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APPROACH TO THE REGIONALIZATION OF AGRICULTURAL-PASTURALIZATION AROUND CHANGSHAN ISLANDS IN NORTHERN YELLOW SEA

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ABSTRACT: Based on the data of resources, environment and foundation of production, applying principal components-clustering quantitative analysis, this article divides the maritime space of Changshan Islands into three regions of agricultural-pasturalization, providing a scientific basis for the rational distribution of marine cultivation. The three regions are as follows: 1)The region of an agricultural-pasturalization in the northern part of maritime space. It includes Da Wangjia and Shicheng islands. The main production is cultivation of prawn and molluscs in sea beach, float raft culture of mussel in shallow sea and scallop, and breeding of sea cucumber in submarine. 2) The region of agricultural-pasturalization in the middle western part of maritime space. It includes Da Changshan and Guanglu islands, and western part of Xiao Chengshan Island. The main production is float raft culture of mussel and scallop in shallow sea, and breeding of sea cucumber in submarine. 3)The region of agricultural-pasturalization of the southeastern part of maritime space. It includes the eastern part of Xiao ChangShan Island, Haiyang and Zhangzi islands. The main production is breeding of abalone, sea cucumber, algaes and fish.

KEY WORDS: Yellow Sea; Changshan Islands; agricultural-pasturalization of seashore; principal components-clustering analysis; regionalization

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There are great varieties of organic resources in the sea. Fishing for most of the animals and plants is characteristic of collecting and hunting, while artificial culture of some animals and plants has the characteristic of agricultural production (ZENG, 1980). Agricultrual-pasturalization of the seashore means artificial culturing and breeding of some marine organic resources such as molluscs, algae, fish, and shrimps. It aims to raise biological abundance, turn the mode of production from collecting and hunting natural resources into cultivating and breeding, and provide more and more marine products to meet people's increasing demands of lives. At present, molluscs, algae, fish and shrimps are bred and cultured in the sea. Breeding in the sea has developed from traditional "four main molluscs" into prawns, mussels scallops, abalone and some fish, and has gradually become a new and developing property of marine industries.

1 ANALYSIS ON THE NATURE OF MARITIME SPACE AROUND CHANGSHAN ISLANDS

Changshan Islands are located in the southeast of Liaodong Pennisula in the northern Yellow Sea, and consists of 112 islands, lumps and reefs. Its total area is 3428.5km^2 (this is the marine space area of Changhai County). The main northern islands (Shicheng, Da Wangjia and Xiao Wangjia) are only over 10km away from land; the farthest islands of Zhangzi and Haiyang are about 70km away from land; the east-west span of these islands goes beyond 100km. Because they lie on the rim of the continent, its state of sea, water regime, and meteorological characters are all influenced by land. Some run-off from the Yalu River, the Dayang River, the Zhuanghe River and the Biliu River of Liaodong Pennisula converge into this maritime space in northern Yellow Sea, and influnce the northern and

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middle part of the sea rather obviously. Distributions of key marine hydrographic elements are different with the variation of distance from land.

1.1 Maritime Environment

The maritime environment consists of depth of water, water temperature, ocean currents, substrates, salinity, ice conditions and seawater nutrient (Table 1) (ZHANG and ZHANG, 1997). These factors have a close relationship with the development of sea water cultivation.

Table 1 shows that depth of water in the whole maritime region is less than 50m, it extends towards the south and southeast, and becomes gradually deeper. Most of the substrate is oozy, parts of it is rock, gravel, and shell around islands. Only one or two islands are sandy. In tidal zones, the substrates of various islands are different, but mostly rocky, sandy and gravel etc.

Ocean currents of this region are mainly influenced by the littoral currents of southern Liaoning, which are formed by fresh water coverging from the Yalu River and the Biliu River. They appear seasonally, especially in the middle-northern part of maritime space. Freezing

Table 1 Environmental elements of maritime space of Changshan Islands

Elements	Maritime space		
	North	Middle	South
Maritime area (km^2)	728.7	979.9	1719.9
Degree influenced by land	most	a little	nothing
Depth of water (m)	< 30	< 40	< 50
Substrate	clay	clay and many other types	rocky reefs
Freezing condition	seriously	lightly	never
Standard number of watercolor	11	10	7
Transparency (m)	3.25	5.6	10.5
Surface temperature (℃)	7.9	9.4	10.5
Maximum surface temperature in summer months (℃)	> 25	< 25	< 24
Surface salinity (‰)	24.5	27.7	31.65
Phosphate (mg/m^3)	9.2	9.9	6.6
Quantity of phytoplankton($\times 10^3$ $cell/m^3$)	1550	1696	1960

Source: Report and Data on Agricultural Regionalization of Changhai County, 1986; Basic Investigation of Coastal-islands in Liaoning Province, 1990.

usually takes place to the south of the continent and in the north of those islands in the middle maritime, it begins from the middle ten days of December and lasts to the first ten days of March. In the maritime space of Shicheng Islands, freezing is the most serious, where ice thickness can reach 50 – 60cm. In the north of the islands in middle marine area it is about 10cm thick, and in the southern part, it never ices up.

The surface salinity increases gradually from north to south. In southern maritime space its average value is 31.65‰, making it high salinity seawater. Influnced by run-off from Liaodong Pennisula, the average in the northern part is 24.5‰, making it low salinity seawater and its variance in different years can reach 10‰, while the southern part varies no more than 5‰. Vertical variation of the salinity is not very obvious.

Sea water nutrient (especially phosphate) is the material basis on which phytoplankton rely to reproduce. The primary productive forces of some maritime space has a close relationship with nutrient content. In this maritime space, distribution of nutrient content decreases gradually from north to south. And its nurtrition types are shown in Table 2 (ZHANG and ZHANG, 1997).

Demands on the natural environment on which living things rely to habitate, grow and reproduce, mean that different predominant species cultivated in those three different regions belong to different nutrient types. The Northern region (including the tidal zone) is suitable for cultivating *Penaeus orientalis kishinoge*, *Ruditapes philippinarum*, *Mytilus edulis* and Scallop; the middle region is appropriate to cultivate *Stichopus japonicus selentea*, *Mytilus edulis*, Scallop, Ostrea, Kelp; the southern region will be suitable for cultivating *Haliotis discus hanna*, Conch and *Undaria pinnatifida* etc.

1.2 The Resoures of Maritime Space Suitable for Culture

Considering marine natural condition, distance from land and forage conditions etc., according to the

Table 3 Space resources of seawater culture in Changshan Islands (ha)

Maritime space suitable for culture	Area of maritime space	Area of shallow sea suitable for culture	Area submarine breeding suitable for culture	Area of seabeach	Area suitable for culture in seabeach
North	72870	2266.7	666.7	1340.0	533.3
Middle	97900	6000.0	10000.0	1629.7	426.4
South	171990	5033.0	18000.0	907.3	419.3
Total	342850	13299.7	28666.7	3870.0	1379.0

existing techonological level of cultivation, the area of the shallow sea whose depth of water is 20 – 40m, and suitable for float raft culture of mulluscs and algae, is about 133.3km^2, containing 4 percent of the total sea area. Relating to space resource suitable for seawater culture see Table 3(ZHANG and ZHANG, 1997).

Based on substrate of maritime space and distribution of organic resources, using the techonology of artificial raising and submarine breeding, as well as laying man-made fish bank to breed resources, the area of the seabed suitable for breeding is about 28666.7ha, including 6660ha of rocky reefs, 8660ha of gravel, 9330ha of conch and 4000ha of oozy substrate.

The area of the tidal zone amounts to 3870ha. According to the distribution of living resources and nutritional conditions, the area of the region suitable for culture is about 1330ha, among which about 400ha of seabeach is suitable for culture of *Ruditapes philippinarum* and prawns, and 930ha of rocky reef is suitable for culture of ostrea and *Mytilus edulis*.

1.3 Organic Resources

The maritime space of Changshan Islands has advantageous natural conditions and rich marine organic resources.

(1) Plankton

It has the character of having great varieties, among them about 55 species are phytoplankton, mostly diatoms. Their average biomass is 2660×10^3 cell/m^3; the highest is about 7840×10^3 cell/m^3. There are about 44 species of zooplankton, mostly protist, coelenterate, and arthropod, with an average biomass of 145 cell/m^3. Biocomposition and biomass change seasonally; in summer and autumn months they are higher than in spring and winter. Phytoplankton is distributed mainly in northern maritime space, whereas zooplankton is mainly in the southern area. Mussels and scallops mainly ingest Bacillariophyta, so plankton provides rich bait for fish, shrimp and mulluscs.

(2) Tidal zone organisms

Benthos includes eight phylums and 55 species of animal, and three phylums and 17 species of algae, with an average biomass of 810g/m^3. The primary ecomomic types are *Ostrea plicatula*, *Ruditapes philippinarum*, *Mytilus edulis*, *sargassum fusiforme*, etc. Most of them are not in use (Table 4) (ZHANG and HU, 1997).

(3) Shallow sea benthos in the coastal zone

They are mainly distributed in the benthic zone from low tide line to a depth of 20m or so. The primary benthos is echinoderm, taking 48 percent; molluscs take 38 percent and the rest are algae, coelenterate, annelid, arthropad, chordate, spongia, and so on. The average biomass is 348g/m^3. Among them, the most important economic species are *Haliotis disaus hannai*, *Stichopus japonicus selentea*, *Chlamys farrcri*, *Pinna(Atrina) pectinat(linnacus)*, *Saxidomus purpuratus*(sowerby), *Strongylocentrotus nadus(A. Agassiz)*, *Arca boncardi(Jousseaume)*, *Neptunea cumingi crosse*, *Mytilus coruscus*, and *Scapharca hroughtonii* (schrenck), as well as Agar etc. (Table 4) (ZHANG and HU, 1997).

Because of the differences among every type of maritime space enviroment, organisms′ distribution and their quantitative constitution all reflect the degree of its adaptability to circumstances and rigorous regional boundary lines, especially in the view of culture. For example, *Venerpis philippinarum*, a species cultivated in sandy coasts, dwells in middle or low tide regions. The approporiate water temperature ranges from 0℃ to 30℃, the specific gravity range of seawater is 1.015 – 1.027, and optimal water temperature varies from 14℃ to 28℃. Mussel, a species of shallow sea float raft culture, feeds mainly on diatoms and organic scrap. The appropriate water temperature range is rather broad at -2 – 28℃. And optimal water temperature ranges from 15℃ to 23℃, but it has some demands on turbidity and salinity. Scallop, a species cultivated by net-cage in pelagic regions, mainly ingests diatoms. The appropriate water temperature is 0 – 28℃; the optimal is

Table 4 Marine organic resources in Changshan Islands

			Total	North		Middle		South	
				Amount	Proportion (%)	Amount	Proportion (%)	Amount	Proportion (%)
Marine organic resources in tidal zone	Area (ha)	① *Ostrea plicatula*	912.67	448.73	48.2	302.65	32.5	179.29	19.3
		② *Ruditapes philippinarum*	195.87	79.33	40.6	70.8	36.1	45.73	23.3
		③ *Mytilus edulis*	214.07	22.37	10.4	98.73	46.1	93.06	43.5
	Amount of resource (t)	① *Ostrea plicatula*	11538.80	9685.90	83.9	1125.70	9.8	727.20	6.3
		② *Ruditapes philippinarum*	1493.00	1392.00	93.2	33.40	2.2	68.00	4.6
		③ *Mytilus edulis*	2833.90	112.20	4.0	313.50	11.0	2408.20	85.0
Benthos resources in coastal bay	Area (ha)	① *Haliotis discus hanna*	50.82			1.69	3.3	49.13	96.5
		② *Stichopus japonicus selenlea*	2768.40	132.27	4.8	2444.20	88.3	191.87	6.9
		③ *Neptunea cumingi crosse*	7598.60	12.00	0.1	142.33	1.9	7444.60	98.0
		④ *Chlamys farreri*	7168.29	4.83	0.1	318.33	4.4	6845.13	95.5
		⑤ *Saxidomus purpuratus*	27.09			5.47	20.1	21.62	79.9
		⑥ *Strongy locentrotus nadus*	37733.33			13466.67	37.7	24266.37	64.3
	Amount of resource (t)	① *Haliotis discus hanna*	146.20			0.10	0.1	146.10	99.9
		② *Stichopus japonicus selenlea*	2368.00	437.00	19.0	955.30	41.5	908.00	39.5
		③ *Neptunea cumingi crosse*	1481.30	12.40	0.8	67.70	4.6	1401.20	94.6
		④ *Chlamys farreri*	250.90	4.30	1.7	0.30	0.1	246.30	98.2
		⑤ *Saxidomus purpuratus*	1407.60			9.00	0.6	1398.60	99.4
		⑥ *Strongy locentrotus nadus*	2876.00			659.00	22.9	2217.00	77.1

15 – 20 ℃. When the specific gravity of sea water is below 1.017, its growing will stagnate. Thus maritime space for culturing of scallop, requires clean water and great flowability. As for the culturing of abalone and sea cucumber, they cann't be separated from their appropriate habitat.

2 PRODUCTIVE AND SCIENTIFIC EXPERIMENTS PROVIDE PREREQUISITES FOR AGRICULTURAL-PASTURALIZATION OF SEA SHORE

In the past, Changhai County was an island county majoring in fishing . Along with the decrease of organic resources in the sea, fishing production decreases year by year. In order to make up for the decrease in fish catches and increase production, one of the approaches is developing seawater culturing and breeding, and conducting agricultural-pasturalization of the seashore. In the 1950s, Changhai County began to develop mariculture, mostly culturing of kelp. Culture of mussel began in the 1970s. In the 1980s, they began cultivating scallops. And oyster, *Scapharca broughtonii*, abalone and sea cucumber were cultured in the 1990s. Its cultured area extended year by year from 2558ha in 1980 to 25 067ha in 1987, it increased about 10 times. Production increased from 23 041t in 1980 to 169 985t in 1999, it increased 7.4 times. The proportion of cultural production in gross marine products increased year after year, up to 1987, marine cultural production passed the production of marine fishing (Table 5) . The structure of mariculture also rises obvious change, from single culture to varied culture (Table 6) (TING, 2001; ZHANG, 1999).

Except for culturing of mussels, scallops(gulf scallop, *Chlamys farreri* and *Patinopecten*(*Mizuhopecten*) *yessoensls jay*) and prawns, the techonology of bottom breeding of sea cucumber, abalone and *Patinopecten* (*Mizuhopecten*) *yessoensls jay*, has got some new breakthroughs. For instance, in 1985, experiments on bottom breeding of sea cucumber was carried out in the seabed around Haiyang Islands. The exepriment area was 4.5ha, amounting to 35.3×10^4 bulbs. Average body length was 1.8cm, average weight was 0.2g, density of bottom seeding was 8bulbs/m^2, and depth of bottom breeding was 8 – 10m. The conditions were sand-oozy substrate, great water quality and grew a mass of zostera marina linne. Three years later, young sea cucumbers grew to 18cm in length, 200g in weight, and survival rate reached over 40 percent. In 1987 and 1988, experiments on abalone and *Patinopecten* (*Mizuhopecten*) *Yessoensls Jay* were carried out respectively, also achieved good results.

Growing seedings industry is a prerequisite of developing mariculture, so we must pay more attention to this in developing agricultural-pasturalization. Since 1984, Changhai County has made some breakthroughs in growing seedings technology of scallop, abalone, *Stichopus japonicus selentea* and prawns, and has developed a growing seedings industry. There were 16 rooms for growing seedings all over county in 1999, and

Table 5 The variation of structure of fishing and culture in Changhai County(%)

	1957	1965	1975	1980	1985	1987	1990	1995	1996	1998	1999	2000
Fishing	100.0	96.6	95.6	76.1	71.7	48.3	35.7	38.2	38.3	50.0	43.3	40.6
Culture	0.0	3.4	4.4	23.9	28.3	51.7	64.3	61.8	61.7	50.0	56.6	59.4

Table 6 The variation of structure of mariculture in Changhai County(%)

Year	Alage	Mussel	Scallop	*Scapharca brought onii*	Oyster	Prawn	Variegated clam	Fishes	Others*	Total
1965	95.5								4.5	100.0
1970	90.9								9.1	100.0
1975	77.2	22.7							0.1	100.0
1980	44.4	55.5							0.1	100.0
1985	6.4	92.6	0.7						0.3	100.0
1990		85.8	13.2						1.0	100.0
1995		31.0	63.2	1.0	0.1	0.3	3.0		1.4	100.0
1996	0.1	18.4	78.2	0.5			0.2		2.6	100.0
1999	1.1	43.1	34.3	0.1	8.3		3.9	0.3	8.9	100.0
2000	4.5	25.2	39.6	0.1	23.6		3.8	0.3	2.9	100.0

* It mainly points to high economic valued varieties such as abalone, sea cucumber etc. Source: Statistic Data of Changhai County.

in utilizing water body and surface: there were 15 730m^3 for all kinds of scallops, 60m^3 for seawater fishes, 3350 m^3 for sea cucumber, 500m^3 for *Scapharca brought onii*, 875m^2 for *Haliotis discus hanna*. The production of seedings: all kinds of scallops were $312\ 364 \times 10^4$ grains, seawater fishes were 3×10^4 tails, sea cucumber was 1367×10^4 bulbs, *Scapharca brought onii* was $10\ 000 \times 10^4$, abalone was 830×10^4. A natural collecting seeding region of chlamys farreri formed.

3 REGIONALIZATION OF AGRICULTURAL-PASTURALIZATION OF SEASHORE

3.1 Experiments on Regionalization with Quatitative Methods

The division of agricultural area on land has been researched extensively, whereas the study on regionalization of marine agricultural-pasturalization was less, especially on quantitative methods or combining qualitative methods with quantitative methods. Being like the land, marine natural conditions and island socio-economic conditions have regional differences. And being like crops, the species of culture has its own biological characteristic and is influnced by circumstances. There is also the problem of making suitable measures in line with the local and marine conditions. In short, we should divide agricultural-pasturalization of the seashore based on geographical position of maritime space, its physical and chemical nature, resource conditions, organisms' biohabitat, and types of culture structures etc. (ZHANG, 1999).

As to regionalization, we should think of the similarity of marine agricultural-pasturalization conditions, and that of culture structures, existing problems, and developing prospects. However, it is difficult to keep the executive boundary lines intact, as those lines would not be very exact.

When we delimit regions with quantitative methods, there are some difficulties. Because the scope of maritime space is very large and studies on the sea are rather few partial, it is impossible to get data as intact as that of land. Thus there are only attempt and debate. The quantitative method adopted here is a principal components-clustering analysis(ZHANG and FANG, 1982).

(1) Variable selection

Considering the natural environment of maritime space, physical and chemical elements of seawater, organic resources and their structure distribution etc., we selected sixteen variables.

x_1— area of maritime space
x_2— area of maritime space suitable for culture
x_3— sea water temperature
x_4— air temperature
x_5— seawater transparency
x_6— salinity
x_7— pH
x_8— ammoniacal nitrogen
x_9— phosphate

x_{10}— seawater color

x_{11}— annual precipitation

x_{12}— distribution area of *Stichopus japonicus selentea*

x_{13}— distribution area of *Haliotis discus hannai*

x_{14}— distribution area of *Chlamys farreri*

x_{15}— distribution area of *Strongy locentrotus nadus* (*A. Agassiy*)

x_{16}— distribution area of *Neptunea cumingi crosse*

(2) Principal components analysis

The difficulty with multivariate statistical analysis is that there are too many dimensions, but the effect of principal components analysis is to combine many variables into several general variables(ZHANG and HU, 1997). Suppose we have n samples, and every sample has m indicators, the number of m indicators of No i sample are Z_{i1}, Z_{i2}, ⋯, Z_{im}. These $n \times m$ data fully describe the distinguishing features among n samples. If these m indicators are interindependant, it is impossible to decrease some indicators; if any two indicators have a completely linear correlation, we can reduce them to one general indicator. In fact, between every two indicators, some are neither completely independant nor completely correlated, but correlated in some degree. Through calculation we can turn these sixteen variables into several new general indicators, and keep their difference as great as possible. Simultaneously, these general indicators are bound to be orthogonal in a statistics sense. Therefore we can consider these new general indicators(principal components) as a new database for distinguishing the differences of maritime space.

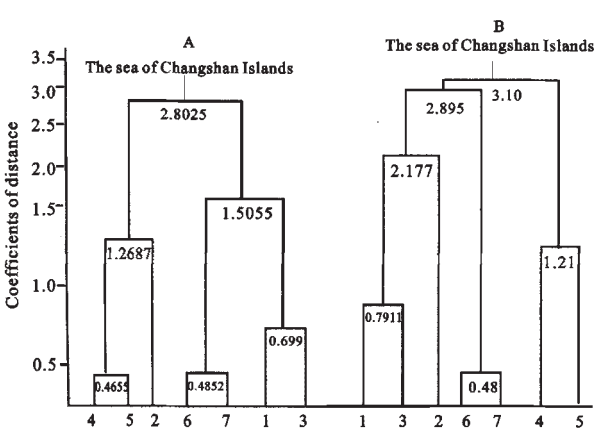
After calculation, we can get component scores (Table 7) which can be considered as the basis upon which we divide types or regions. If we take Ⅰ component as the abscissa, Ⅱ component as the ordinate, then point the component scores of every island in this coordinate system, we can divide Changshan Islands into four types of agricultural-pasturalization regions: Shicheng and Wangjia islands, Da Changshan and Guanglu islands, Haiyang and Zhangzi islands, and Xiao Changshan islands.

(3) Clustering analysis

Table 7 Components scores

Maritime space	Number	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
Da Changshan	1	−1.6293	1.5443	−0.5152	0.2645	0.208
Xiao Changshan	2	1.3524	0.741	−1.4264	−0.7122	−0.0999
Guanglu	3	−2.1816	1.9326	1.0826	0.2219	−0.1367
Zhangzi	4	5.2043	−0.5872	−0.2572	0.9063	−0.0372
Haiyang	5	3.6455	−0.4462	1.2267	−0.7247	−0.0837
Shicheng	6	−3.6657	−1.8425	−0.0170	0.0825	−0.1670
Wangjia	7	−2.7257	−1.3419	0.0935	−0.0383	−0.0012

From thirty-two species of clustering dendrogram, we select two—A and B (Fig 1).



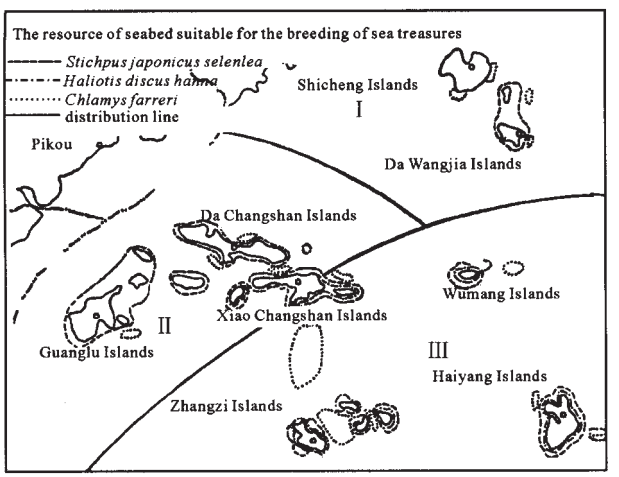
1. Da Changshan Islands; 2. Xiao Changshan Islands; 3. Guanglu Islands; 4. Zhangzi Islands; 5. Haiyang Islands; 6. Shicheng Islands; 7. Wangjia Islands

Fig. 1 The dendrogram of classification of agricultural-pasturalization function of the sea of Changshan Islands

The coefficients show that if we draw a horizonal line where the coefficients of distance is 0.45, those seven islands become seven separate types (in fact, maritime space of every island has its own characters). If we draw this line through the point of 1.0, then Changshan Islands are divided into four regions: Shicheng and Wangjia, Da Changshan and Guanglu, Zhangzi and Haiyang, and Xiao Changshan islands. Considering principal components analysis, Xiao Changshan Islands has two clustering results: on one hand, it should belong to Haiyang and Zhangzi maritime space (A, Fig. 1); on the other hand, it should belong to Da Changshan and Guanglu maritime space (B, Fig. 1). Of course, we can also consider it as one isolated type.

Therefore, we should consider both content of study and the fact, and combine quantitative methods with qualitative ones in the analyses. In view of their geographical position, Xiao Changshan Islands should belong to Da Changshan and Guanglu, but in considering

the requirements of marine agricultural-pasturalization, they should belong to Haiyang and Zhangzi islands. In fact, their characteristics in the western part, is similar to Da Changshan islands, whereas that of eastern part (including Baqiao and Wumang Islands) is similar to Haiyang and Zhangzi islands. For these analyses, especially the last, we divide Changshan Islands into three marine agricultural-pasturalization regions (Fig. 2).



I: The region of an agricultural-pasturalization of the northern part of maritime space of Wangjia and Shicheng islands. The main production is cultivation of prawn and mulluscs of seabeach, shallow sea float raft culture of mussel and scallop, and breed of sea cucumber in submarine.

II: The region of agricultural-pasturalization of the middle western part of maritime space of Da Changshan Guanglu islands, shallow sea float raft culture of mussel and scallop, and breed of sea cucumber in submarine.

III: The region of agricultural-pasturalization of the southeastern part of maritime space of the eastern part of Xiao Changshan Islands, Haiyang and Zhangzi islands, shallow sea floot raft culture of *Pattinopecten yessoenis*, and breed of abalone, sea cucumber, algaes and fish.

Fig. 2 Division of agriculture-pasturalization of sea in Changshan islands

3.2 Brief Introductions on Every Region

Ⅰ—Marine agricultural-pasturalization of northern maritime space includes the maritime space of Shicheng and Wangjia islands, whose main production is cultivation of prawns(Fig. 2).

The shallow sea area of this region is 72 867ha, and takes 21.3 percent of the total sea area of Changhai County. It is heavily influnced by the land. Depth of seawater is 10 – 25m, substrate is oozy. Seawater transparency is below 3, seawater salinity is low, and surface water temperature is lower than that of the middle and southern parts. In winter months, the frozen area is very large, thickness of ice can reach 50 – 60cm or so. This maritime space belongs to the nutrient-rich type, suitable for growing molluscs.

The shallow sea area that can be used in this region is 2267ha, taking 22.6 percent of the whole region. The area of seabeach is 1340ha, amounting to 34.6 percent. In Shicheng Islands there are 267ha seabeach suitable for culture of prawns, amounting to 90 percent of the total of this type of seabeach. The area suitable for culturing *Ruditapes philippinarum* is 180ha(40.4 percent), and the area suitable for culturing of Ostrea is over 287ha(30.7 percent). In future, this region should develop culturing *Ruditapes philippinarum*, Oyster and prawns, mussel, scallop and agar, properly develop breeding sea cucumber in submarine area, actively develop growing prawn seedings and liberating breeding, and set up seedings base for mussel.

Ⅱ— Marine agricultural-pasturalization of middle-western maritime space includes Da Changshan, Guanglu, and the western part of Xiao Changshan islands. The main production is shallow sea float raft culture of mussels(Fig. 2).

This region is lightly influnced by land. Depth of water is not greater than 35m(concerning natural conditions see Table 1). Total area is 98 000ha, of which the shallow gulf suitable for float raft culture is 6000ha, shallow seafloor suitable for breeding is 11 000ha; and seabeach, 1600ha. As to organic resources, on seabeach the distribution area of *Ostrea plicatula*, *Ruditapes philippinarum*, *Mytilus edulis*, represents one third of that or so. The shallow sea gulf distribution area of *Stichopus japonicus selentea* is the largest, taking 88 percent of the total area of sea cucumber, but its resource abundance represents only 41.5 percent. In the sea floor suitable for breeding, the distribution area of sea cucumber covers 41.4 percent.

In future this region should regard float raft culture of mussels and scallops as the most important, properly develop breed of sea cucumber in submarine, develop culture of prawns and breed of *Ruditapes philippinarum* and *Mytilus edulis* on the seabeach. Full use of existing water body to grow sea cucumber and scallop seedings, and to develop parts of culturing algae, will meet the social demands and keep maritime space in ecobalance.

Ⅲ— Marine agricultural-pasturalization of southeastern maritime space includes Haiyang, Zhangzi islands, and the eastern part of Xiao Changshan Islands. The main production is culture of *Chlamys farreri*.

The area of this region is 172 000ha, taking 50.1 percent of the total area. Because of the large maritime

space area, and long distance from the coast, it is almost not influnced at all by land.

In this region resources of sea treasures are abundant, and the distribution area of abalone and scallops both represents over 95 percent; the abundance of abalone is 99.9 percent and of scallops is 98.2 percent of the whole. Although the distribution area of sea cucumber takes only 6.9 percent, its abundance represents 39.5 percent. Shallow submarine resources suitable for breeding are mostly abalone, scallops and sea cucumber. As well, this region lies in the central part of the fishing ground. In Haiyang Islands, the abundance of fish is also good, consisting mostly of *Flounder, Scombero morns sinensis, Agrammus, Sebastodes fuscescens (Houttuyn), Astroconger myrnaster(Brevoort). Agrammus* and *Sebastodes fuscescens* in particular, both belong to offshore short-distance migration fishes, and are one kind of economic fish suitable for artificial breeding.

Although its primary productive force is relatively lower, it has high salinity, good transparency and clean water as well as great flowability, so is suitable for culturing and breeding of abalone, sea cucumber, and scallops. The maritime space to the south of Xiao Changshan and north of Zhangzi islands, have substrate and sea water temperatures suitable for breeding of *Patinopecten(Mizuhopecton) yessoensls jay* in the submarine. In future we should fully make use of the areas suitable for growing sea cucumber and scallop seedings, especially the maritime space around Haiyang Islands, which can become the natural basis for collecting *Chlamys farreri* seedings, and supply seedings for culture of scallops. Besides, we should actively develop the culture of *Undaria pinnatifida* and *Gelidium amansii.*

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