REGIONAL DISTRIBUTION OF ORGANIC MATTER IN BOTTOM SEDIMENTS IN THE VICINITY OF OKUSHIRI STRAIT, HOKKAIDO

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Introduction

As yet few available data have been published regarding regional distribution of organic substances accumulated in the bottom sediments in the seas adjacent to Japan. The author has hitherto carried out a series of investigations on areal distribution of marine humus (Kato, 1949–1955). Likewise, the Hokkaido Regional Fisheries Research Laboratory attempted during 1948–1952 to investigate submarine topography and bottom characters of the off-shore fishing grounds, at about 100–1,000 meters depth, around the coast of Hokkaido. During 23-31 of August, 1952, the area in the vicinity of Okushri Strait was investigated as one of the series of surveys by the Laboratory. As a part of that survey, the author has undertaken chemical investigation dealing with the bottom sediments, of which samples were collected by Mr. H. Kosugi of the Laboratory and Mr. S. Tanaka, a research student of the University on board **"Tankai-Maru"** (68 tons), the research vessel of the Laboratory. The survey was conducted at intervals of three miles, so the bottom characters were observed at 83 stations; 44 bottom samples were subjected to laboratory investigation involving microscopic observation and chemical or mechanical analysis (Fig. 1).

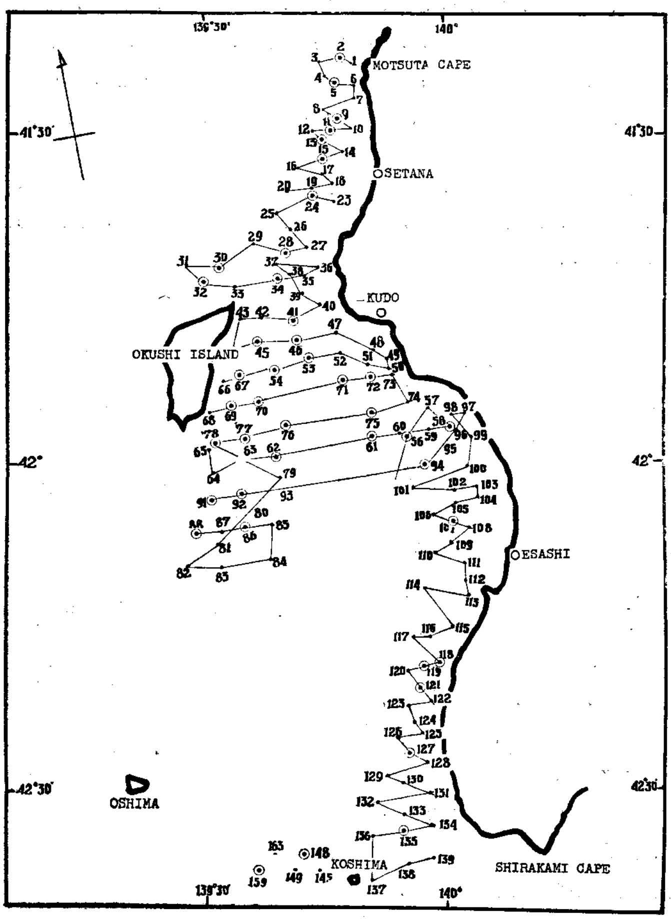

Fig. 1. Chart of observation stations

Methods employed

The oceanographic observation was carried out with good position control. For obtaining locations accurately, not only was the visible or sextant method employed, but other kinds of instrumental controls were used. Echo-sounding played in practice a very important role carrying on the investigation of topography.

Bottom samples were obtained by using a small coring device or a snapper. The samples obtained thus were submitted to laboratory investigation. To prevent deterioration, however, the larger organic remains, as benthos or weeds, found in sediments were stored in vials containing formalin solution or spirit for biological examination.

Of the bottom sample dried at 100–105°C, the organic carbon content was determined by means of the same titration method as employed by Waksman (1933), and the total nitrogen content by using the common Kjeldahl method.

As to mechanical analysis of the sample, the wet seiving method was employed for separating the fractions larger than 0.06mm in diameter, while the settling methtod was used for the finer fractions. From the results of the analysis, a cumulative frequency curve was drawn with respect to the grain size of the sample; thus the mass properties of the sample were examined.

Laboratory work, next, led to microscopic observation of planktonic remains accumulated in the sediment, for ascertainment of how the organic remains had affected the organic accumulation in the bottom floor.

Geographic view of the area and bottom character

The area under discussion is located intermediate between Motta Cape (42° 316 ′N) and Koshima Island (41° 19 ′N) neighboring the western entrance of Tsugaru Strait. Tsushima Current flows northward through the area and used to branch off forward Okushiri Island.

The character of submarine topography in the area may be emphasized as follows (Fig. 2, Ogaki *et al*, 1953): The continental shelf is very narrow, namely, about one to five miles wide, and goes down in a steep slope to the deep bottom of the Japan Sea. The channel of Okushiri lying between Okushiri Island and the Oshima Peninsula, is comparatively shallow in depth. Midway in the channel, runs a narrow trough having about 500 meters depth. A shelf lies in the vicinity of Shirakami Cape and Koshima Island. It is another characteristic of the area that a number of small submarine valleys traverse the shelf of the peninsula.

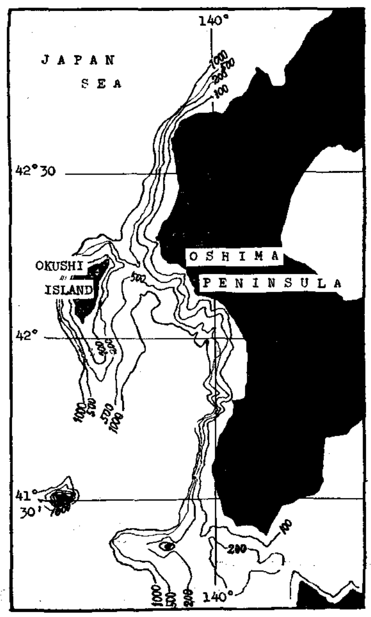

Fig. 2 . Submarine topography (m)

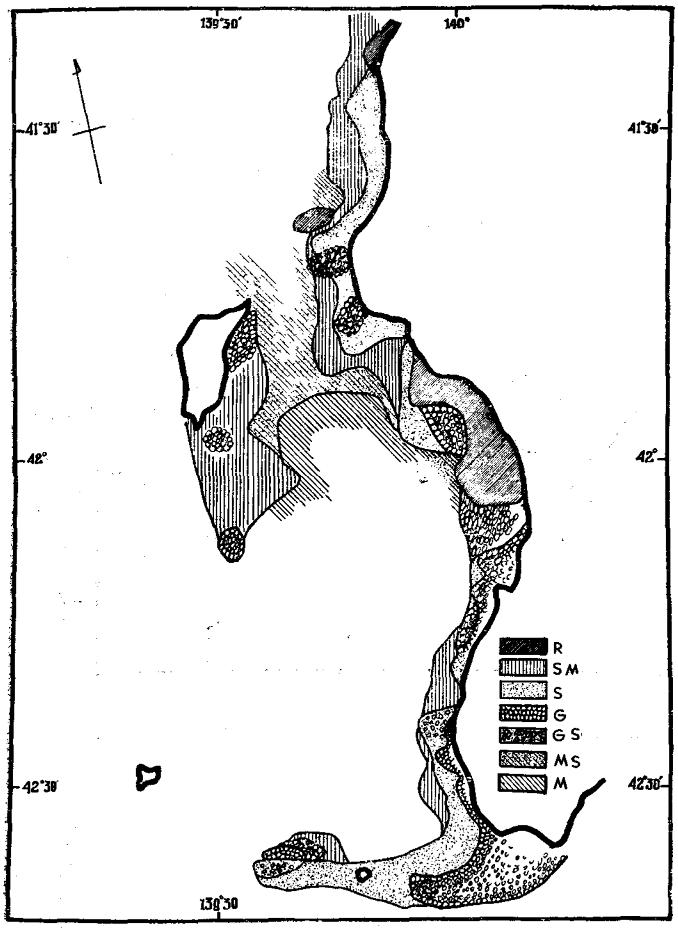

Fig. 3. Bottom character

As illustrated in Fig. 3, bottom character of the shelf is rocky, sandy or gravelly, that of the steep slope is muddy.

Results and discussion

General properties of the bottom samples from the area are summarized in Table 1, and regional distribution of organic substances in sediments is illustrated in Figs. 4-6. Some statistical examinations have been made regarding organic contents in sediments as well as their relations to the water depth of the site of deposition; the results are summarized in Table 2.

Sedimentary accumulation of organic matter in bottom floor was fairly abundant in the area; the mean contents of organic matter were indicated as 1.22% C or 0.13% N. Such abundant accumulation of organic matter appears to be one of characteristics of organic accumulation in the Japan Sea (Kato, 1951). These mean organic contents are, however, rather less abundant than those of sediments in the vicinity of Musashi Bank (1.87% C and 0.21% N,) (Kato, 1951). The amount of organic matter accumulated in sediments appears to have some relatiom to the water depth at the site of deposition, that is, the contour of organic content as shown in Figs. 4 and 5 may probably be parallel to the submarine contour of Fig. 2. So, some statistical observations were undertaken regarding the correlationship of organic accumulation to the water depth as tabulated in Table 2.

According to Table 2, it is clear that there will be found some positive correlationship between water depth and accumulation of such organic constituents as carbon or nitrogen. However the examination on the ratio of carbon to nitrogen showed that it

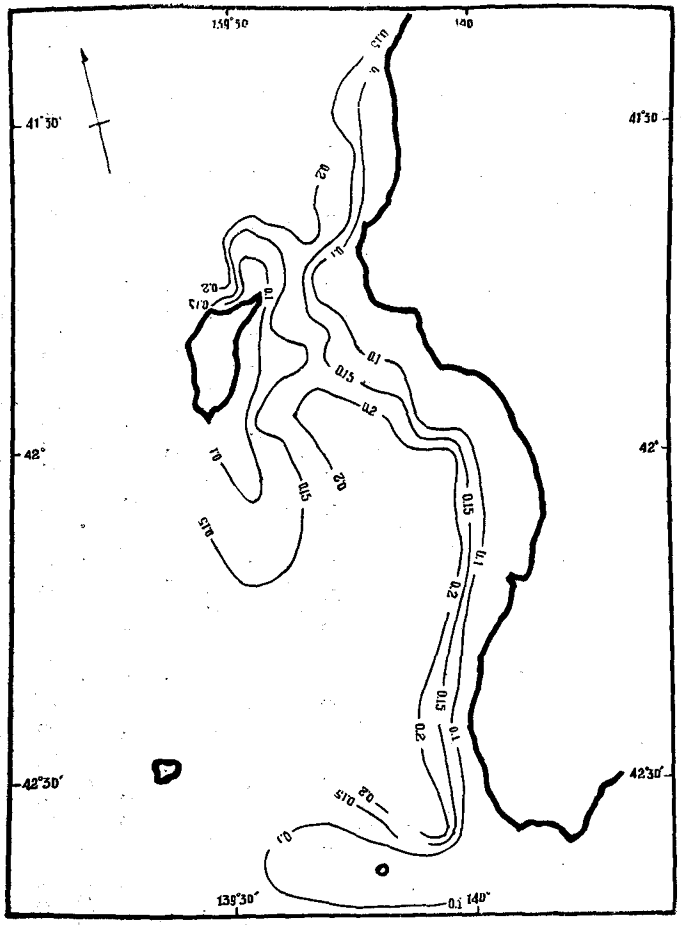

Fig. 5. Distribution of total nitrogen content in sediment (%)

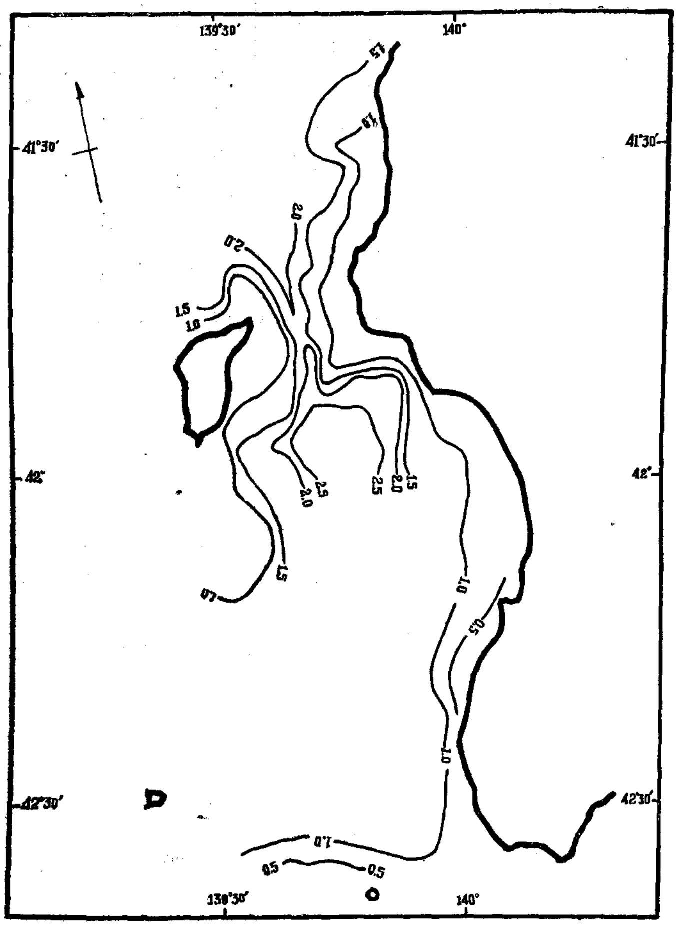

Fig. 4. Distribution of organic carbon content in sediment (%)

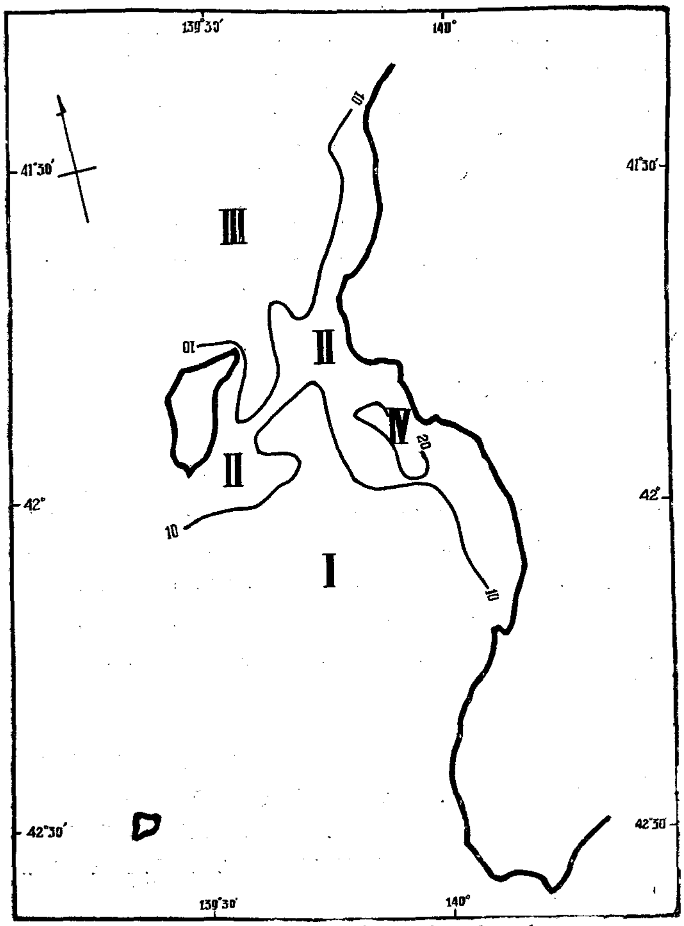

Fig. 6. Distribution of the ratio of carbon to nitrogen in sediment

might be hard to find any correlation to the water depth. Although no correlationship of that ratio to the depth was found, a further examination would show that the regional variation of the ratio as illustrated in Fig. 6 was rather reasonable in relation to the environments of organic accumulation: Ratios higher than 10 were observed on the samples from the shelf in the vicinity of Okushiri Strait (II and IV), but rather low ratios were obtained from the bottom samples of the other open areas (I and III). One may notice in particular that some remarkably large ratios near or over 20 were observed in the samples from the eastern side of the strait (IV).

Rather high ratio suggests the possibility of supplies of fresh terregenous organic substances or progressive decomposition of nitrogenous substances by marine bacteria. Waksman (1938) has shown that fresh organic matter attacked by bacteria will first lose nitrogen than carbon until a more or less definite equilibrinm ratio is attained. On the bottom floor at Okushiri Strait, not only was there a fairly good amount of carbonous substances, but nitrogenous substances in sediments would be decomposed more progressively by bacteria than non-nitrogenous ones owing to the sufficient supply of oxygen in the water judging from fairly good sorting of sediments.

At the eastern side of the strait where irregularly large ratios were observed, abundant accumulation of carbonous substances might be somewhat affected by floating fragments of sea weeds which had grown thick in the neighboring coast. The above accumulation would indicate that a small eddy current used to be induced by a branch of Tsushima Current flowing northwards.

Table 2. Organic contents in the sediments and their relations to the water depth of the site of deposition (a=0.05)

	Number of samples	Population mean (x)	Standard deviation (s)	Correlation coefficient in sample (γ)	Correl. coef. in population	Equation of regression*
Org.-C	44	1.143-1.303%	0.260%	0.569	$\rho \neq 0$	C=0.00201d+0.296
Total-N	44	0.124-0.140%	0.016%	0.663	$\rho \neq 0$	N=0.00020d+0.0634
C / N	44	7.89-10.75	4.64	0.014	$\rho = 0$	....

* C : Carbon content (%)
N : Nitrogen content (%)
d : Water depth of the site of deposition (m)

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Table 1. General properties of bottom samples from the northern Japan Sea in the vicinity of Okushiri Strait (August 23-31, 1952)

Station number	Location		Water Depth	Texture of sample				Organic content (%, in dry basis)				Organic remains under microscope	
	Lat.N	Long.E	(m)	Sight	Md	So	Sk	Org-C	Total-N	C/N	Ignition loss	Diatom residue	Silicious sponge
2	42°36.5′	139°48.2′	540	M S	0.075	3.542	0.270	1.73	0.193	8.91	…………	A	
5	42°37.2′	139°47.2′	550	M S	……	……	……	1.27	0.128	9.91	…………	R	
9	42°31.6′	139°46.4′	400	S m	0.096	1.594	0.960	1.16	0.093	12.46	5.16	R R	C
11	42°30.5′	139°45.4′	500	M S	……	……	……	0.97	0.112	8.66	6.15	A	C
13	42°29.4′	139°44.8′	400	M S	……	……	……	1.08	0.113	9.55	…………	R	A
15	42°27.8′	139°44.9′	620	M S	……	……	……	1.54	0.175	8.80	…………	C	C
24	42°24.2′	139°43.0′	550	M	……	……	……	1.66	0.168	7.88	7.22	A	A
28	42°19.2′	139°39.8′	660	M S	……	……	……	1.64	0.213	7.69	8.15	C	C
30	42°16.4′	139°31.6′	700	M S	……	……	……	0.86	0.102	8.43	…………	R	
32	42°16.4′	139°30.0′	550	M S	……	……	……	1.56	0.071	9.62	…………	A	
34	42°16.8′	139°39.6′	480	M S	0.114	1.718	0.845	1.35	0.095	14.20	6.28	C	C
37	42°17.9′	139°39.1′	520	M	……	……	……	1.95	0.168	12.60	8.85	C	C
41	42°13.2′	139°40.6′	540	M S	……	……	……	1.50	0.102	14.70	6.44	R	C
45	42°10.9′	139°36.9′	550	M S	……	……	……	0.86	0.168	5.17	5.29	C	
46	42°11.3′	139°41.2′	580	M	……	……	……	2.07	0.158	13.10	…………	A	C
53	42°09.5′	139°42.4′	380	M	……	……	……	1.13	0.131	8.62	4.72	R	C
54	42°08.2′	139°38.5′	600	M S	0.078	3.685	0.321	1.41	0.126	11.19	5.98	A A	C
56	42°02.2′	139°57.2′	330	S m	……	……	……	1.23	0.052	23.57	4.75	R	A
58	42°02.2′	139°00.2′	160	S m	……	……	……	0.97	0.080	12.12	…………		
61	42°02.5′	139°50.4′	820	M	0.051	6.582	0.150	2.46	0.193	12.16	9.28	R	A
62	42°00.9′	139°38.2′	680	M	……	……	……	1.53	0.161	9.50	7.77	R	
63	42°00.4′	139°34.8′	610	M S	0.096	4.438	0.214	1.53	0.141	10.85	6.34	C	C
67	42°07.9′	139°34.4′	450	M S	……	……	……	1.04	0.118	8.81	…………	C	A
69	42°05.2′	139°33.4′	460	M S	……	……	……	1.31	0.109	11.90	5.11	C	C
70	42°05.8′	139°37.0′	660	M	……	……	……	1.33	0.184	7.23	5.28	C	C
71	42°07.5′	139°47.0′	640	M	0.002	8.944	20.000	2.25	0.116	19.31	7.56	C	C
72	42°07.8′	139°50.8′	330	M S	……	……	……	2.14	0.106	20.17	…………	C	A
75	42°04.8′	139°50.0′	700	M	……	……	……	2.03	0.187	10.52	8.52	C	C
76	42°03.5′	139°39.9′	770	M S	……	……	……	2.87	0.230	12.46	…………	C	A
77	42°02.6′	139°34.9′	620	M S	……	……	……	1.87	0.168	11.18	…………	C	C
86	41°54.1′	139°35.3′	480	M S	……	……	……	0.85	0.112	7.72	…………	C	
88	41°53.4′	139°28.7′	580	M	……	……	……	0.73	0.132	5.60	9.00	C	C
91	41°56.5′	139°30.0′	70	S m	……	……	……	0.87	0.114	7.25	…………	C	A
92	41°57.0′	139°34.5′	400	S M	……	……	……	1.06	0.115	8.41	…………	R	A
94	42°00.3′	139°56.6′	730	M	……	……	……	1.26	0.212	5.94	8.57	R	A
107	41°54.5′	140°00.8′	300	G M S	……	……	……	0.94	0.101	9.30	…………		
118	41°41.6′	139°59.0′	90	S	0.582	1.507	0.876	0.21	0.034	6.17	3.04	R R	
119	41°41.4′	139°57.3′	410	S m	0.219	2.236	0.704	0.61	0.105	5.80	3.53	R	C
121	41°39.3′	139°56.7′	470	S m	0.250	3.030	0.547	1.14	0.126	9.04	5.40		
127	41°33.4′	139°54.9′	600	M	0.083	8.031	0.150	1.39	0.180	7.72	7.96	C	C
135	41°25.8′	139°54.4′	520	M	0.072	9.083	0.092	1.09	0.229	4.75	8.48	(R)	C
148	41°22.5′	139°40.0′	400	G S m	……	……	……	0.46	0.075	6.13	1.39	R	C
159	41°19.8′	139°37.5′	300	G M m	……	……	……	0.32	0.058	5.51	…………	R R	