New record of a wood-boring isopod damaged *Sonneratia alba* J. Sm. in Thi Nai lagoon, Binh Dinh province, Vietnam

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Abstract*:*Thi Nai is the biggest lagoon in Binh Dinh province. Mangroves in Thi Nai havean important role in environment and local socio-economic development. However, their survival is threatened due to pests and diseases. Our study focused on wood-boring isopods, Sphaeroma terebrans. This species was first recorded in Vietnam. This isopod may have negative impacts for mangrove growth and it should be considered in planning and developing mangroves.

Keywords:*mangrove, wood-boring isopod, Thi Nai lagoon, Binh Dinh province.*

I. Introduction

Mangroves are valuable resources in estuaries and coastal areas. They are responsible for coastal protection from storms, hurricanes and wave actions.Mangrove systems have great impact in reducing up to 85% wave height, specifically from 0.2m to 1.3m. Thus,they contribute to the preservation ofthe land[1]. Moreover, mangrove forest is the habitat and breeding ground of aquatic species, provides conditions for rich aquatic resources, contributes topoverty reduction, society development and local livelihoods improvement. Microorganisms living in soil and water disintegrate mangrove stems and leaves into 60-70% of the intake food for aquatic species[2].In addition, more than 10% of essential organiccarbon for the oceans is made up from mangroves[3].

Binh Dinh - coastal province in South Central Vietnam, has coastline of 134 km long. The coastal area of Binh Dinh includes plenty of estuaries, bays and lagoons. Thi Nai - the biggest lagoon in Binh Dinh is an important ecosystem, which has a high biodiversity with an area of about 5,060 hectares, of which mangrove area sometimes is about 100hectares.Currently, there are more than 8 hectaresof 3-years-old *Sonneratia alba* plantationreported dead in Thi Nai lagoon. There is a numerous wood-boring isopods were foundin almost stems and roots of dead trees. Common mangrove boring isopods were recorded belong to *Sphaeroma* genus. They reported to be distributed in tropical waters throughout the world: Hawaii, Virginia, Florida, Gulf of Mexico, Venezuela, Brazil, Costa Rica, Southern Africa, India, Kenya, Pakistan, Taiwan, Malaysia, Singapore, Brunei and Eastern Australia [4],[5], [6], [7], [8], [9], [10]. However, no species of *Sphaeroma* had been identified from Vietnam to date. The presence and abundance of this borerhere is abig concern, as the boring activities of this isopod has the potential harm to things made by wood in general and mangrove trees in particular[8], [10], [11]. Therefore, our study focused on infestation rate assessment, identification and morphological description of this isopod on *S. alba* in Thi Nai lagoon, Binh Dinh province.

II. Study site and methods

2.1. Study site

Thi Nai lagoon is located in Quy Nhon city, Binh Dinh province. It is placed in the northwest of Quy Nhon, and is the biggest lagoon in Binh Dinh. Thi Nai lagoon was covered an area of 72.76 hectares of mangrove forest. There are some main mangrove species in Thi Nai lagoon, including *S.alba, Rhizophora apiculata, Rhizophora mucronata, Avicennia alba, Avicennia marina*, in which *S. alba* has the largest area with 22.67 hectares. Mangroves in Thi Nai lagoon have a key role in coastal protection as well as the habitat for aquatic species.

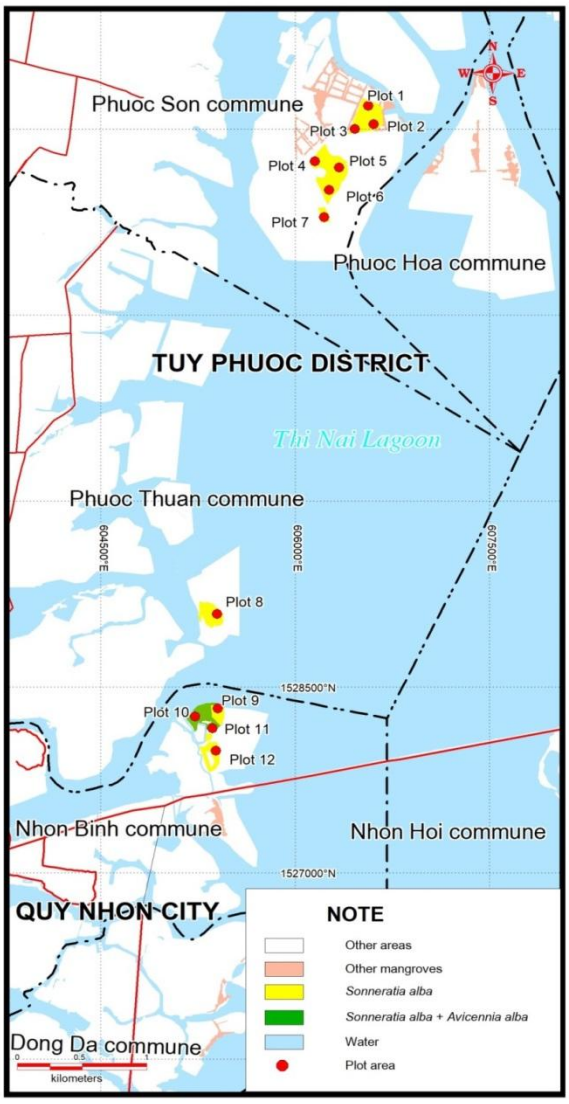


Figure 1. Map of study site in Thi Nai lagoon

Thi Nai lagoon is characterized by South Central climate with two distinct seasons: a dry season from February to August and a rainy season from September to January. The average temperature is 25-27^{o}C. The average rainfall is 1,500-2,000mm (*Monitoring data of Climate and Hydrography of Quy Nhon station, Binh Dinh province from 2006 - 2017).*

Salinity varies from 5- 30‰ depend on time in a year. In rainy season, average salinity is around 5‰. Salinity reaches to17‰ at the beginning and 30‰ at the end of dry season. The tidal regime is irregular semi-diurnal.

2.2. Methodology

2.2.1. Wood-boring isopods survey

In this study, survey was conducted from 9th to 12th February 2019 in dry season. 12 sample plots were randomly established. The plots were 500m^2 in size (20x25m). At each plot, total trees were observed. Assessment of mangrove isopods was conducted with the following criteria.

Table 1. Criteria for status of tree

Symptom description	Status
No borer	Healthy tree
Stem borer >=1	Infestedtree

Infestation rate of wood-boring isopod was determined according to the formula:

P (%) = n/N x 100

n: Number of infested trees by wood-boring isopod

N: The total number of trees in each plot

2.2.2. Collection and identification of wood-boring isopods

Samples of wood-boring isopods were collected in the field and preserved in 90% ethyl alcohol for identification. Moreover, fallen wood with bore-holeswas collected randomly by machete and was brought to the laboratory and dissected with a knife to take more fresh samples.

Preparing 15 samples toidentify in the laboratory according to the documents of Kensley and Schotte (1989), Harrison, Ellis(1991), Hossain and Bamber (2013) and online guide (http://www.marinespecies.org/) [12], [13], [8].

III. Results and discussion

3.1. Infestation rate of wood-boring isopods

Infestation rate of wood-boring isopods is different among sample plots. The highest infestation rate was recorded for plot 4, 5, 6,7,8 (more than 88% in all plots), followed by plot 9 and 12 (45-50%). *S. alba*trees in plot 10 and 11 showeda lower infestationrate(25-28%) while *A. alba* trees in these plots had no infestationsymptom. Newly plantedS. *alba*trees in plot 1, 2, 3 showed no sign of infestation of wood-boring isopod (TABLE 2).

The *S. alba* trees in plot 4, 5, 6, 7, 8 were heavily infested by wood-boring isopods with the symptom of dried stem, branch and leaf loss (Fig. 2). Wood-boring isopods burrowed holes into main stem and caused appeared unhealthy trees (Fig. 3).

Table 2. Infestationrate of wood-boring isopodson *S. alba*in Thi Nai lagoon

Plot	Intertidal height (meter)	Inundation period (hour)	Main species	Year of planting	Infestation rate (%)
1	+ 0.5	>7	*S. alba*	2018	0
2	+ 0.4	>7	*S. alba*	2018	0
3	+ 0.8	>7	*S. alba*	2018	0
4	- 0.3	<7	*S. alba*	2013	93
5	- 0.5	<7	*S. alba*	2013	90
6	- 0.5	<7	*S. alba*	2013	91

7	- 0.7	<7	*S. alba*	2013	88
8	- 0.3	<6	*S. alba*	2012	95
9	+ 0.2	>7	*S. alba*	2015	45
10	+ 0.2	>7	*S. alba, A. alba*	2015	25
11	+ 0.2	>7	*S. alba, A. alba*	2015	28
12	+ 0.3	>7	*S. alba*	2015	50

Figure 2. *S. alba*trees died due to wood-boring isopods in plot 4

Figure 3.Wood-boring isopods on *S. alba* in plot 4, Thi Nai lagoon

There are many factors affected to infestation rate of wood-boring isopods to mangrove trees.Mangrove trees in muddy substrates in the lower intertidal showed high prevalence and intensity of isopods infestation[14].Existing environment conditions such as inundation period was also considered to affect the infestation rate of wood-boring isopodsin the study site. Planting sites which are in lower intertidal of plot 4, 5, 6, 7, 8 (from -0.7m to -0.3m) might be caused the highest infestation rate of *S. alba*trees.

Although *A. alba* trees were planted with a mixture of *S. alba*trees, *A. alba* showed no infestationsymptom of wood-boring isopods. This finding contradict those reported by Davidson et al.(2016), who found that wood-boring isopods, *S.terebrans* damaged both mangroves *R. stylosa* and *A. marina* in Taiwan. Furthermore, *S. alba*trees that mixed with *A. alba* in plot 10, 11 also had the lower infestation rate (25-28%) compared with *S. alba* trees in monoculture plots (plot 4, 5, 6, 7, 8). Thus, polyculture of different mangrove species could reduce infestation rate of wood-boring isopods.

3.2. Morphological description

Adults of this isopodare9 to 12 mm in length (N=15). They have reddish-brown to brown cover. Body is compress, convex and elliptical, usuallycurling into a protective ball whenencountering external stimulus.

Head is approximately semicircular, with two large sessile compound eyes. Mouth has a pair of antennaextend to posterior edge from eyes.Mandible is nearly equilateral triangle and forcipate shape.

Pereon has seven pairs of jointed legs (pereopods). Left and right pereopods show a fundamental bilateral symmetry.Coxal extend ventrally and laterally, pereopods fourth to seventh do not have setae while pereopods first to third bear dense flattened setiferous on the upper surface, adapting for filter-feeding.

Pleon has pleotelson and uropod. Pleotelson has irregulary granular cover with some strong tubercles and triangle posteriorly telson. Outer edge of uropodal exopod has five teeth, which are strongly serrated and hairy.

Based on documents of [12], [13], [8]and online guide (http://www.marinespecies.org/), identification results showed that the wood-boring isopod on *S. alba*in Thi Nai lagoon is *Sphaeroma terebrans* Bate, 1966.

S. terebrans has distinct characteristics from other similar species in *Sphaeroma* genus. Shape of telson is triangle while *S. walkeri*Stebbing, 1905 and *S. quadridentata*Say, 1818 are broadly rounded. In addition, the exopod of uropodis densely hairy, but two other species are not.

Pereopod 1

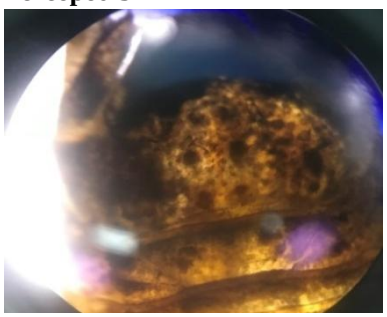
Pereopod 4

Pereopod 2

Pereopod 5

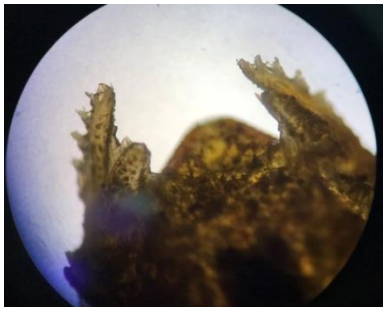
Pereopod 3

Pereopod 6

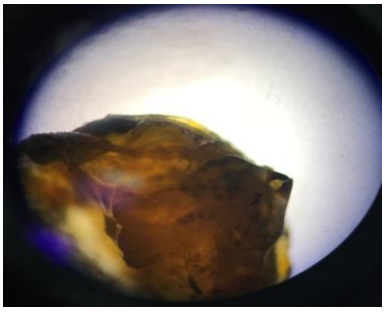


Strong tubercles

Pereopod 7



Serrate exopod and triangle telson



Head

Figure4. Shape and stucture of*S. terebrans*

3.3. Ecological characteristics

*S. terebrans*often burrows stems and roots of*S. alba*into holes with diameters from 0.4 to 1.0 cm as a shelter and breeding ground. This isopod also make borers on other mangroves such as *Rhizophora* genus [5], [6], [10], *R. stylosa, A. marina*[9].*S. terebrans*does not eat mangrove tissue, but it captures plankton living in the water for food[15].Stem and rootborers reduce the growth of mangrove trees, which made the trees more vulnerable due to the impact of high waves and strong winds. In lower intertidal areas, this species causes less damage than longer intertidal because they use algae and plankton in water for food.

IV. Conclusion

Our findings showed that *S. terebrans* was a wood-boring isopod on *S. alba* in Thi Nai lagoon. The presence of *S. terebrans* in Thi Nai lagoon, Vietnam is clearly of concern. This isopod has harmful potentials for mangrove growth. Mix culture of *S. alba* and *A. alba* had a potential to reduce the infestation rate of *S. terebrans*. Thus, it should be considered in mangrove restoration and development activities.

V. Acknowledgment

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