Original Research Article

Occurrence of Leaf Spot Antrachnose in the Monostand of *Rhizophora apuculata* in Sitio Marabahay, Rio Tuba, Bataraza~~,~~ and Palawan

ABSTRACT

Mangrove trees are naturally resilient to pathogenic attacks with its salt tolerant mechanism, but was reported to be lowest in *Rhizophora apiculata* making it susceptible to pathogenic attacks. This study aimed to document the occurrence of leaf spot anthracnose affecting trees of *R. apiculata* in Sitio Marabahay, Rio Tuba, Bataraza and~~,~~ Palawan for the purpose of documenting the presence of mangrove~~s~~ diseases that may~~ight~~ later on affect the population and diversity of mangroves in Palawan.

There were at least 100 *R. apiculata* trees near the settlement area that were affected by the anthracnose. Almost 85-90% of all sampled leaves were affected by the anthracnose which indicates that the *R. apiculata* that were thriving in Marabahay, Rio Tuba, Bataraza, Palawan were~~as~~ under severe threats of great lost both in terms of quality and quantity of *R. apiculata* in the area.

The occurrence of this disease in *R. apiculata* could be attributed to the humidity brought by the rainy weather during the month of October favoring the growth of fungal pathogens. The low salt-tolerance of *R. apiculata* and environmental stress brought by the waste management of the settlers in the area contributed also to~~for~~ the spread of the disease among the monostand of *R. apiculata*.

Monitoring of the occurrence of this disease should be conducted frequently and water condition and other environmental factors in the settlement area should be evaluated to avoid decline of the mangrove biodiversity in the area.

Keywords: Mangrove diseases, leaves, occurrence, acid rain

1. INTRODUCTION

Mangroves are few of the emergent land plants that can tolerate salinity of ~~the~~ coastal water [1] and a vital floral ecosystem in tropical coastal communities such as the Philippines [2]. Mangroves are important source of fishery (seaweeds, fish, crabs, prawns, mollusks and other invertebrates) and forestry (timber, firewood, tanbark for dyes, fibers and ropes, corks, etc.) products. Mangrove amenities include coastal protection from typhoons and storm surges, erosion control, flood regulation, sediment trapping, nutrient recycling, wildlife habitat, and nurseries [3,4]. Mangroves particularly *R. apiculata* contain anti-inflammatory properties and is also an important source of traditional medicines [5].

In 2014, threats to this important resource were identified to include direct collection for timber, firewood and charcoal making, tanbark gathering and land conversion for purposes of fishpond establishment, tourism infrastructure and encroachment for settlement [6]. However, one major biological threat to this resource especially to the *R. apiculata* stand was identified to be the occurrence of pathologic diseases [4].

Leaf spot anthracnose is a fungal disease known to be caused by infection from *Colletotrichum* and *Pestalotiopsis* [7,8]. The disease was documented to be infecting the mangrove stand in Guanxi, China, but of different symptomatic manifestation per species [9].

The mangrove areas of Palawan is a declared mangrove swamp forest reserved as early as 1981 by virtue of Presidential Proclamation 2152 [10]. Only few reports have been made on the occurrence of disease in the mangroves area in Palawan. Further, very little is known about the effects of either widespread or localized mangrove area loss on individual mangrove species or populations. Disease occurrence could be one of the factor for diversity lost and species or population decline not only on mangrove area but also to other aquatic animals that relies on mangroves. The objectives of this study is to morphologically verify the fungus affecting *R. apiculata in the area*, and determine extent and severity of fungal infection present in *R. apiculata*, in Sitio Marabahay, Rio Tuba, Bataraza and, Palawan last October 2019.

2. METHODOLOGY

2.1 Study Site

During one of the bi-annual site visit in the coastal area of Sitio Marabahay, Rio Tuba, Bataraza and, Palawan, the unusual damage to the foliage of the *R. apiculata* monostand was observed. A monostand of *Rhizophora apiculata* is thriving in the coastal area of Sitio Marabahay, a fishing village in Barangay Rio Tuba in Bataraza, Palawan (Figure 1).

Sitio Marabahay is one of the 11 sitios of Barangay Rio Tuba in the Municipality of Bataraza, the southernmost municipality of mainland Palawan. Barangay Rio Tuba is also home to the Rio Tuba Nickel Mining Corporation and Coral Bay Nickel Corporation as early as 1977 and 2001 respectively.

Along the coast of Rio Tuba resides a fishing community with houses built along the fringe mangrove forest. Coastal residential houses situated in the mangrove area directly dispose of domestic waste from kitchen refuse and toilets into the receiving coastal waters. The area is likewise utilized as a boat docking area where washing and flushing of oil-laden water are dumped.

Figure 1. Rio Tuba and its coastal community (settlement area) location map (Source: Coral Bay Nickel Corporation/googlemaps:https://www.google.com/maps/place/Palawan/@11.7802056,117.9055427,6z/data=!4m5!3m4!1s0x33b5bce750b99e45:0xdfc65f6c0c8d3beb!8m2!3d9.8349493!4d118.7383615.

2.2 Sampling and analysis

Photographs were taken in all angles and sent to plant pathology experts from the Forest Biological Science Department of the College of Forestry and Natural Resources, University of the Philippines, Los Banos, Laguna for confirmation. The type of fungal disease infecting the leaves were examined using morphological characteristics of the fungus infecting *R. apiculata*. In the absence of pathogenic isolation by culturing samples, the disease verification was limited in identifying the type of plant disease present in general and not up to species level of the fungi causing the infection

Infected leaves were sampled and compared to the healthy leaves of the same species. Severity of the disease was then visually examined against the healthy leaf samples. The extent of the infection was based on the percentage area damage in the affected leaves.

3. RESULTS AND DISCUSSION

The infected *R. apiculata* trees were found thriving in these highly polluted waters and within the residential populace. The plant pathology experts confirmed based on the morphological characteristics of the fungus present in *R. apiculata*, that the fungus was leaf anthracnose that is caused either by filamentous fungi in the genus *Colletotrichum* or *Gloeosporium* (Figure 2).

Figure 2. Leaf spot infected *R. apiculata* leaves (A) infected twig (B) ventral side of the infected leaf (C) dorsal side of infected leaf

There were at least 100 *R. apiculata* trees in the area that were~~are~~ affected by the anthracnose leaf spot. Almost 85-90% of all sampled leaves were infected by the anthracnose which indicates that the *R. apiculata* that were thriving in Marabahay, Rio Tuba, Bataraza, Palawan was under severe threats of great lost both in terms of quality and quantity (Figure 3).

Figure 3. Comparison of leaf spot Anthracnose infected *R. apiculata* (A) dorsal (B) ventral

Anthracnose is a serious plant disease affecting different plants worldwide characterized by small light brown leaf spots of dead tissue which emerges on the leaves often on the leaf's vein system that causes necrotic lesions and early senescence or early leaf aging [11,12]. This disease was reported to be present in mango, avocado and rubber trees [11, 13, 14].

~~The e~~Environmental factors like temperature, relative humidity and rainfall plays a role in plant disease development and these environmental factors are being used to

forecast disease severity [13, 14]. In the present study, infection of anthracnose occurred during the wet season (October 2019). The high humidity during wet season favors the development of anthracnose in the foliage and water droplets from the rain helps in the spread of the disease among the leaves, eventually killing the tress [16]. Without a fully functioning foliage, important functions for plant growth and development are impaired leading to the death of the plant [17].

Aside from environmental factors, the salt (NaCl) tolerance mechanisms present in different mangrove species could also play a role in disease development [18]. *Avicennia*, for example, excretes salt through leaf glands and has the highest salinity of residual rainwater on leaves, *Laguncularia* which accumulates salt in the leaves has the greatest bulk of salt concentration, while *Rhizophora*, which excludes salt at the roots has little salt associated with leaves [18]. The *R. apiculata* is more salt-sensitive than the *R. stylosa* [19]. Mangrove leaves provide a unique function of filtering excess NaCl from the salty water before it can be transported and utilized for normal cell function and nutrient absorption for cellular respiration. The high salt concentrations associated with the leaves as with *Avicennia* and *Laguncularia*, were sufficient to inhibit the germination of many fungi associated with mangrove forests [18].

Recent study identified the presence of *Colletotrichum gloeosporioides* and *Pestalotiopsis uvicola* in *R. apiculate* [20]. Although in the present study, the identification of fungi causing the leaf spot were also limited to morphological characteristics, it is possible that the two mentioned above are the fungi responsible for the occurrence of anthracnose in Sitio Marabahay, Rio Tuba, Palawan.

4. CONCLUSION

The occurrence of the leaf spot in Sitio Marabahay, Rio Tuba, Palawan was only observed once in year 2019. The frequency of its occurrence and the severity of infection should be monitored and studied to protect the population of *R. apiculata* present in the area. Furthermore, the environmental condition in the area should also be assessed to ascertain the influence of the local environmental condition in the growth of *R. apiculata.*

CONSENT (WHERE EVER APPLICABLE)

Not applicable

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

Not applicable

COMPETING INTERESTS DISCLAIMER:

AUTHORS HAVE DECLARED THAT NO COMPETING INTERESTS EXIST. THE PRODUCTS USED FOR THIS RESEARCH ARE COMMONLY AND PREDOMINANTLY USE PRODUCTS IN OUR AREA OF RESEARCH AND COUNTRY. THERE IS ABSOLUTELY NO CONFLICT OF INTEREST BETWEEN THE AUTHORS AND PRODUCERS OF THE PRODUCTS BECAUSE WE DO NOT INTEND TO USE THESE PRODUCTS AS AN AVENUE FOR ANY

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REFERENCES

[1] Odum EP and Barrett GW. Fundamentals of ecology. 5th ed. Belmont, CA: Thomson Brooks/Cole. 2005.

[2] Dangan-Galon F, Dolorosa RG, Sespeñe JS and Mendoza NI. Diversity and structural complexity of mangrove forest along Puerto Princesa Bay, Palawan Island, Philippines. Journal of Marine Island Cultures. 2016; 5: 118–125. DOI: 10.1016/j.imic.2016.09.001

[3] Primavera JH and Esteban JMA. A review of mangrove rehabilitation in the Philippines: successes, failures and future prospects. Wetlands Ecology and Management. 2008; 16: 345–358. DOI 10.1007/s11273-008-9101-y

[4] Osorio JA, Wingfield MJ and Roux J. A review of factors associated with decline and death of mangroves, with particular reference to fungal pathogens. South African Journal of Botany. 2016; 103: 295-301. DOI: 10.1016/j.sajb.2014.08.010

[5] Prabhu VV and Guruvayoorappan C. Anti-inflammatory and anti-tumor activity of the marine mangrove *Rhizophora apiculata*. Journal of Immunotoxicology. 2012; 9(4): 341-352. DOI: 10.3109/1547691X.2012.660997

[6] Palawan Council for Sustainable Development (PCSDS). 2016. Palawan Sustainable Development Strategies and Action Plan. https://pkp.pcsd.gov.ph/images/PSDSAP%20and%20SD%20Agenda%20FINAL.pdf. January 07, 2020.

[7] Rojas HVS and Quezada GDA. Phylogenetic and morphological identification of *Colletotrichum boninense*: a novel causal agent of anthracnose in avocado. Plant Pathology. 2011; 60(5): 899–908. DOI: 10.1111/j.1365-3059.2011.02452.x

[8] Valencia A, Torres R and Latorre B. First report of *Pestalotiopsis clavispora* and *Pestalotiopsis* spp. causing postharvest stem end rot of avocado in Chile. Plant Disease. 2011; 95(4): 492-493. DOI: 10.1094/PDIS-11-10-0844

[9] Liu B, Zhou Y and Xue J. Pathogenesis and Control of Mangrove Leaf Spot Disease. 2017 International Conference on Materials Science and Biological Engineering (ICMSBE 2017) Proceedings. 2017; 56–59. DOI: 10.25236/icmsbe.2017.11

[10] Proclamation No. 2152, series of 1981.Declaring the entire province of Palawan and certain parcels of the public domain and/or parts of the country as mangrove swamp forest reserves. Signed on Dec 29. 1981. https://www.officialgazette.gov.ph/1981/12/29/proclamation-no-2152-s-1981/. January 05, 2020.

[11] Kimaru SK, Monda E, Cheruiyot RC, Mbaka J and Alakonya A. Morphological and Molecular Identification of the Causal Agent of Anthracnose Disease of Avocado in Kenya. Hindawi, International Journal of Microbiology. 2018: 1-10. DOI: 10.1155/2018/4568520

[12] Jain A, Sarsaiya S, Wu Q, Lu Y and Shi J. A review of plant leaf fungal diseases and its environment speciation. Bioengineered. 2019. 10: 409–424. DOI: 10.1080/21655979.2019.1649520

[13] Dodd JC, Estrada AB, Matcham J, Jeffries P and Jeger MJ. The effect of climatic factors on *Colletotrichum gloeosporioides*, causal agent of mango anthracnose, in the Philippines. Plant Pathology. 1991; 40: 568-575. DOI: 10.1111/j.1365-3059.1991.tb02421.x

[14] Liu X, Li B, Cai J, Zheng X, Feng Y and Huang G. *Colletotrichum* Species Causing Anthracnose of Rubber Trees in China. Scientific Reports. 2018; 8: 10435. DOI:10.1038/s41598-018-28166-7.

[15] Kulkarni S and Raja. Epidemiology of greengram (*Vigna radiate*) anthracnose in northern Karnataka. Journal of Pharmacognosy and Phytochemistry. 2019; 8(4): 434-437.

[16] Estrada AB, Dodd JC and Jeffries P. Effect of humidity and temperature on conidial germination and appressorium development of two Philippine isolates of the mango anthracnose pathogen *Colletotrichum gloeosporioides*. Plant Pathology. 2000; 49: 608–618. DOI: 10.1046/j.1365-3059.2000.00492.x

[17] Esau K.Esau's Plant Anatomy, Meristems, Cells, and Tissues of the Plant Body: their Structure, Function, and Development. 3rd edition. New Jersey: John Wiley & Sons, Inc. 2006. DOI: 10.1093/aob/mcm015

[18] Gilbert GS, Mejía-Chang M and Rojas E. Fungal diversity and plant disease in mangrove forests: Salt excretion as a possible defense mechanism. Oecologia. 2002; 132: 278–285. DOI: 10.1007/s00442-002-0966-9

[19] Ball MC, Cochrane MJ and Rawson HM. Growth and water use of the mangroves *Rhizophora apiculata* and *R. stylosa* in response to salinity and humidity under ambient and elevated concentrations of atmospheric CO2. Plant, Cell and Environment. 1997; 20(9): 1158-1166. DOI: 10.1046/j.1365-3040.1997.d01-144.x

[20] Guerroro JJ, General MA and Serrano JE. Culturable Foliar Fungal Endophytes of Mangrove Species in Bicol Region, Philippines. Philippine Journal of Science 2018; 147(4): 563-574.