Urchins and White Sea Urchins

In the Caribbean, the population of rock-boring sea urchins increased between April and December in Trois Rivières or remained more or less stable in Diamant (**Figure 5**). On the other hand, over the same period, white sea urchins were rare in Sainte-Luce or decreased in Diamant.

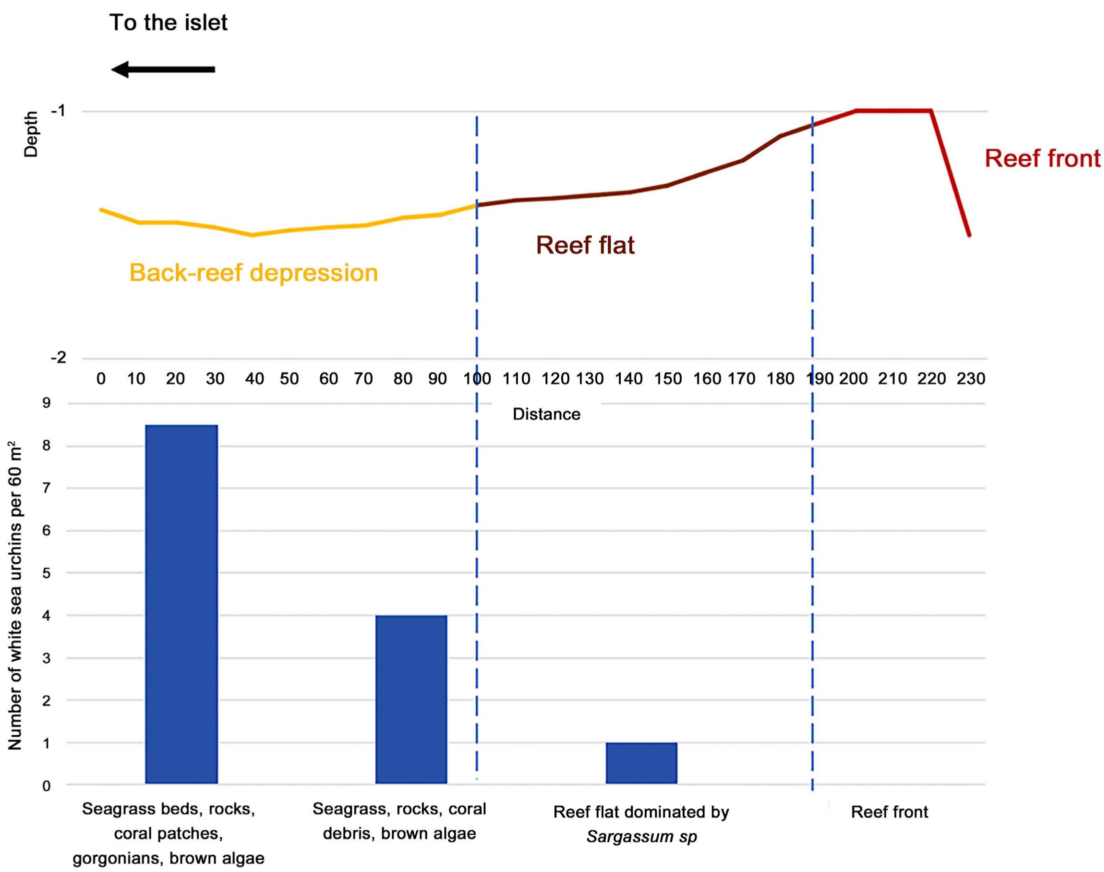

Figure 3. Number of white sea urchins as a function of the difference in level of the fringing reef at the Eau islet in Robert.

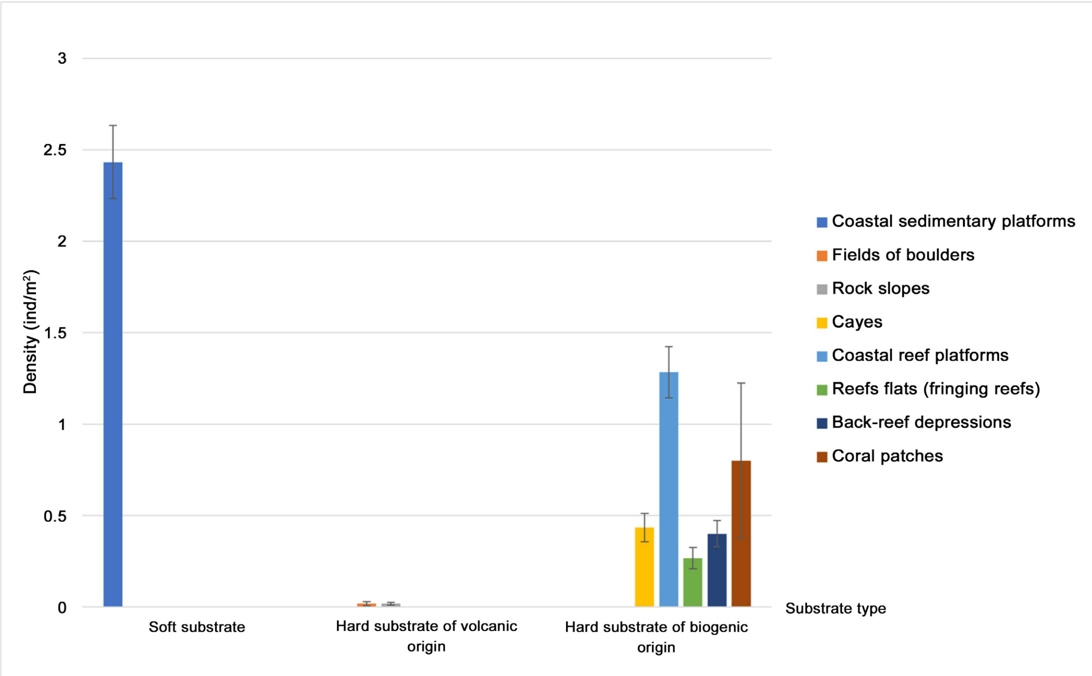

Figure 4. Number of white sea urchins per square meter (mean ± standard error) according to the type of substrate and the typology of the seabed.

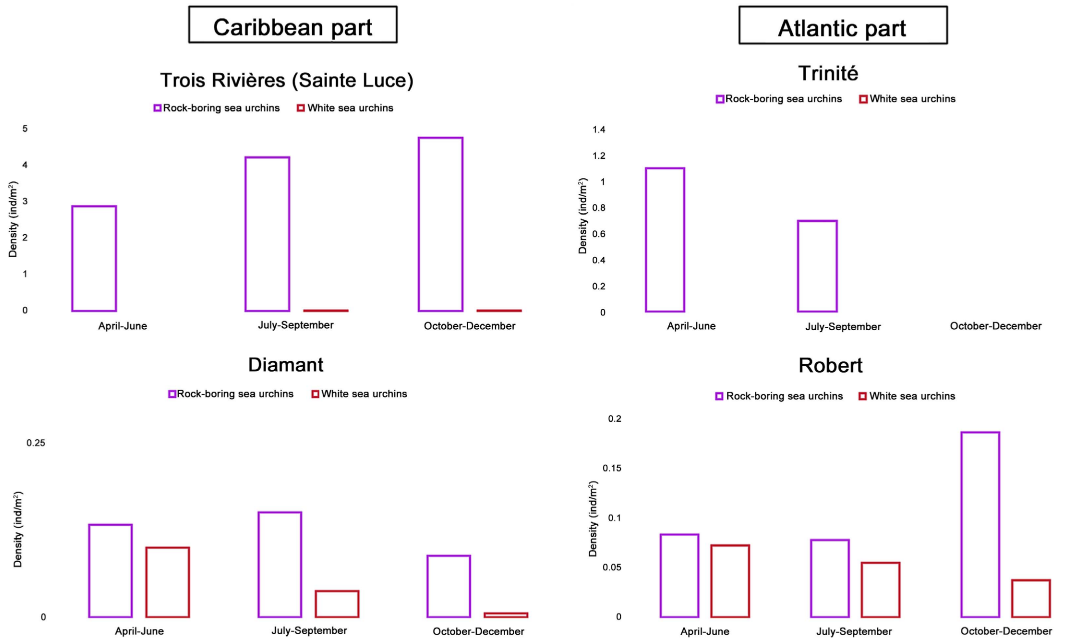

Figure 5. Number of white sea urchins and rock-boring sea urchins between the months of April-June, July-September, October-December in Trois Rivières, Diamant, Trinité and Robert.

In the Atlantic zone, in Trinité, there were no white sea urchins (**Figure 5**). For rock-boring sea urchins, their density ranged from 0.7 to 1.1 individuals per square metre. Between October and December, due to weather conditions, no data were recorded. In Robert, the population of *Tripneustes ventricosus* and rock-boring sea urchins was almost at the same level over the period from April to September (**Figure 5**). However, an increase in the number of rock-boring sea urchins was observed in November while the number of white sea urchins decreased.

In the end, the population of *Echinometra lucunter* is higher than the white sea urchins between the months of April and December at all the sites sampled. These rock-boring sea urchins were significantly larger only for the months of July-September ($P < 0.001$) and October-December ($P < 0.0001$). These sea urchins have been found in biogenic hard substrates, on reef flats and coral patches.

4. Discussion

4.1. Loose Substrate

White sea urchins are more numerous in mixed seagrass communities in good condition of *Thalassia testudinum* and *Syringodium filiforme*. These seagrass beds are part of their food preference [3] [4] [16]. According to our observations, white sea urchins also manage to develop on the meadows of *Halophila stipulacea.* It is an invasive species that comes from the Red Sea. It was first observed in Martinique in 2006 and continues to spread [25]. It is generally visible in anchorage areas [25] [27] such as in Anses d'Arlet. Nevertheless, the number of sea urchins is lower compared to other seagrass beds, which can be explained by the fact that *Halophila stipulacea* has a lower nutritional value than that of *Thalassia testudi-*

num and *Syringodium filiforme* [28]. In the bay of Fort-de-France, at the Cabrits islet and Grande Anse, the reasons that may explain the lack of white sea urchins are as follows: first, the seagrass beds are very degraded and the second, there is a strong nautical activity and/or agricultural production nearby. Similarly, the Hardy islet and Chevalier islet are areas with a lot of poaching. In addition, white sea urchins may also be present on other communities of marine phanerogams in Martinique, such as in the exclusive beds of *Syringodium filiforme* [29].

4.2. Hard Substrate

White sea urchins seem to dislike hard substrates of volcanic origin. These habitats are more or less devoid of food for white sea urchins. Only the commune of Anses d'Arlet is colonised by white sea urchins. The town of Anses d'Arlet was composed of fields of brown algae blocks, dominated by *Dictyota sp.* This algae is part of the diet of the white sea urchin [3] [30]. At the site of La Baleine (Anses d'Arlet), the only sea urchin present had a pile of greenish-brown threads on its test. This has never been observed before, nor described in the literature. In addition, according to divers, there are usually no white sea urchins in this area.

The southern zone is an area with the most white sea urchins. It is composed of hard biogenic substrate. It is in this area that fishing for white sea urchins is more important. At the Chéry Caye, our observations were able to show the importance of this coral structure for the white sea urchin. Indeed, the cays facilitate the metamorphosis of the larvae and therefore allow a larger population on these shoals [16]. On the other hand, in the Atlantic zone, an extinction of the population of *Tripneustes ventricosus* has been observed. According to fishermen, Trinité and the cays of François were once rich in white sea urchins. In Robert and François, they live hidden in the crevices of reef flats or shallow coral patches (1 - 2 metres). This behaviour is usually visible when the light is too bright [2]. It is accentuated when the depths are shallow. Numerous shells of dead young sea urchins have also been found near the sites studied in François. The high temperatures of recent years may have had a negative impact on the white sea urchin population. Sea urchins do not tolerate high temperatures [31].

4.3. Geomorphology of the Seabed

The presence of white sea urchins depends on the type of substrate, the biocenotic communities and therefore on the geomorphology of the seabed. The population of *Tripneustes ventricosus* is concentrated in Anses d'Arlet, in the southern zone and in the Atlantic part. In the North Caribbean (Prêcheur-Case-Pilote), they are absent. In this area, food for white sea urchins is scarce, the slopes are too steep for the white sea urchin to develop. It is also very rich in corals, gorgonians and fish. Nevertheless, according to fishermen and divers, there are white sea urchins in Prêcheur at depths of about 40 metres.

In the Caribbean, in Jamaica, Haley and Solandt [14] also noted this difference in density between the front and back of the reef. They found that the population of white sea urchins was larger and more stable at the back reefs. The latter was composed of seagrass beds and corals.

4.4. Rock-Boring Sea Urchins

The rock-boring sea urchins, *Echinometra lucunter* are significantly larger than the population of white sea urchins. Moreover, in Trois Rivières (Kaye Baré), a significant increase was observed between 2022 and 2024 (personal observation). At the beginning of July, there was a strong swell in Martinique, particularly in Diamant, caused by the passage of Hurricane Beryl. It seems that the rock-boring sea urchins were not affected by this swell, unlike the white sea urchin, which, on the contrary, accentuated its decline. This may be due to the fact that rock-boring sea urchins are smaller in size and tend to lodge in small crevices. This sea urchin is also a species that is resistant to heat stress, unlike the *Tripneustes ventricosus*. The slightest thermal variation can lead to numerical erosion of the latter [31]. A further study over time will confirm these results and understand the reasons for its resistance to environmental stresses.

5. Conclusions

Tripneustes ventricosus lives in a variety of habitats: seagrass beds, under boulders overgrown with brown algae, cays, back reef depressions, coastal reef platforms, coral patches, and reef flats. White sea urchins thrive mainly in the soft substrates of *Thalassia testudinum* and *Syringodium filiforme* meadows. Seagrass communities composed of the invasive species *Halophila stipulacea* are also part of the habitats of the white sea urchin. They have been able to adapt to this species but their numbers remain low because the nutritional value of this species is lower compared to other seagrass species. Nevertheless, white sea urchins are generally absent in hard substrates of volcanic origin (rock platforms, rock slopes, turf and encrusting coral boulder fields, beginning of drop-offs) and in bare soft substrate. The typology of the seabed has an impact on the distribution of the white sea urchin population. White sea urchins are concentrated in the south of Martinique and in the Atlantic area. The latter were composed of soft substrate and hard substrate of coral origin. The geomorphology of the North Caribbean (Case-Pilote, Prêcheur) does not allow the white sea urchins to develop due to the lack of food and the presence of the hard substrate of volcanic origin.

Rock-boring sea urchins inhabit the same habitat as white sea urchins, in coral patches and reef flats. They are more numerous than white sea urchins and increase between April and December 2024. On the other hand, the population of the *Tripneustes ventricosus* has decreased. *Echinometra lucunter* is a species that is not very sensitive to its environment and eats some common algae with the *Tripneustes ventricosus* (*Dictyota sp*). Thus, the decline in the population of white sea urchins seems to allow the population of rock-boring sea urchins to increase.

In addition, this species is one of the edible sea urchins. It is, moreover, marketed in Senegal. Due to the large number of rock-boring sea urchins, it would be interesting to study whether it is possible to fish for this species in Martinique.

Acknowledgements

The authors thank the fishermen and divers for participating in this study. Thank you to the fishermen for sharing their knowledge of the marine environment and sea urchins (white sea urchin and rock-boring sea urchin).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Caso, M.E. (1974) Contribución al estudio de los equinoideos de México el género, Tripneustes Agassiz. Morphología y ecología de *Tripneustes ventricosus* (Lamarck). *Anales del centro de ciencias del mar y limnología*, **1**, 1-24.

[2] Kehas, A.J., Theoharides, K.A. and Gilbert, J.J. (2004) Effect of Sunlight Intensity and Albinism on the Covering Response of the Caribbean Sea Urchin *Tripneustes ventricosus*. *Marine Biology*, **146**, 1111-1117. https://doi.org/10.1007/s00227-004-1514-4

[3] Lewis, J.B. (1958) The Biology of the Tropical Sea Urchin *Tripneustes esculentus* Leske in Barbados, British West Indies. *Canadian Journal of Zoology*, **36**, 607-621. https://doi.org/10.1139/z58-055

[4] Lilly, G.R. (1975) The Influence of Diet on the Growth and Bioenergetics of the Tropical Sea Urchin, *Tripneustes ventricosus*, Lamarck. Ph.D. Thesis, University of British Columbia. https://doi.org/10.14288/1.0093587

[5] Tertschnig, W.P. (1989) Diel Activity Patterns and Foraging Dynamics of the Sea Urchin *Tripneustes ventricosus* in a Tropical Seagrass Community and a Reef Environment (Virgin Islands). *Marine Ecology*, **10**, 3-21. https://doi.org/10.1111/j.1439-0485.1989.tb00063.x

[6] Barrios, J. and Reyes, J. (2008) Hábitos alimenticios de *Tripneustes ventricosus* (Lamarck, 1816) (Echinodermata, Echinoidea) en Isla Tortuga, Venezuela. *Foro Iberoamericano de Recursos Marinos y Acuicultura*, **2**, 583-589.

[7] Keller, B.D. (1983) Coexistence of Sea Urchins in Seagreas Meadows: An Experimental Analysis of Competition and Predation. *Ecology*, **64**, 1581-1598. https://doi.org/10.2307/1937512

[8] Amato, K.R., Emel, S.L., Lindgren, C.A., Sullan, K.M., Wright, P.R. and Gilbert, J.J. (2008) Covering Behavior of Two Co-Occurring Jamaican Sea Urchins: Differences in the Amount of Covering and Selection of Covering Material. *Bulletin of Marine Science*, **82**, 255-261.

[9] Cameron, R.A. (1986) Reproduction, Larval Occurrence and Recruitment in Caribbean Sea Urchins. *Bulletin of Marine Science*, **39**, 332-346.

[10] Scheibling, R.E. and Mladenov, P.V. (1987) The Decline of the Sea Urchin, *Tripneustes ventricosus*, Fishery of Barbados: A Survey of Fishermen and Consumers. *Marine Fisheries Review*, **49**, 62-69.

[11] Maciá, S. and Robinson, M.P. (2008) Habitat-Dependent Growth in a Caribbean Sea Urchin *Tripneustes ventricosus*: The Importance of Food Type. *Helgoland Marine Research*, **62**, 303-308. https://doi.org/10.1007/s10152-008-0117-8

[12] Valle Cortés, S.M., Cardé Serrano, J.A. and Morales Díaz, H.D. (2021) A Short-Term

Study of the Fertility and Embryonic Development of *Tripneustes ventricosus* off the Northwest Coast of Puerto Rico. *BIOS*, **91**, 271-277. https://doi.org/10.1893/0005-3155-91.4.271

[13] Hendler, G. (1977) The Differential Effects of Seasonal Stress and Predation on the Stability of Reef-Flat Echinoid Populations. *Proceedings of the Third International Coral Reef Symposium*, Miami, May 1977, 217-223.

[14] Haley, M.P. and Solandt, J.L. (2001) Population Fluctuations of the Sea Urchins *Diadema antillarum* and *Tripneustes ventricosus* at Discovery Bay, Jamaica: A Case of Biological Succession? *Caribbean Journal of Science*, **37**, 239-245.

[15] Moses, C. and Bonem, R. (2001) Recent Population Dynamics of *Diadema antillarum* and *Tripneustes ventricosus* along the North Coast of Jamaica, W I. *Bulletin of Marine Science*, **68**, 327-336.

[16] Daniel, P. (2003) La pêcherie aux oursins blancs (*Tripneustes ventricosus*, Lamarck) sur le plateau insulaire martiniquais: Analyse et modélisation des paramètres d'exploitation. Ifremer.

[17] McPherson, B.F. (1969) Studies on the Biology of the Tropical Sea Urchins, *Echinometra lucunter* and *Echinometra viridis*. *Bulletin of Marine Science*, **19**, 194-213.

[18] Kier, P. and Grant, R.E. (1965) Echinoid Distribution and Habits, Key Largo Coral Reef Preserve. Smithsonian Institution.

[19] McClanahan, T.R. and Muthiga, N.A. (2020) Chapter 28: Echinometra. In: Lawrence, J.M., Ed., *Sea Urchins*: *Biology and Ecology*, Elsevier, 497-517.

[20] Roman, J. (1984) Les echinides et les milieux de vie du tertiaire quelques exemples. *Geobios*, **17**, 115-124. https://doi.org/10.1016/s0016-6995(84)80164-3

[21] Reyes-Luján, J., Barrios, J., Arrieche, D., Zapata-Vívenes, E., Salgado, W. and Lo-deiros, C. (2015) Dieta del erizo negro *Echinometra lucunter* (Echinometra: Echinoidea) en el Nororiente de Venezuela. *Revista de Biología Tropical*, **63**, 233-242.

[22] Leclerc, F., Feuillet, N., Perret, M., Cabioch, G., Bazin, S., Lebrun, J., *et al.* (2015) The Reef Platform of Martinique: Interplay between Eustasy, Tectonic Subsidence and Volcanism since Late Pleistocene. *Marine Geology*, **369**, 34-51. https://doi.org/10.1016/j.margeo.2015.08.001

[23] Battistini, R. (1978) Les récifs coralliens de la Martinique: Comparaison avec ceux du Sud-Ouest de l'Océan Indien. Cahiers ORSTOM. *Série Océanographie*, **16**, 157-177.

[24] Legrand, H. (2010) Cartographie des biocénoses benthiques du littoral martiniquais et eutrophisation en zone récifale en relation avec les sources de pression d'origine anthropique. Ph.D. Thesis, Université de Perpignan.

[25] Maréchal, J., Meesters, E.H., Vedie, F. and Hellio, C. (2013) Occurrence of the Alien Seagrass *Halophila stipulacea* in Martinique (French West Indies). *Marine Biodiversity Records*, **6**, e127. https://doi.org/10.1017/s1755267213000961

[26] Bouchon, C., Bouchon-Navaro, Y. and Louis, M. (2004) Critères d'évaluation de la dégradation des communautés coralliennes dans la région caraïbe. *Revue d'Écologie* (*La Terre et La Vie*), **59**, 112-121. https://doi.org/10.3406/revec.2004.6384

[27] Willette, D.A. and Ambrose, R.F. (2009) The Distribution and Expansion of the Invasive Seagrass *Halophila stipulacea* in Dominica, West Indies, with a Preliminary Report from St. Lucia. *Aquatic Botany*, **91**, 137-142. https://doi.org/10.1016/j.aquabot.2009.04.001

[28] Bouchon, C., Mellinger, J. and Bouchon-Navaro, Y. (2015) *Halophila stipulacea*: Une espèce invasive de Phanérogame marine dans les Antilles. Report, UMR Borea, Université Antilles-Guyane, Guadeloupe.

[29] Borelva, C. Importance des herbiers et des macroalgues sur la réparti-tion du *Tripneustes ventricosus* en Martinique.

[30] Prince, J.S., LeBlanc, W.G. and Macia, S. (2004) Design and Analysis of Multiple Choice Feeding Preference Data. *Oecologia*, **138**, 1-4. https://doi.org/10.1007/s00442-003-1413-2

[31] Glynn, P.W. (1968) Mass Mortalities of Echinoids and Other Reef Flat Organisms Coincident with Midday, Low Water Exposures in Puerto Rico. *Marine Biology*, **1**, 226-243. https://doi.org/10.1007/bf00347116