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Original article

Invertebrates fauna in the intertidal regions of Yubudo Island, South Korea

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ABSTRACT

Yubudo Island, which is located at the estuary of the Geumgang River, is known to have high biodiversity level. This study investigated the invertebrates fauna in the intertidal regions of Yubudo Island during May 2014 to December 2014. A total of 49 species from 32 families were observed. Among them, arthropods were the most abundant, accounting for 48% of the total with 24 species. A large number of *Uca* (*Austruca*) *lactea*, Endangered Wild Species Class II of Korea, were found on the mud flats in December 2014.

Introduction

Yubudo Island has well-developed estuarial mud flats because it is geographically located at the estuary of Geumgang (Park et al 2008). Its ecosystem shows a high level of biodiversity as it is part of the Seocheon Tidal Flat Wetland Protection Area, which is one of the 21 marine protected areas designated in accordance with Article 25 of the "Conservation and Management of Marine Ecosystems Act." The coastline has a well-developed beach sand layer including dune and beach sands (Choi and Hwang 2013). The intertidal region of Yubudo Island is composed of sand beaches and mud flats, and provides a wintering place and stopovers for many shorebirds including *Haematopus ostralegus*. It has been designated as a Natural Monument (No. 326) by the Cultural Heritage Administration of Korea and an Endangered Wild Species Class II by the Ministry of Environment (Choi and Hwang 2013; NFRDI 2008; Park et al 2008; Hur et al 2011). Furthermore, many bird researchers are continuously monitoring and studying migratory birds at Yubodo (Kang et al 2010; Han 2011, 2012; Hur et al 2011).

Meanwhile, a small number of studies on benthic invertebrates in Yubudo were carried out by the former Ministry of Science and Technology (1989), Ko (2009), and the Korea Marine Environment Management Corporation (2010); however, most of the studies reported only on the dominant species, and no data were reported on the overall diversity of benthic invertebrates that inhabit Yubudo. Park et al (2008) and the Korea Marine Environment Management Corporation (2010) reported that Yubudo is an important area for migratory birds, and there were changes in the ocean currents in the area because the waterways were blocked owing to the construction of the estuary bank of Geumgang and the Saemangeum Seawall construction. This accounted for the change in the sedimentary composition of the Yubudo area. The diversity in the mudflat structure affects the benthic invertebrate habitat in Yubudo, and such diversity in the habitat environment has displayed a close relationship to the distribution of benthic invertebrate fauna; therefore, research is required. Despite its importance, however, there is still a lack of research on the diversity and distribution features of the benthic invertebrates of Yubudo. Consequently, the purpose of this study is to verify the biodiversity of the benthic invertebrates living in the island intertidal zones and to use it as fundamental data for research on the changes in distribution of benthic invertebrate fauna in accordance to the mud flat sedimentary structure.

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Materials and methods

In order to examine invertebrates fauna in the intertidal regions of Yubudo Island, investigations were made on four separate occasions from May 2014 to December 2014, and the distribution features per season were compared. The research area was the entire intertidal zone of the Island located at Jangam-ri, Janghang-eub, Seocheon, Chungnam (Figure 1). For the collection method, a shovel for mudflats (length 1 m, width 18 cm) was used while moving at 5-m intervals from the uppermost part of the intertidal zone to the low waterline by digging in excess of 50 cm to sort out living organisms. Species that could be identified on the spot were photographed and recorded on site, and species that were difficult to identify were fastened with 95% ethyl alcohol and sent to a laboratory for identification. Species classification was made by referring to Porifera (Rho 1977), Cnidaria (Song 2004; Park 2010), Echinodermata (Shin and Rho 1996; Shin 2010), Annelida (Paik 1989), Mollusca (Choi 1992), and Arthropod (Kim 1973; 1977), and the classification systems used by the Korean Society of Systemic Zoology (1997) and the World Register of Marine Species (2014).

Results

In this study, 49 species of 32 families of 16 orders of 10 classes of eight phyla of invertebrates were found (Table 1). For the number of species that appeared by taxonomic group, 24 species (accounted for 49%) were Arthropods, 16 species (33%) were Mollusca, three species (6%) were Cnidaria, two species (4%) were Annelida, and there were one each (2%) of Echinodermata, Porifera, and Brachiopoda (Figure 2). Based on an analysis of the seasonal number of species of invertebrates in 2014, 23 species appeared in the spring in May, 35 species in the summer in July, 34 species in the autumn in September, and 12 species in the winter in December, showing the highest biodiversity in summer and autumn. With respect to the type of habitat, 34 species lived in mixed mud flats, 16 species in gravel and rock beds, 12 species in tidal sand flats, 11 species in tidal mud flats, and two species in reed beds (Figure 3).

Discussion

The intertidal regions of Yubudo Island have various benthic environments including sand, mud, mixed flats, gravel and rock beds, and reed beds (Figure 1), located at the transition belt, where freshwater and seawater meet, of the estuary of Geumgang so habitats around the island show a high biodiversity. In the previous study of Ko (2009), Annelids were shown to be most common, whereas a higher number of Arthropods were found in this study. Inferring from the dead *Macrophthalmus* (*Macrophthalmus*) *abbreviatus* and *Portunus* (*Portunus*) *trituberculatus* found in the study site Figure 4, it is suggested that the high diversity of Annelids and Arthropods would be potential food sources for various birds that stop over in the island. This is consistent with the results of Kang et al (2010), who reported that the distribution of benthic invertebrates, which are the primary food source of shorebirds, has a high correlation with their flyway. There are currently various shellfishes and marine organisms living in the intertidal regions of the island, but they are being collected excessively by humans Figure 5, and there is no regulation or countermeasure to protect the ecosystem by the central or local governments. Furthermore, owing to the change in seawater flow resulting from mud flat reclamation and large-scale tide embankment construction for the establishment of nearby

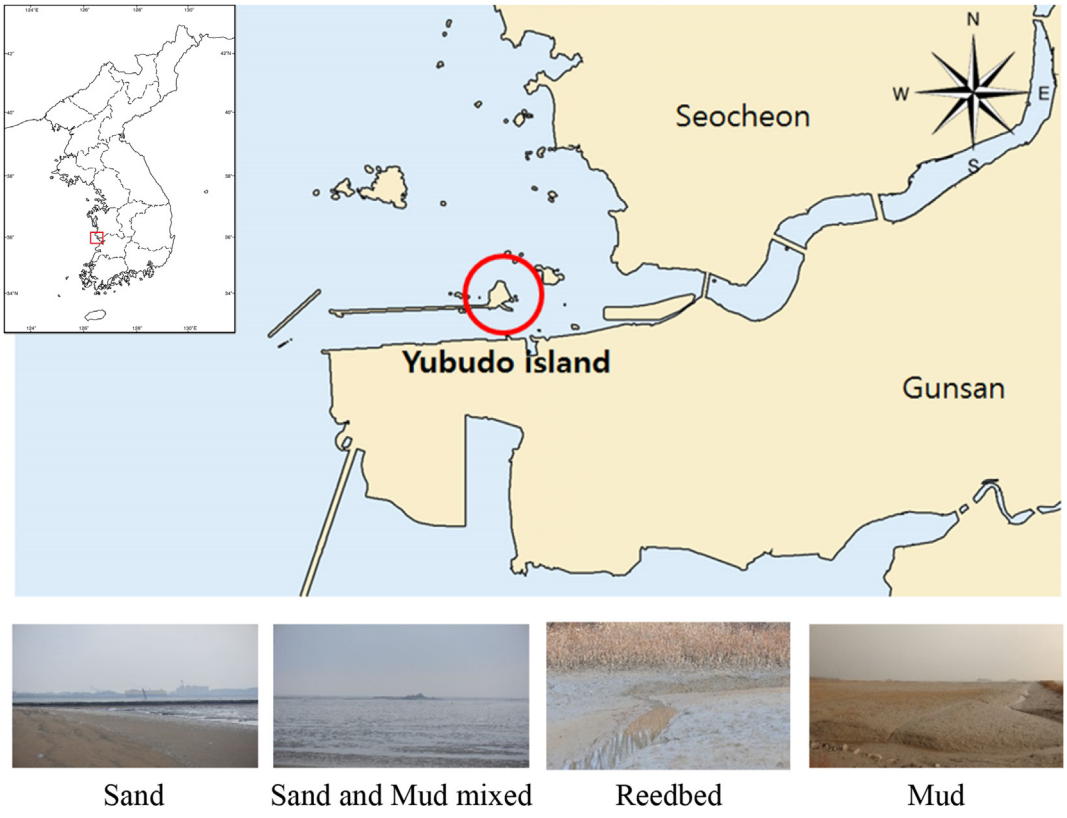

Figure 1. Location of the study area and habitat types.

Table 1. Macro benthic invertebrates appearing in Yubudo Island.

Scientific name	Habitat type					This study (2014)			
	S	SM	R	M	GR	May	Jul	Sep	Dec
Phylum Porifera									
Class Demospongiae									
Order Halichondrida									
Family Halichondriidae									
Hymeniacidon sinapium de Laubenfels, 1930					+		+	+	
Phylum Cnidaria									
Class Anthozoa									
Order Actinaria									
Family Actiniidae									
Anthopleura kurogane Uchida & Muramatsu, 1958					+		+	+	
Anthopleura midori Uchida & Muramatsu, 1958					+		+	+	
Family Haliplanellidea									
Diadumene lineata (Verrill, 1869)					+		+	+	
Phylum Platyhelminthes									
Class Turbellaria									
Order Polycladida									
Polycladida sp.		+				+			
Phylum Brachiopoda									
Class Inarticulata									
Order Atremata									
Family Ligulidae									
Lingula unguis Linnaeus, 1758		+				+	+	+	+
Phylum Mollusca									
Class Polyplacophora									
Order Neoloricata									
Family Chitonidae									
Acanthochitona achates (Gould, 1859)					+	+	+	+	
Liolophura japonica (Lischke, 1873)					+	+	+	+	
Class Gastropoda									
Order Archaeogastropoda									
Family Trochidae									
Umbonium giganteum (Lesson, 1831)	+	+		+		+	+	+	
Order Neogastropoda									
Family Muricidae									
Rapana venosa (Valenciennes, 1846)		+						+	
Reishia clavigera (Küster, 1860)					+	+	+	+	
Family Nassariidae									
Nassarius fraterculus (Dunker, 1860)		+		+	+	+	+	+	
Order Littorinimorph									
Family Littorinidae									
Littorina brevicula (Philippi, 1844)		+			+	+	+	+	+
Order Cephalaspidea									
Family Haminoeidae									
Bullacta exarata (Philippi, 1849)		+		+		+	+	+	
Class Bivalvia									
Order Pterioida									
Family Ostreidae									
Crassostrea gigas (Thunberg, 1793)					+	+	+	+	+
Order Veneroida									
Family Mactridae									
Mactra quadrangularis Reeve, 1854		+				+	+	+	+
Family Solenidae									
Solen strictus Gould, 1861	+	+				+	+	+	
Family Tellinidae									
Moerella sp.		+					+	+	
Family Psammobiidae									
Nuttallia japonica (Reeve, 1857)	+							+	
Family Veneridae									
Phacosomaj aponicus (Reeve, 1850)		+					+		
Ruditapes philippinarum (Adams & Reeve, 1850)		+				+	+		
Meretrix petechialis (Lamarck, 1818)		+					+	+	+
Phylum Annelida									
Class Polychaeta									
Order Phyllodocida									
Family Phyllodocidae									
Phyllodocidae sp.		+					+		
Family Nereidae									
Nereidae sp.	+	+							+
Phylum Arthropoda									
Class Crustacea									
Order Thoracica									

Table 1. (*continued*)

Scientific name	Habitat type					This study (2014)			
	S	SM	R	M	GR	May	Jul	Sep	Dec
Family Balanidae									
Amphibalanus reticulatus (Utinomi, 1967)		+					+		+
Fistulobalanus albicostatus (Pilsbry, 1916)		+			+	+	+	+	
Order Decapoda									
Family Alpheidae									
Alpheidae sp.	+	+							+
Family Portunidae									
Portunus (*Portunus*) *trituberculatus* (Miers, 1876)		+		+			+	+	
Charybdis (*Charybdis*) *japonica* (A. Milne-Edwards, 1861)		+		+				+	
Family Calappidae								+	
Matuta planipes Fabricius, 1798	+	+							
Family Leucosiidae									
Pyrhila pisum (De Haan, 1841)		+		+		+	+	+	
Family Sesarmidae									
Chiromantes haematocheir (De Haan, 1833)	+	+			+	+	+		
Parasesarma pictum (De Haan, 1835)	+	+		+	+	+	+		
Family Varunidae									
Gaetice depressus (De Haan, 1833)		+			+	+	+	+	
Helicana japonica (K. Sakai & Yatsuzuka, 1980)		+		+					+
Helicetient sinensis Rathbun, 1931		+	+	+		+	+		
Helice tridens (De Haan, 1835)		+	+	+			+	+	+
Hemigrapsus penicillatus (De Haan, 1835)		+			+	+	+	+	
Hemigrapsus sanguineus (De Haan, 1835)		+			+	+	+	+	
Family Dotillidae									
Scopimera globosa (De Haan, 1835)	+								
Family Macrophthalmidae									
Macrophthalmus (*Macrophthalmus*) *abbreviatus* Manning & Holthuis, 1981				+		+	+	+	
Macrophthalmus (*Mareotis*) *japonicus* (De Haan, 1835)			+		+	+	+		
Uca (*Tubuca*) *arcuata* (De Haan, 1835)				+			+		
Uca (Austruca) lactea (De Haan, 1835)	+	+						+	
Family Callianasiidae									
Callianasa japonica Ortmann, 1891	+	+				+	+		
Family Upogebidae									
Upogebia major (De Haan, 1841)		+					+		
Order Amphipoda									
Family Talitridae									
Talitridae sp.	+					+	+	+	
Phylum Enchinodermata									
Class Stelleroidea									
Order Spinulosa									
Family Asterinidae									
Patiria pectinifera (Muller & Troschel, 1842)		+					+	+	+

GR = gravel and rock bed; M = mud; R = reed bed; S = sand, SM = sand and mud.

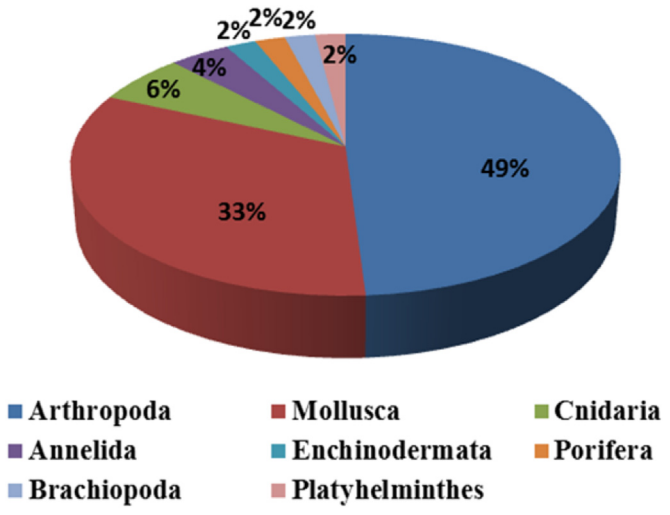

Figure 2. Composition of taxonomical groups of invertebrates fauna.

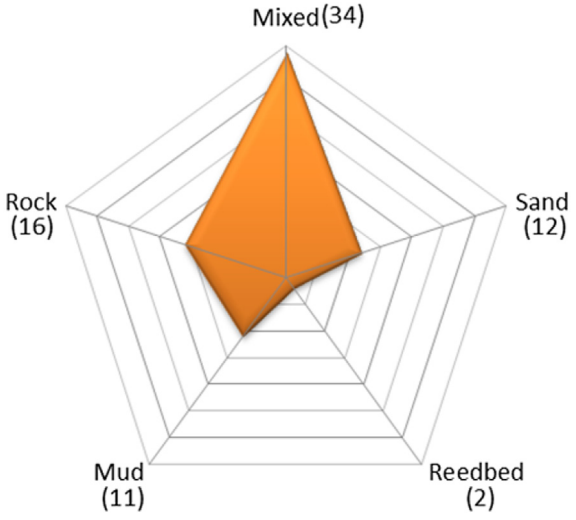

Figure 3. Species occurrence by habitat types.

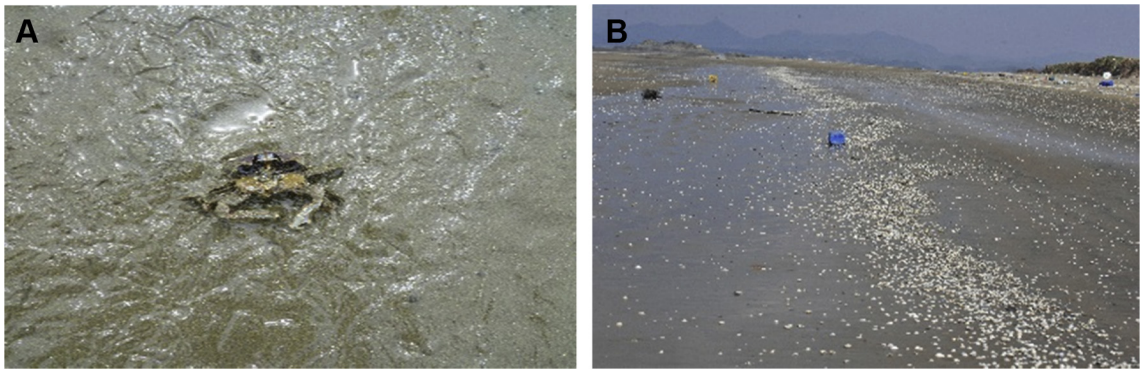

Figure 4. Dead animals observed during the survey: A, *Macrophthalmus (Macrophthalmus) abbreviatus*; B, Massive shellfishes death.

Figure 5. Harvest of *Mactra quadrangularis*.

industrial complexes (Gunsan National Industrial Complex and Gunsan General Industrial Complex), changes in sediments of the surface layer are reacting sensitively (Park 2002; Kang et al 2010), thereby making it necessary to conduct a long-term monitoring of the mud flats. A shift in the ocean currents resulted from the above-mentioned extensive changes such as the Saemangeum seawall establishment, whose construction was completed in 2004 (An et al 2006), and such a current shift has been instrumental in changing the sedimentary layer of the tidal flat at the estuary of Geumgang from sand to mud. Because of this, the population of sand-dwelling shellfish and marine organisms sharply declined (Park et al 2008). It is suggested that such changes could have a negative impact on the habitat of *Uca (Austruca) lactea* (Figure 6), the second class of endangered species designated by the Ministry of Environment. Furthermore, it is indicated that the massive death of shellfishes in the intertidal zones during the survey period Figure 4 leads to an assumption that the habitat environment of these mud flats is faced with changes, and that the biodiversity of benthic invertebrates is decreasing considerably. It is assumed that such changes in benthic invertebrates have a negative impact on various migratory birds (especially shorebirds) that feed on them. Therefore, in order to conserve the marine habitat environment of the island, which has a high ecological value, it is necessary to identify the changes in benthic invertebrates and shellfishes according to changes in the marine environment through continuous and systematic monitoring studies of the intertidal zones, and based on the data from these further studies, the central and local governments should devise efficient management plans to conserve the intertidal regions of the islands that are used as habitats by migratory birds and a wide array of marine organisms.

Figure 6. *Uca* (*Austruca*) *lactea* (De Haan, 1835).

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