Diversity of Intertidal Benthic Invertebrate of Dokdo and Ulleung-do Island from Korea

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Abstract: In order to conduct a study on diversity of benthic invertebrate in the intertidal zone of Ulleung-do (Ullengdo Island) and Dokdo, this study investigated the diversity of benthic invertebrate on harbor rocks of Ulleung-do (Jeodong Harbor), Tonggumi Mongdol Coast, Geobuk Bawi and rocks in Dokdo docks for twice in June and September. As a result, it was shown that total 26 species including 3 species of Cnidaria, 14 species of Mollusks, 6 species of Arthropod and 3 species of Echinoderm live in rocks of Dokdo docks, and as for Ulleung-do, it was shown that 24 species live on rocks of Tonggumi Mongdol Coast, 13 species in Geobuk Bawi and 2 species in Jeodong Harbor.

Keywords: Invertebrate, Ulleung-do Island, Dokdo Island

Introduction

Ulleung-do (Ullengdo Island) which is situated at the eastern extremity of South Korea belongs to Ullung-gun, Gyeongsangbuk-do of the administrative district. The direct distance from east to west, and from south to north is 10 km and 9.5 km respectively, total extent is 73.5 km², and it is a volcanic island created by large-sized volcanic activity in the continental shelf of the East Coast from the Miocene epoch to the Pleistocene epoch. Dokdo belongs to Dokdo-ri, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, total extent is 187.544 m², and it is divided into Seo-do and Dong-do (Ulleung-gun Journal, 2007). It was designated as a natural monument no. 336 ‘Dokdo Natural Reserve’ in 1999, and it has a great academic value as it has not been influenced by human’s activities and maintains natural biota.

As for the comprehensive research report on Ulleung-do and Dokdo, ‘Comprehensive academic report on Ulleung-do and Dokdo’ implemented by the Korean Association for Conservation of Nature in 1981 reported the biota of land and marine life in Ulleung-do and Dokdo (Korean Association for Conservation of Nature, 1981). Marine biota in Ulleung-do and Dokdo is different from that in the East Coast on the same latitude, and it is reported that the biota is rather similar to that in the South Coast such as Jeju Island due to the influence of warm current (Ministry of Maritime Affairs and Fisheries, 1999). In Dokdo which was designated as a natural reserve, studies on marine life living in the intertidal zone are conducted constantly (Ministry of Environment, Daegu Office, 2007, 2008, 2009, 2010).

This study investigated the diversity of marine life living in the intertidal zone of Ulleung-do and Dokdo for twice in June and September, 2012 as a part of joint research of coalition of National Biodiversity Institutions, and it aims to complete a species list of benthic invertebrate living in the intertidal zone of Ulleung-do and Dokdo by arranging a species list revealed through this investigation and existing investigation records.

Materials and Methods

The study selected 3 spots in the intertidal zone which is expected that various kinds of benthic invertebrate live (rocks in Jeodong Harbor, Tonggumi Mongdol Coast and Geobuk Bawi) and 1 spot in rocks of Dongdo Dock in Dokdo, and conducted total 2 times of investigation in June and September, 2012 (Fig. 1). Attached organisms living on rocks in the intertidal zone were collected using a chisel and a pair of tweezers. Specimens collected in Ulleung-do were anesthetized according to each taxon, fixed in 70% ethyl alcohol or 5~10% formalin on the spot, and researchers carried them to a specimen making room by each taxon and made the immersion specimen. Species investigated in Dokdo were photo shot, and if it was not possible, 1~2 specimens were collected and fixed by each taxon.

For deciding names, the study referred to Cnidaria...
Results

List of species

Through this study, total 4 phyla, 7 classes, 13 orders 20 families and 26 species of benthic invertebrates were investigated in the rock intertidal zone of Dokdo, and as for the number of species by each taxa, the study investigated 14 species of mollusks (53%), 6 species of arthropod (23%), 3 species of echinoderm (12%) and 3 species of Cnidarian (12%). Total 4 phyla, 8 classes, 13 orders 23 families and 28 species of benthic invertebrates were investigated in the rock intertidal zone of Ulleung-do, and as for the number of species by each taxa, the study investigated 15 species of mollusks (54%), 6 species of arthropod (21%), 4 species of echinoderm (14%) and 3 species of Cnidarian (11%), showing that species diversity of mollusks was the highest.

Phylum Cnidaria

Class Anthozoa

Order Actiniaria

1. Actinia equina
   Material examined: Dokdo Island, 2012. 6. 28/2012. 9. 4
2. Anthopleura japonica
   Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29
   Literature: Detailed investigation report on ecosystem in Dokdo, 2010; Song (2004)
3. Anthopleura Kurogane

Phylum Mollusca

Class Gastropoda

Order Neogastropoda

5. Reishia bronni
   Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29
6. Reishia clavigera
   Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29

Order Mesogastropoda

Family Muricidae

7. Serpulorbis imbricatus
   Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Family Littorinidae

8. Granulilittorina exigua
   Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29;
   Geobukbawi, 2012. 6. 27/2012. 9. 5
   Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Order Archaeogastropoda

Family Trochidae

9. Omphalius rusticus rusticus
Material examined: Dokdo Island, 2012. 6. 28
10. Chlorostoma argyrostoma lischkei 밤고둥
Material examined: Dokdo Island, 2012. 6. 28
Literature: Detailed investigation report on ecosystem in Dokdo, 2010

11. Monodonta perplexa 갯장각시고둥

12. Chlorostoma argyrostoma turbinatum 구멍밤고둥

13. Omphalius pfifferi carpenteri 빗어고둥
Material examined: Ulleungdo Island, Tonggumi, 2012. 6. 29

Family Patellidae 삿갓조개과
14. Cellana toreuma 애기삿갓조개
Material examined: Ulleungdo Island, Tonggumi, 2012. 6. 29

Family Acmaeidae 흰삿갓조개과
15. Notoacmea schrenkii 배무래기
Material examined: Ulleungdo Island, Tonggumi, 2012. 6. 29

Family Turbinidae 소라과
16. Turbo cornutus 소라
Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29

Order Basommatophora 기안목
Family Siphonariidae 고랑딱개비과
17. Sacculosiphonaria japonica 고랑딱개비
Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29

18. Anthosphonaria sirius 꽃고랑딱개비
Material examined: Dokdo Island, 2012. 6. 28

Order Aplysiomorpha 군소목
Family Aplysiidae 군소과
19. Aplysia kurodai 군소
Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Class Polyplacophora 다판강
Order Neoloricata 신군부목
Family Chitonidae 군부과

20. Onithochiton hirasei 비단군부
Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29

Family Acanthochitonidae 가시군부과
21. Acanthochiton achatas 종털군부
Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29

Family Ischnochitonidae 연두군부과
22. Ischnochiton sp.

Class Bivalvia 이매패강
Order Mytiloida 홍합목
Family Mytilidae 홍합과
23. Mytilus edulis 진주담치

Order Pterioida 익각목
Family Ostreidae 골과
24. Crassostrea gigas 굴
Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Phylum Arthropoda 절지동물문
Class Maxillopoda
Order Thorcica 완흉목
Family Tetraclitidae 사각따개비과
25. Tetraclita japonica 검은큰따개비
Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Geobukbawi, 2012. 6. 27/2012. 9. 5
Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Family Balanidae 마개비과
26. Megabalanus volcano 큰빨강따개비
Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Geobukbawi, 2012. 6. 27/2012. 9. 5

Family Chthamalidae 조무래기따개비과
27. Chthamalus challengeri 조무래기따개비
Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Geobukbawi, 2012. 6. 27/2012. 9. 5
Literature: Detailed investigation report on ecosystem in Dokdo, 2010
Family Scalpellidae 거북손과
28. Pollicipes mitella 거북손
Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Class Malacostraca
Order Decapoda 십각목
Family Grapsidae 바위게과
29. Pachygrapsus crassipes 바위게
Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Family Paguridae 집게과
30. Pagurus sp.
Material examined: Ulleungdo Island, Tonggumi, 2012. 6. 29

Order Isopoda 동각목
Family Ligiidae 갯강구과
31. Ligia exotica 갯강구
Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Phylum Echinodermata 극피동물
Class Echinoidea 성게강
Order Echinoida 성게목
Family Echinometridae 만두성게과
32. Anthocidaris crassispina 보라성게
Literature: Detailed investigation report on ecosystem in Dokdo, 2010

Family Strongylocentrotidae 둥근성게과
33. Hemicentrotus pulcherrimus 말똥성게
Material examined: Dokdo Island, 2012. 6. 28; Ulleungdo Island, Tonggumi, 2012. 6. 29

Class Stelleroidea 별가사리강
Order Spinulosida 유극목
Family Asterinidae 별불가사리과
34. Asterina pectinifera 별불가사리

Table 1. Benthic invertebrate appearing in the rock littoral zone of the dock in Dokdo

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Scientific name</th>
<th>Korean name</th>
<th>Dokdo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinia equina</td>
<td>해변말미잘</td>
<td>+</td>
<td>Ministry of Environment, 2010</td>
</tr>
<tr>
<td>Anthopleura japonica</td>
<td>갈색꽃해변말미잘</td>
<td>+</td>
<td>Daegu Office (2010)</td>
</tr>
<tr>
<td>Anthopleura Karugane</td>
<td>검정꽃해변말미잘</td>
<td>+</td>
<td>This study (2012)</td>
</tr>
<tr>
<td>Reishia bronni</td>
<td>두드락고둥</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Onithochiton hirasei</td>
<td>비단군부</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Acanthochitona achatas</td>
<td>홍립군부</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Serpulorhis imbricatus</td>
<td>콤병고둥</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Omphalius rusticus rusticus</td>
<td>보말고둥</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Chrostostoma argyrostomaischkei</td>
<td>밤고둥</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Reishia clavigera</td>
<td>대수리</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Aplysia kursdai</td>
<td>군소</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Granulilittorina exigua</td>
<td>흉煞무늬총알고둥</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Crassostrea gigas</td>
<td>금</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Cellana toreuma</td>
<td>에기장갑조개</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Saccusoolphoria japonica</td>
<td>고망박개비</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Anthosiphonia sirius</td>
<td>빗고망박개비</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Batillas cornatus</td>
<td>소라</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Tetroclita japonica</td>
<td>검은관마개비</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Megabalanus volcano</td>
<td>콤병장마개비</td>
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<tr>
<td>Olthamalus challengeri</td>
<td>조부례기마개비</td>
<td>+</td>
<td></td>
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<tr>
<td>Pollicipes mitella</td>
<td>거북손</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Pachygrapsus crassipes</td>
<td>바위게</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Ligia exotica</td>
<td>갯강구</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Anthocidaris crassispina</td>
<td>보라성게</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Hemicentrotus pulcherrimus</td>
<td>말똥성게</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Asterina pectinifera</td>
<td>별불가사리</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>
28; Ulleungdo Island, Tonggumi, 2012. 6. 29/2012. 9. 5

Order Forcipulata 차극목
Family Asteriidae 불가사리과
35. Sclerasterias sp.

Material examined: Ulleungdo Island, Tonggumi, 2012. 6. 29

Comparison of species in Dokdo rock intertidal zone
In order to conduct comparative analysis on Dokdo rock intertidal zone, the study compared and analyzed species of the detailed investigation report on ecosystem in Dokdo (Ministry of Environment, Daegu Office, 2010) and of this study. As a result, benthic invertebrate additionally investigated in this study includes Actinia equina, Onithochiton hirasei, Acanthochitona achates, Reishia clavigera, Saccuslophonaria japonica, Anthosphonaria sirius, Megabalanus volcano, Hemicentrotus pulcherrimus, Asterina pectinifera and Batillus cornutus (Table 1).

Table 2. Benthic invertebrate appearing in the rock littoral zone in Ulleung-do

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Scientific name</th>
<th>Korean name</th>
<th>Tonggumi Mongdol Coast</th>
<th>Geobuk Bawi</th>
<th>Rock in Jeodong Harbor</th>
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</thead>
<tbody>
<tr>
<td>Cnidarian</td>
<td>Anthopleura japonica</td>
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<tr>
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<td>Anthopleura kurogane</td>
<td>검정꽃해변말미잘</td>
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<td></td>
<td>Anthopleura midori</td>
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<td></td>
<td>Acanthochitona achates</td>
<td>중밀군부</td>
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<tr>
<td></td>
<td>Onithochiton hirasei</td>
<td>비단군부</td>
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<td></td>
<td>Reishia bronni</td>
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<td>Reishia clavigera</td>
<td>대수리</td>
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<td></td>
<td>Ischnochiton sp.</td>
<td>군부류</td>
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<td></td>
<td>Serpukorhis imbricatus</td>
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<td>Granulilitorina exigua</td>
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<td></td>
<td>Monodonta perplexa</td>
<td>깜장각시고둥</td>
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<td></td>
<td>Chlorostoma argyrostoma turbinatum</td>
<td>구멍밤고둥</td>
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<td>Notoacmea schrenkii</td>
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<td>Omphalilus pfeifferi carpenteri</td>
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<td>Siphonaria (Saccuslophonaria) japonica</td>
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<td>Batillus cornutus</td>
<td>소라</td>
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<td></td>
<td>Aplysiu kurodai</td>
<td>군소</td>
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<tr>
<td></td>
<td>Mytilus edulis</td>
<td>진주담치</td>
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<tr>
<td>Mollusks</td>
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<td></td>
<td>Tetrochita japonica</td>
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<td>Megabalanus rosa</td>
<td>큰 selvage</td>
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<td></td>
<td>Chthamalus challengeri</td>
<td>조무래기따개비</td>
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<tr>
<td></td>
<td>Pagurus sp.</td>
<td>집개류</td>
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<td></td>
<td>Pachygrapsus crassipes</td>
<td>마 אותה</td>
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<tr>
<td>Arthropod</td>
<td>Pollicipes mitella</td>
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<td>Tetrochita japonica</td>
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<td>Pagurus sp.</td>
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<td>Pachygraposus crassipes</td>
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<td></td>
<td>Hemicentrotus pulcherrimus</td>
<td>말동상계</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Asterina pectinifera</td>
<td>볼사리</td>
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<td>+</td>
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</tr>
<tr>
<td></td>
<td>Sclerasterias sp.</td>
<td>단단불가사리류</td>
<td>+</td>
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</tr>
</tbody>
</table>

Comparison of species in Ulleung-do rock intertidal zone
As a result of investigating benthic invertebrate in Ulleung-do rock intertidal zone, the study observed 3 species of cnidarian, 14 species of mollusks, 3 species of arthropod and 4 species echinoderm in Tonggumi Mongdol Coast, and 2 species of cnidarian, 5 species of mollusks, 5 species of arthropod and 1 species of echinoderm in the intertidal zone of Geobuk Bawi. In rocks of Jeodong Harbor, 2 species including Monodonta perplexa and Chlorostoma argyrostoma turbinatum were observed. It was shown that various kinds of zoobenthos were distributed around rocks of Tonggumi Mongdol Coast among the investigated spots (Table 2).

Discussion
The study investigated benthic invertebrate in the intertidal zone of Ulleung-do and Dokdo as a part of joint research of coalition of National Biodiversity Institutions for twice in
June and September, 2012. As for Dokdo which is designated as a natural monument (no. 336), the study conducted in-depth investigation on one spot of rocks in Dongdo Dock which is expected to have many benthic invertebrate due to limited access and limited investigation time. As a result, additional species including *Actinia equina*, *Onithochiton hirasei*, *Acanthochitona achates*, *Reishia clavigera*, *Sacculusiphonaria japonica*, *Anthosiphonaria sirius*, *Megabalanus volcano*, *Hemicentrotus pulcherrimus* and *Asterina pectinifera* were observed comparing with species in the ‘Detailed investigation report on ecosystem in Dokdo (Ministry of Environment, Daegu Office, 2010).’ If detailed investigation with professionals in each taxon would be conducted in Dokdo intertidal zone, it is expected to find various benthic invertebrate.

As for Ulleung-do intertidal zone, there have been few investigation in the intertidal zone since the ‘study on seasonal changes in benthic invertebrate in the intertidal zone of Ulleung-do and Dokdo (Cha JaeHun, Je JongGil and Kim GiTae, 1999).’ As a result of investigating 3 spots of intertidal zone in Ulleung-do through this joint investigation, total 24 species of benthic invertebrates including 3 species of cnidarian, 14 species of mollusks, 3 species of arthropod and 4 species of echinoderm were observed in Tonggumi Mongdol Coast, and 2 species of cnidarian, 5 species of mollusks, 5 species of arthropod and 1 species of echinoderm in Geobuk Bawi. 2 species including *Monodonta perplexa* and *Chlorostoma argyrostroma turbinate* were observed in rocks of Jeodong Harbor. It is expected that various kinds of benthic invertebrate will be

**Fig. 2.** Major benthic invertebrate in the intertidal zone of Dokdo. A. *Actinia equina*; B. *Aplysia kurodai*; C. *Onithochiton hirasei*; D. *Acanthochitona achates*; E. *Batillus cornutus*; F. *Pachygrapsus crassipes*; G. *Pollicipes mitella*; H. *Tetracitha japonica*. 
observed in future systematic investigation in the intertidal zone of Ulleung-do.

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Fig. 3. Major benthic invertebrate in the intertidal zone of Ulleung-do. A. Anthopleura japonica; B. Anthopleura midori; C. Aplysia kurodai; D. Monodonta perplexa; E. Megabalanus rosa; F. Chthamalus challengeri; G. Anthocidaris crassispina; H. Asterina pectinifera.
Ulleung-gun County Office, 2007

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