

# Biological Assessment of Ecologically Important Areas for the Coastal Mollusks Taxonomic Group of the Yellow Sea Ecoregion

## Korea Part

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### Ecological sub-regions

#### Definition and description of sub-regions

Sub-regions were defined by characteristic species, bottom sediment texture, and water temperature (Je, 1993). Based on the cluster analysis with molluscan assemblage data, Je (1993) divided the Yellow Sea and the South Sea of Korea into six sub-regions (Fig. 1).

Sub-region G1: *Nitidotellina nitidula* – *Thyasira tokunagai* assemblage (coarse sediment, low salinity (31.9-33.1‰) and seasonally fluctuating temperature)

Sub-region G2: *Thyasira tokunagai* – *Nucula paulula* assemblage of cold bottom water mass in the Yellow Sea (fine sediment, low salinity and seasonally constant temperature).

Sub-region G3: Southwest assemblage without characteristic species (fine sediment, low salinity and seasonally fluctuating temperature)

Sub-region G4: *Raeta pulchella* – *Nucula tokyoensis* assemblage as a transition zone between the South Sea and the Yellow Sea (fine sediment, intermediate salinity and temperature between the South Sea and the Yellow Sea)

Sub-region G5: *Leptomya minuta* – *Mactra dolabrata* assemblage with many rare species (lowest salinity)

Sub-region G6: Tsushima current assemblage without characteristic species (Increasing salinity and temperature toward the East Sea from the South Sea)

### Common Criteria for identification of Ecologically Important Areas of YSE

The molluscan taxonomic group adopted the common criteria listed in Table 1 to identify Ecologically Important Areas (EIAs) for mollusk in the Yellow Sea Ecoregion (YSE).

**Table 1. List of Adopted Common Criteria for the Molluskan Taxonomic Group**

Adopted Common Criteria	Selected Indicator Species/Species Groups	Definition of Indicator Species	Definition of Ecologically Important Areas
Criterion 1: representative species / habitat types	<i>Nitidotellina nitidula</i> (Tellin)	Characteristic species	Subtidal/Low Salinity, coarse sediment (Yellow Sea Area G1)
	<i>Thyasira tokunagai</i>	"	Subtidal/Low Salinity (Yellow Sea Area G1, G2)
	<i>Nucula paulula</i> (Nut clam)	"	Subtidal/Low Salinity, fine sediment (Yellow Sea Area G2)
	<i>Raetella pulchella</i>	"	Subtidal/Middle Salinity, fine sediment (Yellow Sea Area G3, G4)
	<i>Leptomya minuta</i>	"	Subtidal/Low Salinity (Yellow Sea Area G5)
	<i>Umbonium thomasi</i> (Yellow Sea button top shell)	Dominant with a wide range of distribution,	Intertidal (sandy bottoms)
	<i>Potamocorbula cf. laevis</i>	Only inhabiting in estuary	Intertidal/Shallow subtidal (mud bottoms), inhabits estuaries
	<i>Mactra veneriformis</i> (Surf clam)	Dominant with a wide range of distribution	Intertidal/Shallow subtidal (sandy bottoms), inhabits estuaries
Criterion 2: endemism and unique species assemblages (endemic to Yellow Sea)	<i>Umbonium thomasi</i> (Yellow Sea button top shell)	Indigenous to the Yellow Sea	West and south coast of Korea
	<i>Bullacta exarata</i> (Mud bubble)	"	"
Criterion 3: species richness	Not applicable	Intertidal (soft and hard bottom): more than 60 species	Tidal flat (soft bottom): estuary and large salt marsh shore (hard bottom): south coast islands and Jeju Island
Criterion 4-A: species of special concern (depleted stocks)	<i>Mactra veneriformis</i> (Surf clam)	Depleted by the reclamation of tidal flats	Saemangeum area and Incheon-Songdo tidal flat
	<i>Meretrix</i> species (Oriental hard clam)		
Criterion 5-A: commercially important (Volume)	<i>Ruditapes philippinarum</i> (Short necked clam)	High level of catch (ton) in Korea from the 1960s to 2000s (in weight)	
	<i>Scapharca subcrenata</i> and <i>Tegillarca granosa</i> (Cockle)		
	<i>Rapana venosa</i> (Rapa whelk)		
	<i>Mactra veneriformis</i> (Surf clam)		
	<i>Mactra chinensis</i> (Japanese clam)		
Criterion 5-B: commercially important (Value)	<i>Ruditapes philippinarum</i> (Short necked clam)	High level of total value (Won) sold in Korea from the 1960s to 2000s	
	<i>Rapana venosa</i> (Rapa whelk)		
	<i>Mactra chinensis</i> (Japanese clam)		
	<i>Haliotidae</i> species (Abalone)		
	<i>Atrina pectinata</i> (Pen shell)		

Adopted Common Criteria	Selected Indicator Species/Species Groups	Definition of Indicator Species	Definition of Ecologically Important Areas
	<i>Meretrix</i> species (Oriental hard clam)		
Criterion 5-C: commercially important (Unit price)	<i>Haliotidae</i> species (Abalone) <i>Rapana venosa</i> (Rapa whelk) <i>Cyclina sinensis</i> (Venus clam) <i>Meretrix</i> species (Oriental hard clam)	High level of unit price (Won/kg) in Korea from 1960s to 2000s	
Criterion 6: intact habitat / ecological processes	Not adopted	Not adopted	Not adopted

### Selected Indicator Species under Criterion 1: Representative species/ habitat types

#### Definition of Indicator Species under Criterion 1:

Dominant species with a wide range of distribution in the Yellow Sea.

#### Selected Indicator Species:

- 1) [Tellin] [*Nitidotellina nitidula*] [접시조개, Jeopsijogae]:

Reason for Selection:

*Nitidotellina nitidula* is a temperate species and lives in intertidal and shallow waters in Korea, representing a characteristic species at Sub-region 1 (G1) in the Yellow Sea (Je, 1993). Sub-region G1 retains low salinity (31.9~33.1‰), has coarse sediment, and has an average depth of 48.6 m.

- 2) [*Thyasira tokunagai*] [Japanese name: TOKUNAGA-HANASHI or HANASHI-GAI] (No information on English nor Korean name):

Reason for Selection:

*T. tokunagai* distributes in boreal and temperate shallow water of Korea, China and Japan. Sub-regions 1 (G1) and 2 (G2) are characterized by this species (Je, 1993). Low salinity prevails in these areas. In particular, a high abundance of this species was observed at the Yellow Sea cold-water mass in G2.

- 3) [Nut clam] [*Nucula paulula*] [작은호두조개, Jageunhodujogae] [Japanese name: MAMEKURUMI]:

Reason for Selection:

*Nucula paulula* is a temperate species and is a characteristic species of G2 of the Yellow Sea (Je, 1993). G2 has a similar environment to the Yellow Sea cold-water mass, showing low salinity, low temperature and fine sediment with high organic content. Habitat depth is 80.5 m on average.

- 4) [*Raetella pulchella*] [새개량조개, Swaegaeryangjogae] (No information on English name):

Reason for Selection:

*Raetella pulchella* is a temperate species and occurs as a characteristic species at Sub-region 4 (G4) in the Yellow Sea and a dominant species at Sub-region 3 (G3) in Korean coastal waters. G4 is located in the transition zone between the Yellow Sea cold-water mass and the Tsushima current water mass, and shows fine sediment with slightly high organic content. This species is distributed in Korea, China, Japan and Russia, and is very commonly observed in the muddy bottoms of sheltered waters (Kira, 1962).

- 5) [*Leptomya minuta*] (No information on English or Korean name):

Reason for Selection:

*Leptomya minuta* is a temperate species and occurs as a characteristic species in G4 of the Yellow Sea and is a dominant species at G3 in Korean coastal waters, just like *R. pulchella*.

6) [Yellow Sea button top shell] [*Umbonium thomasi*] [황해비단고둥, Hwanghaebidangodung]:

Reason for Selection:

*Umbonium thomasi* is a temperate species distributed mainly in the intertidal sand flats of the Korean west coast (Choi, 1986). Abundance of this species has been reported as high as 518 individuals/m<sup>2</sup> in the Jeju Island.

7) [*Potamocorbula* species cf. *laevis*] [쇠방사늑조개, Swaebangsaneukjogae] (No Information on English name):

Reason for Selection:

*Potamocorbula* cf. *laevis* is a temperate species and occurs with very high abundance in intertidal mudflat of estuary, e.g., Ganghwa and Saemangeum tidal flats (MOMAF, 2003).

8) [Surf clam] [*Macra veneriformis*] [동죽, Dongjuk]:

Reason for Selection:

*Macra veneriformis* is a subtropical species inhabiting in west and south intertidal sand flats of Korea. This commercially important species was caught in very large quantity in the 1970s and 1980s. They have recently decreased sharply due to loss of their main habitats, such as Songdo and Saemangeum tidal flats, by reclamation.

**Selected Indicator Species under Criterion 2: Endemism and unique species assemblages**

1) [Yellow Sea button top shell] [*Umbonium thomasi*] (황해비단고둥, Hwanghaebidangodung):

Reason for Selection:

*Umbonium thomasi* is only recorded in Korea and China as a unique species endemic to the Yellow Sea. This species occurs abundantly along the west coast of Korea and is rarely found along the southern coast. There is no record of them in Jeju Island. On the China side, Huanghai and the Bohai Sea are the habitats of *U. thomasi* (Huang, 1994).

2) [Mud bubble] [*Bullacta exarata*] [민챙이, Minchaengi]:

Reason for Selection:

*Bullacta exarata* inhabits in intertidal mudflat. Distribution of this species widely covers the west and south coasts of Korea, and covers the coast of China from the Bohai Sea to Hainan.



**Table 2 List of Selected Indicator Species under criteria 1-5C**

Selected Indicator Species	Adopted Common Criteria	Criterion 1: Representative species/habitat types	Criterion 2: Endemism and unique species assemblages	Criterion 3: Species of Special Concern	Criterion 5A: Commercially important (Volume)	Criterion 5B: Commercially important (Value)	Criterion 5C: Commercially important (unit Value)
<i>Nitidotellina nitidula</i>		X					
<i>Thyasira tokunagai</i>		X					
<i>Nucula paulula</i>		X					
<i>Raetella pulchella</i>		X					
<i>Leptomys minuta</i>		X					
<i>Potamocorbula cf. laevis</i>		X					
<i>Umbonium thomasi</i>		X	X				
<i>Mactra veneriformis</i>		X		X	X		
<i>Bullacta exarata</i>			X				
<i>Meretrix</i> species				X			X
<i>Scapharca subcrenata</i> and <i>Tegillarca granosa</i>					X		
<i>Ruditapes philippinarum</i>					X	X	
<i>Mactra chinensis</i>					X	X	
<i>Rapana venosa</i>					X	X	X
<i>Atrina pectinata</i>						X	
<i>Haliotidae</i> species						X	X
<i>Cyclina sinensis</i>							X

Note: X indicates that the species was selected under the corresponding criterion.

### Selected Indicator Species under Criterion 3: Species richness

#### Definition of Indicator Species under Criterion 3:

Among the areas with upper 20% of the total number of mollusk species number, those having more than 60 species can satisfy the criterion 3. ME (2002) and MOMAF (1999-2003) data were used to propose criterion 3. Although any indicator species is not selected, the important preservation area can be designated under this criterion.

#### Selected Site of High Species richness

- 1) Tidal Flats (MOMAF): The southern tidal flat of Ganghwa Island (Estuary, Gyeonggi-do), Yeoja Bay Tidal flat (Large Salt Marsh, Jeollanam-do) (Map 10)
- 2) Seashore (ME): Ui Island, Cheongsan Island, Daeheuksan Island, Soheuksan Island, (Jeollanam-do), Chuja Island, Shinyang (Jeju Island) (Map 10)

Ganghwa tidal flat extends to 87 km<sup>2</sup> between 126° 21~32' E and 37° 35~50' N. It has suffered pressure from metropolitan development in Seoul and Incheon. One example is the Incheon International Airport. It was constructed on a reclaimed tidal flat and threatens the biological diversity of this tidal flat.

Yeoja Bay tidal flat is located at 127° 20~37' E and 34° 30~59' N. Salt marsh is well developed at the innermost part of this bay.

Ecosystems with high species richness are usually located at untouched areas. However, most parts of the Korean coasts are affected by human development and untouched areas are rare. Natural coasts only exist at the islands off the south coast and Jeju Island.

The sampling size is critical to estimate species richness for comparative studies. Use of data and the criteria for comparison should be discussed further.

## **Selected Indicator Species under Criterion 4A: Species of Special Concern (depleted stocks)**

### **Definition of Indicator Species under Criterion 4A**

Species that decreased significantly in stock size were selected.

### **Selected Indicator Species**

- 1) [Surf clam] [*Mactra veneriformis*] [동죽, Dongjuk]:

Reason for Selection:

*Mactra veneriformis* was caught in large quantity in Saemangeum and Songdo tidal flat. Before 1990, clam from these two tidal flats amounted to more than 90% of the total domestic catch. Large scale reclamation projects have been conducted on these two tidal flats and this species sharply decreased since 1990 (Fig. 3). Songdo tidal flat disappeared with the completion of reclamation and the fate of Saemangeum tidal flat, where the construction of a sea dike was completed in April 2006, remains doubtful.

- 2) [Oriental hard clam] [*Meretrix* spp.] [백합, Baekhap]:

Reason for Selection:

Hard clams include *M. lusoria* and *M. petechialis* species. The unit price of *Meretrix* in Korea is as high as 5 US dollars per kilogram. The economic value of this species has motivated artificial farming since the 1960s, but production decreased dramatically since 1990. Jeollabuk-do, in particular, produced more than 80% of this species in Korea, which also decreased markedly in recent years (Fig. 3).

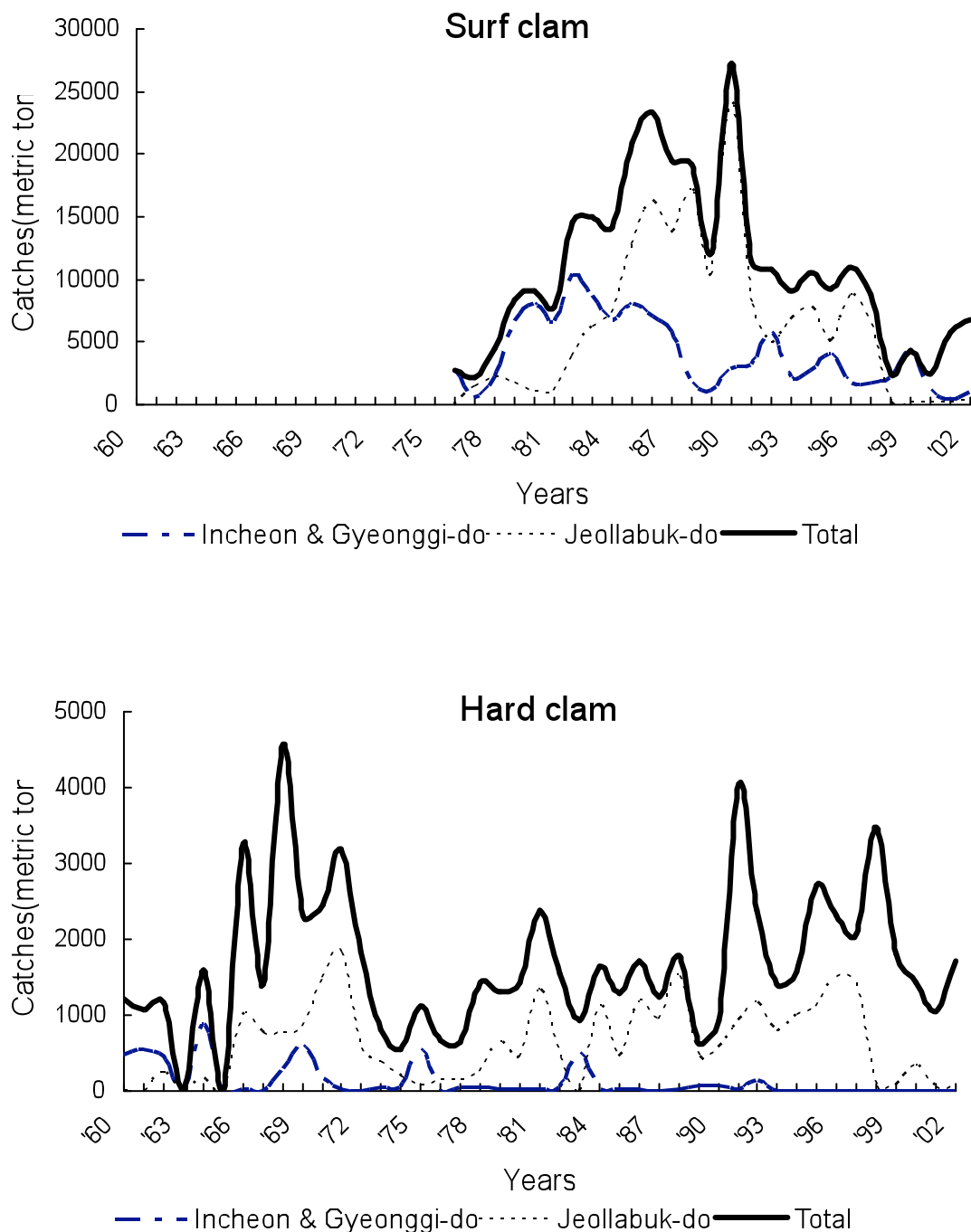


Fig 3. Long-term changes in annual harvest (unit: metric ton) of Surf clam (*Macra veneriformis*) and Oriental hard clam (*Meretrix* species) (adopted from Bureau of Fisheries, Ministry of Agriculture & Forestry, 1960-1983; Ministry of Agriculture & Forestry, 1984-1996; Ministry of Maritime Affairs & Fisheries, 1997-2004)

### Proposed Indicator Species under Criterion 5A: commercially important (Volume)

#### Definition of Indicator Species under Criterion 5A:

Molluskan species harvested in Korean coastal areas exclusive of cultured species, based on the total weight of catches recorded from official statistics. (Bureau of Fisheries, Ministry of Agriculture & Forestry, 1960-1983; Ministry of Agriculture & Forestry, 1984-1996; Ministry of Maritime Affairs & Fisheries, 1997-2004)

#### Selected Indicator Species

- 1) [Short necked clam] [*Ruditapes philippinarum*] [바지락, Bajirak]
- 2) [Cockle] [*Scapharca species* & *Tegillarca granosa*] [꼬막류, Ggomak-ryu]
- 3) [Rapa whelk] [*Rapana venosa*] [피빨고둥, Pippulgodung]
- 4) [Surf clam] [*Mactra veneriformis*] [동죽, Dongjuk]
- 5) [Japanese clam] [*Mactra chinensis*] [개랑조개, Gaeryangjogae]

Reason for Selection:

Indicator species were the highest ranked in domestic total weight of catches as follows:

1960's: Oyster (Ostreidae species), Short necked clam (*Ruditapes philippinarum*), Cockle (*Scapharca species* or *Tegillarca species*), Mussel (*Mytilus species*), Rapa whelk (*Rapana venosa*)

1970's: Japanese clam (*Mactra chinensis*), Short necked clam (*Ruditapes philippinarum*), Oyster (Ostreidae species), Mussel (*Mytilus species*), Rapa whelk (*Rapana venosa*)

1980's: Short necked clam (*Ruditapes philippinarum*), Surf clam (*Mactra veneriformis*), Oyster (Ostreidae species), Japanese clam (*Mactra chinensis*), Moon shell (*Glossaulax species*)

1990's: Oyster (Ostreidae species), Short necked clam (*Ruditapes philippinarum*), Surf clam (*Mactra veneriformis*), Rapa whelk (*Rapana venosa*), Japanese clam (*Mactra chinensis*)

2000's: Short necked clam (*Ruditapes philippinarum*), Oyster (Ostreidae species), Surf clam (*Mactra veneriformis*), Rapa whelk (*Rapana venosa*), Japanese clam (*Mactra chinensis*)

### Proposed Indicator Species under Criterion 5B: commercially important (Value)

#### Definition of Indicator Species under Criterion 5B:

Molluskan species harvested in Korean coastal areas were selected based on their total sales value in the domestic market.

#### Selected Indicator Species

- 1) [Short necked clam] [*Ruditapes philippinarum*] [바지락, Bajirak]
- 2) [Rapa whelk] [*Rapana venosa*] [피빨고둥, Pippulgodung]
- 3) [Japanese clam] [*Mactra chinensis*] [개랑조개, Gaeryangjogae]
- 4) [Abalone] [*Haliotidae species*] [전복류, Jeonbok-ryu]
- 5) [Pen shell] [*Atrina pectinata*] [키조개, Kijogae]
- 6) [Oriental hard clam] [*Meretrix species*] [백합, Baekhap]

Reason for Selection:

Selected indicator species are the highest in domestic total sales as follows:

1960's: Oyster (Ostreidae species), Cockle (*Scapharca subcrenata* or *Tegillarca granosa*), Abalone (*Haliotidae species*), Short necked clam (*Ruditapes philippinarum*), Mussel (*Mytilus species*)

1970's: Rapa whelk (*Rapana venosa*), Abalone (*Haliotidae species*), Ark shell (*Scapharca broughtonii*), Japanese clam (*Mactra chinensis*), Oyster (Ostreidae species)

1980's: Rapa whelk (*Rapana venosa*), Short necked clam (*Ruditapes philippinarum*), Pen shell (*Atrina pectinata*), Moon shell (*Glossaulax* species)

1990's: Rapa whelk (*Rapana venosa*), Short necked clam (*Ruditapes philippinarum*), Oyster (Ostreidae species), Pen shell (*Atrina pectinata*), Abalone (Haliotidae species)

2000's: Rapa whelk (*Rapana venosa*), Short necked clam (*Ruditapes philippinarum*), Oyster (Ostreidae species), Surf clam (*Macraa veneriformis*), Pen shell (*Atrina pectinata*)

### Proposed Indicator Species under Criterion 5C: commercially important (Unit price)

#### Definition of Indicator Species under Criterion 5C:

Unit price (value/weight) of molluskan species was also put into consideration to propose indicator species.

#### Selected Indicator Species

- 1) [Abalone] [*Haliotidae* species] [진복류, Jeonbok-ryu]
- 2) [Rapa whelk] [*Rapana venosa*] [피빨고둥, Pippulgodung]
- 3) [Venus clam] [*Cyclina sinensis*] [가무락, Gamurak]
- 4) [Oriental hard clam] [*Meretrix* species] [백합, Baekhap]

Reason for Selection:

Selected indicator species have the highest domestic unit price as follows:

1960's: Abalone (Haliotidae species), Ark shell (*Scapharca broughtonii*), Surf clam (*Macraa veneriformis*), Cockle (*Scapharca subcrenata* or *Tegillarca granosa*)

1970's: Abalone (Haliotidae species), Ark shell (*Scapharca broughtonii*), Pen shell (*Atrina pectinata*), Rapa whelk (*Rapana venosa*), Moon shell (*Glossaulax* species)

1980's: Rapa whelk (*Rapana venosa*), Short necked clam (*Ruditapes philippinarum*), Pen shell (*Atrina pectinata*)

1990's: Abalone (Haliotidae species), Rapa whelk (*Rapana venosa*), Ark shell (*Scapharca broughtonii*), Pen shell (*Atrina pectinata*), Venus clam (*Cyclina sinensis*)

2000's: Abalone (Haliotidae species), Pen shell (*Atrina pectinata*), Scallop, Venus clam (*Cyclina sinensis*), Rapa whelk (*Rapana venosa*)

- 1) [Short necked clam] [*Ruditapes philippinarum*] [바지락, Bajirak]:

Reason for Selection:

This commercial species is mostly produced from aquacultures where spats are introduced and raised, taking a large part of the catchment in Korean fisheries. It is distributed across the entire coastal waters of Korea, mainly in muddy sand or gravel mixed soft bottom from intertidal to shallow subtidal around at a depth of two meters. This species is a big catchment of the Korean fisheries.

- 2) [Rapa whelk] [*Rapana venosa*] [피빨고둥, Pippulgodung]:

Reason for Selection:

This commercial species is a representative in southern and western coast of Korea, mostly caught by hand, occurring densely near the Saemangeum area. It prefers to inhabit fine sand with mud, small pebbles, and rocky bottoms from lower intertidal to shallow subtidal areas around 10 m deep. Its price is high and is very profitable for fishermen.

- 3) [Japanese clam] [*Macraa chinensis*] [개량조개, Gaeryangjogae]:

Reason for Selection:

This commercial species shows a high production near the Saemangeum area, distributed along the southern and western coast of Korea. It inhabits sand or mud from lower intertidal to shallow areas around 10 m deep.

4) [Pen shell] [*Atrina pectinata*] [키조개, Kijogae]:

Reason for Selection:

This high-valued commercial species is distributed mainly Seongap Island, Chungcheongnam-do, Wi Island of west coast and in Gamak Bay, Yeoja Bay, Deungyang Bay and Namhae Island of the South Sea. (Hong *et al.* 2002) It prefers to inhabit in soft sandy and muddy soft bottoms from lower subtidal to subtidal areas at a depth of around 40 m.

5) [Japanesis cockle] [*Fulvia mutica*] [새조개, Saejogae]:

Reason for Selection:

This commercial species prefers to inhabit sandy and muddy soft bottoms at a depth of 6-30 m. It is distributed mainly Taean and Seosan regions of southern coast and also occurs Jangheung and Namhae regions of western coast of Korea. (Min *et al.* 2004)

6) [Abalone] [*Haliotidae* species] [전복류, Jeonbok-ryu]:

Reason for Selection:

This high-valued commercial taxon has been farmed in Korea since the 1970s. It prefers to inhabit rocky bottoms from lower intertidal to subtidal areas at around 30 m in depth. Recorded species in Korea include *Sulculus diversicolor diversicolor*, *S. diversicolor supertexta*, *Nordotis madaka*, *N. gigantea* and *N. discus discus*. *Sulculus diversicolor diversicolor*, *S. diversicolor supertexta* and *Nordotis madaka* are mainly distributed along the Jeju coast. And *N. gigantea* and *N. discus discus* distributes mainly in all part of Korean coast (Choe *et al.* 1999).

7) [Cockle] [*Scapharca subcrenata*, *S. broughtonii* & *Tegillarca granosa*] [꼬막류, Ggomak-ryu]:

Reason for Selection:

According to Korean fisheries statistics, three species are included in this taxon (*Scapharca subcrenata*, *S. broughtonii*, *Tegillarca granosa*). The most valued species is *S. broughtonii*. These species inhabit quiet muddy soft bottoms from intertidal to subtidal zones above 10 m in depth in enclosed bays. It distributes mainly in southern coast and western coast of Korea (Choe *et al.* 1999).

**MAPS AND DESCRIPTION OF ECOLOGICALLY IMPORTANT AREAS FOR COASTAL MOLLUSKS TAXONOMIC GROUP**

**Table 3 List of Maps and Area Names for Coastal Mollusk Ecologically Important Areas (CMEIA)**

Map	Indicator Species.	Area Numbers for Mollusk Ecologically Important Areas (refer to abbreviations)	
Map 1	<i>Nitidotellina nitidula</i>	G1	
Map 2	<i>Thyasira tokunagai</i>	G2	
Map 3	<i>Nucula paulula</i>	G2	
Map 4	<i>Raetella pulchella</i>	G2	G4
Map 5	<i>Leptomya minuta</i>	G5	
Map 6	<i>Potamocorbula</i> species	GH, SM, DA, YJ	3,17,18,20,
Map 7	<i>Umboonium thomasi</i>	GH, GR, SM, JI	2,4,5,8,9,13,16,17,18,19
Map 8	<i>Mactra veneriformis</i>	GH, GR, SM, DA, YJ	12,16,17,18,20
Map 9	<i>Bullacta exarata</i>	GH, GR, SM, HP, JI, AP	2,7,11,12,16,18,19,20,22,

Map 10	(60 species <) Species richness	GH,YJ	23,24,25,26,28,31,34
Map 11	<i>Ruditapes philippinarum</i>	GH,GR,SM,HP,JI,AP,DA, YJ	4,5,8,9,10,11,12,13,15,16,18,19,20,22,23,26,27,28,29,32,34
Map 12	<i>Scapharca</i> species & <i>Tagillarca</i> species	GH,HP,JI,DA, YJ,GJ	6,18,27,28,29
Map 13	<i>Rapana venosa</i>	DA	3,4,5,11,13,16,18,19,27,28
Map 14	<i>Mactra chinensis</i>	GH,GR,SM	1,4,9,13,15,19,21
Map 15	<i>Meretrix</i> species	GH,SM	16,17,18
Map 16	<i>Cyclina sinensis</i>	GH,SM,JI,AP, DA,YJ	10,11,12,19, 20,28,29
Map 17	<i>Atrina pectinata</i>	YJ, GJ	37, 38, 39, 40
Map 18	<i>Fulvia mutixa</i>	GJ	41, 42, 43

### Abbreviations for Table 3

AP: Aphae Island  
 DA: Doam Bay  
 GH: Ganghwa Island (Incheon Metropolitan City)  
 GR: Garorim Bay (Chungcheongnam-do)  
 GJ: Gangjin Bay (Gyeongsangnam-do)  
 HP: Hampyong Bay (Jeollanam-do)  
 JI: Jeung Island  
 SM: Saemanguem Area (Jeollabuk-do)  
 YJ: Yeoja Bay (Jeollanam-do)

1: Daecheong Island,	16: Hongwon,	31: Chuja Island,
2: Boleum Island,	17: Janghang,	32: Gimnyeong,
3: Oepo-ri,	18: Gyehaw Island,	33: Haengwon,
4: Deokjeok Island,	19: Gyeokpo,	34: Shinyang,
5: Seungbong Island,	20: Gomso,	35: Gosan,
6: Ul Island,	21: Yeonggwang,	36: Mara Island
7: Shinyoung-ri,	22: Musan,	37: Seongap Island
8: Hagampo,	23: Daeheuksan Island,	38: Wi Island
9: Shinjin Island,	24: Soheuksan Island,	39: Deungyang Bay
10: Ganweol Island,	25: Ui Island,	40: Gamak Bay
11: So Island,	26: Cheongsan Island,	41: Taean
12: Hyoja Island,	27: Boseong,	42: Seosan
13: Sapsi Island,	28: Goheung,	43: Jangheung
14: Nok Island,	29: Oenala Island,	
15: Daecheong Island,	30: Geomun Island,	

#### CMEIA for *Nitidotellina nitideula*. (Map 1)

Area Name: Sub-region 1 (G1)

Location: 35° 19'N ~ 36° 51'N, 124° 28'E ~ 126° 20'E

Description of Area: coarse sediment, low salinity (31.9~33.1‰) and seasonally fluctuating temperature.

#### CMEIA for *Thyasira tokunagai* (Map 2)

Area Name: Sub-region 2 (G2)

Location: 33° 51'N ~ 36° 51'N, 123° 28'E ~ 126° 50'E

Description of Area: cold bottom water mass of the Yellow Sea showing fine sediment, low salinity and seasonally constant temperature.

#### CMEIA for *Nucula paulua* (Map 3)

Area Name: G2

Location: 33° 51'N ~ 36° 51'N, 123° 28'E ~ 126° 50'E

Description of Area: cold bottom water mass of the Yellow Sea showing fine sediment, low salinity and seasonally constant temperature.

CMEIA for *Raetella pulchella* (Map 4)

Area Name: G2, G4

Location: 33° 31'N ~ 36° 49'N, 123° 28'E ~ 126° 19'E

Description of Area: This species is widely distributed in the Yellow Sea, especially near the coast (muddy sediment).

CMEIA for *Leptomya minuta* (Map 5)

Area Name: Sub-region 5 (G5)

Location: 32° 29'N ~ 34° 21'N, 123° 29'E ~ 126° 17'E

Description of Area: This species is widely distributed in the south sea of Korea and the East China Sea.

CMEIA for *Potamocorbula cf. laevis* (Map 6)

Area Name: All part of the Korean coast in the Estuary

Location: Incheon, Jeollabuk-do and Jeollanam-do

Description of Area: Habitat of this species is intertidal muddy bottoms in estuaries.

CMEIA for *Umbonium thomasi* (Map 7)

Area Name: Korean coast of the Yellow Sea

Location: Incheon, Chungcheongnam-do, Jeollabuk-do and Jeollanam-do

Description of Area: Habitat is intertidal muddy and sand bottoms.

CMEIA for *Mactra veneriformis* (Map 8)

Area Name: All part of the Korean intertidal coast

Location: Incheon, Chungcheongnam-do, Jeollabuk-do and Jeollanam-do

Description of Area: Habitat of the species is the muddy and sand bottoms in the intertidal zone.

CMEIA for *Bullacta exarata* (Map 9)

Area Name: All part of the Korean coast in the mud intertidal zone

Location: Incheon, Chungcheongnam-do, Jeollabuk-do and Jeollanam-do

Description of Area: Habitat of the species is the muddy and sandy bottoms in intertidal zones.

CMEIA for areas with high species number (more than 60 species) (Map 10)

Area Name: Korean southwest islands and Jeju Island

Location: Ganghwa Island, Jeollanam-do and Jeju Island

Description of Area: These areas maintain natural coasts undisturbed by human intervention. They exclusively include the southwest islands and Jeju Island.

CMEIA for *Ruditapes philippinarum* (Map 11)

Area Name: All part of the Korean coast

Location: All part of the Korean coast

Description of Area: This species is a commercially important bivalve in Korea and its habitat is the muddy sand and sandy mud bottom in intertidal and shallow subtidal zones.

CMEIA for *Scapharca subcrenata* and *Tegillarca granosa* (Map 12)

Area Name: south coast of Korea

Location: Jeollanam-do

Description of Area: These bivalve species are distributed in soft bottoms in lower intertidal and shallow subtidal zones

CMEIA for *Rapana venosa* (Map 13)

Area Name: west and south coast of Korea

Location: Incheon, Chungcheongnam-do, Jeollabuk-do and Jeollanam-do

Description of Area: This carnivorous gastropod species inhabits mainly in shallow subtidal hard bottom areas.

CMEIA for *Mactra chinensis* (Map 14)

Area Name: west coast of Korea

Location: Incheon, Chungcheongnam-do and Jeollabuk-do

Description of Area: The habitat of this species is mainly the subtidal sand-bottoms



CMEIA for *Meretrix* species (Map 15)

Area Name: the Korean west coast

Location: Incheon, Jeollabuk-do (Saemangeum Area)

Description of Area: Habitat of the species is intertidal and shallow subtidal sand-bottoms in the estuaries.

CMEIA for *Cyclina sinensis* (Map 16)

Area Name: All part of the Korean coast

Location: Incheon, Chungcheongnam-do, Jeollabuk-do and Jeollanam-do

Description of Area: This bivalve species inhabits mainly the intertidal sandy mud bottom.

CMEIA for *Atrina pectinata* (Map 17)

Area Name: west and south coast of Korea

Location: Incheon, Chungcheongnam-do, Jeollabuk-do, Jeollanam-do and Gyeongsangnam-do

Description of Area: This bivalve species inhabit in sandy mud soft bottom from lower subtidal to subtidal zones of around 40 m depth.

CMEIA for *Fulvia mutixa* (Map 18)

Area Name: west and south coast of Korea

Location: Chungcheongnam-do, Jeollanam-do and Gyeongsangnam-do

Description of Area: This bivalve species inhabit in sandy mud soft bottom at the depth of 6-30 m.

### Knowledge Gaps and specific studies needed for Coastal Mollusks

Though data regarding distribution of mollusks in Yellow Sea is scant, we tried to review several Korean reports published officially. Our report chose the number of species as an index for selecting ecological important areas. Since the number of species highly depends on sampling method and size, our results have limited implications for selecting important priority areas for protection.

We refer to three official reports, including Je (1993), MOMAF (1999-2003) and ME (1997-2003). We anticipate that more inventory and distribution data will be revealed through the 10-year research on Korean coastal waters launched in 2006 by the Korean government.

### References

#### Major three references:

- Je (1993): Soft Bottom of the Korean Seas
- ME (1997~2003): The Seashore of Korea
- MOMAF(1999~2003): Nine Tidal flats of Korea

#### - JE (1993):

This study was carried out to investigate the distribution patterns of mollusks inhabiting the soft bottoms of seas around Korea between 1983 and 1990. Samples were collected using the Smith-McIntyre grab and van Veen grab at 300 stations.

#### - ME (Ministry of Environment) (1997 - 2003):

This report was published as a result of the second research of the natural environment in Korea from 1997 through 2003. The coastal part of this report was used to write an inventory of mollusk species. Thirty-six sites were selected covering the western and southern parts of Jeollanam-do in Korea (see Map). Total 321 species of mollusks were found to occur at rocky and soft bottom shores by qualitative sampling.

#### - MOMAF (Ministry of Marine Affairs & Fisheries) (1999 – 2003):

This research has been conducted to collect distribution data of intertidal macrobenthos in the major tidal flats of Korea from 1999 through 2003 by the Korean Ministry of Maritime Affairs & Fisheries. Study areas included southern Ganghwa Island, Jangbong Island, Garolim Bay, Hampyeong Bay, Jeung Island, Aphae Island, Doam May, Yeoja Bay and Gangjin Bay. In total, 430 species of macrofauna were identified, among which 194 species were mollusks, 45 % of the total species found.

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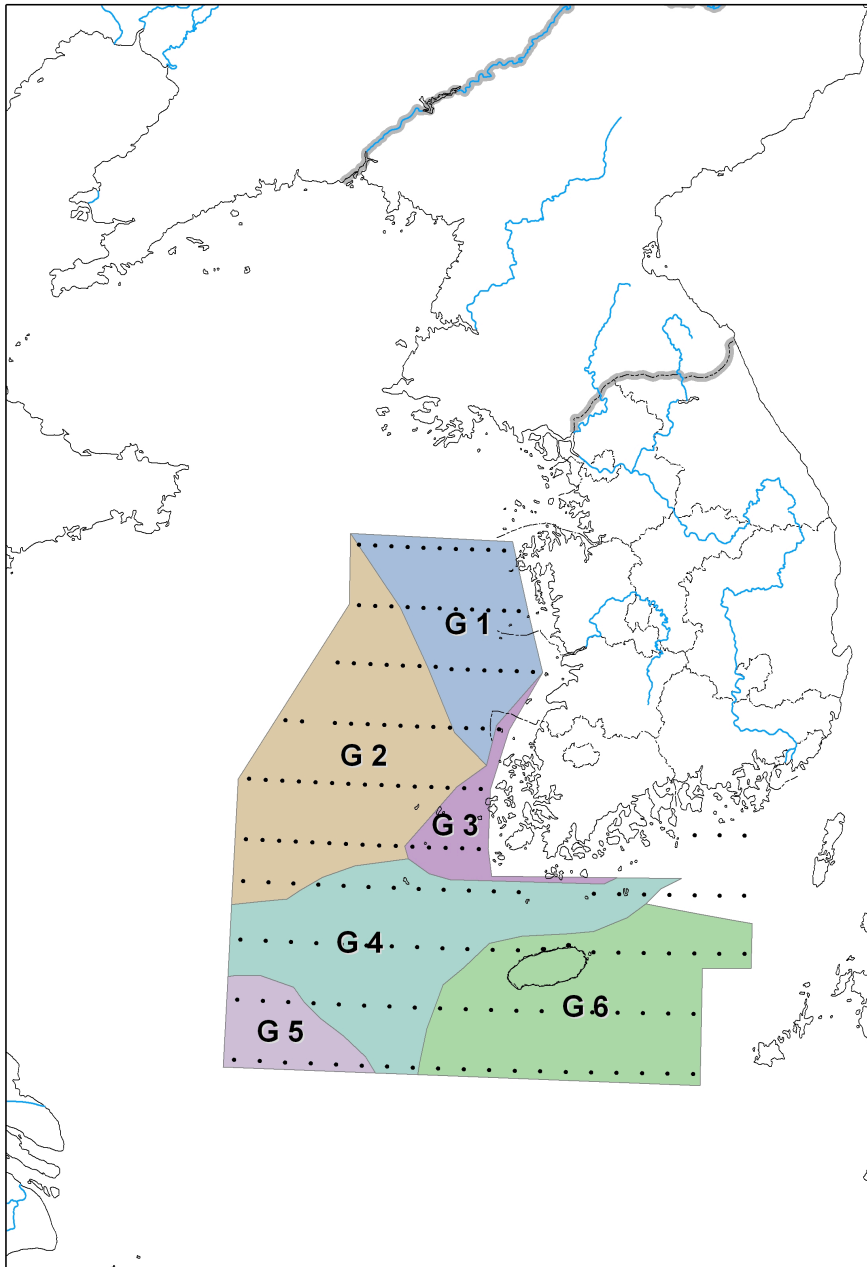


Fig 1. Stations of extensive field surveys on benthic mollusk distribution conducted in the Yellow Sea and the south sea of Korea, between 1983 and 1990 (Je, 1993). Samples were collected using either the Smith-McIntyre grab or the van Veen grab. Distribution of 6 station groups (G1-G6) classified on the basis of cluster analysis with benthic molluscan assemblage data (Je, 1993).

Area Name: The Yellow Sea and the south sea of Korea

Location: 32° 32'N ~ 36° 52'N, 123° 28'E ~ 128° 34'E

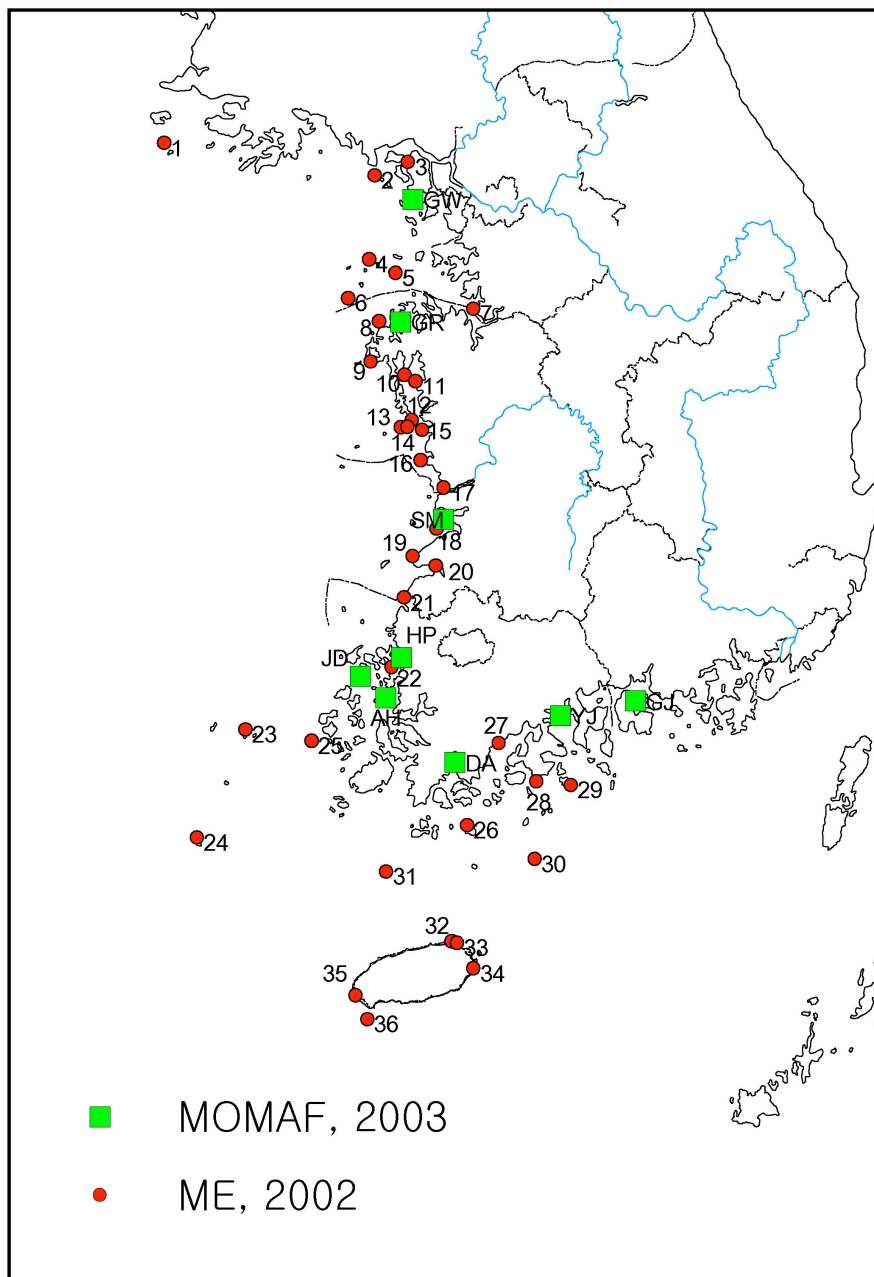
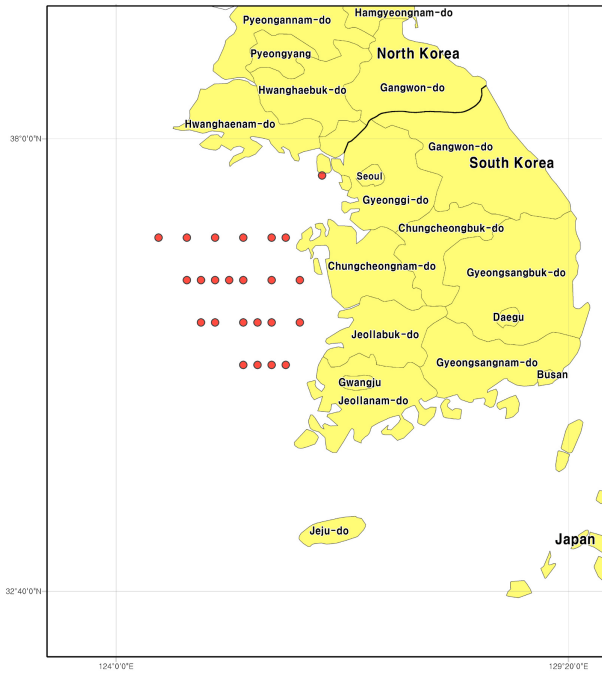


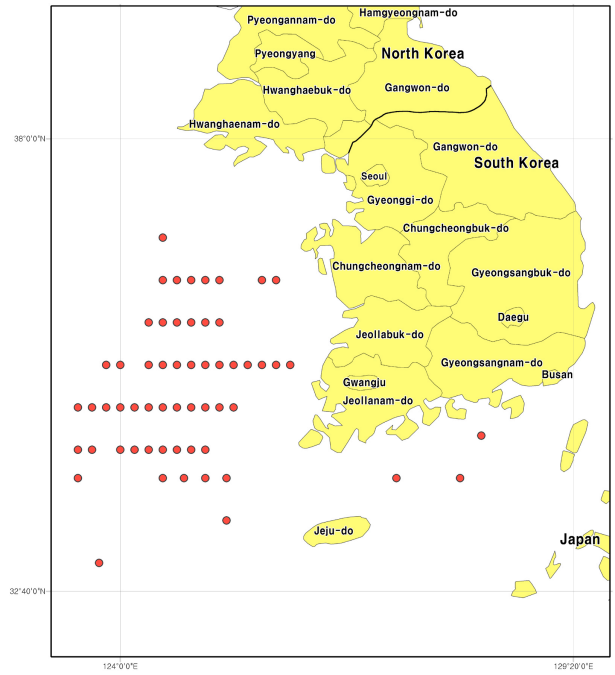
Fig 2. Sites of field investigations on benthic mollusk distribution in Korean coastal areas (MOMAF, 2003; ME, 2002).

Area Name: The west and south coast of Korea, tidal flats (9 sites) and seashores (36 sites)

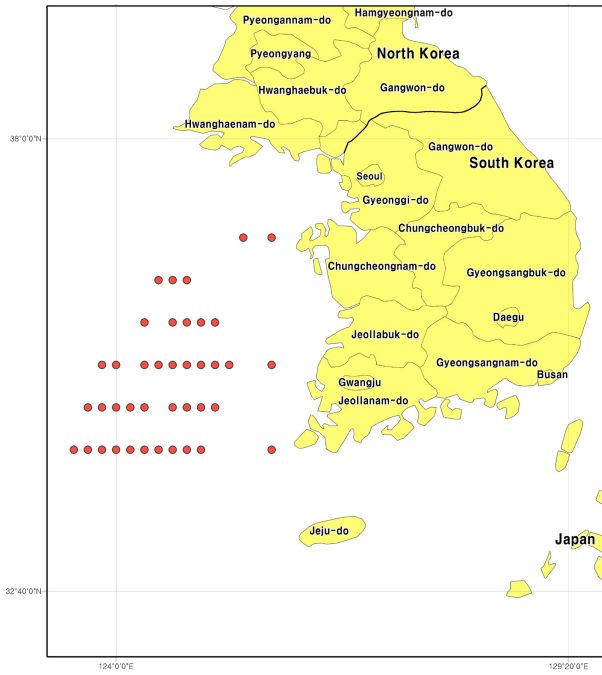
Locations: Gyeonggi Bay, Chungcheongnam-do, Jeollabuk-do, Jeollanam-do, Namhae Island (Part of Gyeongsangnam-do)



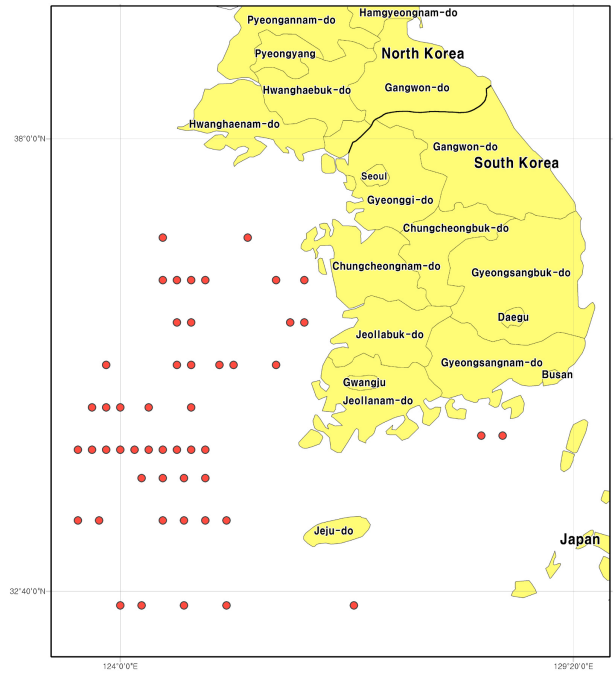
Map 1 *Nitidotellina nitidula*



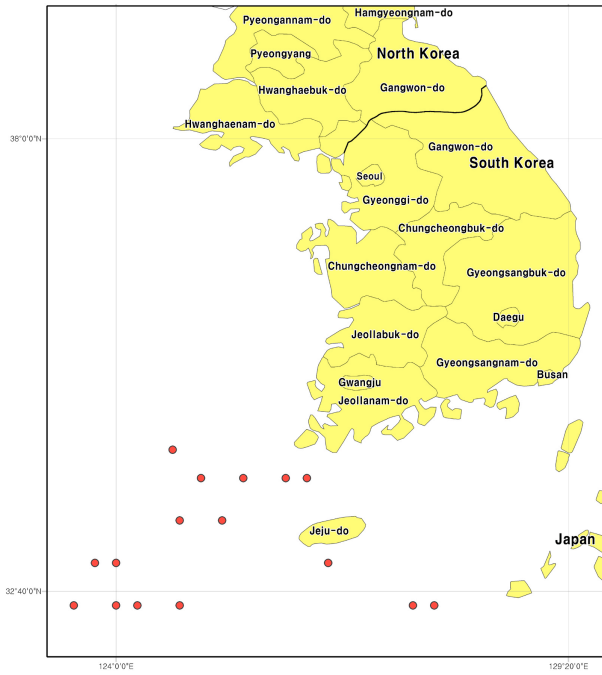
Map 2 *Thyasira tokunagai*



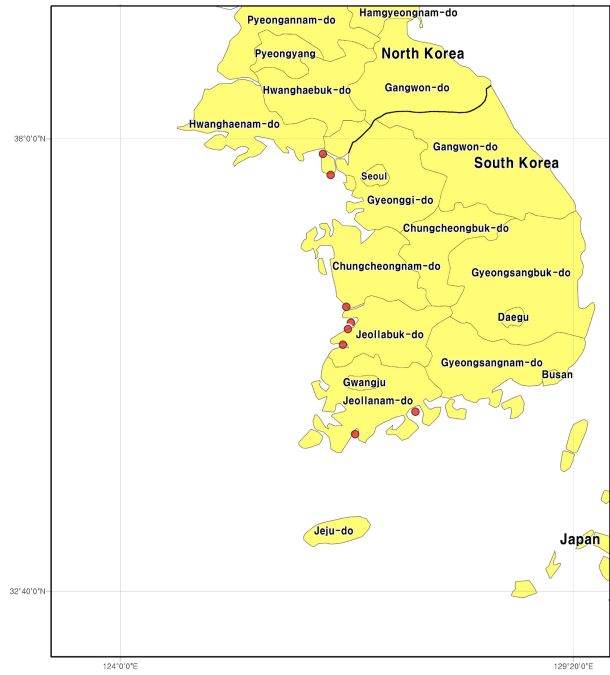
Map 3 *Nucula paulula*



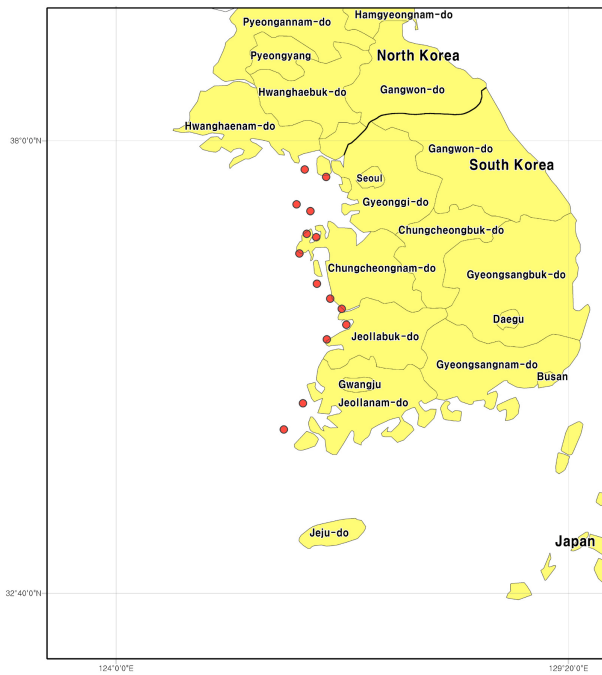
Map 4 *Rastella pulchella*



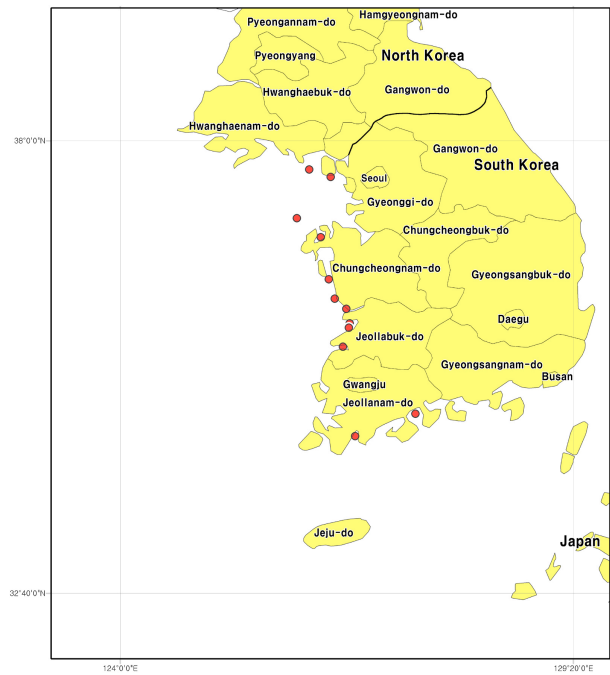
Map 5 *Leptomya minuta*



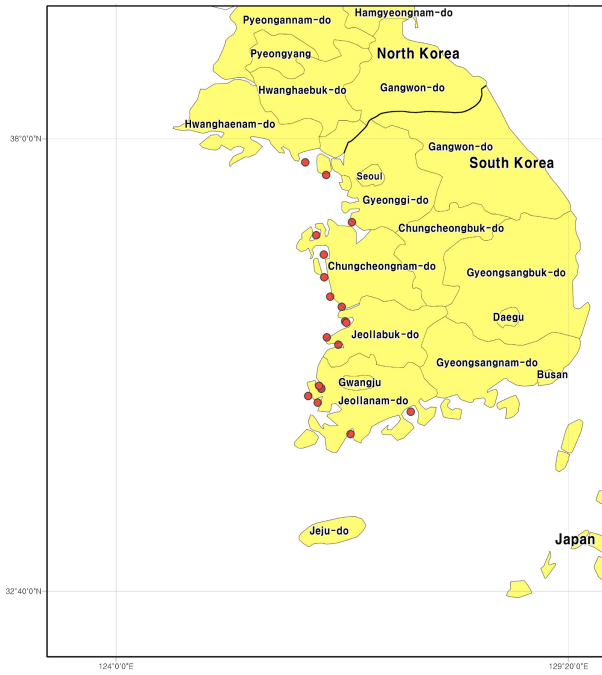
Map 6 *Potamocorbula* species



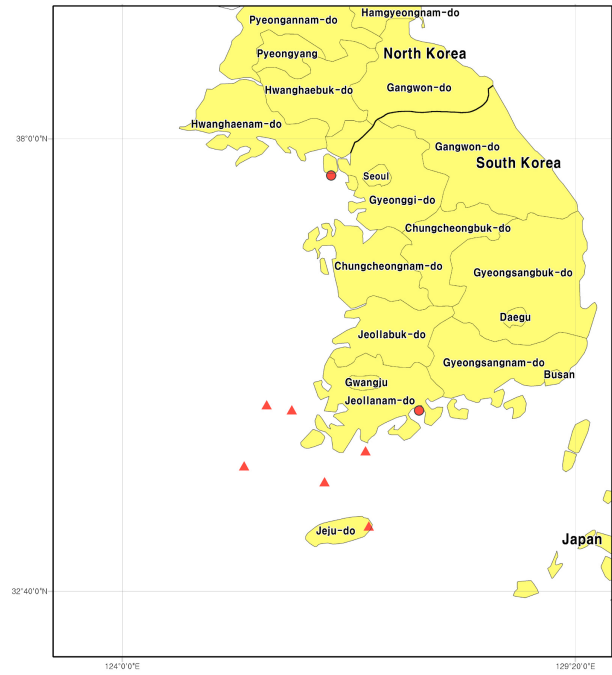
Map 7 *Umbonium thomasi*



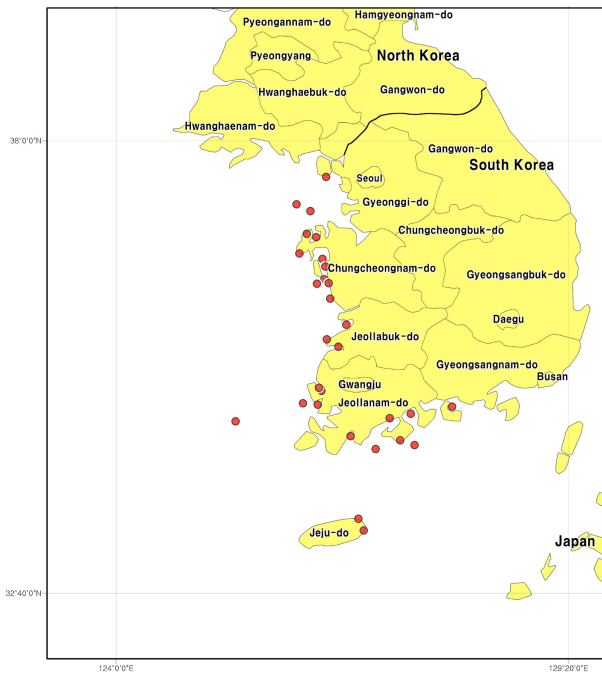
Map 8 *Mactra veneriformis*



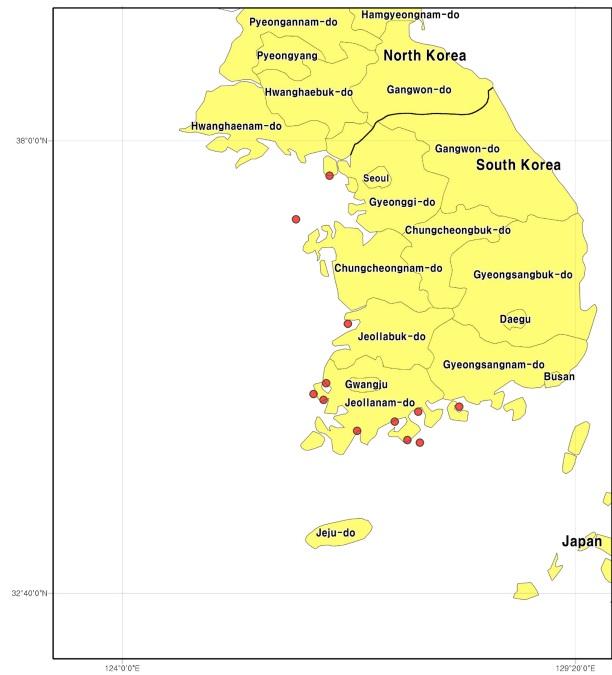
Map 9 *Bullacta exarata*



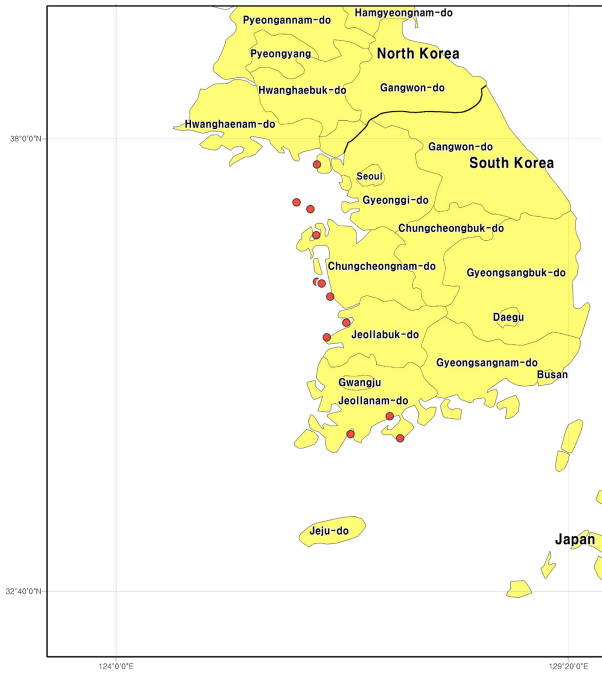
Map 10 (60 species <)Species richness



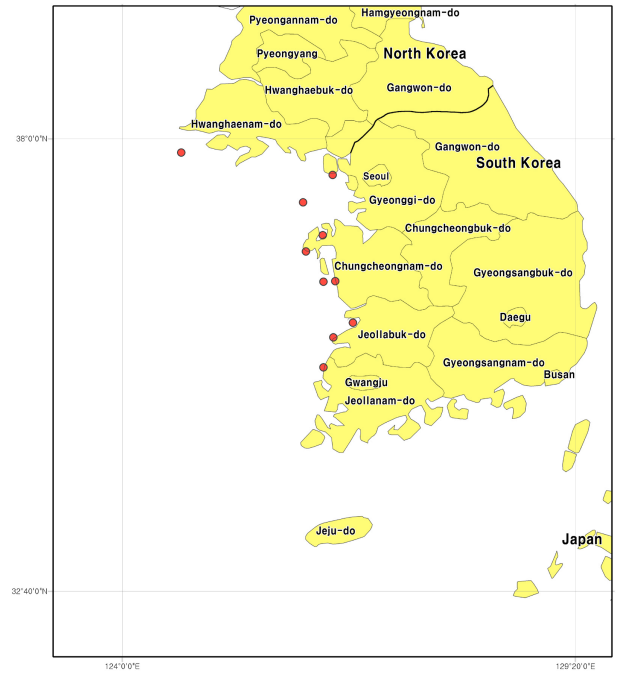
Map 11 *Ruditapes philippinarum*



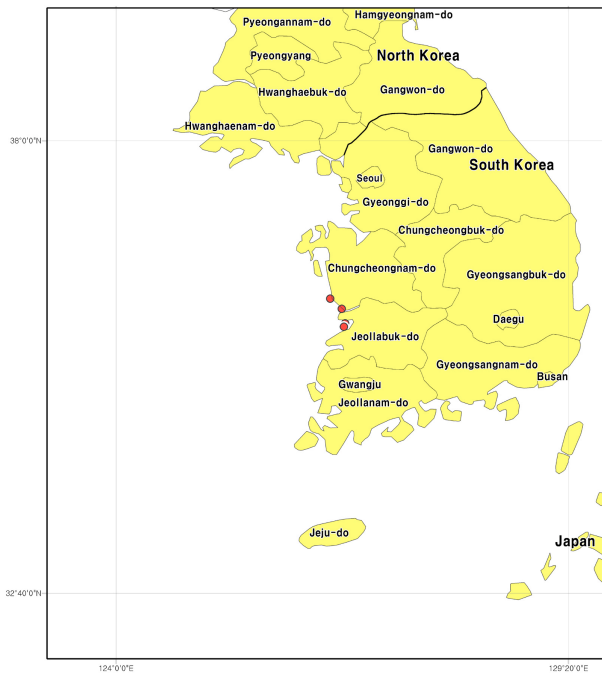
Map 12 *Scapharca* species & *Tagillarca* species



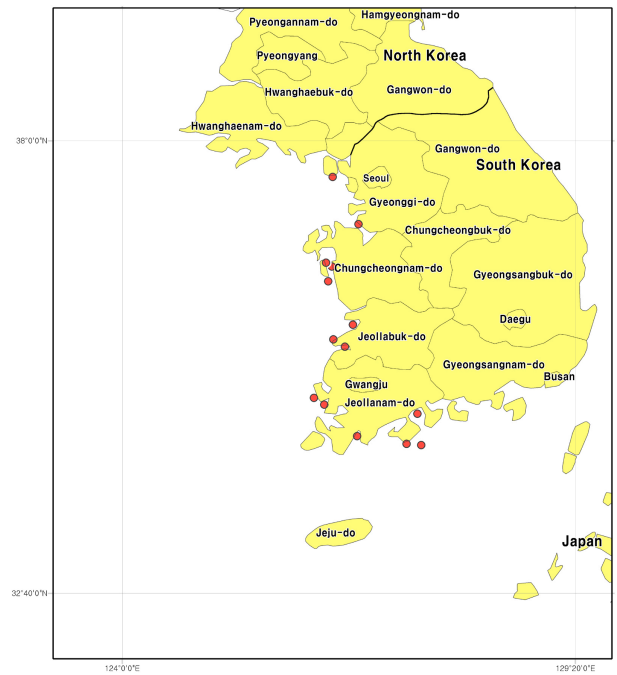
Map 13 *Rapana venosa*



Map 14 *Mactra chinensis*

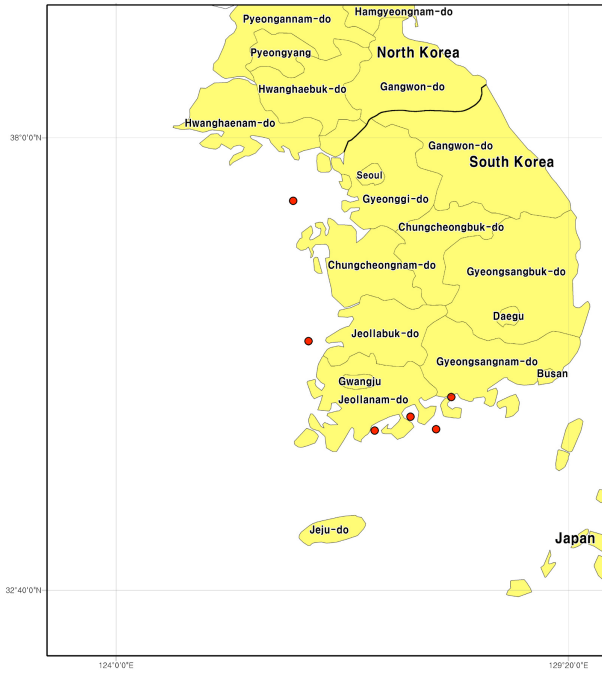


Map 15 *Meretrix species*

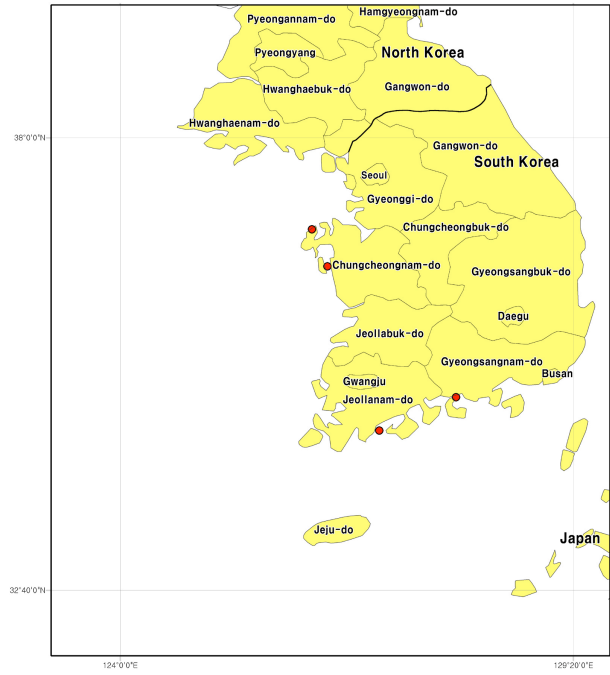


Map 16 *Cyclina sinensis*





Map 17 *Atrina pectinata*



Map 18 *Fulvia mutixa*