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The Distribution and Feeding Characteristics of Some Dominant Polychaetes in the Continental Shelf of the East Sea, Korea

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東海 大陸棚에 分布하는 主要 多毛類의 棲息地 環境

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Abstracts

This study was carried out for appreciable information on the proper habitats and feeding modes of some dominant polychaetes in the continental shelf of the East Sea during April, 1985. Among 95 polychaete species, we selected 9 dominant species in terms of their occurring frequency, abundance and population density. These are *Terebellides stroemi, Chaetozone setosa, Magelona japonica, Ampharete arctica, Aglaophamus sinensis, Nothria holobranchiata, Lumbrineris japonica, Myriochele gracilis, Notoproctus pacificus.* Major food items of these species are centric diatoms and detritus. The feeding modes of the them are mainly surface or subsurface deposit feeding, though two species, *N. holobranchiata* and *L. japonica*, could be assumed to be potential carnivores. To a certain degree, most deposit feeders in the coarse sediments showed selectivity in feeding and tube building. The feeding mode, gut content and the tube structure, and the distribution pattern of dominant polychaetes correspond well with the habitat characters, e.g. the bottom topography, the source of food and the sediment composition.

요약 : 본 연구는 한국 동해 대륙붕에 출현하는 주요 저서 다모류의 서식지 환경에 대한 정보를 얻기 위해 1985년 4월에 수행되었다. 총 95출현종 중 조사 지역에서의 출현빈도, 출현량 또는 개체군 밀도에 있어서 중요한 우점종들로는 ***Terebellides stroemi, Chaetozone setosa, Magelona japonica, Ampharete arctica, Aglaophamus sinensis, Nothria holobranchiata, Lumbrineris japonica, Myriochele gracilis, Notoproctus pacificus*** 등 9개 종이다. 이들 우점종의 주된 먹이는 규조류와 기타 유기파편들로 구성되었으며 식이형에 있어서는 표층하 퇴적물 식자(subsurface deposit feeder)와 표층 퇴적물 식자(surface deposit feeder)에 속하는 종들이 대부분이다. 육식자로 간주되는 ***N. holobranchiata***와 ***L. japonica***의 경우에도 그들의 내장 내용물이 세립질 퇴적물로 구성된 경우가 많다. 사질 또는 역질의 조립질 퇴적물이 우세한 환경에 서식하는 관서 다모류는 내장이 매우 세립질의 퇴적물로 채워져 있고, 또한 그들의 서관도 서식지 퇴적물에 비해 세립질의 입자들로 구성되어 있다. 이러한 사실들은 이들 다모류가 식이와 서관 형성에 있어서 어느 정도 선택성을 가지고 있음을 시사한다. 주요 우점 다모류의 식이형, 먹이 내용물, 서관의 구조와 지역적인 분포 양상은 동해 대륙붕에서의 서식지 환경 특징인 해저지형 구조 또는 수심, 먹이의 공급원, 퇴적환경의 에너지 분포에 의한 퇴적물 입도 조성등과 잘 일치됨을 보여 준다.

INTRODUCTION

The food of benthic organisms has been a primary concern in the biological and ecological researches (Hunt, 1925; Sanders, 1958; etc). Therefore the information on the feeding modes of benthic animals related with their food is inevitably required for the

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analytic or synthetic study of a marine bethic community. Many studies on this parameter were conducted from early this century (Blegvad, 1914; hunt, 1925; Yonge, 1928).

Polychaetes were frequently reported to be major benthic fauna in the soft bottoms of estuarine bays of Korean peninsula (Lee, 1976; Yi et al., 1982; Choi and Koh, 1984) and of other regions (Sanders, 1958; Young and Rhoads, 1971; Zarkanellas and Kattoulas, 1982). These polychaete worms also occupied a main component of soft bottom faunal communities in the continental slopes (Jumars and Fauchald, 1977) and in the deep sea (Hessler and Jumars, 1974; Sanders and Hessler, 1969). Thus the general information on the feeding guilds of polychaetes could be a basis to make any sort of predictive statements about the marine benthos at any level (Fauchald and Jumars, 1979). However, for directly relating the benthic community structure to their environments, it will be also necessary to get other information on some biological and ecological characteristics of major benthic animals at species level, especially in the case of our study area where any study has not yet conducted.

This study is a part of investigations on the oceanographical processes in the boundary region of the various water masses on the southern waters of the East Sea, for which a survey cruise, coworked with geological oceanographer, was performed in April, 1985. Our interest was first focused on the habitat characteristics of the polychaete worms represented by main animal group within benthic community. The purpose of this study is to gather information on the proper habitat conditions and feeding adaptations of some dominant polychaetes in the shelf of the East Sea, Korea. We attempted to describe and relate some biological features such as food and feeding modes with the distribution patterns and habitats of dominant polychaete species. These dominant species were selected by following criterial; 1) species showing high frequency, 2) species occurred with high density, 3) species occurred at some restricted regions.

STUDY AREA AND SAMPLE COLLECTION

The study area is located in the southwestern part of the East Sea (between 36°00 N and 37°30′ N latitude) and covers approximately 6500 km² (Fig. 1). In the central region of the study area, Jugbyeon-Youngdeog marine ravine is located (36°20′N-37°10′N) and this ravine system is unique to the east coast of Korea (Park and Lee, 1985). Based on the presence of this marine ravine, the shelf can be divided into innershelf area to the west and outershelf area to the east of the ravine.

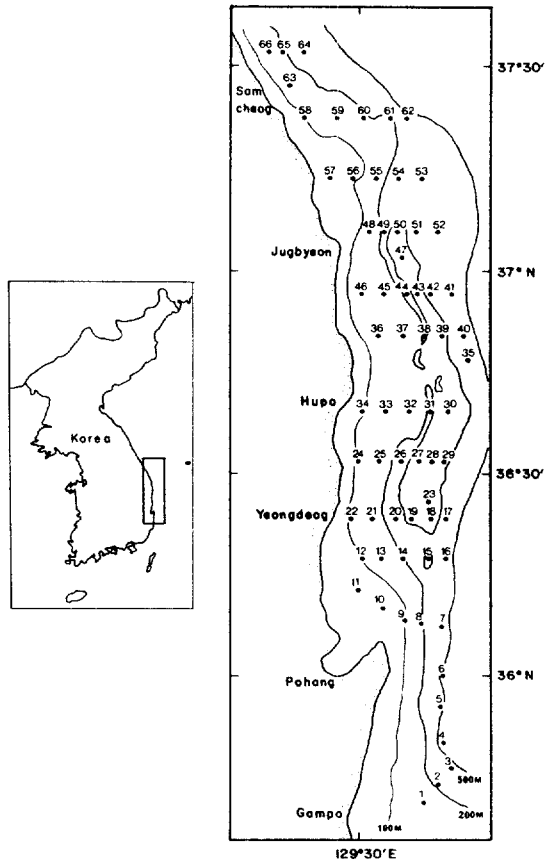

Fig. 1. A map showing study area and sampling stations. Polychaetes treated in this study were from st. 7 to st. 66.

Shallow innershelf area is a protected nearshore environment characterized by low energy. The sediments of this area mainly consist of fine grains. However, shallow outershelf area is represented by the high energy and shallow nearshore barrier environment, and comprises higher proportion of sand grains and gravels which are relict in origin. As narrow and deep boundary area, the marine ravine is represented by low energy and back barrier deep embayment, and shows fine or mixed sediments (Park and Lee, 1985).

Thus under the assumption that this unique ravine morphology in the East Sea shelf will impact significant effects on the distribution of marine polychaetous annelids, we selected total 59 sampling stations (Fig. 1) and investigated the polychaetes occurred in this area to detect the effects of shelf morphology on the benthic animal distribution. The single or duplicated samples were taken with a 0.1m improved Van Veen grav and the sediments hauled were sieved through 1 mm mesh screen with sea water. The residuals in the screen were fixed with 10% buffered formalin. The polychaetes were sorted and identified into species or genera level. Some biological features of polychaetes such as feeding modes, mobility and food, and habitat position were checked.

RESULTS AND DISCUSSIONS

Characteristics of species composition

The marine polychaetes collected in the study area comprised 72 genera and 95 species included in 35 families. Among these families, the maldanids possessed the most diverse species and 16 species were included in this family. Other families such as lumbrinerids, ampharetids, phyllodocids, spionids, and terebellids also contained 5 to 7 species. These 6 families comprised about the half of total polychaete species. The abundance of polychaetes was also concentrated in a few families. Cirratulids and lumbrinerids each accounted for 13% of total individuals, and maldanids, nephtyids, trichobranchids, ampharetids, onuphids, and magelonids were main contributors of polychaete abundance. These 8 families accounted for 64.4% of total specimens.

The most dominant species in the study area was *Terebellides stroemi* (Fam. Trichobranchidae) which occurred at 46 stations (78% frequency) and occupied 9.0% of total polychaete individuals. *Aglaophamus sinensis, Ampharete arctica, Lumbrineris japonica, Nothria holobranchiata, Chaetozone setosa* were also dominant species which not only occurred over broad area but also showed rather higher population densities. *Magelona japonica* and *Notoproctus pacificus, Myriochele gracilis*, even though occurred only at some restricted area, showed very high population densities.

The stations with the highest species richness were St. 39 and St. 57, whereas the least species richness was shown at St. 11. The station with the most abundant individual was St. 10 where the mean density of polychaetes reached 2,020 indiv./m^2, and the next was at St. 57 with the density of 1,030 indiv./m^2. Overall mean density of the study area was 394 indiv./m^2.

Habitat Conditions and Feeding Modes of Dominant Species

Terebellides stroemi

T. stroemi is a cosmopolitan species (Hartman, 1969). This specie was the most abundant and frequently met species in the study area, and showed higher population density at Jugbyeon - Yeongdeog marine ravine than at other regions (Fig. 2 a). The maximum density of this species was 180 indiv./m^2. *T. stroemi* occurred at all sediment types, but sandy sediments or gravely sandy sediments were in-

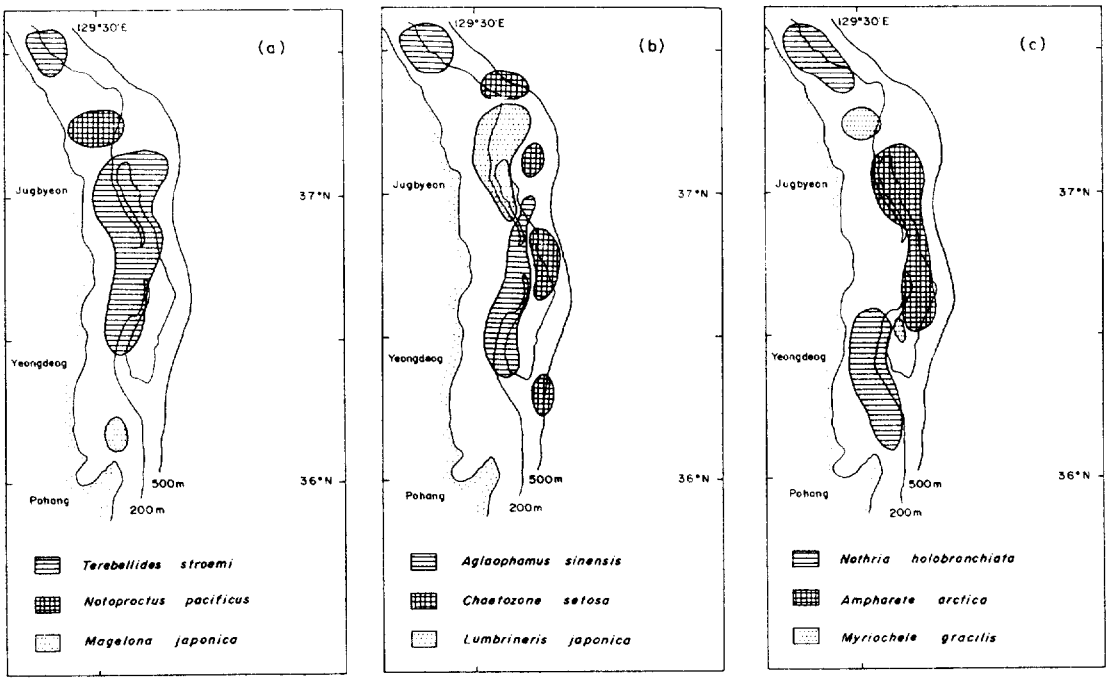

Fig. 2. Distribution area of dominant polychaetes occured with more than 50 indiv./m² in the East Sea shelf.

habited by very low population density. In other shallow coastal waters of Korea, this species also shows rather higher density at finer sediments or rarely mixed sediments than coarse sediments such as sand or gravely sand (Choi and Koh, 1984; pers. obs.). It seems that *T. stroemi* prefers to finer sediments than coarse sediments.

T. stroemi is a tubicolous and strongly cephalized polychaete species. Trichobranchids feed on the bottom surface as selective deposit feeders, using their retractable tentacles. They sometimes use the expended upper lip as a scoop and employ the fine feeding tentacles to sort through sediment excavated by this scoop (Fauchald and Jumars, 1979). The food items of this worm were detritus-mineral and centric diatoms, most of which were fragmented.

The body size of *T. stroemi* collected in the study area was in the range of 1 cm to 5 cm. Even considering rather longer tube length than the worm, the population of *T. stroemi* may be restricted in the upper 10 cm layer from sediment - water interface.

Chaetozone setosa

This species was collected at 23 stations. The higher population density of *C. setosa* was shown at the upper continental slope of the study area (St. 52, 61, 62, 64) and at St. 16 (Fig. 2 b). Although *C. setosa* was reported to be a cosmopolitan species occurring in silty sediments from littoral zones to the continental slopes (556m) (Hartman, 1969), its occurrence in the Yellow Sea and other regions of the East Sea has not been reported (Yamashita, 1976; Yi et al., 1982).

was 520 indiv./m² at St. 62 and the second high density of 410 indiv/m² at St. 61. These two stations are closely located each other and have a similar sediment of very fine particles (Mz = 8.5 – 8.9 ϕ). The allied species of cirratulids, *Tharyx* sp. which was known as a pollution indicator of organic enrichment area

(Fauchald and Jumars, 1979), occurred with high density at the shallow northern outer shelf where coarse particles predominate (St. 28, 39, 43, 47).

Although some cirratulids are known as tube builders (mud or calcareous tube) or driller in coral substrata, most cirratulids are free moving worms. They are also assumed to be surface deposit feeders using their palps for food collection, and they will show selectivity both in terms of particle composition and in the size of the particle (Fauchald and Jumars, 1979). Our observations that there were no muddy tube, and that the content of foregut mainly consisted of diatoms and very fine detritus-mineral also support the above statements.

Magelona japonica

M. japonica is a common species in Korean coastal waters and may prefer to relatively clean areas (Yi et al., 1982). In this study area the occurrence of this species was restricted at only 3 stations, especially at St. 10. The population density of *M. japonica* at St. 10 was 1,550 indiv./m^2, the largest population among 95 species of the study area (Fig. 2a).

The sediment at St. 10 composed of more than 70% sand particles. Any magelonids did not occurred at neighbouring station, St. 11 where the sediment composition was very similar to that of St. 10, and other closely located stations. Though the large populations of *M. japonica* were inhabited in sandy sediments of this study area, some isolated large populations were also found in the shallow muddy sediments of another region of the east coast of Korea (pers. obs.). So the isolated distribution pattern of this species seems to be related with specific reproductive strategies.

Magelonids are motile surface deposit feeders living in sands or muds. When feeding on poorly sorted material, the magelonids prefer to handle larger particles and may be carnivorous if the opportunity is given (Fauchald and Jumars, 1979), *M. japonica* in our study area, however, did not contain any larger particles in its gut; the content of gut consisted of diatoms, and mineral - detritus aggregates. Magelonids are very good burrowers, living in sands or muds. They feed by using tow long papillose palps and with the add of mucus secretion. The fecal pellets are created in the fargut and packed in mucus membrane.

Ampharete arctica

This species was collected at 37 stations and relatively higher population densities were shown in the northern part of the marine ravine and outershelf area (Fig. 2 c). The highest density was 290 indiv./m^2 at St. 52 and the next was 220 indiv./m^2 at St. 44. These two stations showed different sediment composition; more than 70% clay particles and only 1% sand (Mz = 9.3 ø) at St. 52, but less than 20% clay and 75% sand (Mz = 3.7 ø) at St. 44 located in the northern part of the marine ravine whose sedimentological properties seem to be similar to the outershelf. *A. arctica* is known as a cosmopolitan species in biogeography (Hartman, 1969) and abundant in the shallow coasts of the East Sea (pers. obs.).

All ampharetids make mucus-lined tubes covered with fine sediment particles. They are surface deposit feeders spreading the tentacle plate over the substratum, and keeping the branchiae up in the water. Ingested material included detritus, fragments of centric diatoms and very fine mineral particles. We found that all tubes of *A. arctica* were built up with the mixture of very fine sand and mud. So it is suggested that *A. arctica* inhabiting in coarse sediment may be selective in feeding and tube-building.

Aglaophamus sinensis

A. sinensis was secondary common

species in the study area; it was collected over 41 stations, comprising 136 specimens. It showed the highest density of 120 indiv./m² at St. 64 and rather larger populations in the northern part (St. 63, 64, 65, 66) and at some deep stations below 200 m (St. 16, 31, 42) (Fig. 2 b).

The populations of *A. sinensis* are found only in the northwestern Pacific, and in Korea this species was recently reported from Korean coastal parts of the Yellow Sea (Lee and Jae, 1983). *A. sinensis* of the Yellow Sea showed their habitats in sand or rarely in silty sand bottom with the depth range of 20 m to 85 m. In the East Sea, however, this species occurred in mud, sandy mud and muddy sand bottoms, and it seems that *A. sinensis* prefers finer sediments to coarse sediments.

Nephtyids are free-living burrowers. They have very large eversible pharynges armored with a pair of jaws. The gut content of *A. sinensis* was nearly empty except for some remains of small cirratulid worms. *Nephtys ciliata* which occurred at 34 stations also have empty gut. We consider that all the nephtyids in the study area are motile predators.

Nothria holobranchiata

Three species of *Nothria* were collected at almost all stations of the study area. Among them *N. holobranchiata* was the most important species in both frequency and abundance. *N. holobranchiata* occupied over broad area excluding shallow outershelf region where *N. conchylega* or *N. pallida* predominate. The maximum density of *N. holobranchiata* was 170 indiv./m² at St. 13 (Fig. 2c).

The distribution of *N. holobranchiata* has not been known yet in Korean coasts. *N. conchylega* is known as northern species widely distributed in the Arctic (Pettibone, 1963) and *N. pallida* was abundant at the central region of the Yellow Sea in winter season (Yamashita, 1976). Although larger populations of *N. holobranchiata* inhabit in shallow innershelf area (St. 13, 14, 24, 25, 59, 63, 66), we suggest that *N. holobranchiata* also should be a northern species.

N. holobranchiata constructed a strong mucus-lined tube covered with finer particles whereas the tubes of *N. conchylega* were built with sand particles or a flat tube with small gravels. Onuphids possess well developed mouthparts consisted of large two jaws, maxillary carrier and three pairs of maxillae. They are assumed to be primarily omnivorous scavengers, and may functionally become food specialists if a single food item dominates (Fauchald and Jumars, 1979).

The foregut of *N. holobranchiata* was entirely empty, but the fargut was filled with detritus and diatom fragments, and any remains of prey animals were not found. If all species of *Northria* are thought to be sessile (Fauchald and Jumars, 1979), and if considering well armored large and strong jaws in the mouth of this genus, we propose that the feeding mode of *N. holobranchiata* will be, as Blegvad's subdivision of deposit feeder, carnivorous detritus-feeder (Yonge, 1928).

Lumbrineris japonica

Lumbrinerids in the study area show lower population density than in the coastal area of Korea, while the number of species is rather higher; they were harvested total 297 speciemens within 7 species at 56 stations. The population of *L. japonica* accounted for 40% of total lumbrinerids and showed the maximum density of 110 indiv./m² at St. 53 (Fig. 2b).

L. japonica occur in various regions from tropic to boreal (Hartman, 1969). In Korean coasts, this species is rarely dominant whereas *L. longifolia* almost all predominates in benthic faunal communities (Yi et al., 1982; Lee et al., 1983; Choi and Koh, 1984). *Ninoe japonica,* which was ranked in the third species in abundance among lumbrinerids, is also rare species in Korean coasts; only *N.*

palmata was reported at the silty bottom of Ulsan Bay in the East Sea (Yi et al., 1982) and *N. gemma* in the central region of the Yellow Sea (Yamashita, 1976). The populations of *Ninoe* seem to be restricted in cold waters surrounding Korean peninsula.

The detritus-mineral aggregates and diatoms were the main components of the gut material of *L. japonica* and other lumbrinerids. Although the remains of small polychaetes were occasionally found to be mixed with fine sediments, those were only a small portion of gut materials. Fauchald and Jumars (1979) postulated that each lumbrinerid species might use only one feeding mode even if three modes of feeding were able to be utilized. On the basis of our observation about the gut content of lumbrinerids, we propose that the lumbrinerids are non selective, subsurface deposit feeders, but they can alternate their feeding modes from deposit feeders to carnivores when small prey animals are encountered.

Notoproctus pacificus

The dominant species in abundance among maldanids were *N. pacificus, Maldane cristata, Praxillella gracilis.* These three species accounted for 78% of total maldanids. The maximum population density of *N. pacificus* were 630 indiv./m² at St. 57 and those of *M. cristata* and *P. gracilis* was 220 indiv./m² and 90 indiv./m² at St. 10 respectively. *N. pacificus* occurred at only 7 stations located in the northern part of the outershelf and innershelf, where sand and gravel are dominant components of sediment (Fig. 2a).

The tube of *N. pacificus* is stiff and built with a thin mucus lining plastered with reddish clay and coarse sand grains, while *M. cristata* have strong tubes with thick lining and a thick outer covering of mud. Maldanids are representative infauna known as head-down conveyor belt feeders (sensu Roads, 1974). The gut of *N. pacificus* was filled with mineral-detritus aggregates, centric diatoms and ciliatous protozoans, but no coarse grains.

It is a very interesting phenomenon that the gut materials of *N. pacificus* consisted of finer particles, considering the facts that their habitat is predominated by coarse particles (more than 80%) and the maldanids are non selective feeders. In the guts of *M. cristata* and *P. gracilis,* a large portion of coarse sands was included. This indicates that they have no selectivity in feeding. The selectivity of food particles in subsurface deposit feeders which feed by everting their muscular pharynges onto the substratum may come from using papillae, mucus, and cilia on the surface of the pharynx (Fauchald and Jumars, 1979). Thus we consider that the selective feeding of *N. pacificus* could be performed by the aid of papillae on the pharynx.

Myriochele gracilis

This species is one of oweniids with small body size. *M. gracilis* occurred at 8 stations where each proportion of sand particles is relatively higher in the study area. The maximum density of *M. gracilis* was 140 indiv./m² at St. 27. The next of 130 indiv./m² at St. 56 (Fig. 2c).

These two stations are located in the innershelf and outershelf respectively, but the sediment composition is similar to each other in comprising more than 80% of sand. The tube of *M. gracilis* is divided into two parts; upper tube is made of tough mucus being covered with mud, and connects to water-sediment interface, while lower part is fabricated with small round pillars of quartz and flat sand particles. Thus the sediment with high proportion of sand is required for *M. gracilis* to build this elaborate tube.

The large populations of *Myriochele* were yet not found in the Korean coasts of the Yellows Sea and in the southern coasts of Korea. Only one species of this genus was

found in the East Sea (Paik, 1986). *M. gracilis* were found from western Canada and Alaska to southern California in shelf and bathyal depths (Fauchald and Hancock, 1981). This species seems to be nothern species, though mainly occurred at shallow waters with depth ranges of 90 m to 150 m in our study area.

The gut contents of *M. gracilis* were composed of mineral-detritus aggregates and diatom fragments. There are no appendages on the head of *M. gracilis* for feeding as some species of *Owenia*. Thus the feeding mode of *M. gracilis* was supposed to be a subsurface deposit feeder using proboscis (Fauchald and Jumars, 1979). But the anterior tube of *M. gracilis* is very narraw, and probablely this prevents the worms from feedng on external sediments easily. Considering the spindle shaped tube structure and the well sorted gut materials, we suggest that the feeding mode of *M. gracilis* may be a filter feeder, and that the worms will obtain their food by undulating or peristaltic movements from suspended materials included in the inhalent current.

CONCLUSIONS

Most dominant polychaetes showed a trend to occupy their specific habitats which are different in the sediment types and bottom depths (Table 1). The distribution pattern of dominant species closely corresponds to the topography of this study area, which may determine the physical environments of the habitats of polychaetes. The food items of dominant species in the study area were nearly identical in the composition; they were mainly composed of detritus and centric diatoms from which their origin was suggested to be pelagic, and the diatoms with typical benthic forms were not found in the guts of all investigated worms. This reflects that the main

Table 1. Some biological and ecological characteristics of 9 dminant polychaete species in the East Sea (SDF: surface deposit feeder, SSDF: subsurface deposit feeder, FF: filter feeder)

Species	Food items	Tube	Feeding mode	Proper habitat			
				Depth	Mz (ø)	Density	Region
Terebellides stroemi	centric diatoms detritus	mucus mud + sand	selective SDF	180-230m	9.4	180	marine ravine
Chaetozone setosa	centric diatoms detritus	not found	selective SDF	280m	8.9	520	upper continental margin
Magelona japonica	centric diatoms detritus	not found	selective SDF	70m	3.9	1,500	inner shelf
Ampharete arctica	centric diatoms detritus	mucus mud + sand	selective SDF	370m	9.3	290	outer shelf margin
Aglaophamus sinensis	small animals detritus	without tube	carnivore	290m	7.8	120	northern shelf
Nothria holobranchiata	small animals detritus	stiff mucus thick mud	carnivorous SSDF	100m	7.9	170	inner shelf
Lumbrineris japonica	small animals detritus	without tube	SSDF/carnivore	270m	3.9	110	marine ravine
Notoproctus pacificus	centric diatoms detritus	chitinized fine sand	selective SSDF	40m	-0.1	630	northern inner shelf
Myriochele gracilis	centric diatoms detritus	mucus sand + pillar	SSDF or FF (?)	100m	1.9	140	outer shelf

food source of the polychaetes or benthos in the East Sea shelf may be the organic materials produced in overlying euphotic layer, or partly be allochthonous organic materials transported by currents.

The feeding modes and the tube structures of polychaete worms also reflect the environmental conditions of the East Sea shelf. In low-energy regimes, the polychaetes showed selective surface or subsurface deposit feeding mode, and their tubes were built with thin mucus lining and thick covering of fine particles. Worms in the shallow and high-energy barrier region showed filter feeding or subsurface deposit feeding mode, and had very stiff tubes with chitinized lining and coarse covering of sand particles.

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