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An Examination of Supply Processes of Sponge Spicules to the Sediment of the Northeastern to Eastern Part of Sagami Bay

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Abstract

The investigated area is the northeastern and eastern parts of Sagami Bay where sponge spicules occur abundantly in the sediment and informations on living sponges are available. The amount and composition of morphologic types of sponge spicules in the sediment show a wide range of local varieties. This is supposed to result from the local variation of geographical distribution and biomass of sponge species.

One of the clear correlation results is presented by an examination of sediment sample and sponge specimens collected at a station off Enoshima Island. The greater part of sponge spicules, oxea and calthrop, in the sediment are correlative with spicules of sponge specimens collected. However some types of spicule have no equivalent between the sediment and sponge specimen. Thus no sponge specimen has triaene and sterraster which occur in the sediment. On the contrary most microscleres of sponges collected are not detectable. The former inconsistencies are explained by insufficient sampling or the transportation of spicules concerned from distant places. And the latter inconsistencies suggest the facility of disappearance of microscleres through supply processes to the sediment.

Another example of clear correlation between spicule assemblages in the sediment and those of living sponge animals is presented by data on the shelf west of Miura Peninsula. Thus the occurrence of calcareous sponges is mainly limited to the shallow water area. The fact coincides with the limited occurrence of calcareous spicules in the sediment of the shelf along Miura Peninsula.

The result of the investigation is summarized as follows:

1. Sponge spicules in the sediment in the investigated area are supposed to undergo little or no transportation over several kilometers. Thus the supply of them to the sediment is local.

2. However amount and morphologic types of spicules of living sponge are not always consistent with those of spicules in the sediment.

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I INTRODUCTION

The purpose of the present paper is to examine the correlation of sponge spicules in sediment with those of living sponges in Sagami Bay.

Sponge spicule is an common constituent of sediment and sedimentary rock. A sponge animal has a skeleton which consists of spicules or of spongin fibers or of a combination of both. Skeletons are not always conserved well in the sediment and only isolated spicules usually remain. An idea that spicules can be useful in making inferences about the nature of the depositional environment has been described and applied to depositional environment has been described and applied to Cretaceous to Recent sediment by Koltun (1959, 1960, 1961, and 1966). He named the method as 'Spicule Analysis'.

To make spicule analysis successful, the study of the correlation of the spicule

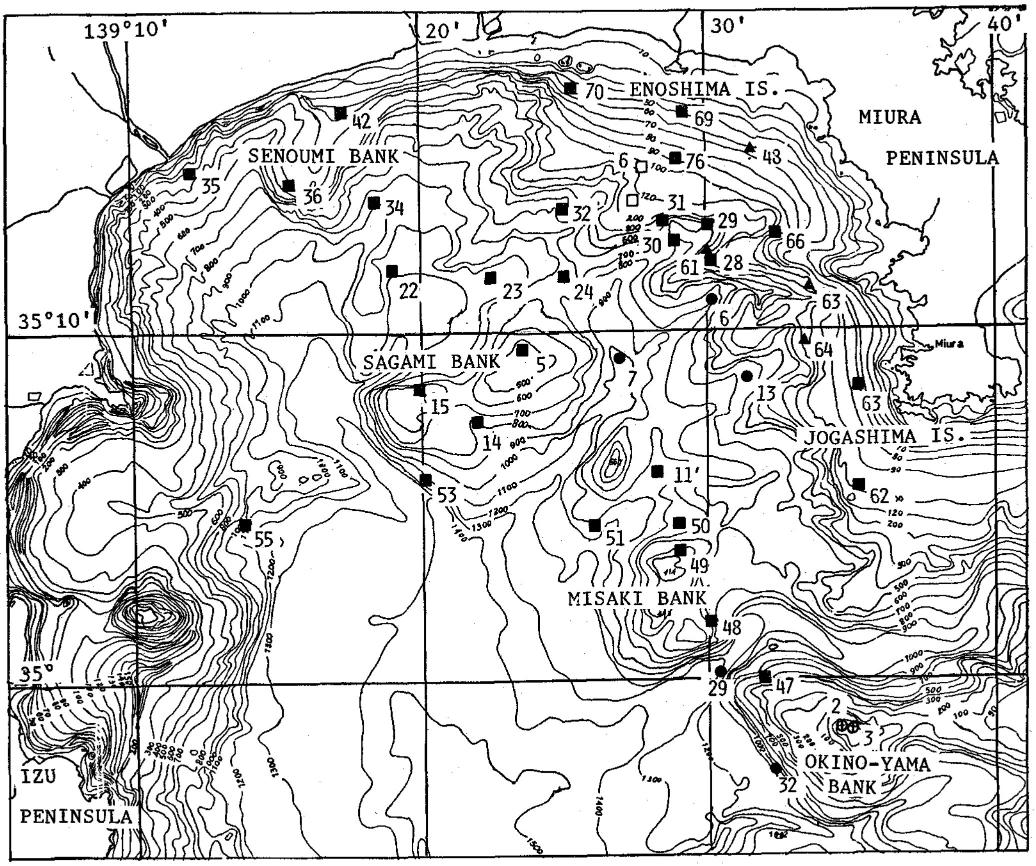

Figure 1. Sampling positions of sediment examined.
Each symbol represents a cruise. Black square; KT-70-4 cruise: open square; KT-73-13 cruise: black triangle; KT-78-10 cruise: black circle; KT-82-2 and KT-82-3 cruise: open circle; KT-81-2 cruise.

Table 1. Sampling positions

St. No.		Latitude	Longitude	Depth	Remarks
KT-70-4	5	35°09.5'	139°23.5'	470m	D
KT-70-4	11'	06.0'	28.2'	977	D
KT-70-4	14	07.5'	22.0'	740	D
KT-70-4	15	08.4'	19.9'	520	D
KT-70-4	22	11.8'	19.1'	1025	D
KT-70-4	23	11.5'	22.5'	1010	D
KT-70-4	24	11.6'	24.9'	785	D
KT-70-4	28	12.0'	30.2'	200	D
KT-70-4	29	13.1'	30.2'	485	D
KT-70-4	30	12.5'	28.9'	680	D
KT-70-4	31	13.2'	28.6'	470	D
KT-70-4	32	13.4'	25.1'	575	D
KT-70-4	34	13.8'	18.8'	890	D
KT-70-4	35	14.6'	12.1'	280	D
KT-70-4	36	14.3'	15.5'	250	D
KT-70-4	42	16.3'	17.3'	90	D
KT-70-4	47	00.2'	31.5'	1060	D
KT-70-4	48	01.6'	30.0'	960	D
KT-70-4	49	03.7'	29.1'	648	D
KT-70-4	50	04.8'	28.8'	630	D
KT-70-4	51	04.4'	26.0'	1122	D
KT-70-4	53	05.9'	20.9'	1080	D
KT-70-4	55	04.6'	13.9'	1080	D
KT-70-4	62	06.6'	35.4'	100	D
KT-70-4	63	08.4'	35.3'	80	D
KT-70-4	66	12.7'	32.3'	84	D
KT-70-4	69	16.3'	29.2'	62	D
KT-70-4	70	16.9'	25.5'	66	D
KT-70-4	76	15.0'	29.0'	96	D
640930-8		15.6'	30.7'	69	D
KT-71-8	2	02.3'	09.0'	102	DN
KT-73-13	6	14.7'	27.7'	115	DN
KT-73-13	19	06.3'	35.0'	96	DN
KT-78-10	48	15.5'	31.3'	60	G
KT-78-10	61	12.3'	30.1'	207	G
KT-78-10	63	11.3'	33.6'	205	G
KT-78-10	64	10.1'	33.5'	186	G
KT-81-2	2	34°58.6'	34.6'	70	G
KT-81-2	3	58.5'	34.9'	70	G
KT-82-2	13	35°08.7'	31.2'	650	G
KT-82-3	6	11.0'	30.1'	780	G
KT-82-3	7	09.2'	26.9'	1050	G
KT-82-3	29	00.1'	30.0'	1320	G
KT-82-3	32	34°57.3'	32.4'	1050	G

D: dredge DN: dredge net G: grab sampler

assemblage in the sediment with the spicule assemblage of living sponges are needed. The author has investigated the study of samples collected in Sagami Bay (Inoue, 1983 and 1984).

The width of the shelf of Sagami Bay is rather wide in the eastern part to north-eastern part of the bay, but very narrow from the northern to western part. Coarse-grained sediment of sand to gravel is widely distributed on shelves and somewhere rock exposes. Coarse-grained sediment is also distributed on some of banks, which line up in a row from northwest to southeast in the central part of the bay (Figure 1).

The distribution of living sponges are restricted to relatively small areas. Many reports have been published about sponge specimens of Calcarea, Hexactinellida and Demospongia collected in Sagami Bay (Doederlein, 1883; Carter, 1885; Lampe, 1886;

Ridley and Dendy, 1887; Sollas, 1888; Doederlein, 1892; Hara, 1894; Thiele, 1898; Lebwohl, 1914; Hozawa, 1916, Kadota, 1922; Topsent, 1928; Hozawa, 1929; Topsent, 1930; Tanita, 1941, 1970). Spicules of these sponges are supposed to have been supplied to the sediment of the bay.

Sediment samples treated were collected during cruises of the Research Vessel Tansei Maru of Ocean Research Institute, University of Tokyo (Table 1 and Figure 1).

Sediment samples were washed by a supersonic washer for a few minutes in order to separate grains and clean their surface. After accomplishment of mechanical disintegration and cleaning sediment samples were sieved using a sieve of No. 250 mesh (63 microns in diameter) in a wet system. Extraction of spicules was carried out with a steel needle from the fraction coarser than 63 microns using a biocular microscope.

II DESCRIPTION OF SPICULES IN RECENT SEDIMENTS OF SAGAMI BAY

1. Quantitative Distribution of Demosponge Spicules

The geographic distribution of the number of spicules excluding sterraster of demosponge in 1 gram of sand fraction is shown in Figure 2. Sterrasters, a kind of microscleres, have been treated separately from other spicules of demosponge because sterraster having ovoid form is considered to behave differently in the transportation processes from other spicules which have not so simple form, for example such a long form as oxea, style or strongyle and such a form having cladi as triaene.

Spicules are abundant in the sediment of the shelf edge to continental slope of the northeastern part of Sagmi Bay. Spicules in the sediment of banks are variable in amount.

Sterrasters are also abundant around the shelf edge to continental slope of the northeastern part of the bay and around Miura Bank and Okino-Yama Bank. A family of sponge Geodiidae, which has sterraster in its cortex layer, has also different types of spicules, such as triaenes, oxeas, styles and other together. Therefore sterraster must be accompanied by other types of spicules without selective sorting during the transportation. It is apparently indeed that the areas where is rich in demosponge spicules in the sediment coincide with the areas where is rich in sterrasters in the sediment, although the ratio of number of spicules excluding sterraster to number of sterrasters is so variable at places.

Some sediment samples examined have been analysed granulometrically by Otsuka (1972). He classified them based on Shepard's nomenclature (Shepard, 1954), which depends on relative abundance of sand, silt and clay fractions. Stations whose sediment is rich in demosponge spicules (excluding sterrasters) are almost equivalent to the area of a particular sediment type of sand-silt-clay. But sediment, whose textural type is sand-silt-clay, does not always yield abundant spicules. And at each station

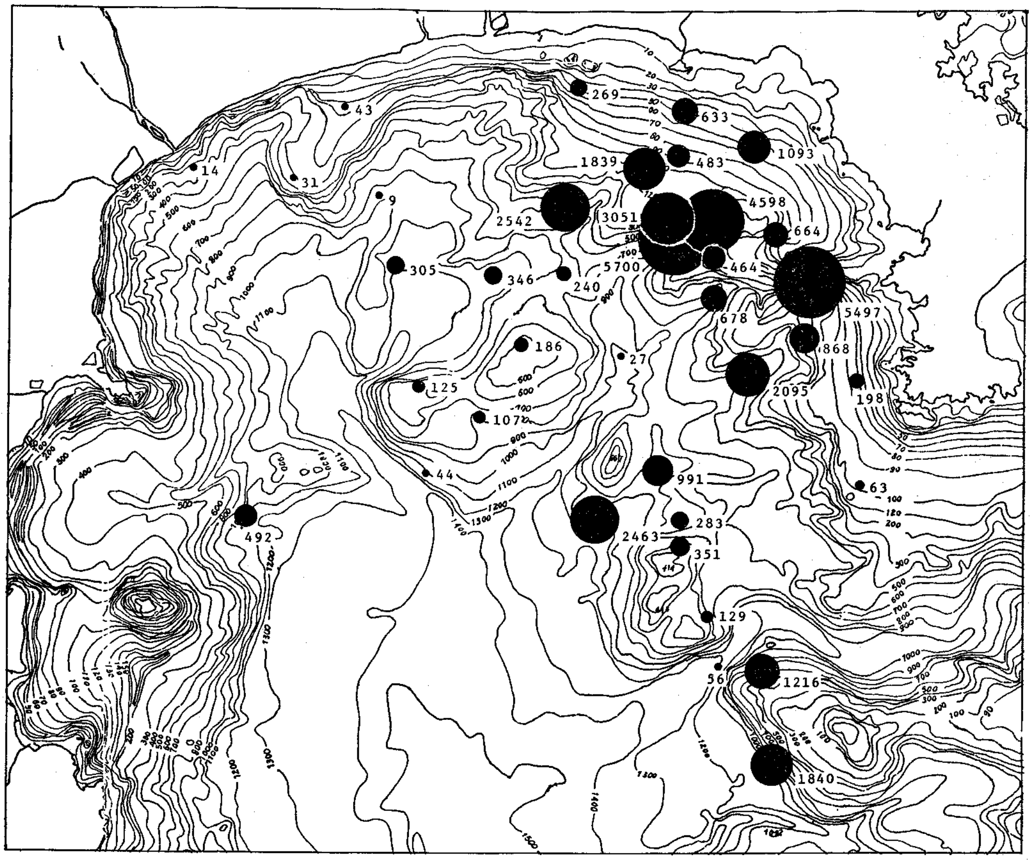

Figure 2. Number of demosponge spicules excluding sterraster in 1 gram of a sand fraction of dried sediment.

which is underlain by the same type of sediment, amount of spicules in the sediment are much variable. Thus the textural type of sediment has no obvious relation to the amount of spicule in it.

2. Relative Abundance of Morphologic Types of Sponge Spicules

Relative abundance of morphologic types of demosponge spicules and calcareous spicules in the sediment has been examined (Figure 3). Many sponge spicules in the sediment can not be determined into a peculiar morphologic type because of their breakage. Thus oxea, strongyle, style, tylostyle and tylote which have lost only a tip of their end are not determinable. These spicules have been counted as indetermined spicules.

Sediments off Enoshima Island yield many sponge spicules. Stations 29, 30 and 31 on the continental slope are located within a few kilometers each other. However their relative abundance of morphologic types of spicule is variable. The amount of the spicule with both broken ends widely ranges from 21.2% at Station 30 to 62.8% at Station 29. Dominant morphologic types of spicule at the three stations are variable

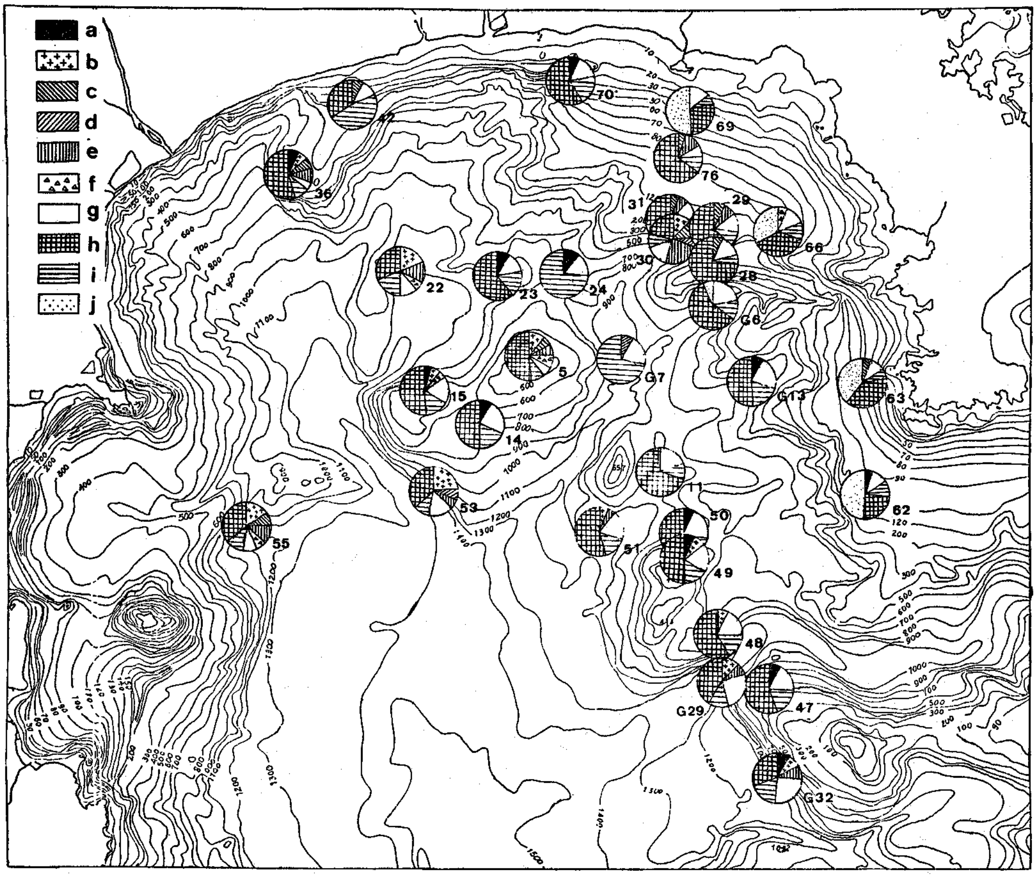

Figure 3. Relative abundance of different types of sponge spicules.
a–i. Demosponge spicules
a–g. Morphologically determinable spicules
a. oxea ; b. calthrop ; c. plagiotriaene ; d. orthotriaene ; e. dichotriaene ;
f. desma ; g. others
h–i. Morphologically indeterminable spicule fragments
h. fragments with both ends broken ; i. other fragments
j. Calcareous spicules
As for morphologically determinable demosponge spicules, spicule types whose contents are more than 5% have been adopted in pie-graphs. At Stations 24 and G 7 morphologically indeterminable spicule fragments have not been subdivided into two subgroups with both ends broken or not.

both in kinds and relative abundance. Dominant types at Station 29 are dichotriaene (8.9%), and plagiotriaene (6.2%). Those at Station 30 are dichotriaene (23.7%), calthrop (12.7%), plagiotriaene (11.9%) and orthotriaene (6.5%). Those at Station 31 are dichotriaene (8.2%), plagiotriaene (6.2%) and oxea (4.7%).

Though Stations 76 and 69 are located not so remote each other in a distance of about 3 km and located up- and down-stream on the shelf off Enoshima Island, morphologic types of spicule in the sediment differ remarkably in relative abundance. The sediment at Station 69 yields much amount of calcareous spicules (51.4%) and predominant demosponge spicules of dichotriaene (4.6%) and plagiotriaene (3.9%). Spicules with both broken ends is in a rather small amount (28.6%). On the other hand the sediment at Station 76 yields no calcareous spicule and yields dichotriaene (11.6%) and plagiotriaene (5.2%) as dominant demosponge spicule. Spicules with both broken ends amount to 64.9%.

Thus each station shows its peculiar morphologic composition of sponge spicule and has little interrelation with another nearest station.

III ZOOGEOGRAPHY AND BIOMASS OF LIVING SPONGE ANIMALS IN SAGAMI BAY

Although many reports of sponge specimens collected in the bay have been published previously, sampling localities of them are often obscure and a zoogeographic map of sponge animals has not yet been published.

Table 2. List of sponges collected at some stations in Sagami Bay and morphologic types of their spicules (compiled by Dr. Senji Tanita based on Lebwohl 1914)

	Species	Spicule type
	Sphinctrella retheides Lebwohl	oxea, tylostyle, tylote, triaene (plagio-, ortho-), microxea, aster, sphere
	Pachastrella tenuilaminaris (Sollas)	oxea, calthrop, microxea, aster
	Yodomia ijimai Lebwohl	oxea, tylostyle, triaene(plagio-, meso-), aster, sphere
1	*Stelletta japonica* Lebwohl	oxea, triaene(dicho-, pro-, ana-, plagio-), aster
	S. tuba Lebwohl	oxea, triaene(dicho-, pro-, ana-, plagio-), aster
	Geodia orthomesotriaene Lebwohl	oxea, triaene(dicho-, ana-, ortho-, meso-), sterraster
	G. reniformis var. *robusta* Lebwohl	oxea, triaene(dicho-, ana-, ortho-, meso-), sterraster
	Sphinctrella porosa Lebwohl	oxea, style, triaene(plagio-, ortho-), calthrop, microxea, aster
2	*Pachastrella cribrum* Lebwohl	oxea, calthrop, aster
	Caminella velata Lebwohl	oxea, style, triaene(plagio-), sterraster, aster
	Geodia variospiculosa var. *aapta* Lebwohl	oxea, triaene(dicho-, ana-, ortho-, meso-), sterraster
3	*Stelletta pilula* Lebwohl	oxea, triaene(dicho-, pro-, ana-, plagio-), aster
	Tetilla ovata (Thiele)	oxea, triaene(pro-, ana-), sigma

The letters 1 - 3 in the left column correspond to following areas.
1: Yodomi; 290 to 900 m
2: Okinose; 55 to 180 m
3: Doketsba; 200 m

Table 3. List of sponges collected in Sagami Bay and morphologic types of their spicules (compiled by Dr. Senji Tanita based on Thile 1898)

	Species	Spicule type
	Leucophloeus perforatus Thiele	tylostyle or style
	Acanthella aculeata Thiele	style, strongyle
	Hymeniacidon adhaerens (Thiele)	style or subtylostyle
	H. penicilata (Thiele)	style or subtylostyle
	Axinella tenuis Thiele	style, strongyle, oxea 140 f
	Ceratopsis clavata Thiele	style, strongyle, microxea 130 m
	Raspailia folium Thiele	style, trachystyle
	Spirastrella panis Thiele	style, aster
	Polymastia affinis Thiele	style, tylostyle
	P. simplicissima Thiele	style, tylostyle
	Prosuberites exiguus Thiele	tylostyle 100 f
	P. inconspicuus Thiele	tylostyle
	P. agamensis Thiele	tylostyle 50-80 f
	Suberites clavata (Thiele)	tylostyle, microstrongyle 100 f
	S. ficus (Johnston)	tylostyle, microstrongyle
	S. japonicus Thiele	tylostyle, microstrongyle
	S. infrafoliata (Thiele)	tylostyle, microstrongyle
	Cliona argus var. *laevicollis* Thiele	tylostyle or oxea, aster 140 m
	C. concharum Thiele	tylostyle or oxea, aster
	Tethya deformis Thiele	style, asters
	Stelletta maxima Thiele	oxea, triaene(dicho-, pro-, ana-, plagio-), asters
	S. orientalis Thiele	oxea, triaene(dicho-, pro-, ana-, plagio-), asters
	S. pisum Thiele	oxea, triaene(dicho-, pro-, ana-, plagio-), asters 12 f
E	*Thenea compacta* Thiele	oxea, triaene(dicho-, plagio-, ana-), asters 320-400 m
	T. compressa Thiele	oxea, triaene(dicho-, plagio-, ana-), asters 320-400 m
	T. grayi Sollas	oxea, triaene(dicho-, plagio-, ana-), asters 320-400 m
	T. hemisphaerica Thiele	oxea, triaene(dicho-, plagio-, ana-), asters 200 m
	T. irregularis Thiele	oxea, triaene(dicho-, plagio-, ana-), asters 200 m
	T. nucula Thiele	oxea, triaene(dicho-, plagio-, ana-), asters 320-400 m
E	*Geodia cylindrica* Thiele	oxea, triaene(dicho-, ana-, ortho-, meso-), sterraster, asters
	G. hilgendorfi Thiele	oxea, triaene(dicho-, ana-, ortho-, meso-), sterraster, asters
	G. japonica (Sollas)	oxea, triaene(dicho-, ana-, ortho-, meso-), sterraster, asters
	G. reniformis Thiele	oxea, triaene(dicho-, ana-, ortho-, meso-), sterraster, asters
	Tetilla ovata (Thiele)	oxea, triaene(pro-, ana-), sigma
	Craniella lentiformis Thiele	oxea, triaene(pro-, ana-)
	Pachastrella japonica Thiele	oxea, chelotrop, microxea, aster 300 m
	Plakina monolopha Schulze	oxea, calthrop
	Stylocordyla longissima (Sars)	oxea 200 m
	Leucophloeus incrustans Thiele	tylostyle or style
	Suberites ficus (Johnston)	tylostyle, microstrongyle
J	*Stelletta validissima* Thiele	oxea, triaene(dicho-, pro-, ana-, plagio-), asters
	Geodia variospiculosa Thiele	oxea, triaene(dicho-, ana-, ortho-, meso-), sterraster, asters

	Acanthella insignis Thiele	style, strongyle
	A. simplex Thiele	style, strongyle
	A. vulgata Thiele	style, strongyle
	Auletta consimilis Thiele	oxea, style
	Axinella incrustans Thiele	style, strongyle, oxea
	Ceratopsis expansa Thiele	style, strongyle, microxea
	C. erecta Thiele	style, strongyle, microxea
S	*Phakellia elegans* Thiele	oxea, style
	P. foliacea Thiele	oxea, style
	P. fusca Thiele	oxea, style
	P. paupera Thiele	oxea, style
	P. perforata Thiele	oxea, style
	P. pygmaea Thiele	oxea, style
	Raspailia hirsuta Thiele	style, trachystyle
	Spirastrella insignis Thiele	style, aster
	Suberites clavata (Thiele)	tylostyle, microstrongyle
	Thenea grayi var. *lateralis* Thiele	oxea, triaene(dicho-, plagio-, ana-), asters 130 m

The letters E, J and S in the left column correspond to following areas.
E: Enoshima Island area
J: Jogashima Island area
S: Sagami Bay

1. Living Sponge Animals around Some Banks

Senoumi Bank: Horikoshi (1960) reported benthic community of the bank. Bivalves, ophiuroideans and a crinoid have been found. The occurrence of sponge has never been reported, although spicules in the sediment are present in a small amount (Figure 2).

Sagami Bank: Horikoshi (1970) performed quantitative studies on smaller macrobenthos around the bank. The consistency in composition of major animal groups and the faunal diversity are remarkable on the top of the bank. High diversity in species composition on Sagami Bank is also shown by Ohta (1980). Although amount of spicule in the sediment is not so much abundant, the presence of Calcarea, demosponges and Hexactinellida has been reported (Ohta, 1980). A demosponge *Gellius flagellifer* Ridley & Dendy, whose spicules are oxea and sigma, has been dredged on the top of the bank during KT-76-3 cruise of the Tansei Maru.

Of banks in Sagami Bay Okino-Yama Bank (Okino-se) is noted by the occurrence of sponges rich in both variety and quantity. Some sponge specimens of the Biological Laboratory, Imperial Household were collected on the bank and Lebwohl (1914a and b) described some specimens collected there (Table 2). Some of sponge species which Thiele (1898) described their sampling localities as Sagami Bay simply may be from the bank (Table 3).

2. Living Sponge Animals around the Shelf of the North-Eastern to Eastern Part of Sagami Bay

The existence of various kinds of sponge in the area has been reported previously. Some informations on them based on specimens collected by the Biological Laboratory, Imperial Household have been offered to the author by Dr. Senji Tanita (Figure 4).

A list of sponges collected is shown in Table 4.

Thiele (1898) made descriptions of Japanese sponges. Many of them are sponges collected in Sagami Bay. Sampling localities have been described as Enoshima, Jogashima or Sagami Bay. Some or most of specimens which were described as Enoshima or Jogashima seem to be obtained on the shelf around the islands. A list of them is shown in Table 3.

On the shelf soutwest off Jogashima Island ten species of demosponge specimens have been dredged by Hayami et al. (Table 5).

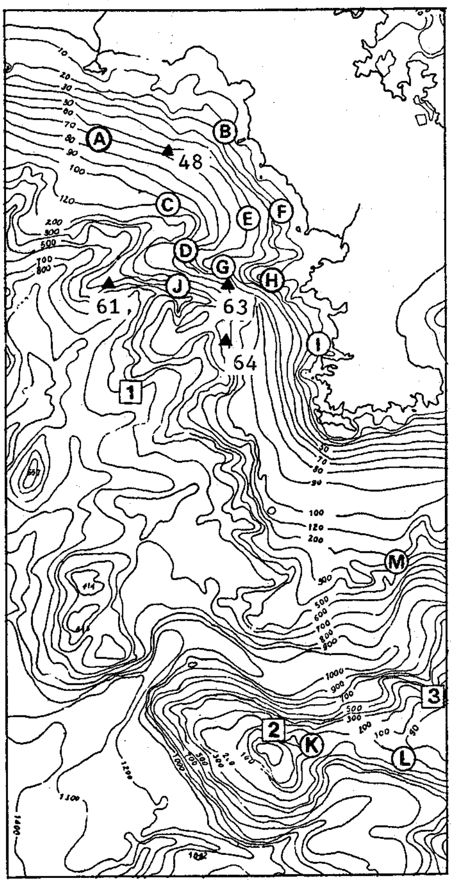

Figure 4. Sampling locations of sponge specimens collected by the Biological Laboratory, Imperial Household and by Professor Ijima (after Lebwohl, 1914) and localities of Stations 48, 61, 63 and 64 of the KT-78-10 cruise.
Letters A–M represent sampling localities of specimens of the Biological Laboratory, Imperial Household and their meanings are the same as used in Table 4.
Letters 1, 2 and 3 represent sampling positions of specimens reported by Lebwohl and their meanings are the same as used in Table 2. Data of positions are not exact.

Table 4. List of sponges collected at some stations in Sagami Bay and morphologic types of their spicules (Specimens of the Biological Laboratory, Imperial Household identified by Dr. Senji Sanita)

	Species	Spicule type
A	*Cribrochalina variabilis* Vosmaer	style or subtylostyle
	Stylocordyla borealis (Loven)	oxea
B	*Grantessa shimeji* Hozawa*	
	Leucandra abratsbo Hozawa*	
	Haliclona cinerea (Grant)	oxea
	Iotrochota baculifera Ridley	style, strongyle, birotulae
	Callyspongia bispicula Tanita	oxea
	C. confoederata (Ridley)	oxea
	C. elegans (Thiele)	oxea
	Ceraochalina differentiata Dendy	oxea
	Siphonochalina truncata Lindgren	strongyle
	Tedania digitata (Schmidt)	style, strongyle or tylote, raphide
	Raspailia trachystyla Tanita	style, trachystyle
	Eurypon naikaiensis Hoshino	style, acanthostyle
	Spirastrella abata Tanita	style, aster
	Suberites infrafoliata (Thiele)	tylostyle, microstrongyle
	Jaspis coriacea (Carter)	oxea, aster
	Stelletta misakensis Lebwohl	oxea, triaene(dicho-, pro-, ana-, plagio-), aster
C	*Ceraochalina spaericuslobatus* Hoshino	oxeon
	Mycale plumosa (Carter)	style or subtylostyle, sigma, anisochela, toxa
	Rhizaxinella clavata Thiele	subtylostyle to style (or tylostrongyle), tylostyle
	Tetilla cranium (Mueller)	oxea, triaene(pro-, ana-), sigma
D	*Cribrochalina variabilis* Vosmaer	style to subtylostyle
	Raspailia folium Thiele	style, trachystyle
	R. villosa Thiele	style, trachystyle
	Biemna rhabdermioides Bergquist	style to subtylostyle, microxea, sigma, sphere
	Acanthella simplex Thiele	style, strongyle
	A. vulgata Thiele	style, strongyle
	Bubaris radiata Dendy	style, strongyle
	Phakellia fusca Thiele	oxea, style
	Polymastia granulosa Brondsted	style, tylostyle
	Quasillina brevis (Bowerbank)	style to subtylostyle, small style
	Rhizaxinella clavata Thiele	subtylostyle to style (or tylostrongyle), tylostyle
	Thenea calyx Thiele	oxea, triaene(dicho-, plagio-, ana-), aster
	Tetilla cranium (Mueller)	oxea, triaene(pro-, ana), sigma
	Discodermia calyx Doederlein	oxea, triaene(disco-, phyllo-), desma, microxea, microstrongyle
	Plakina monolopha Schulze	oxea, calthrop
	Aphrocallistes ?**	
E	*Isodictya infundibuliformis* (Linne)	oxea
	Cribrochalina variabilis Vosmaer	style to subtylote
	Leucosolenia mutsu Hozawa*	
	Ircinia fasciculata (Pallas)	none
	Haliclona oculata (Linne)	oxea
	Iotrochota baculifera Ridley	style, strongyle, birotulae
	Callyspongia ramosa (Gray)	oxea

	Adocia cinerea (Grant)	oxea
	Tedania digitata (Schmidt)	style, strongyle or tylote, raphide
F	*Mycale plumosa* (Carter)	style or subtylostyle, sigma, anisochela, toxa
	Halichondria fibrosa (Fristedt)	oxea
	Hymeniacidon perlevis (Montagu)	style or subtylostyle
	Jaspis coriacea (Carter)	oxea, aster
	Tethya amamensis Thiele	style, asters
	T. japonica Sollas	style, asters
	Stelletta subtilis (Sollas)	oxea, triaene(dicho-, pro-, ana-, plagio-), asters
	Sycon misakensis Hozawa*	
	Gellius jugosus (Bowerbank)	oxea, sigma
G	*Stylocordyla borealis* (Loven)	oxea, triaene(dicho-, plagio-, ana-), asters
	Thenea calyx Thiele	oxea, triaene(dicho-, plagio-, ana-), asters
	Leucosolenia mutsu Hozawa*	
	Sycon ornatum Kirk*	
	Heteropia striata Hozawa*	
	Leucandra abratsbo Hozawa*	
	Hippospongia communis (Lamarck)	none
	Haliclona cinerea (Grant)	oxea
	H. clathrata (Dendy)	oxea
	H. primitivus (Lundbeck)	oxea
	Desmacidon digitata Ridley & Dendy	oxea, isochela
	Callyspongia confoederata (Ridley)	oxea
	C. elegans (Thiele)	oxea
	C. fibrosa (Ridley & Dendy)	oxea
	C. ramosa (Gray)	oxea
H	*Ceraochalina differentiata* Dendy	oxea
	C. pergamentacea (Ridley)	oxea
	C. spaericuslobata Hoshino	oxea
	Siphonochalina truncata Lindgren	strongyle
	Pellina carbonaria (Lamarck)	oxea
	Petrosia similis Ridley & Dendy	oxea
	Tedania brevispiculata Thiele	tylote, style, raphide
	T. digitata (Schmidt)	style, strongyle or tylote, raphide
	Eurypon naikaiensis Hoshino	style, acanthostyle
	Mycale plumosa (Carter)	style or subtylostyle, sigma, anisochela, toxa
	Ciocalypta penicillus Bowerbank	style, oxea
	Spirastrella insignis Thiele	style, aster
	Aaptos aaptos (Schmidt)	style
	Polymastia affinis Thiele	style, tylostyle
	Suberites ficus (Johnston)	tylostyle, microstrongyle
	Jaspis coriacea (Carter)	oxea, aster
	Craniella australiensis (Carter)	oxea, triaene(pro-, ana-)
	Grantessa shimeji Hozawa*	
	Esperiopsis uncigera Topsent	style, isochela
I	*Halichondria okadai* (Kadota)	oxea, rarely style and strongyle
	H. panicea (Pallas)	oxea
	Tethya amamensis Thiele	style, asters
	Tetilla serica (Lebwohl)	oxea, triaene(pro-, ana-), sigma
J	*Esperiopsis plumosa* Tanita	style, isochela
K	*Leucosolenia protogens* (Haeckel)*	
	Aphrocallistes ?**	
L	*Euplectella marchalli* Iijima**	

M *Hexasterophora* sp. ?**

* Calcarea
** Hexactinellida
The letters A - M in tha left column correspond to following areas.
A: Hiramon off Enoshima Island; 70 to 80 m deep
B: off Hayama shallowe than 30 m deep
C: Shirane; 100 to 120 m deep
D: Amadaiba of Kamegi-sho Reef; 70 to 100 m deep
E: Irappodashi of Kamegi-sho Reef; 60 m deep
F: Kasashima Island
G: Kamegi-sho Reef; 30 fathoms deep
H: Kamegi-sho Reef; 5 to 8 fathoms deep
I: Misaki and Koajiro; 1 to 2 fathoms deep
J: 3.5 km west off Arasaki; 500 m deep
K: Okinose; 70 to 90 m deep
L: Okinose to Sunosaki; 100 m deep
M: 12 km northeast off Okinose; 300 m deep

Table 5. List of sponges collected on the shelf southwest off Jogashima Island

Species	Spicule Type
Acanthella vulgata Thiele	style, strongyle
A. sp.	style, oxea
Raspailia folium Thiele	style, trachystyle
Epipolasis novae-zealandiae (Dendy)	oxea, microxea
E. suluensis (Wilson)	oxea
Pachastrella scrobiculosa Lebwohl	oxea, orthotriaene, aster
Stelletta misakensis Lebwohl	oxea, triaene, aster
Ceratopsis expansa Thiele	style, microxea
Lissodendryx isodicyalis (Carter)	style, tylote, sigma, isochela
Papyrula hilgendorfi (Thiele)	oxea, dichotriaene, microxea

These sponge specimens offered by Dr. Itaru Hayami were identified by Dr. Senji Tanita.

The Tokai Regional Fisheries Research Laboratory carried out many deep-sea trawlings in and around Sagami Bay by the R/V Soyo-Maru of the Laboratory from 1957 to 1967. Hexactinellid sponge specimens have been collected at some stations (Okutani, 1969).

IV CORRELATION OF THE SPICULE ASSEBLAGE IN THE SEDIMENT WITH THE SPICULE ASSEMBLAGE OF LIVING SPONGES IN SAGAMI BAY

1. An Examination of Correlation at the Same Station

At Station 6 of the KT-73-13 cruise of the R/V Tansei-Maru off Enoshima Island (Figure 1) a sediment sample of coarse sand and some living sponge specimens were obtained by dredging (one haul only) (Table 1). The composition of morphologic types of spicules in the sediment at the station is characterized by its simplicity, the abundance of unbroken spicule and the presence of fragments of dermal layer with spicules nonseparated (Table 6).

Two-thirds of demosponge spicules are short oxeas and 18.4% are long oxeas (Plate I, Figure 1). Other spicule types except a small amount of calthrop are rare.

The presence of fragile fragments of dermal layers of demosponge with spicules still attached (Plate I, Figure 2) suggests their supply to the sediment with little transportation. A small amount of broken fragments of spicule support the fact too. The types of spicule in the sediment might, therefore, be expected to correlative with the spicule types of living sponges at site. Six species of demosponge and two species of hexactinellid sponge were collected (Table 7).

The short oxeas which constitute the greater part of spicules in the sediment correspond to those of *Sigmadocia vagabunda* (Plate I, Figure 3). Oxeas of the sponge have very uniform length of 400 to 500 microns and are correlative with short oxeas in the sediment in form and size.

Although long oxeas, which are next in abundance, are variable in size (length and thickness), the greater part of them are derived from *Epipolasis novae-zealandiae* (Plate I, Figure 4), which have length of 2 to 3 mm and of *Pachastrella tenuilaminaris*,

Table 6. Morphologic types of spicule in the sediment of Station 6 of the KT-73-13 cruise

Spicule Type	Number
Demosponge spicule	
Short oxea	2181 (65.6%)
Long oxea	612 (18.4)
Style	15 (0.5)
Strongyle	2 (0.1)
Orthotriaene	4 (0.1)
Calthrop	49 (1.5)
Sterraster	15 (0.5)
Sigma	1 (0.0)
Fragment of dermal layer	20 (0.6)
Others (including indeterminable broken fragments of spicule)	390 (11.7)
Hexactinellid sponge spicule	
Framework of spicule	31 (0.9)
Microspicule	6 (0.2)
Total	3326(100.0)

*Number of spicule indicates amount in 1.78 g of sand fraction of sediment

Table 7. List of sponge species collected at Station 6 of the KT-73-13 cruise

Species	Spicule Type
Sigmadocia vagabunda (Schmidt)	oxea, sigma
Mycale adhaerens (Zambe)	style, anisochela, sigma
Phakellia ventilabrum (Johnston)	style
Jaspis sadoensis Tanita	oxea, small oxea, aster
Epipolasis novae-zealandiae (Dendy)	oxea, microxea
Pachastrella tenuilaminaris (Sollas)	oxea, calthrop, microxea, aster
Hexactinellida A, B	

Identified by Dr. Senji Tanita

whose specimens have large bodies and have been collected more than other species specimens (Plate I, Figure 5). Probably the sponge *Pachastrella tenuilaminaris* and *Jaspis sadoensis*, although only one specimen collected, also contribute to long oxeas in the sediment.

Calthrop spicules occur in small numbers in the sediment. Only a sponge species *Pachastrella tenuilaminaris* collected has calthrop in its skeleton and calthrop in the sediment may owe to the sponge.

Thus oxea and calthrop in the sediment are correlative with those of sponges collected. But the source of triaenes, which occur in small amounts in the sediment is presently unknown, because no sponge specimen with triaene in its skeleton have been found. This inconsistency may be explained either by insufficient sampling of living sponges by dredging or by transportation of these spicules from distant places. The former interpretation seems highly likely, because collection of many sponge specimens having triaene has been reported on the shelf off Enoshima Island by some authors. Thiele (1898) reported the existence of *Stelletta*, *Thenea*, *Geodia*, *Tetilla* and *Craniella* which have different kinds of triaene (Table 3).

The provenance of sterraster in the sediment is also unknown, because no sponge specimen bearing sterraster has been collected at the present station. This inconsistency seems to be explicable by the same possibilities as described previously.

Another inconsistency between the spicule assemblage in the sediment and the spicule assemblage of living sponge specimens collected is the absence of microsclere spicules. Sigma spicules are not found in the sediment, though two sponge species, *Sigmadocia vagabunda* and *Mycale adhaerens*, bear a certain number of these spicules. A small number of fragments of hexactinellid skeletons larger than sand grain in size are found in the sediment (Plate I, Figure 7). Sponge specimens of hexactinellid sponge have been obtained at the present station. In spite of the abundant occurrence of microspicules packed in the framework of the skeleton of living forms (Plate I, Figure 6), they hardly occur in the skeletons found in the sediment. Microsclere spicules are supposed to disappear easily through the supply processes to the sediment.

2. An Examination of Interrelation among Four Stations on the Shelf and the Uppermost Part of Continental Slope of Miura Peninsula

Station 48 of the KT–78–10 cruise of the R/V Tansei Maru is situated on the shelf and Stations 61, 63 and 64 are on the uppermost part of continental slope (Figure 4). Although these four stations are situated within several kilometers, the relative abundance of morphologic types of spicule in the sediment is variable (Table 8).

Though the most abundant type of spicule in the sediment is oxea at each station, the relative abundance of oxea ranges from 30.8% at Station 63 to 60.6% at Station 61. Pronounced variation of the relative abundance of tylostyle, plagiotriaene, orthotriaene and dichotriaene is also noticeable at each station.

The inconsistency of relative abundance among four stations suggests the difference

Table 8. Relative abundance of different morphologic types of spicule excluding sterraster in sediment at Stations 48, 61, 63 and 64 of KT-78-10 cruise

Morphologic type	St. 48	St. 61	St. 63	St. 64
Oxea (calcareous)	0.3%	0.2%	6.3%	0.5%
Regular triradiate	11.8	0.9	27.0	4.7
Sagittal triradiate	0.1	0.1	0.1	0.2
Oxea	35.5	60.6	30.8	52.3
Strongyle	2.2	2.3	1.0	0.4
Acanthostrongyle	0.2	0.1	0.0	none
Style	16.0	4.8	6.8	6.0
Tylostyle	14.1	3.6	3.7	7.5
Acanthotylostyle	1.7	2.3	none	none
Calthrop	2.1	1.2	1.0	2.0
Plagiotriaene	3.1	4.0	7.3	6.7
Orthotriaene	0.6	1.0	2.8	3.0
Anatriaene	0.7	0.2	0.8	1.4
Protriaene	none	0.4	0.3	1.0
Dichotriaene	6.0	1.2	6.6	7.2
Phyllotriaene	none	1.0	1.1	1.4
Discotriaene	0.1	0.5	0.0	0.1
Sigma	none	0.2	none	0.4
Desma	none	1.1	1.9	3.1
Others	5.5	4.8	2.5	2.1

of sponge species that have supplied spicules to the sediment and little transportation over long distances. It is also supported by the fact that many spicules in the sediment have not been so much broken.

No sponge specimen was collected together with the sediment at these four stations. However at the locality G shown in Figure 4, where is located in the vicinity of Station 63, demosponge specimens, *Gellius*, *Stylocordyla* and *Thenea*, have been collected (Table 4). Morphologic types of spicule of these demosponges are oxea, dichotriaene, plagiotriane, anatriaene, sigma and asters. Oxea, dichotriaene and plaiotriaene are common constituents of spicule in the sediment at Station 63 although no sigma is found. Thus good correlation is recognizable.

Another noteworthy feature of spicule type composition is the abundance of calcareous spicules (triradiate and oxea). Their abundance is high at Station 63 (33.4%), and intermediate at Stations 48 (12.2%), while it is very low at Stations 64 (5.4%) and 61 (1.2%).

The sediments at some stations on shelves of northeastern part of Sagami Bay (Stations 62, 63, 66 and 69 of KT-70-4; Station G 6 of KT-73-13) are characterized by the abundance of large calcareous spicules (Figure 4). That the sediments of stations beyond the edge of the shelf contain few calcareous spicules suggests an exclusive existence of calcareous sponge on the shelves and little transportation of their spicules over long distances.

At some stations in the vicinity of Station 63 of the KT-78-10 cruise (the areas G and H in Figure 4) some calcareous sponges have been obtained (Table 4). They are *Sycon* in the area G, and *Leucosolenia*, *Sycon*, *Heteropia* and *Leucandra* in the area H. Regular and sagittal triradiate and oxea which are abundantly observable in the sediment of Station 63 can be explained to be originated from these calcareous sponges.

Of the areas A to J shown in Figure 4 the occurrence of living calcareous sponge species is restricted to the nearcoast localities (B, F, G, H, and I) (Table 4). The fact is supposed to result in the low content of calcareous spicules in the sediment of Station 61 where is relatively remote off the coast comparing the other three stations.

Stations 62, 63, 66 and 69 of the KT-70-4 cruise, which are located on the shelf along the western coast of Miura Peninsula also yield many calcareous spicules (Figure 3). These spicules seem to be originated in calcareous sponges inhabited on the shelf area too.

The result of the investigation is summarized as follows:

1. Sponge spicules in the sediment in the investigated area are supposed to undergo little or no transportation over several kilometers. Thus the supply of them to the sediment is local.

2. However amount and morphologic types of spicules of living sponge are not always consistent with those of spicules in the sediment.

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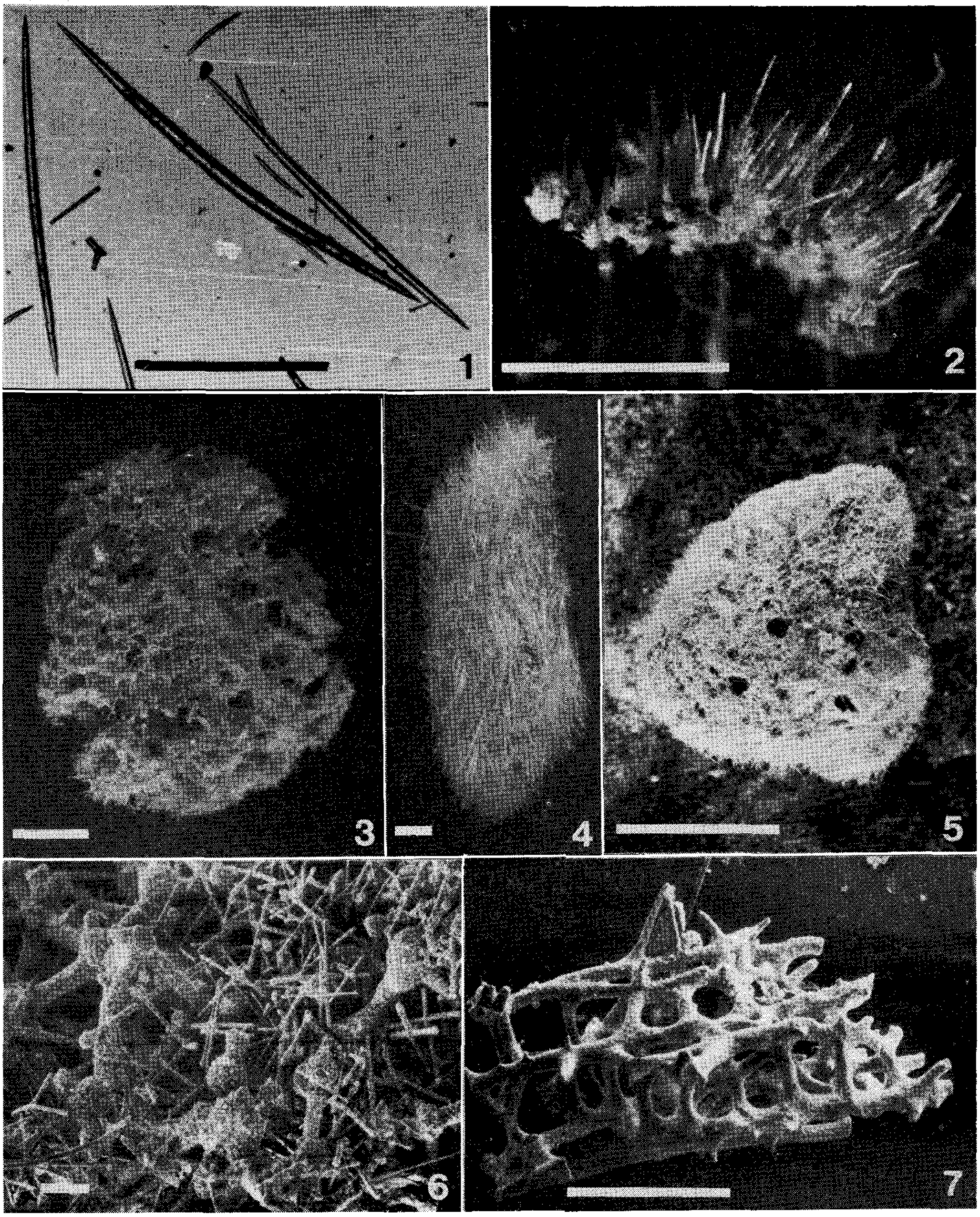

Plate I: Sponge spicules in the sediment and sponge specimens collected at Station 6 of the KT-73-13 cruise (Scale bar indicates 1mm unless otherwise noted).
1: Short oxea and long oxea predominate in the sediment. 2: A fragment of the dermal layer of a sponge. 3: A skeleton consisting of short oxea of the sponge *Sigmadocia vagabunda* (Schmidt). 4: A skeleton consisting of long oxea of the sponge *Epipolasis novaezealandiae* (Dendy). 5: A specimen of the sponge *Pachastrella tenuilaminaris* (Sollas). A compact aggregate of oxea. Scale bar indicates 1cm. 6: A scanning electron micrograph of a skeleton of a hexactinellid sponge. Many microspicules are present in the framework. Scale bar indicates 0.1mm. 7: A scanning electron micrograph of a fragment of a skeleton of a hexactinellid sponge from the sediment. Microspicules are absent.