D-2-2-1 Food Chain Structure in the Offshore Benthic Communities

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Abstract

Food chain structure in the benthic communities were studied by the field survey carried out in the offshore region of San-in district and Yamato Bank, the Sea of Japan. Many kinds of organisms such as snow crab,pink shrimp,flatfishes,eelpouts and sculpin were obtained by the bottom trawl, and stomach contents of the dominant species of the benthic community were analyzed for estimating the predator-prey relationships. Detritus is important food sources in offshore bottom food chain, and small shrimp, gammarus, small squid are also play as food organisms in the communities.

Trophic levels were estimated by means of stable isotope ratios(^{15}N concentration). There were differences in the ^{15}N values of individual species within benthic organisms. Trophic levels are markedly higher in eelpout species which feed on fish and crustacean in San-in region, whereas in Yamato Bank bottom community, the large shrimps which fed on detritus show higher values in ^{15}N concentration.

Key Words food chain, bottom fish, offshore, bioaccumulation

1. Introduction

The concentrations of hazardous chemicals in sediments are higher than those in seawater. Sediments act as the source of pollutants in the marine environment. It is recognized that hazardous chemicals in sediments are accumulated in organisms by mainly two pathways; a direct uptake from seawater after the liberation from sediments and dietary uptake from sediments by the feeding behavior of benthic organisms.

Bioaccumulation characteristics through the benthic food chain are not studied in detail[1,2], therefore, it is an important research to demonstrate the contribution of hazardous chemicals in sediments to the concentration in organisms.

2. Research objective

The bioaccumulation of hazardous chemicals through the benthic food chain from bottom sediments in marine ecosystem are not studied in detail.

Food and feeding habits determine the position of organisms within food webs, and define their ecological role. The main purpose of this research is to demonstrate the benthic food chain structure and their trophic levels of the offshore bottom communities.

3. Research method

The surveys were carried out in the offshore region of San-in district and Yamato Bank, the central part of the Sea of Japan from 1998 and 1999(Fig. 1).

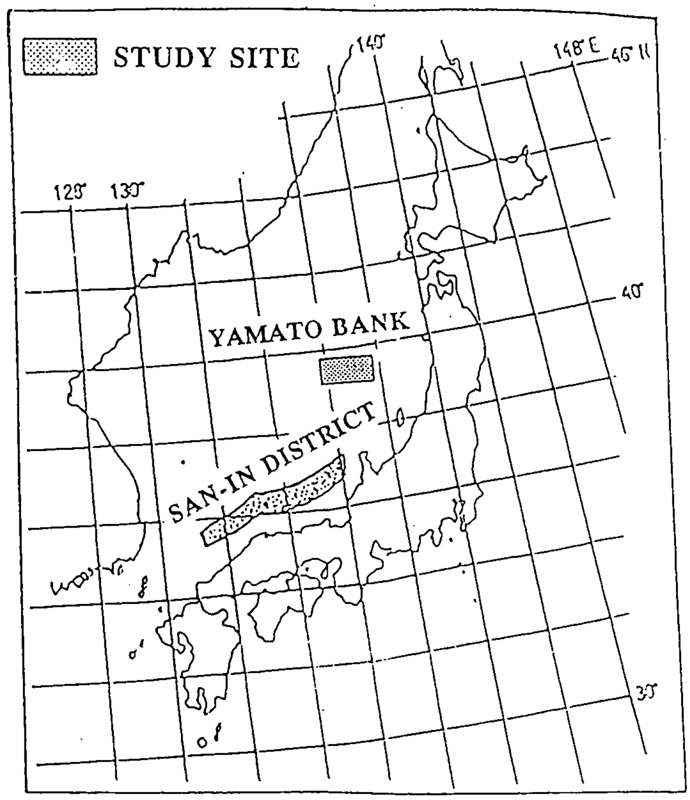

Figure 1. The study area and location of study sites in the Sea of Japan.

Sampling:

Several kinds of benthic organisms including fish, crustacean, bivalvia were caught by means of trawl net. The Smith-McIntyre grab was used for sampling for bottom sediment and benthic organisms. Samples for stomach content analysis were fixed in 10% formalin solution and preserved for later examination. Samples for ^{15}N stable isotope analysis were frozen and returned whole to the laboratory.

Stomach contents analysis:

In the laboratory, stomachs were cut open, and food items were sorted and identified to the lowest taxonomic levels as possible. Percentage of occurrence by prey item were calculated for each species.

Stable nitrogen isotope analysis:

All organisms sampled were freeze-dried, ground to a powder using mortar and pestle and kept frozen until analysis.

Samples for isotope analyses were prepared as described in Wada[3].

4. Results and discussion

Key species in the benthic community off San-in district were snow crab, *Chionoesetes opilio*; pink shrimp,*Pandalus eous*; other shrimps, *Argis toyamaensis*, *Eualus biunguis*; flatfishes,*Hippoglossoidesu dubius*, *Glyptocephalus stelleri*; sandfish,*Arctoscopus japonicus*; eelpouts,*Allolepis hollandi*, *Lycodes tanakai*, *Petroschmidtia toyamensis*; sculpin, *Malacocottus gibber*; and buccinum,*Buccinum tenuissimum*.

Stomach contents of the key species from San-in district were shown in Table 1. Piscivores were eelpout and blackedge eelpout, sculpin and flathead flounder fed on fishes and squid. Sandfish and poroushead eelpout fed mainly on gammarid, Korean flounder fed on polychaeta and ophuroid. Detritivores were snow crab,pink shrimp, Argid shrimp, Eualid shrimp and buccinum. Ophiuroid and polychaeta also important food items for pink shrimp and blackedge eelpout. Euphasid was food for sculpin, flathead flounder and sandfish.

Table 1. Diet composition th ekye species collected from San-in district(Occurrence %)

Species	Pisces	Squid	Crab;shrimp	Gammmarid	Euphasid	Polychaeta	Ophiuroid	Bivalvia	Detritus
Eelpout	26.7	23.3	26.7	26.7				16.6	
Blackedge eelpout	16.7	3.3	16.7	6.7	3.3	13.3	6.7	50.0	
Sculpin	6.7	6.7	30.0	50.0	16.7	6.7	3.3	26.7	
Flathead flounder	6.7	33.3	13.3	3.3	16.7			3.3	
Korean flounder				6.7		50.0	23.3	6.7	
Poroushead eelpout			16.7	66.7	6.70	3.3	3.3		
Sandfish				86.7	13.3				
Snow crab			13.3	13.3		3.3	3.3	3.3	100
Pink shrimp			13.3	16.7		16.7	6.7	6.7	100
Argid shrimp			3.3	13.3			3.3	16.7	100
Eualid shrimp								6.7	100
Buccinum									100

The δ ^{15}N values of main organisms ranged from 8.1‰(*Eualus biunguis*) to 13.8‰(*Lycodes tanakai*)(Fig. 2). Eelpout had the highest value in δ ^{15}N, Korean flounder and blackedge eelpout had relative higher δ ^{15}N values. Small shrimp(Eualid shrimp) and ophiuroid had relative lower δ ^{15}N values. The lowest value was observed in small pelagic fish(perlsides), which were important food for near bottom ecosystems.

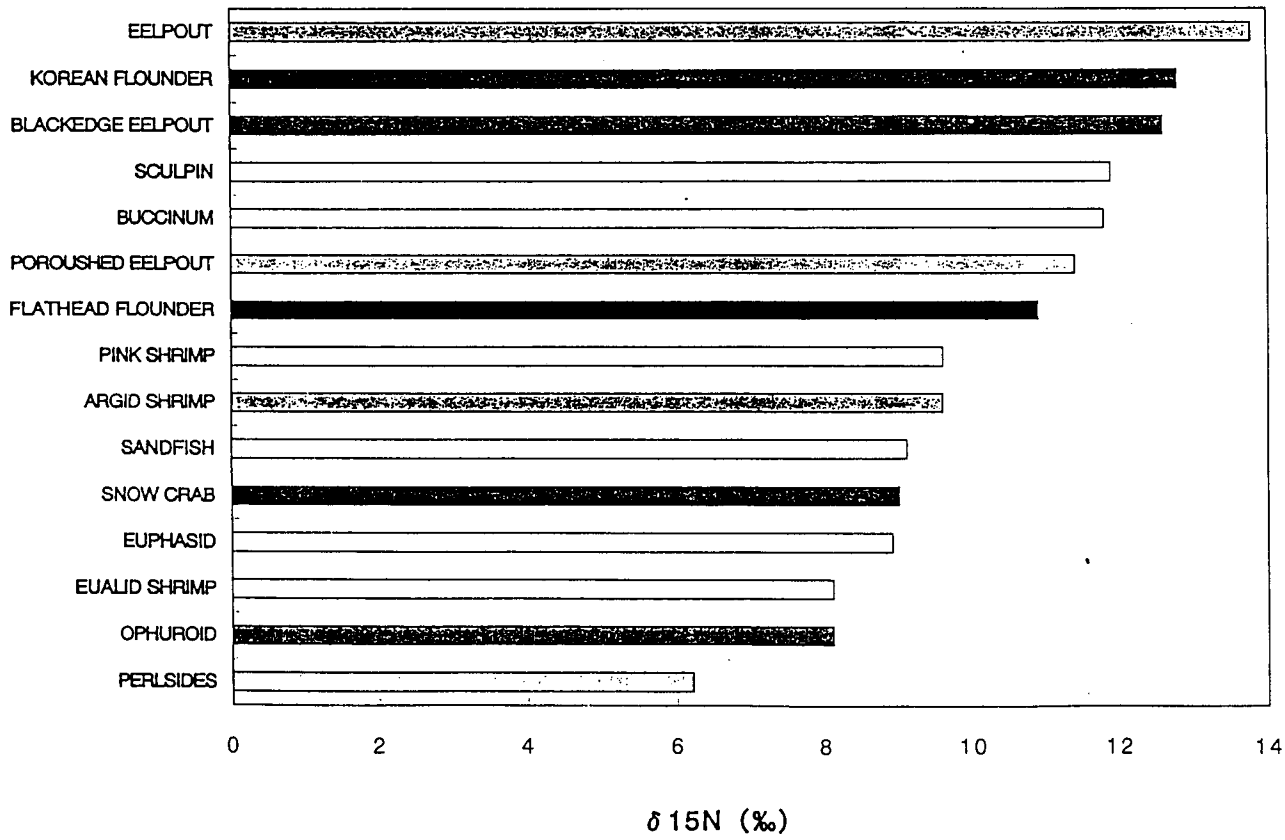

Figure 2. Average δ ^{15}N values of the dominant species off San-in district.

Schematic figure of food chain in offshore bottom communities of San-in district, the Sea of Japan were shown in Fig. 3. The trophic position of eelpout and sculpin were high in the bottton community off San-in district.

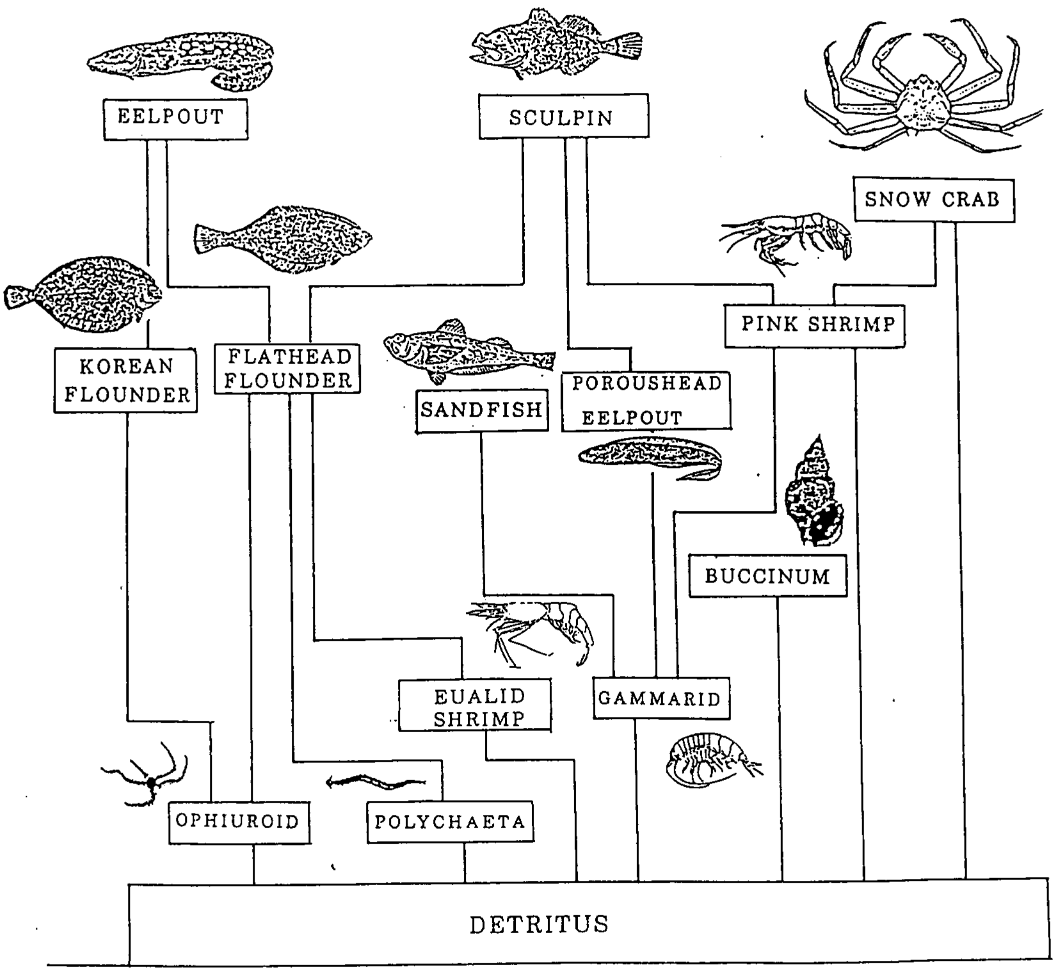

Figure 3. Schematic figure of food chain in bottom community off San-in.

Key species in the benthic community on Yamato Bank were snow crab, *Chionoesetes opilio*; pink shrimp,*Pandalus eous*; other shrimps, *Argis toyamaensis, Lebbeus longipes*; flatfishes,*Hippoglossoidesu dubius, Glyptocephalus stelleri*; *Acanthopsetta nadeshnyi*; eelpout,*Allolepis hollandi*; sculpin, *Malacocottus gibber*;skate,*Bathyraja smirnovi*; snailfish,*Careproctus trachysoma*, squids,*Berryteuthis magister, Enoploteuthis chunii*; and buccinum,*Buccinum tenuissimum*.

Stomach contents of the key species from Yamato Bank were shown in Table 2. Gammmarid was the dominant prey for snailfish, scalyeye flounder, small squid, skate, poroushed eelpout and sculpin. The other prey items of importance for skate were shrimp, squid, euphasid and fishes. Piscivores were skate,sculpin, poroushed eelpout,flathead flounder and scalyeye flounder. Skate, flathead flounder and poroushed eelpout fed on shrimp, gammmarid. Korean flounder fed on polychaeta, Flathead flounder fed on ophiuroid. Detritus feeder were pink shrimp, Argid shrimp, Lebbeus shrimp, snow crab and buccinum.

Table 2. Diet composition of the key species collected from Yamato Bank(Occurrence %)

Species	Pisces	Squid	Crab;shrimp	Gammmarid	Euphausid	Polychaeta	Ophiuroid	Bivalvia	Detritus
Sculpin	10.0	6.6	40.0	56.6	33.3	13.3	3.3	10.0	
Poroushed eelpout	6.6		16.6	76.6	13.3	3.3	3.3		
Skate	13.3	16.6	26.6	93.3	13.3				
Large squid	30.0	16.6	6.6	40.0	10.0				50.0
Small squid				73.3	40.0				
Flathead flounder	6.6	3.3	16.6	3.3	3.3	3.3	86.6	3.3	
Korean flounder	3.3			3.3		50.0	23.3		
Scalyeye flounder	6.6	6.6	13.3	63.3	23.3		3.3	6.6	
Snailfish			6.6	93.3	66.6				
Sandfish				90.0	10.0				
Pink shrimp			3.3	3.3		13.3	6.6	6.6	100
Argid shrimp			3.3	10.0			3.3	10.0	100
Lebbeus shrimp								6.6	100
Snow crab			3.3	13.3		3.3	3.3	3.3	100
Buccinum									100

The δ ^{15}N values of main organisms ranged from 9.4‰(*Lebbeus longipes*) to 14.5‰(*Argis toyamaensis*). Sculpin(*M.gibber*) and flatfish(*G.stellatus*) have relative high values in δ ^{15}N, and their stomach contents showed piscivores. The highest δ ^{15}N value was observed in Argid shrimp whose stomach contents were mainly detritus. Among detritus feeder, buccinum and snow crab had relative higher δ ^{15}N values, pink shrimp and Lebbeus shrimp had lower δ ^{15}N values. Ophuroid had lowest δ ^{15}N value among the bottom organisms.

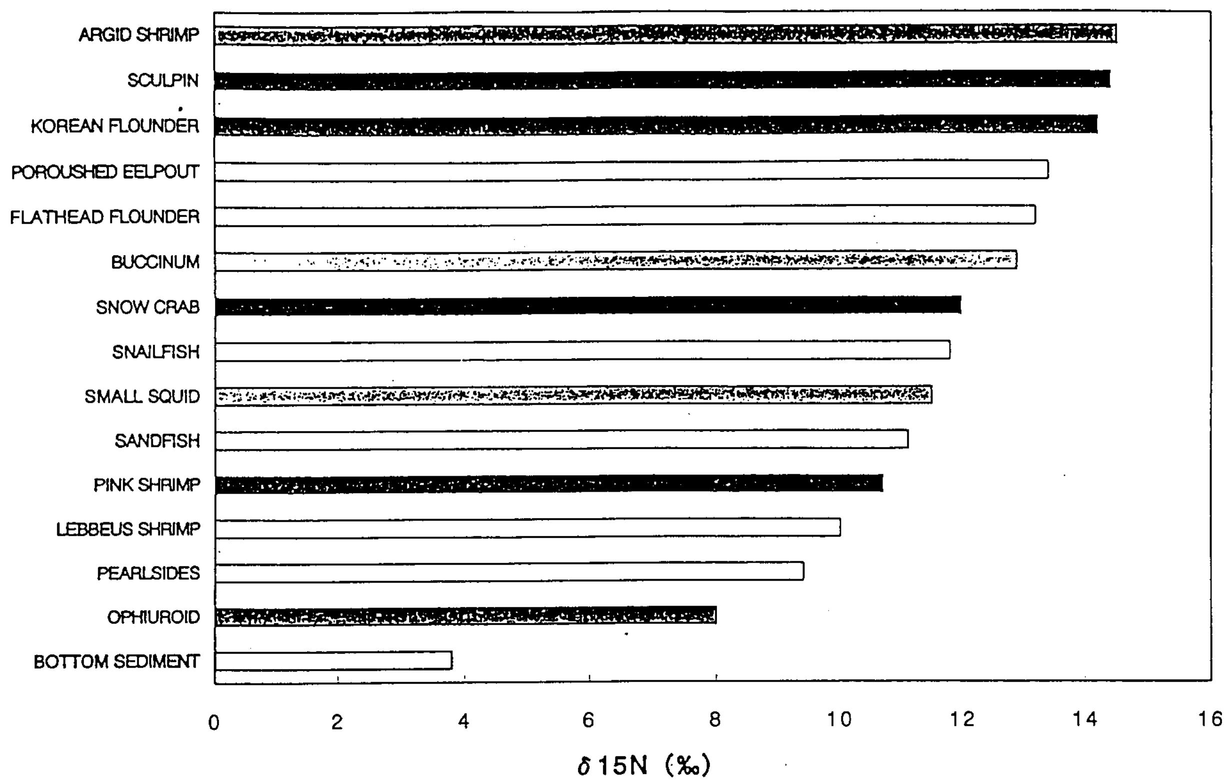

Figure 4. Average δ ^{15}N values of the dominant species on Yamato Bank.

Schematic figure of food chain in bottom communities on Yamato Bank, the Sea of Japan were shown in Fig. 5.

Food chain in two regoinal bottom communities were reratively different from each other on the factors such as species composition, dominant prey organisms and food chain complexity. But, in the every bottom food chain, detritus on or in the bottom sediment may be important factors for lower trophic level production.

Gut content data provides a snapshot of the diet of study population, but will not provide estimates of food web structure and trophic position, unless the diet of their prey are specifically studied as well. Interpreting δ ^{15}N signatures of higher consumers, relative to an appropriate baseline signature, can provide time-integrated depictions of trophic structure.

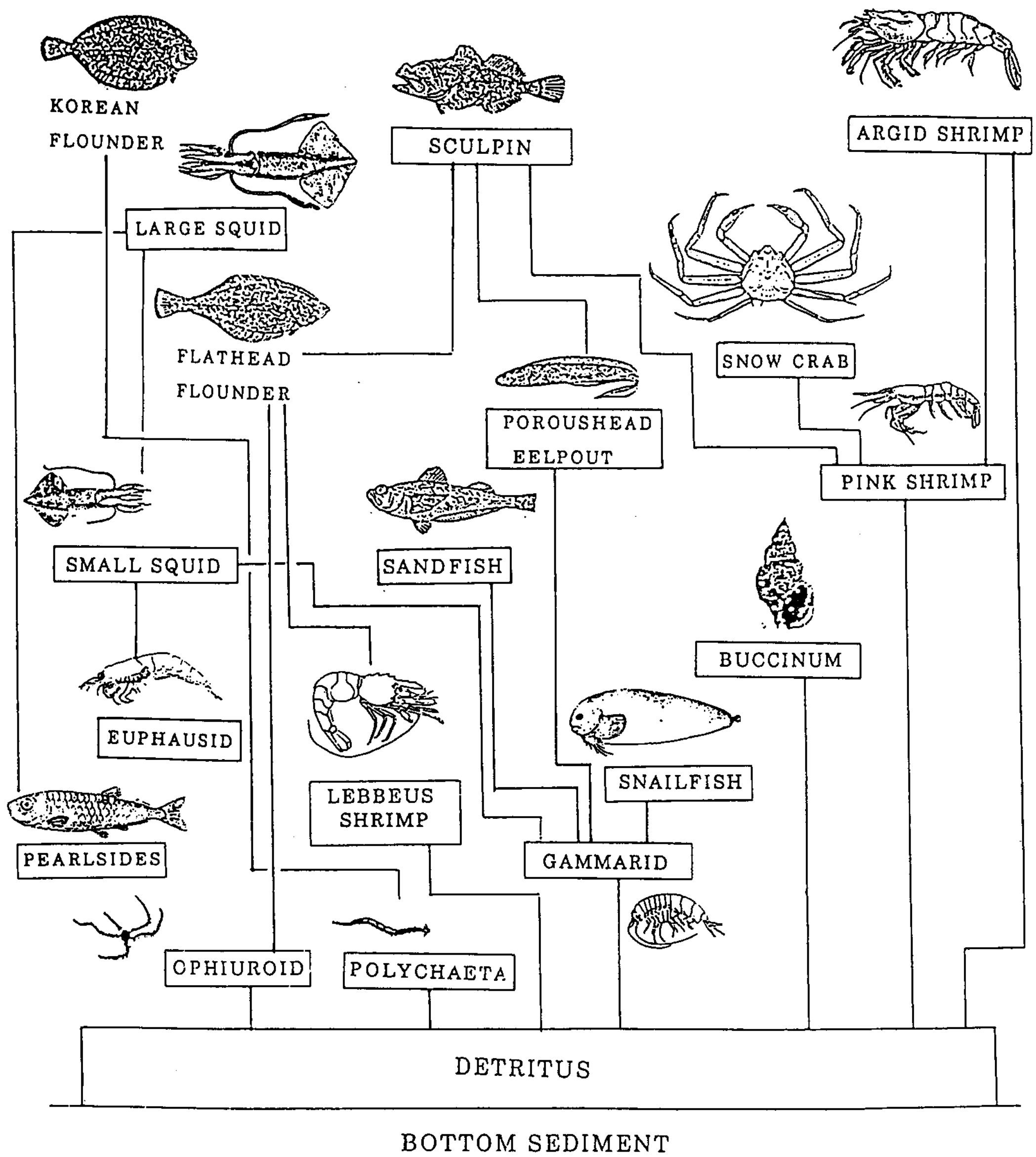

Figure 5. Schematic figure of food chain of the bottom on Yamato Bank.

6. References

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