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Zonation and soil factors of salt marsh halophyte communities

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Abstract

Background: The structures and soil factors of *Suaeda glauca-Suaeda japonica* zonal communities and *Phragmites australis-S. japonica* zonal communities were studied in salt marshes of west and south coasts of South Korea to provide basic data for coastal wetland conservation and restoration.

Results: *S. glauca* community mean length was 67 m and *S. japonica* community mean length was 567 m in zonal communities, and *P. australis* and *S. japonica* community mean length were 57 m and 191 m in zonal communities. Regarding the electrical conductivity, sodium content, and clay contents in Upnae-ri, Shinan-gun, there were significant differences among zonal communities at significance level of 0.05 for two-sided *t* test. However, other factors were not significantly different.

Conclusions: The results indicate that multiple factors such as electronic conductivity, total nitrogen level, clay, and sodium might play important roles in the formation of zonal plant communities of salt marshes.

Keywords: Zonation, Salt marsh plant, Soil factor, *Suaeda glauca*, *S. japonica*, *Phragmites australis*

Background

Zonal distribution of higher plants in salt marshes has been studied extensively for over a century. However, mechanisms of generating the segregation of salt marsh plant species are poorly understood (Caçador et al. 2007; Emery et al. 2001). In order to explain plant zonation, shore height is frequently used as an indicator of abiotic gradient in intertidal ecosystems. This is based on the implicit assumption that shore height is directly correlated with inundation frequency and/or duration (Bockelmann et al. 2002; Sánchez et al. 1996). The objective of this study was to determine structures of zonal communities and factors that might control salt marsh plant patterns and zonations.

Methods

The structures and soil factors of two zonal community types of South Korea were monitored and can be used as basic data for conservation and restoration of coastal wetland ecosystems (Fig. 1). Six *Suaeda glauca-Suaeda japonica* zonal communities (Table 1, No. 1–6 in 1998) and five *Phragmites australis-S. japonica* zonal communities (Table 1, No. 1 in 1998, No. 2–3 in 2005, No. 5–6, 2015) were sampled from the west coast to the south coast of South Korea.

Results and discussion

S. glauca community mean length was 67 m and *S. japonica* community mean length was 567 m in zonal communities, and *P. australis* community mean length was mean 57 m and *S. japonica* community mean length was 191 m in zonal communities (Table 1). *S. glauca* community was found in Unpo-ri, Songhyun-ri, and Chulpo-ri. The community height was 70–80 cm. Its coverage in study areas was 70–80 %. The *S. japonica* community was found in both *S. glauca-S. japonica* and *P. australis-S. japonica* zonal communities. Its community height was 35–45 cm. Its coverage in study areas was 85–100 %. The area of salt marshes in Chulpo-ri and Sinduk-ri was 4–5 km^2. *P. australis* communities were found in Woopo-ri, Nongjoo-ri, and Dongkeom-ri. Community height was 64–125 cm with coverage of 85–100 %.

Soil factors in *S. glauca*, *S. japonica*, and *P. australis* communities of Upnae-ri, Shinan-gun, are shown in Fig. 2. Electrical conductivity ± SE in *S. glauca*, *S. japonica*, and *P. australis* communities were 1.38 ± 0.0015,

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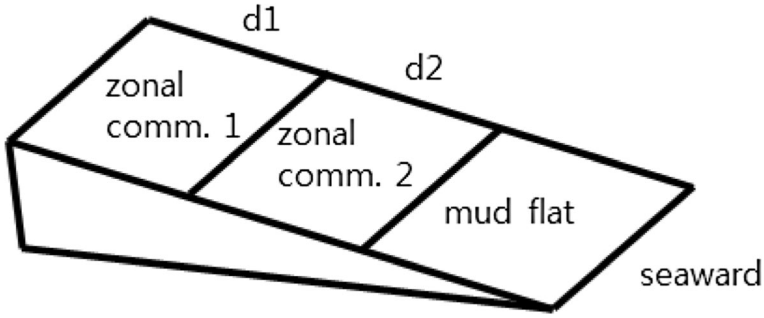

Fig. 1 The first community length of occupation (*d1*, m) and second community length of occupation (*d2*, m) in salt marsh

1.28 ± 0.0045, and 1.01 ± 0.0055 mS/cm, respectively (n = 10). Total nitrogen ± SE in *S. glauca*, *S. japonica*, and *P. australis* communities were 0.21 ± 0.0026, 0.55 ± 0.0026, and 0.69 ± 0.0025 mg/g, respectively (n = 10). Higher total nitrogen level in *S. japonica* community than that in *S. glauca* community might be due to higher density in *S. japonica* community. Higher total nitrogen level in *P. australis* community might be due to higher biomass in *P. australis* community. Total phosphate ± SE in *S. glauca*, *S. japonica*, and *P. australis* communities were 0.05 ± 0.0008, 0.04 ± 0.0009, and 0.04 ± 0.0005 mg/g, respectively (n = 10). Such slight difference might be due to dilution of inland and coastal wastewater by tide. Sodium contents ± SE in *S. glauca*, *S. japonica*, and *P. australis* communities were 15.3 ± 0.0137, 12.3 ± 0.0052, and 5.8 ± 0.0104 mg/g, respectively (n = 10). Clay content ± SE in *S. glauca*, *S. japonica*, and *P. australis* communities were 26.0 ± 0.0344, 25.0 ± 0.0446, and 8.0 ± 0.0274 mg/g, respectively (n = 10). Regarding the electrical conductivity, sodium content, and clay contents in both *S. glauca-S. japonica* and *P. australis-S. japonica* communities and total phosphate in *S. glauca-S. japonica* community in Upnae-ri, Shinan-gun, there were significant differences among zonal communities at significance level of 0.05 for two-sided t test. However, there were little differences in total phosphate levels.

Conclusions

Halophyte distributions are related to multiple reactions of flooding and salinity concentrations (Benito et al. 1990; Caçador et al. 2007; Mert and Varder 1977). In South Korea, halophyte distributions have been determined for soil-water relation and soil texture (Ihm et al. 2007; Rogel et al. 2001) as well as flooding frequency (Lee 1990). A combination of multiple factors such as flooding, soil salinity, and competition have been suggested to play important roles in the formation of zonal plant communities in salt marshes (Pennings and Callaway 1992; Silvestri et al. 2005).

Table 1 Zonal community name, first community length of occupation, second community length of occupation (d1 and d2, m), locations of six *Suaeda glauca-S. japonica*, and five *Phragmites australis-S. japonica* zonal communities

Zonal community name	First community length d1 (m)	Second community length d2 (m)	Locations
Suaeda glauca-S. japonica1	67	990	Kimje-gun Unpo-ri
Suaeda glauca-S. japonica2	100	100	Kimje-gun Sopo-ri
Suaeda glauca-S. japonica3	33	462	Buan-gun Songhyun-ri
Suaeda glauca-S. japonica4	100	627	Buan-gun Chulpo-ri
Suaeda glauca-S. japonica5	67	924	Kochang-gun Sinduk-ri
Suaeda glauca-S. japonica6	33	297	Kochang-gun Wolsan-ri
Mean ± SD	67 ± 30	567 ± 350	
Phragmites australis-S. japonica1	33	231	Yonggwang-gun Hasa-ri
Phragmites australis-S. japonica2	55	210	Gangwha-gun Dongkeom-ri
Phragmites australis-S. japonica3	17	118	Bosung-gun Jeonil-ri
Phragmites australis-S. japonica4	144	216	Suncheon-gun Nongjoo-ri
Phragmites australis-S. japonica5	36	180	Buan-gun Woopo-ri
Mean ± SD	57 ± 51	191 ± 45	

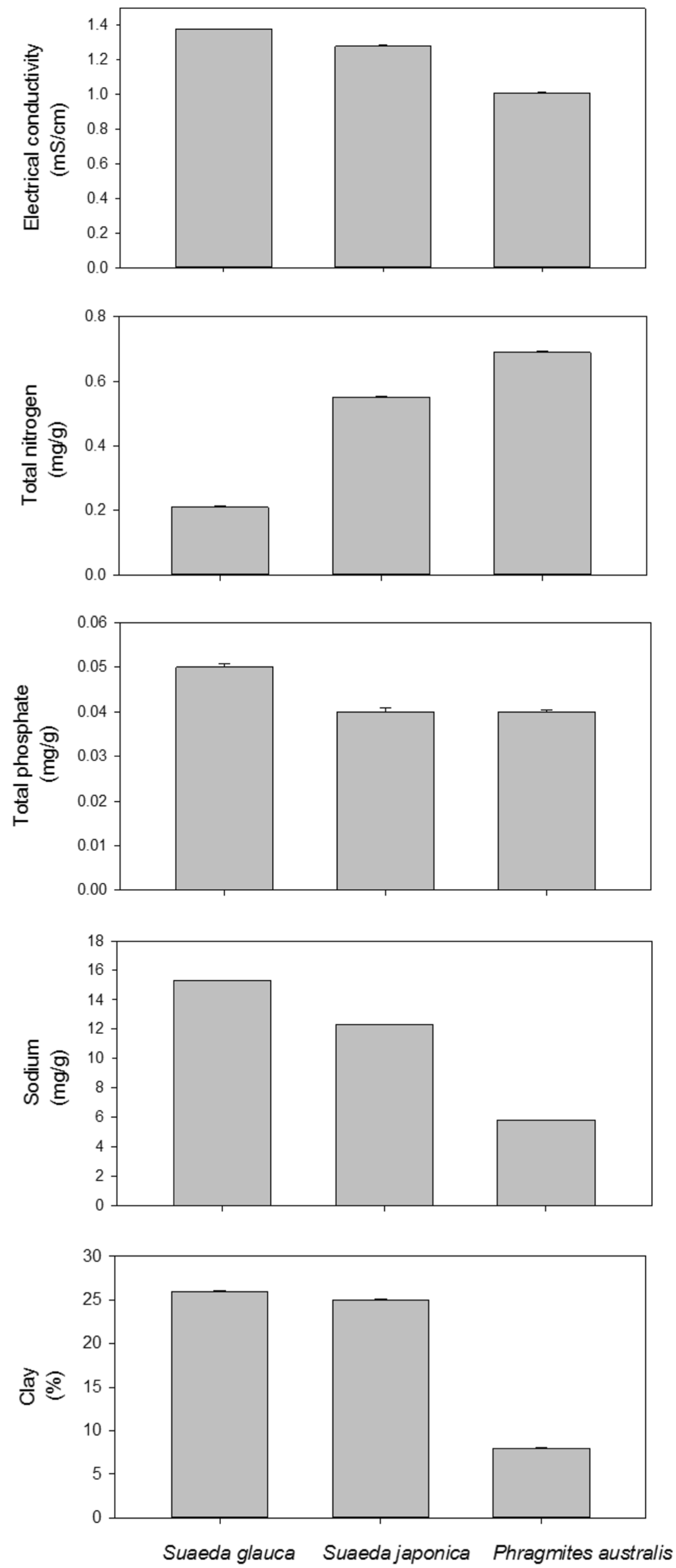

Fig. 2 Electrical conductivity, total nitrogen, total phosphate, sodium, and clay contents (mean ± SE) in *S. glauca*, *S. japonica*, and *P. australis* communities in salt marshes of Upnae-ri, Shinan-gun

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Availability of data and materials
Please contact author for data requests.

Authors' contributions
The study was designed by JSL and JWK. SHL, HHM, and JYL collected and analyzed the data. SHL has helped in the statistical analysis of the data. JWK and SHL has drafted the manuscript. All authors approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

Consent for publication
Not applicable.

Ethics approval and consent to participate
Not applicable.

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