SOME ECOLOGICAL ASPECTS OF ZYUSAN-GATA WITH SPECIAL REFERENCE TO THE HABITATS OF *CORBICULA JAPONICA* GROUP

Akira FUJI

Faculty of Fisheries, Hokkaido University

The Inlet Zyusan-gata, situated near the apex of the Tsugaru Peninsula, Aomori Prefecture, is about 18.5 Km^2 in area. It is connected with the Japan Sea through a narrow strait opening north-westward, which is about 300 m in length and about 100 m in width. The Rivers Yamada and Iwaki empty into this inlet in the south and south-eastern coast respectively as the main rivers. The general shape of the Zyusan-gata is shown in Fig. 1.

In this inlet, Tamura (1952, 1953) has reported mainly on seasonal change of chemical characters of the inlet water, and pointed out that the salinity of inlet water had comparatively high concentration from early summer to late autumn, however, from winter to spring it became nearly zero. As a result of this observation, he concluded that this phenomenon had a controlling influence on the survival of the animal habitants in this inlet.

In the Zyusan-gata the commercial fishing of the clam (*Corbicula japonica*) has been prosecuted for many years and, as shown in Table 1, the annual production of

Table 1. *Yamatosizimi* (*Corbicula japonica*) and other aquatic products processed in Zyusan-gata, 1944 to 1953

Year	*Yamatosizimi*		Other aquatic products	
	Yield	Value of products	Yield	Value of products
	*Kan**	*Yen*	*Kan*	*Yen*
1944	40,000	400,000	35,700	3,860,000
1945	60,000	600,000	30,700	3,290,000
1946	100,000	1,000,000	28,500	3,180,000
1947	100,000	1,500,000	20,300	3,240,000
1948	100,000	1,500,000	17,300	2,690,000
1949	150,000	3,000,000	15,700	2,560,000
1950	130,000	2,600,000	13,200	2,110,000
1951	150,000	3,000,000	11,200	1,760,000
1952	130,000	2,600,000	7,700	1,200,000
1953	120,000	2,400,000	3,800	580,000

* 1 *Kan* is about 3.75 Kg.

this clam amounts to about 120000 *Kan* (about 480 tons). From the above table it will be noticed that the clam fishery has been of very great economic importance to fishermen because it is the only stable fishery that they engage in. Consequently,

that point should be mentioned first in reporting on the ecology of Zyusan-gata with reference to the environmental conditions of the habitat of the clam, although the clam fishery is also vitally interested in various aspects of the ecology of *Corbicula japonica*. In this paper is reported the general ecology of this inlet together with some information on bottom material and benthic animals.

Before proceeding further, the author expresses his heartly thanks to Prof. T. Tamura of the Faculty of Fisheries, Hokkaido University, for his guidance throughout the work. He is also grateful to Mr. T. Banba, Chief of Zyusanmura Fishermen's Association and Mr. S. Kudo of the Aomori Fisheries Experimental Station, for their help of various sorts in collecting the samples in Zyusan-gata.

The present work was carried out with the financial aid of a subsidy for Fisheries Research from the Aomori Prefectural Office.

Method

Survey stations are indicated in Fig. 1, namely 62 stations designed lattice-like being at about 500 m interval from each other. The observations covered the period from Oct. 4, to Oct. 7, 1953, during which measurement of depth, collection of bottom material and quantitative samples of clam were made all stations while quantitative collections of benthos and water samples were made at the 28 stations shown in Fig. 1, as solid circles. Water samplings at these stations were made from bottom layer at 0.1 m above the bottom by Tamura's water sampler. The chlorinity was determined by titration with silver nitrate.

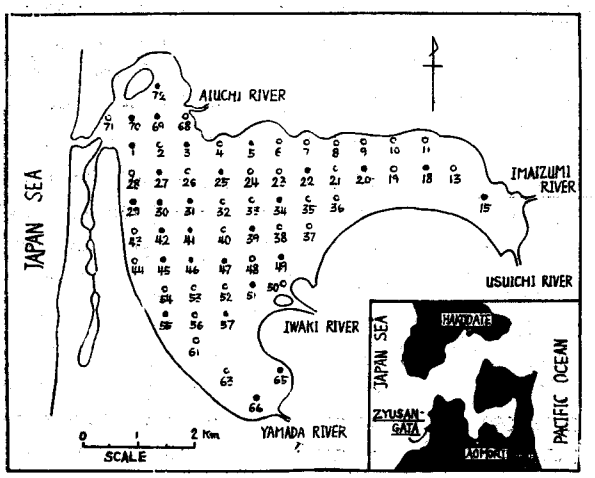


Fig. 1. Sketch-map of Zyusan-gata showing stations of observation

The bottom material was collected with Ekman-Birge type bottom snapper. The bottom samples, after drying, were analysed by the Turin method for organic carbon, and the total nitrogen contents were determined by the Kjeldahl method. The particle size was measured by the Beaker method as follows: viz. gravel (particle diameter over 2 mm), coarse sand (2-0.3 mm), fine sand (0.3-0.05 mm), silt (0.05-0.01 mm), and clay (less than 0.01 mm).

In order to observe the benthos the following operations were repeated at the various stations. The bottom material was quantitatively sampled by Ekman-Birge type bottom snapper of 120 cm^2 area and was sifted out by a wire net with 15 meshes to the linear inch to remove mud and sand. As the next step, the animal specimens

left in the sieve were fixed with about 5 % formalin; the number of individuals of each species was counted and these data were recorded per m^2.

Result

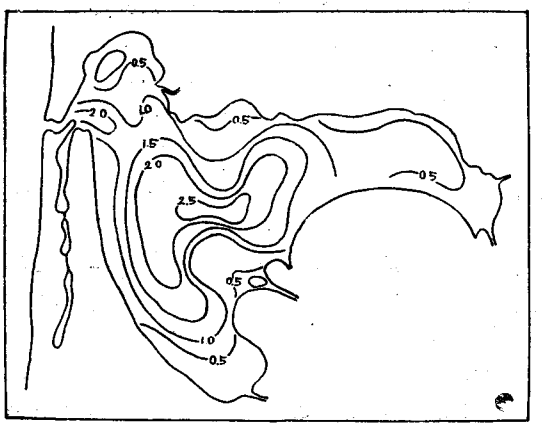


Fig. 2. Depth of water in Zyusan-gata

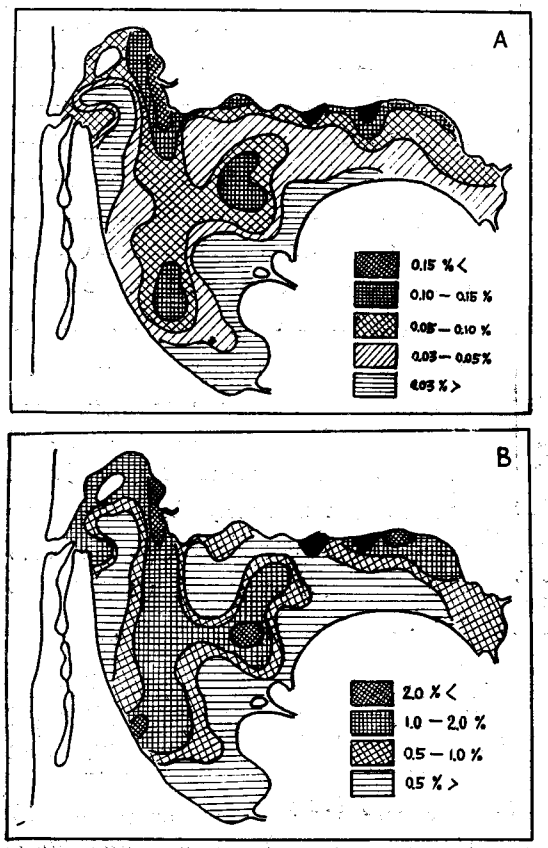


Fig. 3. Distribution of chemical elements in the bottom material
A and B indicate distribution of total nitrogen contents and organic carbon contents respectively.

Bottom material : Generally, the depth of water shows an average of less than 1.5 m, although both the central part and the mouth of strait form a deeper basin with maximum depth of approximately 3.0 m. The channel of the River Iwaki projects toward the central part of inlet near its estuary. A shallow part that is called *Okinose* including St. 24 & 25 also approaches to the central part of the inlet. Such tendency concerning the shallowness in the central part increases suddenly (Fig. 2).

Horizontal distribution of organic carbon and total nitrogen contents of the bottom material are shown in Fig. 3. In Fig. 4, percentage of the particles of less than 0.05 mm diameter against the total composition of the bottom material of all stations is presented. Maximum contents are 40 and 20 % near the south-eastern coast and the central part; these areas have considerably high contents in organic carbon and total nitrogen in comparison with others.

The substratum of the shallow areas which occupy the innermost at the inlet is formed of sandy mud, so that these areas provide favourable substratum conditions as the clam field.

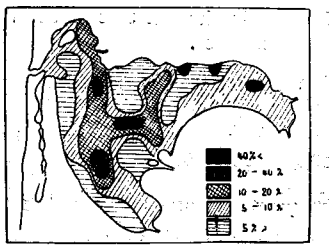


Fig. 4. Distribution of the particles of less than 0.05 mm diameter (silt & clay) in the bottom material

Benthic communities : The composition of benthos collected by Ekman-Birge type bottom snapper with an opening of 120 cm^2 at the 28 stations during the above term in this inlet is as follows:

Corbicula japonica	48.3 %	*Paranthura* sp.	1.3 %
Anisogammarus kygi	20.7	*Neomysis intermedia*	0.8
Neosphaeroma oregonensis	19.6	*Crago affinis*	0.5
Assiminea septentrionalis	6.7	*Semisulcospira libertina*	0.3
Nereis japonica	1.8		

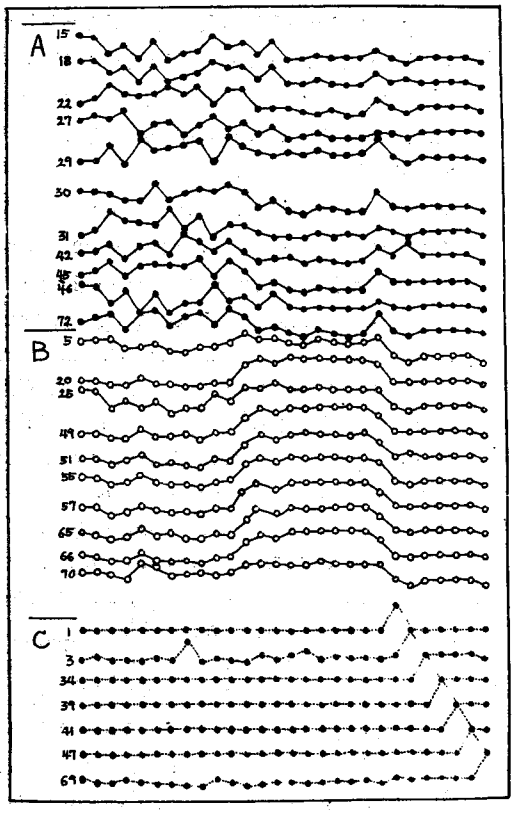


Fig. 5. Series of correlation coefficients of the benthic composition showing the reciprocal relation between the stations. Numbers in the left side of this figure indicate station number.

The number of species and specimens thereof is not great. The maximum number of individuals is 2750 per m^2 for *Corbicula japonica* which is the predominant in this inlet. There are 2080 for *Neosphaeroma oregonensis*, 1580 for *Anisogammarus kygi*, while other species were small in the number of individuals. The composition of benthos is not uniform throughout the inlet, but varies with stations. Such composition of benthos at each station is regarded as a cumulative result of the various environmental conditions. Using the method of Motomura (1936), the correlation coefficient between the composition of every two stations was calculated one by one and thus the reciprocal relation between each of the stations was represented by 28 series of correlation coefficients (Fig.5). It will be seen that they are divided into three groups by their forms, viz. (A), (B) and (C) benthic communities (Fig.6).

The first benthic community is (A). This community spreads out from near the mouth of the strait to the north-western coastal area, which has no river pouring into the inlet. *Anisogammarus* and *Neosphaeroma* are dominant making 36.1 % of the benthos in this area, while *Corbicula* occupies only 8.3 %.

The second community which is situated near the estuaries of all rivers is assumed to contrast with the first community. This area has relatively abundant benthos totaling 65.1 % of the total benthic fauna in this inlet. Dominant species is

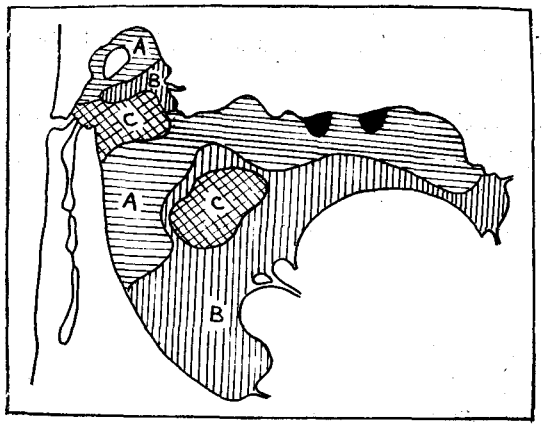
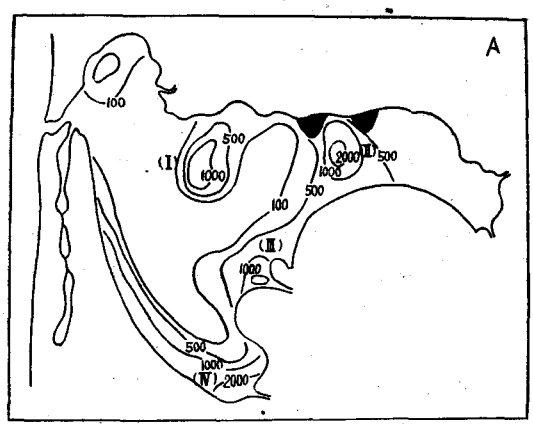


Fig. 6. Map showing the ground of three benthic communities



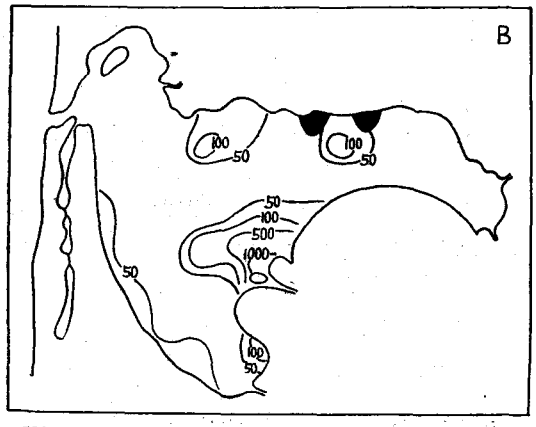


Fig. 7. Distribution of *Corbicula japonica*
A is the distribution of adult clams and **B** display the distribution of larval clams.

Corbicula japonica presenting 71.4 % of the benthic animals in this community, followed by *Anisogammarus kygi* with 12.7 %.

In the third community, benthos is lacking. *Nereis japonica* and *Crago affinis* were found in this area, which show only 0.5 % of the total benthic population in this inlet.

Among them, the horizontal distribution of clam is shown in Fig. 7, A. If the area holding more than 1,000 individuals of clam per m^2 is recognized as the main clam field in this inlet, there will be four areas, viz., areas I, II, III and IV. The distribution of larval clam also shows the same tendency as adult one (Fig. 7, B).

Discussion

On Oct. 4, 1953, the horizontal distribution of salinity was in agreement with Tamura's observation in Oct. 1950 (Tamura, 1953) (Fig. 8). According to Tamura (1953), even in the deepest part no difference was observed between the salinity of surface and bottom water, so it was assumed that the salinity of bottom water has the represented same fluctuation as the surface layer. In the Zyusan-gata, two channels run inward from the mouth of the strait; one is directed to the River Yamada, the other runs toward eastern area of the inlet through the central part. From the above configuration of salinity distribution (Fig. 8) it appears that the sea water inflows inward along these channels. Also, areas possessing abundant contents of humus and fine soil have been found in both channels; this is probably due to the slight particles precipitated by the stagnation

of the water through the channels.

It is believed that the distribution of benthic animals is controlled by hydrographic characters of bottom layer including physical properties of substratum. Yamamoto (1950, 1951) pointed out that the configuration of the benthic communities resembles the distribution of the salinity of bottom layer in Mutsu Bay, and, with that observation as a basis for his opinion, he concluded that the distribution of benthos was controlled by the salinity of bottom layer. Also, Kato & Ishizuka (1949) discussed the relation between the distribution of scallops and the contents of organic carbon in the bottom materials in Mutsu Bay; they pointed out that the factors related to the supplement of oxygen were more important than the physical properties of substratum. Accordingly, benthic communities (A), (B) and (C) were compared with the environmental conditions in Zyusan-gata.

In communities (A) and (B), the substratum is composed of sand or sandy mud and the depth of water is less than 1.5 m in both areas, but the salinity of bottom layer shows a fair likeness with the configuration of the benthic communities. The locality near the estuary Aiuchi is probably affected by fresh water belonging to community (B). From these observations, it is suggested that community (A) is influenced by some characters of sea water and that community (B) receives the properties of fresh water more than the community (A). Finally, in community (C) situated in the central part of the inlet and at the mouth of the strait has no difference comparing with communities (A) and (B) in respect to the salinity of water, however, the bottom characters including higher contents of humus indicate remarkable difference. If all stations are divided into two categories, according to appearance or non-appearance

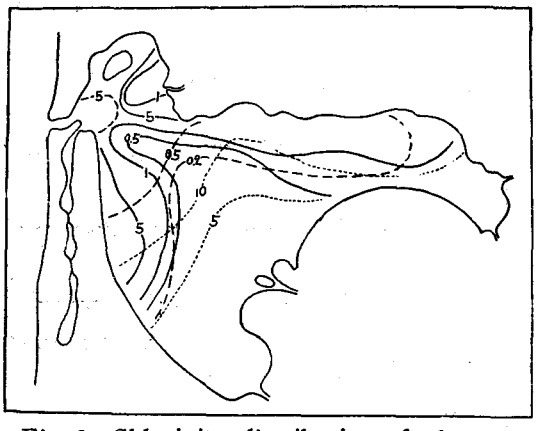


Fig. 8. Chlorinity distribution of the bottom water
Full line indicates the results on Oct. 4, 1953. Broken and dotted lines represent Tamura's observations obtained in Oct. 1950 and June 1948, respectively.

Table 2. Relation between the distribution of clam and the organic carbon contents of the bottom material

Contents of organic carbon	Appearance		Non-appearance
	Number of stations	Number of clam individuals	Number of stations
0.5 % and under	25	208	5
0.5-1.0 %	5	33	7
1.0 % and over	5	33	15
Total	35	274	27

of clam, the relation between the distribution of clam and the contents of organic carbon in the bottom material would show as is tabulated in Table 2. In the first case, the number of stations reporting the appearance of the clam and number of individuals of clam both increase with diminution of the organic carbon; on the other hand, they also increase in proportion to augmentation of the organic carbon in the bottom material.

Summary

1) Generally, in this inlet the water is mostly shallow of less than 1.5 m and in such area the humus content is poor, so that such areas form favourable clam fields.

2) *Corbicula japonica* is dominant forming 48.7 % of the composition in the inlet among the benthos; it is followed by *Anisogammarus kygi* 20.7 % and *Neospheroma oregonensis* 19.6 %.

3) Motomura's correlation coefficient method was employed for the discussion of the benthic communities. There were seen three communities as follows (Fig. 5 & 6):

Community (A) : This community receives influence of sea water, and *Anisogammarus kygi* and *Neosphaeroma oregonensis* are dominant species.

Community (B) : *Corbicula japonica* is dominant. This area is affected by fresh water more largely than community (A).

Community (C) : This community has few benthic animals; the substratum consists of mud including abundant organic humus.

4) In Zyusan-gata, the commercial fishery exploits *Yamatosizimi* (*Corbicula japonica*). As shown in Fig. 7, the main clam field is located in four areas, viz. areas I, II, III and IV.

References

Kato, K. & Ishizuka, T. (1949). *Jour. Fish.* 54. (in Japanese).

Motomura, I. (1936). *Ecol. Rev.* 1. (in Japanese).

Tamura, T. (1952). *Aomoriken Suisan Shigen Chosa Hokoku* 2. (in Japanese).

———— (1953). *Ibid.* 3. (in Japanese).

Yamamoto, G. (1950). *Sci. Rep. Tohoku Univ.* 18.

———— (1951). *Ibid.* 19.