Seagrass diversity in Brunei Darussalam: first records of three species

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Abstract

Borneo is one of the regions expected to have the highest diversity of seagrasses in the world. However, the diversity of seagrasses has scarcely been studied in Brunei Darussalam. The diversity of seagrasses at the intertidal and subtidal zones in Brunei was extensively surveyed in 2016. Six species of seagrasses were found at Pulau Muara Besar and Pulau Bedukang, and this was the first time that three of them (*Halophila beccarii*, *Halodule pinifolia*, and *Cymodocea rotundata*) had been recorded in Brunei. The total area of seagrass distribution around the two islands was approximately 1.5 km^2. The present study extends the distribution of seagrasses on Borneo and suggests that Brunei has a rich seagrass diversity and an aquatic ecosystem supported by the seagrasses.

Index Terms: Borneo, Brunei Bay, seagrass, *Cymodocea rotundata* Asch. & Schweinf., *Halophila beccarii* Asch., *Halodule pinifolia* (Miki) Hartog

1. Introduction

Seagrasses are hydrophytic angiosperms also called marine flowering plants. The importance of seagrasses has been recognized from many perspectives.[1] A total of 72 seagrass species have been reported in the world, and the highest diversity lies in insular Southeast Asia and extends across tropical northern Australia.[2,3] Malaysia has reported the highest diversity of seagrasses (14-18 species) in Southeast Asia, along with the Philippines.[2-9] Borneo has 10-13 species,[6,7] suggesting that the island is one of the most suitable habitats for seagrasses in Asia. This high diversity of seagrasses in Borneo could occur partially because of its complex and diversified geographical structures.[4,5] However, most surveys on seagrass diversity and distribution on Borneo are still limited to Sabah, Malaysia, which is the most northern region of Borneo.[4,6,7]

Brunei Darussalam (hereafter, Brunei) is located on the northwest coast of Borneo and is surrounded by Sarawak, Malaysia (see ***Figure 1***). Though Brunei is expected to have a high diversity of seagrasses, no research article on seagrasses in Brunei is found in major international publications.[10] Four species (*Enhalus acoroides* (L.f) Royle, *Halophila ovalis* (R.Br.) Hook.J., *Halophila spinulosa* (R.Br.) Asch., and *Thalassia hemprichii* (Ehrenb. ex Solms) Asch. were recorded a long time ago, but their specific features and locations have never been described.[11,12] The purpose of this study is to evaluate the present seagrass diversity in Brunei and to develop the knowledge of the diversity and distribution of seagrasses in this region.

2. Materials and Methods

The coastline of Brunei was extensively surveyed by walking during low tide periods from March to October 2016. The survey sites include the coastal areas of Muara (MU), Meragang (ME), Jerudong (JE), Pulau Muara Besar (PMB), and Pulau Bedukang (PB) (see ***Figure 1***). PMB (5°00'N, 115°06'E) and PB (4°58'N, 115°03'E) are small, desolate islands on the Brunei side of

Brunei Bay and are covered with mangrove vegetation. The depth of the surveyed sites was <1.5 m from the mean surface level. Seagrass samples were collected by gently digging the sediment by hand to prevent breakage of the underground parts. Salinity and pH of the water at the collection site were also measured with a multiprobe device (556 MPS, YSI Inc., USA) on 31 August 2016.

After seagrass collection, the seagrasses were brought back to the laboratory of Universiti Brunei Darussalam (UBD) for identification and preservation. Seagrasses were thoroughly cleaned using freshwater and the morphology of each seagrass individual was carefully recorded and then identified according to the references.[13-15] Identified seagrasses were dried, sprayed with 5% formalin, and then pressed to preserve them in the Herbarium of the Faculty of Science, UBD (UBDH).

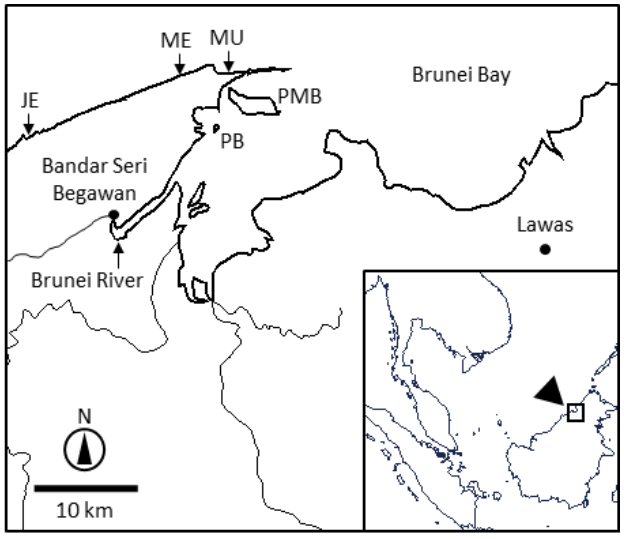

Figure 1. The locations of the survey sites: Pulau Muara Besar (PMB), Pulau Bedukang (PB), Muara (MU), Meragang (ME), and Jerudong (JE).

3. Results

A total of six seagrass species were recorded at PMB and PB (see ***Figure 2***): *Cymodocea rotundata* Asch. & Schweinf., *Enhalus acoroides* (L.f) Royle, *Halophila beccarii* Asch., *Halophila ovalis* (R.Br.) Hook.J., *Halodule pinifolia* (Miki) Hartog, and *Thalassia hemprichii* (Ehrenb. ex Solms) Asch. *E. acoroides, H. beccarii, H. ovalis*, and *T. hemprichii* are in the Hydrocharitaceae family. *C. rotundata* and *H. pinifolia* are in the Cymodoceaceae family.

3.1 Description

Halophila ovalis (R.Br.) Hook.J.

Common name: Spoon grass, dugong grass, paddle weed

The leaf blade is oval, 9−12 mm long and 5−7.5 mm wide. The leaf margin is smooth and without hairs on the leaf surface. There are 10−25 cross veins on the leaf blade, ascending at 45−60° from the mid-vein. A pair of leaves arises from each node, and the petiole is 10−20 mm long. The base of the petioles is covered by leaf scales. The rhizome is white, thin and smooth.

Halophila beccarii Asch.

Common name: Ocean turf grass

H. beccarii has 4 to 10 leaves arranged in a pseudowhorl. The leaf blade is lanceolate, 5−8 mm long and 0.9−1.6 mm wide. There are three longitudinal veins on the leaf blade. The petiole is 4−15 mm long. Each shoot carries a whorl of leaves. The whorl of leaves may arise from the erect shoot or rhizome. The base of the petioles is covered by scales. The rhizome is light-colored, thin and smooth.

Enhalus acoroides (L.f.) Royle

Common name: Tape seagrass

The leaf blade is linear, flat, 310 mm long and 11 mm wide. The leaf tip is rounded, and the leaf margin is thick and slightly inrolled. The rhizome is very thick, measuring up to 10 mm in diameter. The unique feature of this species is the presence of rolled leaves, cord-like roots and black bristles, which are located on the rhizome. Female flower bracts were observed in September 2016. The female flower bract emerged from a long, coiled stalk.

Thalassia hemprichii (Ehrenb. ex Solms) Asch.

Common name: Turtle grass

The leaf blade is sickle-shaped, 20−45 mm long and 4−5 mm wide. The leaf tip is rounded and smooth. The leaf blade has longitudinal veins with red bands of cells. No hairs are present on the leaf surface. The stem is short, erect and

holds 2−4 leaves from every shoot. The base of the shoot is covered by a fully enclosed leaf sheath. The rhizome has leaf scars, and the roots are thick.

Cymodocea rotundata Asch. & Schweinf.
Common name: Smooth ribbon seagrass
The leaf blade is linear and flat, 80−140 mm long and 2−4 mm wide. The leaf tip is rounded, and the leaf margin is slightly serrated. The leaf has longitudinal veins. Each shoot has 2−3 leaves, and the base of the leaves is covered with a rectangular leaf sheath. The rhizome is white and smooth.

Halodule pinifolia (Miki) Hartog
Common name: Needle seagrass
The leaf blade is linear, narrow and flat, 10−150 mm long and <1 mm wide. The leaf margin is smooth and finely serrated at the tip. The diagnostic feature of this species is the black central vein that splits into two at the leaf tip. The stem is short, erect, covered by a sheath and often has scars. Each shoot bears 1−2 leaves. The rhizome is pale-colored, thin, and smooth. The roots are thin (<1 mm).

3.2 Distribution
Four seagrass species (*H. ovalis*, *H. beccarii*, *C. rotundata*, *H. pinifolia*) were found at PMB, while five species (*H. ovalis*, *H. beccarii*, *E. acoroides*, *T. hemprichii*, *H. pinifolia*) were found at PB. *H. ovalis*, *H. beccarii*, *C. rotundata*, and *T. hemprichii* usually coexisted with *H. pinifolia* and those species were often found in the intertidal zone around the pneumatophores of mangrove trees on both islands. *H. pinifolia* was the most extensively distributed around both islands. *E. acoroides* was found only in the subtidal zone at PB and was away from the other seagrass species. The total area of seagrass distribution around PMB and PB was roughly estimated to be 1.5 km^2 from an aerial map. The salinity and pH of the water where the seagrasses were collected at PMB were 22.7 and 7.9, respectively. At PB, the salinity and pH of water were 20.7 and 7.7 respectively. No seagrass was found at the other surveyed coastal sites.

4. Discussion

In total, six species of seagrasses were found at PMB and PB, and this was the first time that three of them (*C. rotundata*, *H. beccarii*, *H. pinifolia*) had been recorded in Brunei. The Brunei coast has been thought unfavorable for seagrass growth[16] and in fact, no seagrass was found at the other surveyed sites in the present study. However, the present discovery of seagrasses at PMB and PB demonstrates that Brunei has an aquatic environment that is suitable for seagrasses. On the Malaysian side of Brunei Bay (Lawas, Sarawak), eight species of seagrasses have been recorded,[8] and six of them correspond to the species in Brunei. This shows that a similar diversity of seagrass is present on both Brunei and Malaysian sides of Brunei Bay. However, due to the geographical location of seagrasses in the Brunei side, which is more enclosed, higher impacts from terrestrial inputs, such as river waters, are expected. These impacts could lower salinity and pH in comparison to common seawater. However, seagrasses are euryhaline plants and are widely distributed in brackish waters around the world[17] and thus, the changes in salinity levels may have little effects on the seagrass diversity in Brunei. Since only intertidal and subtidal zones were surveyed in the present study, more seagrass species may be found in deeper zones in Brunei.

The seagrass beds at PMB and PB are located at the mouth of the Brunei River (see ***Figure 1***). Organic and inorganic soil particles had accumulated on the seagrass leaves, indicating that the seagrass bed is acting as a natural filter to trap particles from the overlying water and is reducing the discharge of turbid waters to offshore coral reefs.[18] The trapped organic matter would support the nutritional requirements of epiphytic organisms and lead to increased biodiversity of the estuarine ecosystem.[19] Moreover, some feeding trails of dugongs were observed at PMB while conducting the present study (data not shown). These findings emphasize the ecological and environmental importance of the seagrass beds in Brunei and highlight the necessity of further specific research in the future.

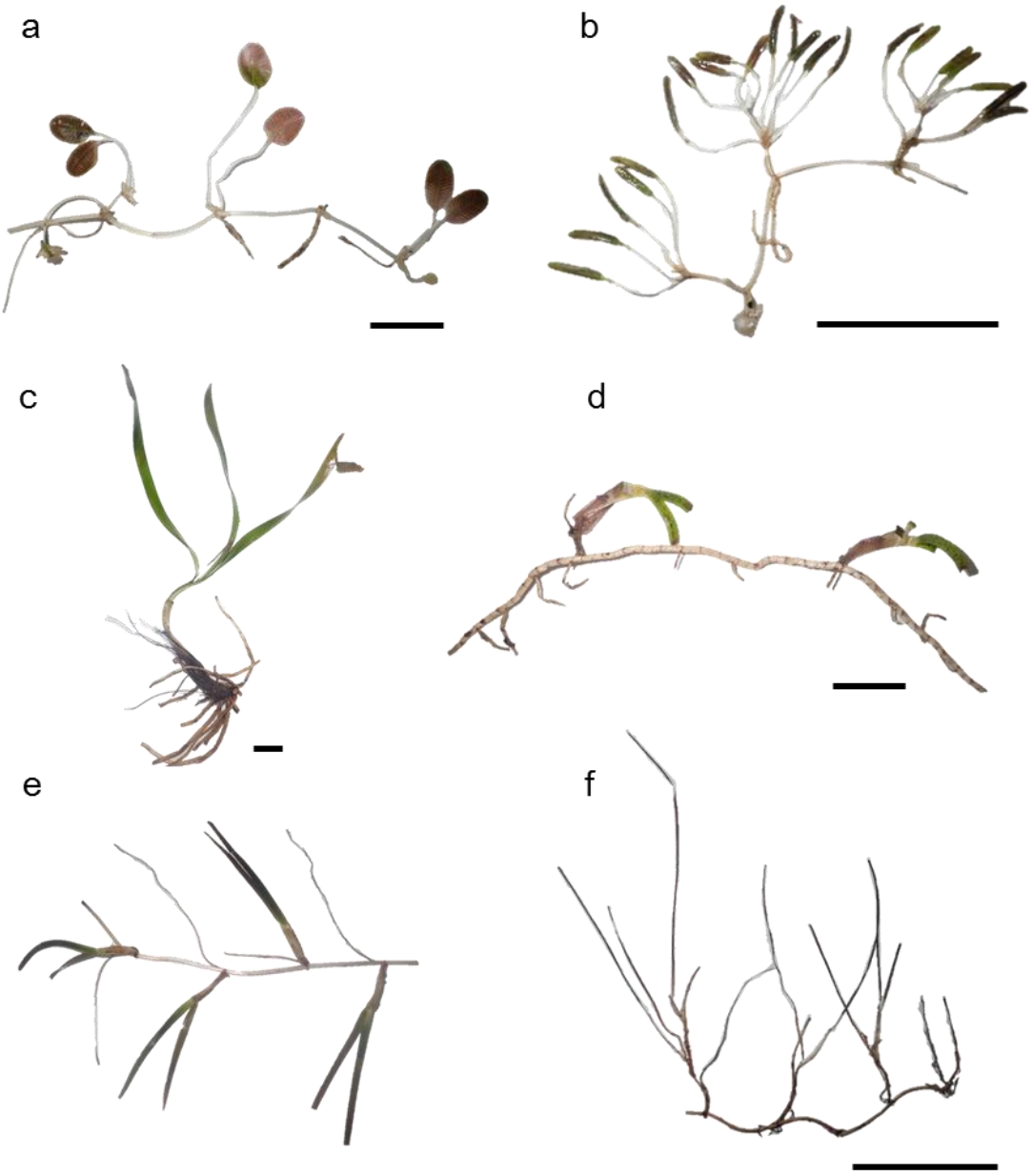

Figure 2. The seagrasses collected in Brunei Darussalam. (a) *Halophila ovalis*, (b) *Halophila beccarii*, (c) *Enhalus acoroides*, (d) *Thalassia hemprichii*, (e) *Cymodocea rotundata*, (f) *Halodule pinifolia*. Scale bar = 3 cm.

5. Conclusion

The first extensive surveys of seagrasses have been conducted along the coastline of Brunei in 2016, and six species, including three never previously recorded in Brunei, were found at PMB and PB in Brunei Bay. The present findings suggest that Brunei Bay has a rich seagrass diversity comparable to other regions in Southeast Asia and emphasizes the importance of taking action to conserve and monitor the seagrass community.

Acknowledgements

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