Status of mangroves and faunistic components in Vanishing Island, Island Garden City of Samal, Philippines

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ABSTRACT

This study aimed to determine the status of the mangrove ecosystem in Island Garden City of Samal, specifically in Vanishing Island or is also known as Sanipaan Marine Park, through species composition assessment. It also aimed to discover the density, diversity, associated faunal species, and number of mangrove trees, saplings, and seedlings of different species as well as abiotic factors such as pH level and salinity. After analysis of the results, it was found that the mangrove species abundance is low; moreover, mangroves also have a very low classification of diversity, which implied that there is slim variation of species. Furthermore, the very low diversity of the faunal species also meant that there is food and habitat loss. The number of mangrove trees, saplings, and seedlings is also connected to the diversity and density, resulting in low population count. Lastly, abiotic factors also reflect to others results as the pH level is strong alkaline; salinity is of standard level that can be tolerated by trees but not by mangrove saplings and seedlings. Therefore, the mangrove ecosystem in Sanipaan Marine Park is unhealthy despite it being a marine protected area. It is recommended to plant different mangrove seedlings, periodic monitoring of these seedlings and strict implementation of city ordinances.

Keywords: *mangroves, assessment, abiotic factors, Island Garden City of Samal*

INTRODUCTION

Amidst the growing population of the world, marine coastal protectors are suffering due to the destruction of habitat and over collection of marine species. Mangrove ecosystem provides an essential benefit not only to humans but also to the coastal and marine ecosystem (Anand, 2018). Primavera (2004) has stated the beneficial services brought to us by mangroves such as soil erosion control, flood regulation, coastal protection, sediment stabilization, regeneration of nutrients and its supplies, treatment of wastes and lastly, it serves as a habitat for the marine wildlife. Researchers preserve water quality and help in reducing pollution by filtering materials and absorbing dissolved nutrients, but despite its complementary uses, its population is now decreasing. Natural threats are one of the reasons; however, human activities rapidly increase the rate of its loss (Dynamics, 2016).

Traditionally, mangroves are used in various forms. In the 1998 study of Bandaranayake, mangroves are used as firewood, lumber, charcoal, and artifacts. Moreover, the extracts of these trees are used in folkloric medicine such as pesticide and insecticide. Land reclamation and conversion of mangrove forests to fishponds, pier, housing, and over-cutting of mangrove trees are some of the man-made activities which threaten the mangrove community (Department of Environment and Natural Resources (DENR) 2018; Melana & Mapalo, 2005). Oblivious of the situation, the government has converted wide mangrove forests to fishponds which have created problems to the marine habitat. The government should have implemented strict policies which could have helped in the restoration of mangroves. Mangroves have specific components to know their health status (Prasetya & Ambariyanto, 2017).

In the study of Fernando and Pancho (1980), there are about a total of thirty-nine (39) species of mangrove trees in the Philippines out of seventy (70) species of mangroves around the globe. These belong in different genera like *Acanthus*, *Camptostemon*, etc. In the report stated by Mendoza (2017), it was found out that there are 66 provinces that harbor mangroves out of the 82 (80%) provinces of the Philippines. In Northern Luzon, there were thirty-three (33) true mangrove species and twenty-three (23) associate species harboring the region (Philippines' Research Initiative on Mangrove Management and Enhancement Strategies against Natural Disasters (PRIM2E StAND), 2018). Visayas also has a fair share of mangrove species most especially in the island of Palawan with the thirty-one (31) species alone which also indicates that 90% of the total mangrove species in the country are found here (Travel Palawan, 2018). Here, *Rhizora apiculata* was found to be the most dominant and densest species (Puerto Princesa City Government, 2012). Meanwhile in Davao del Norte, Mindanao, the city of Panabo holds the highest number of species in the province with sixteen (16) species and ten (10) families (Popotan, Capin, Tinoy, &Novero, 2017). The Sanipaan Marine Park Management Plan 2013 – 2017 (2013) stated that the Island Garden City of Samal has an overall 63.56 ha of mangroves forest while Brgy. Tambo has 10.40 ha. However, these species were labelled either least concerned or nearly threatened by the International Union of Conservation of Nature (IUCN).

Reviews and studies were presented about the mangrove species. Problem and statistics about these species, furthermore, has been elaborated. These pieces of information have helped in expressing the scenario of the problem; however, the species composition remains to be a missing piece. There are no published works which can fill this gap; hence this serves as the driving force for this study to happen

In the summary of PRIM^{2}E StAND (2018), there are forty-one (41) mangrove species evaluated wherein there are four (4) nearly threatened species, two (2) vulnerable, and the rest are either least concerned or are not yet assessed. These species were part of the 2001 Red List of Threatened Species labelled by the IUCN. In the same summary of PRIM^{2}E StAND (2018), *Camtostemon philippinensis,* a species only found in the Philippines, is the one and only endangered species in the Red List. This species is usually found in central Luzon. According to IUCN (2018), population growth and urban development lead to increased use of mangrove products which further leads to the degradation of its number.

The purpose of this study is to conduct an assessment to know the species composition of the mangrove ecosystem in Island Garden City of Samal. This study will further embed its significance to macro facilities in the locality to provide sustainable management on the mangrove ecosystem.

MATERIALS AND METHODS

The study conducted by the researchers used a descriptive method, utilizing quantitative type of research. The study was conducted in a mangrove ecosystem in Island Garden City of Samal. Specifically, in Sanipaan Marine Park, Vanishing Island, Barangay Tambo, Babak District, 8119 Samal Island, Davao del Norte. Sanipaan Marine Park Management Plan of Samal, 2013 – 2017(2013). Shown in Figure 1 is the geographical map of Samal wherein the Vanishing Island is emphasized in a circle.

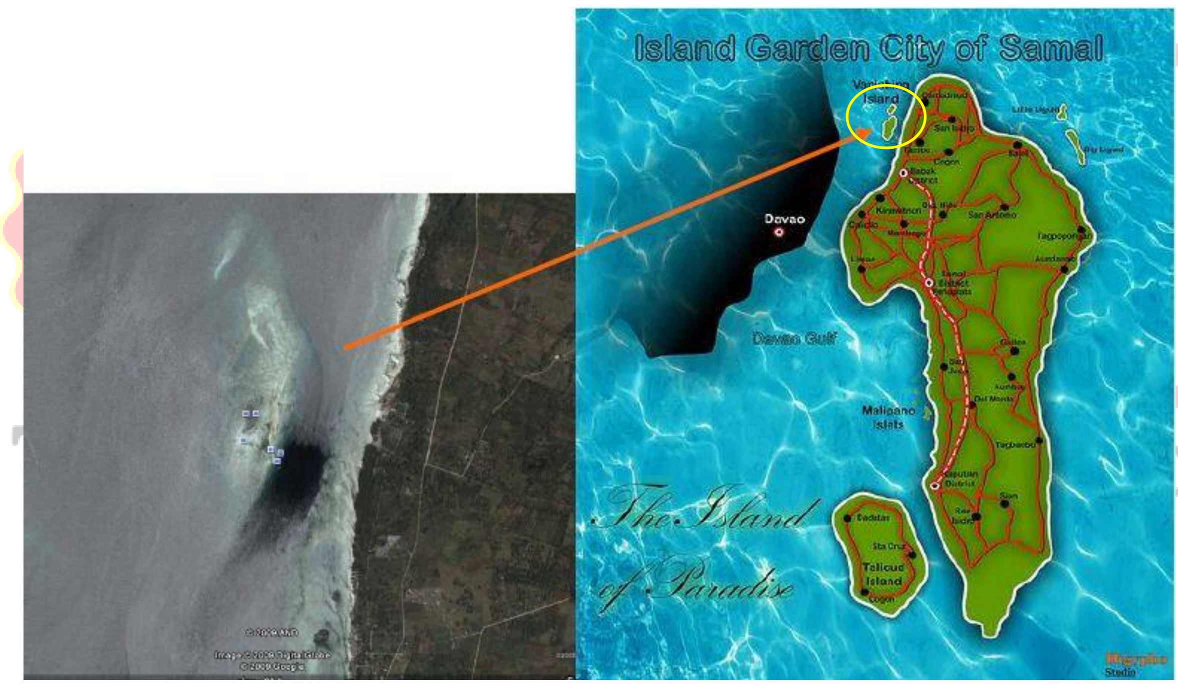

Figure 1. *Geographical map showing the study area in Samal Island.*

In evaluating the species composition of mangroves, a checklist was utilized. The checklist contained the components that helped in assessing the species composition of the mangrove. There were four (4) quadrats with a measurement of 0.25 x 0.25m used to perform the Quadrat Sampling in identifying the density of the mangrove. Transect tapes were also used to make a boundary of 100 x 100 m area to perform Line Transect Method. Moreover, a pH electrode was used to measure the pH level of the soil. Salinity refractor was also used to measure the salinity of the water. Slate boards were also used to bring ease to the researchers in writing down observations. For the safety of the researchers, boots and life vests were provided to protect the researchers against the sharp roots of the mangroves and in case of emergency upon travelling to Vanishing Island.

The duration of data gathering only lasted for a day during the lowest tide level of the month. Moreover, the methodology of this study was monitored based on the following procedures: First, a formal letter was given to the captain of Barangay Tambo, Mayor of Island Garden City of Samal, and to the Officer-in-charge of the City Environment and Natural Resources Office (CENRO) Island Garden City of Samal that served as a permission to conduct the study in the area. The letter was signed by the research adviser as a note that this study is validated and ready for the assessment. After preliminary submissions of documents, the study was subjected to ethics review. Then, a letter of permission to conduct the study was given to the head of the Senior High School Department, wherein the study, objectives, locale, dates of conduct, and names of adult companions were stated. A letter for Academic and Co-Curricular Activities was also submitted to the Dean of College and Arts as well as consent letters to the parents of the researchers. A letter was also given to marine biologist interns to request for assistance during the conduct of the study. Lastly, a letter was submitted to the head of the Department of Science and Laboratory of San Pedro College to formally request materials needed for the study such as meter sticks, thermometer, salinity refractor, pH electrode, transect tape, slate boards, vests and boots and to perform calibration on the Quadrats and ropes prepared prior to the conduct. Upon getting the approval, conduct of the study began. The presence of the research adviser and marine biologist interns was expected during the conduct of the study.

For the quadrat sampling, quadrats were made. First, four (4) ½" PVC pipes were used to make a square frame with ½" PVC elbows attached on each corner of the frame. The quadrat measured 0.25 x 0.25m and was replicated four (4) times. Transect tapes were laid to make a 100 x 100m boundary on the area.

Life vests and boots were used by the researchers before the actual gathering of the data. First, transect tape was laid on the land until it reached 100 m. Then, quadrat was laid on every five (5) m of the transect tape: the other half of the quadrat was placed on the left side of the transect while the other half was on the right. Mangroves that were found inside the quadrat were identified first. The number of mangrove trees, saplings and seedlings per species was tallied. Then, the invertebrate animals that were found inside the quadrat were also identified and tallied per species.

In checking the physico-chemical properties of the mangroves, salinity refractor was used for salinity test of the water and pH electrode was used in identifying the pH level of the water. Samples were collected once for every quadrat; however, for the quadrat that did not contain any sea water, the physico-chemical Analysis was not done. The same procedures were done until four (4) transect tapes were laid.

Figure 2. *Floor plan of the study (Adopted: Gumia, 2014).*

Figure 2 shows the Floor plan of the study consisting of the positions where the transect tapes, represented by yellow lines, were placed during the data gathering. The Transect numbers are labelled as T. The quadrats were represented by the red squares plotted on every 5 meters of the transect.

At the end of the data collection, materials used during the conduct were returned to the Department of Science and Laboratory. Any form of wastes produced by the researchers were kept and thrown in proper garbage bins.

In the analysis of the data, the researchers basically tallied the components by how much they occur on the mangroves that were observed. In addition, Shannon-Wiener formula was used to understand diversity of the species. As the value of Shannon-Wiener index increases, the diversity also increases. It also serves as a valuable tool that enables biologists to quantify diversity in a community and describe its numerical function (Beals, Gross & Harell, 2000; Kerkhoff, 2010). Typical values of Shannon-Weiner ranges between 1.5 – 3.5 in most ecological studies and the index is greater than 4 (Kerkhoff, 2010).

RESULTS

There were 3 species (Sonneratia *alba*, *Rhizophora apiculata*, and *Rhizophora mucronata*) from 2 genera (*Rhizophoreae* and *Sonneratia*) identified on the 10,000 m^2-area. Both genera were labelled as true mangroves by Primavera (2004) and Ibrahim, Latiff, Hakeem and Ozturk (2013). There were four (4) 100 m-transects laid with four (4) quadrats placed on every 5 meters. In total, there were eight hundred (800) quadrats placed on the sample area of 10,000 m^2.

Compared to the 0.0031 indiv/10, 000 m^2 and 0.0006 indiv/10, 000 m^2 density of the *Rhizophora* species, the *Sonneratia alb*a has the highest population per 10, 000 m^2 area; hence the only mangrove species to have the highest density recorded in the Sanipaan Marine Park or also known as the Vanishing Island.

The Table 1 presents the densities of mangroves of different species, invertebrates and vertebrates. The density of these species was measured using the Quadrat Sampling. In the 10,000 m^2area, the sampling was performed in every five (5) meters. After deliberating the total population of these species which is presented in Table 5, the density was computed by dividing the total population of each transect by the total area, which is 10, 000 m^2. This implies that the population of the mangrove species is relative to the area. Since *Sonneratia alba* has the highest population and thus has the highest density, it means that this species is abundant in the study area.

Table 1. Density of the mangrove and faunal species

Mangroves Species	Density (indiv/ 10, 000 m^2)	Overall density (indiv/ 10, 000 m^2)
Sonneratia alba	0.0049	0.0086
Rhizophora apiculata	0.0031	
Rhizophora mucronata	0.0006	
Invertebrate Species	0.0305	0.0305
Vertebrate Species	0.0006	0.0006

Looking into the computed density of the mangroves which is 0.0086 indiv/10, 000 m^2, it indicates that the current status of the mangroves in the area cannot be considered in a healthy condition as Prasetya and Ambariyanto (2017) mentioned that the density must be high in order to completely infer that the mangrove ecosystem is healthy. It is also supported by the study of George, G. (2018) stating that mangrove trees should have a density of 1678.08 indiv/ha while saplings and seedlings should have a combined density of 2238.35 indiv/ha. As can be seen, the densities mentioned in the study of George, G. (2018) is strongly high compared to the density of mangroves found.

Shown in table 2 is the overall diversity of mangroves which is 0.874. It can be read that Transect 2 has the richest diversity with H' = 1.9101, followed by Transect 4 with H' = 1.154, then Transect 1 with H' = 0.4756. Lastly, Transect 3 showed no diverse population with H'=0 reading. Beals, Gross and Harell (2000) and Kerkhoff (2010) both stated that the diversity and the Shannon-Weiner value are relative: as the value increases, the diversity also increases. However, the diversity of mangroves which is 0.874 signifies that the diversity is low. This is also supported with the Classification Scheme of Shannon-Wiener Index by Fernando et. al. (1998) mentioned in the study of Landicho et al. (2016). It interprets the diversity of the mangroves as very low. This classification constitutes relative values of 1.99 and below. This implies that the diversity of mangroves in Sanipaan Marine Park is very low; hence the species found in the area is not rich and therefore the mangroves are not diverse. This is also applicable to vertebrates since the diversity of vertebrates is 0.6931; thus, classified as very low. On the other hand, the diversity of Invertebrates is 2.1989 and is classified as low in diversity.

Table 2. *Diversity of the mangroves and faunal species in Vanishing Island*

Species	Diversity (H')				
	Transect 1	Transect 2	Transect 3	Transect 4	Overall
Mangroves	0.4756	1.9104	0	1.154	0.874
Invertebrates	1.8395	1.7841	1.4576	1.071	2.1989
Vertebrates	0	0	0	0.6931	0.6931

There are 311 invertebrate and vertebrate species in the 10,000 m^2 area of the study. The hermit crab had the highest population of 77 (25%) followed by brittle starfish with 65 (21%), sea cucumber with 54 (18%) and Species H with 32 (10%) population. Other species loosely follows: Species C with 17 (6%), Species F with 14 (5%), starfish with 13 (4%), and sea urchin with 6 (2%). Snail, crab, mudskipper, and fish tied with 3 (1%). Sea slug got 2 (1%). And lastly, shell, bahag-bahag, Species A, D, E and I got the lowest population with 1 or 0.3% of the total population.

Table 3. *Overall distribution of invertebrate and vertebrate species.*

Species	*f*	%
Sea cucumber	54	18
Sea slug	2	1
Hermit crab	77	25
Snail	3	1
Brittle starfish	65	21
Starfish	13	4
Sea urchin	6	2
Crab	3	1
Shell	1	0.3
Bahag-bahag	1	0.3
Mudskipper*	3	1
Fish*	3	1
A	1	0.3
B	4	1

C	17	6
D	1	0.3
E	1	0.3
F	14	5
G	9	3
H	32	10
I	1	0.3
Total	311	100

**vertebrates*

The study of Rajpar and Zakier (2013) is attributed to the diversity of both invertebrate and vertebrate species presented in Table 2. It is stated that high number of fauna species is related to the richness of food resources and diversity of vegetation; however, since the diversity of invertebrates is classified as low while the vertebrates' diversity is very low, it can be inferred that there is no richness of food resources in the mangrove ecosystem. In line with that, habitat loss is now an evident risk to mangrove-dependent animals. The results show that both invertebrates and vertebrates in Samal are low in number not exceeding half of its total percentage. In that case, the food resources and other benefits that they obtain from the mangroves are not anymore of an advantage since the mangrove forest is also declining.

Luther and Greenberg (2009) have further supported this by stating that if mangrove areas continue to decrease in size and quality, approximately 40% of mangrove-associated terrestrial vertebrate species worldwide are at risk of becoming extinct. This explains that there is a relationship between the faunal and mangrove ecosystem as the mangrove population subsides, the population of associated faunal species is also at risk; hence the marine ecosystem will be irreversibly damaged in the long run as claimed by Olomukoro and Azubuike (2009).

Table 4. Physico-chemical Properties in terms of Salinity and pH level

Transect	Ph	Salinity (ppt)
1	8	34
2	9	35
3	9	35
4	9	35
Average	8.75	34.5

In Table 4, the Transect 1 has an average pH level of 8.39 and a salinity of 34 parts per thousand (ppt). The Transect 2 has an average pH of 8.89 and a salinity of 35 ppt. Then the Transect 3 got the highest pH of 9.46 with 35 ppt of salinity. The Transect 4 followed with 9.45 pH level and a 35ppt salinity. In average, there is a pH level of 8.75 and a salinity of 34.5 ppt in the study area.

In measuring the pH level and salinity, only the quadrats with water are tested. A sterile container is dipped in the sea water then it will be tested for pH and salinity. A pH electrode was used to measure its pH level while a salinity refractor was used to measure the salinity. The salinity of the water was tested on the left and right part of the transect. When the two sides differ, the average was computed.

The average pH level obtained from all the transects is higher than the ideal pH level of seawater. Radke (2019) stated that the standard sea water pH level should be 8.2, a slightly alkaline scale. However, as can be seen, there is about 8.75 of pH level signifying that it is above the normal pH level of seawater. This implies that the sea water in Vanishing Island has a strong alkalinity.

Moreover, the standard salinity of seawater should be 35 ppt as stated by Lim et. al. (2001). Noor et. al. said that the factors that negatively affect the mangrove growth are high salt, low temperature, drought and high temperature. These are the common abiotic stress conditions that adversely affect plant growth and production. The pH level and salinity of water are highly related since these abiotic components as well as the temperature are critical to the survival of aquatic plants and animals (Biscayne Bay Water Watch, 2019). This implies that as pH level gets acidic, the higher the sewage runoff is and will affect the local organisms causing the aquatic organisms to leave or die. Salinity controls the local species composition because animals and plants are sensitive to changes in salinity levels. Since the salinity of water is of the standard level, the mangroves species are expected to be in a healthy condition (Biscayne Bay Water Watch, 2019). However, this claim is contrary with Kodikara et. al. (2017), stating that mangrove seedlings should be in a low saline water (3-5 ppt) if below 5 months and moderate saline water (15-17 ppt) if 5 months and older to survive. The Facilitation Theory also supports this claim by indicating that mangroves, especially seedlings, experience stress during high tide that is caused by high salinity (Huxham, 2010). This implies that mangrove trees will be able to tolerate the salinity of 35 ppt; however, seedlings and saplings cannot tolerate the salinity and will not survive in the long run.

As to the mangrove species profiled, *Sonneratia alba* has the highest population of 49 followed by *Rhizophora apiculata* with 31 population. It is loosely followed by *Rhizophora mucronata* with 6 populations. In total, there are 86 mangrove populations in the 10,000 m^2 area.

Table 5. *Overall distribution of mangrove species*

Mangroves Species	Overall			
	Trees	Saplings	Seedlings	Total
Sonneratia alba	46	1	2	49
Rhizophora apiculata	1	11	19	31
Rhizophora mucronata	5	0	1	6
Total	52	12	22	86

The number of species found in Sanipaan Marine Park during the data gathering reflects the claim of Sanipaan Marine Park Management Plan of Samal, 2013 – 2017 (2013) since *Rhizophora apiculata* and *Sonneratia alba* presence were observed in the area. However, the *Xylocarpus granatum* that was claimed to be present was not observed in the sample area, instead, *Rhizophora mucronata* was found. This implies *Rhizophora apiculata, Sonneratia alba, and Rhizophora mucronata* inhibit the Sanipaan Marine Park.

The absence of *Xylocarpus granatum* means that this species might have depleted its population or it was coincidentally not present in the subject area. The sense that there are only eighty-six (86) mangrove individuals in the 100 x 100m or 0.086indiv/10,000m^2 density implies that the mangroves are low in population and the H' = 0.874 indicates low diversity. Duke et. al. (2010), Kathiresan et. al. (2010), and Ellison et. al. (2010) have mentioned that *Sonneratia alba*, *Rhizophora apiculata*, and *Xylocarpus granatum* are labelled as the least concern species by IUCN but later claimed that these species are decreasing in population. Moreover, the *Rhizophora mucronata* is also in the Least Concern category of IUCN and is also decreasing in population the same as the mentioned species are undergoing. This reflects the distribution of mangrove species as the population of mangrove trees, saplings, and seedlings has a low count of 86 mangroves as compared to the 3,916-mangrove count of George (2018).

With the decreasing statistics of land coverage of mangroves around the world supported by different claims with respect to the abiotic factors, it can be suggested that the mangrove ecosystem in Sanipaan Marine Park is highly disturbed and is unhealthy. The salinity greatly affects this phenomenon especially to the mangrove seedlings as Facilitation Theory states that high salinity affects the survival of these individuals especially during high tide (Huxham, 2010). This claim is aided by the density and diversity index presented. The position of seedlings planted individually perpendicular to the mainland of Davao City is also involved in this phenomenon as the Wetland experiments and ecological theory states that the seedlings should be planted in clusters for higher survival (Toledo et. al., 1994).

CONCLUSIONS

Mangroves are marine coastal protectors that have been declining in population worldwide throughout the years. Hastened with human activities, the mangrove ecosystem has been ruined and the marine ecosystem will be irreversibly damaged in the long run if not stopped. This study intends to assess the status of the mangrove ecosystem in Vanishing Island, also known as the Sanipaan Marine Park, through exploring its species composition. Based on the results, the density of the mangroves is 0.0086 indiv/10000 m2 implying that there is low density. The variation of these mangroves also indicates H' = 0.874 and is classified as a very low diversity. Associate faunal species, having 311 population, also connects with the mentioned density and diversity as it has a low density, low diversity for invertebrates, and very low diversity for vertebrates. The low diversity of faunal species also indicates that there is a habitat and resources loss due to the disturbed ecosystem of mangroves. Moreover, physico-chemical components in terms of pH and salinity levels display strong alkalinity of 9.04 and a salinity of 34.5 ppt however, the 34.5 ppt salinity will only be tolerable for mangrove trees but not on the seedlings and saplings. The distribution of mangrove trees, saplings, and seedlings is also affected with these abiotic factors stated as there is a total of 86 mangroves in a 10,000 m^2.

In conclusion, there is a low mangrove density, very low mangrove species diversity, and a standard pH and salinity level that can only be tolerable by mangrove trees but not by mangrove saplings and seedlings. Moreover, a low population count of faunal species indicates low and very low diversity for both invertebrate and vertebrate species respectively. Lastly, low population count of mangrove trees, saplings, and seedlings in the 10,000 m2 study area. Therefore, with these species compositions, it can be suggested that the status of the mangrove ecosystem in Sanipaan

Marine Park is unhealthy despite it being a marine protected area of the Island Garden City of Samal.

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