



# Perspective China Arctic Research Activities

- with focusing on the biological information

Guoping Zhu  
gpzhu@shou.edu.cn

The Third Meeting of Scientific Experts on Fish Stocks in the  
Central Arctic Ocean  
April 14 – 16, 2015



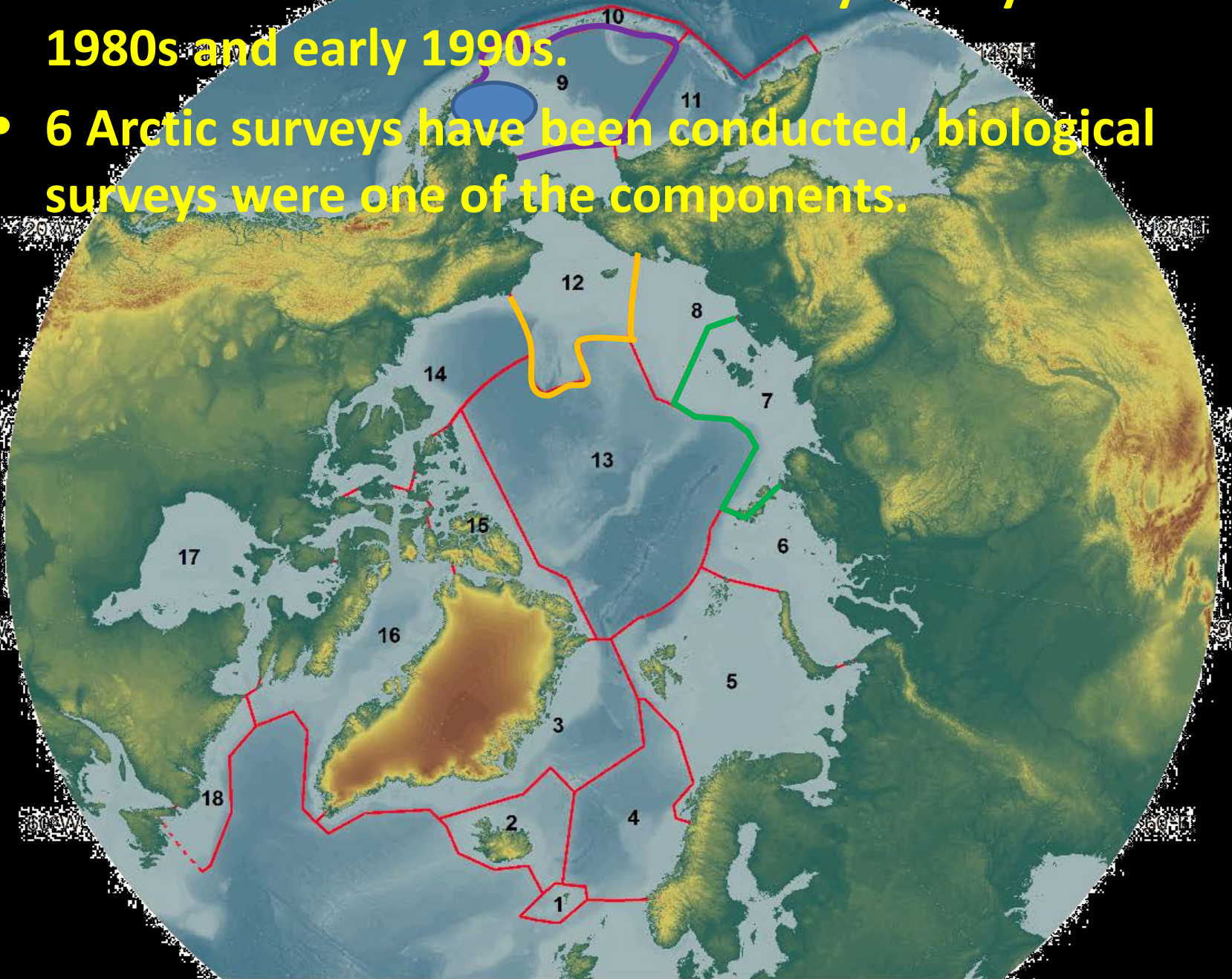
# Outline

- China Arctic biological survey
- Composition of **fish** species in Bering Sea and Chukchi Sea
- **Macrobenthos** in the Chukchi Sea and Bering Sea
- Species composition, abundance and distribution pattern of **phytoplankton** in the Bering Sea and Chukchi Sea
- Distribution pattern of **zooplankton** in the Bering Sea



# China Arctic Biological Survey

- China have conducted some fishery surveys in later 1980s and early 1990s.
- 6 Arctic surveys have been conducted, biological surveys were one of the components.



Fish

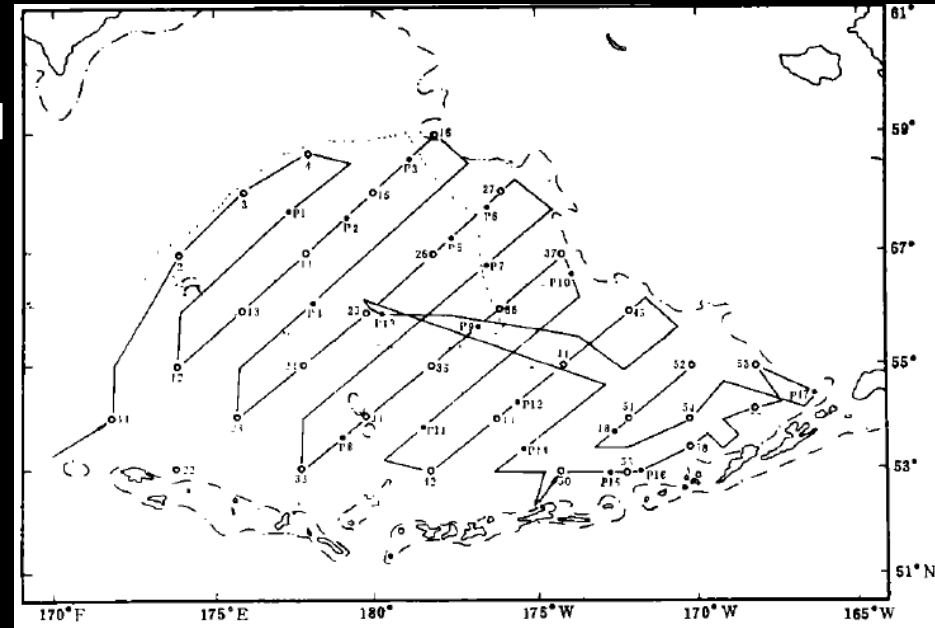


# Composition of fish species in Bering Sea and Chukchi Sea

- **7 papers** has been published with Chinese in China.
- Song Y S, Chen D G. Research in age and growth of yellowfin sole (*Limanda aspera*) from Eastern Bering Sea. Transactions of Oceanology and Limnology, 1989a, 3: 63-70.
- Song Y S, Chen D G. The characteristics of fishing ground oceanography and fishery biology of yellowfin sole in Eastern Bering Sea. Marine Sciences, 1989b, 1: 45-48.
- Su Z M. Comparative studies on the fish stock structure and growth characteristics of three commercial species of family Pleuronectidae from the Eastern Bering Sea. Journal of Ocean University of Qingdao, 1992, 22(4): 111-121.
- Tang Q S, Jin X S, Li F G, et al. Distribution and abundance of age zero walleye pollock *Theragra chalcogramma* in the Aleutian Basin. Journal of Fishery Sciences of China, 1994, 1(1): 37-47.
- Wan R J. The taxonomic components and abundance distribution of fish eggs and larvae in the Aleutian Basin of the Bering Sea in Summer 1993. Journal of Fisheries of China, 1999, 23(suppl): 28-33.
- Lin L S, Liao Y C, Zhang J, et al. Composition and distribution of fish species collected during the fourth Chinese National Arctic Research Expedition in 2010. Advances in Polar Science, 2012, 23(2): 116-127.
- Chen Y J, Lin L S, Liao Y C, et al. Composition of fish species in Bering Sea and Chukchi Sea and its response to changes of ecological environment. Acta Oceanologica Sinica (in Chinese), 2013, 35(2): 113-125.

# Distribution and abundance of age zero walleye pollock *Theragra chalcogramma* in the Aleutian Basin

Survey period: June 28 to July 24, 1993  
Four-panel midwater trawl with 4cm codend  
mesh size, 38-40 m mouth height and 121-  
123 m otterdoor spreading.



Acoustic / midwater trawl survey for walleye pollock  
in the Aleutian Basin, June 28 – July 24, 1993



# Distribution and abundance of age zero walleye pollock

## *Theragra chalcogramma* in the Aleutian Basin

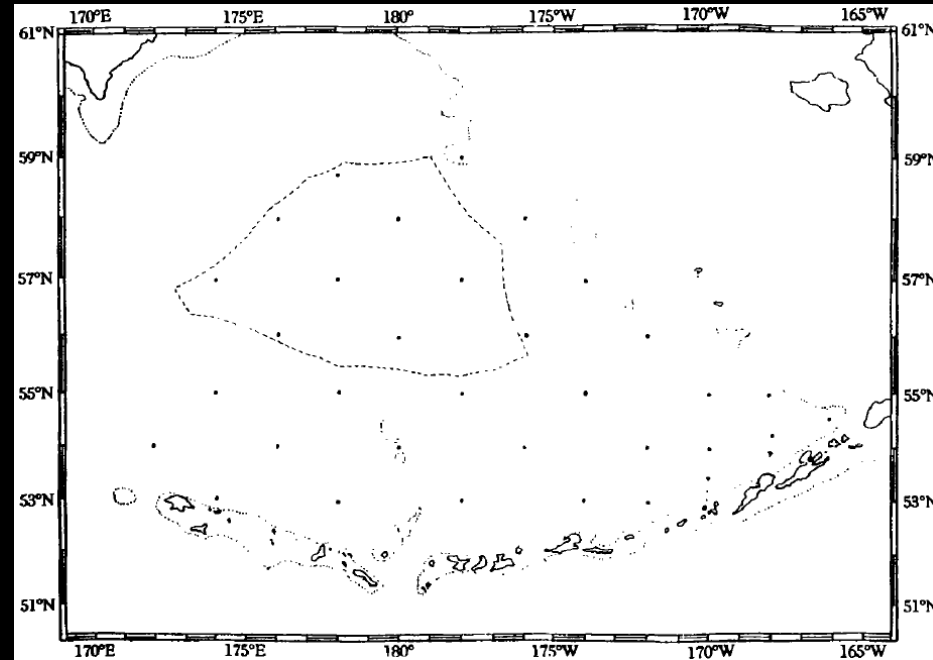
- The juvenile were mainly distributed in the northeast part of the Aleutian Basin extending from northwest to southeast, and the densest distribution area was observed between the eastern continental slope and the Bering High Seas.
- The juveniles mainly inhabited the water layer of 80 to 120 m depth, and showed a clear vertical migration.
- During July, the juveniles in the northeast part of the Aleutian Basin ranged from 29-47 mm in fork length, but the juveniles around the Bogslof Island ranged from 11 to 17 mm in fork length.
- A good relationship between the concentration of age zero pollock and geographic environment in the continental slope and forage organisms.





# The taxonomic components and abundance distribution of fish eggs and larvae in the Aleutian Basin of the Bering Sea in Summer 1993

Survey period: July 28 to August 3, 1993  
33 stations were deployed in the Bering Sea



Sampling stations in the Bering Sea  
and Chukchi Sea



# The taxonomic components and abundance distribution of fish eggs and larvae in the Aleutian Basin of the Bering Sea in Summer 1993

- A total of **10 species of fish eggs and larvae** were identified during the survey in the Aleutian Basin of the Bering Sea. The dominant species were *Bathymaster sp.*, *Sebastes sp.* and Alaska pollock *Theragra chalcogramma*.
- Fish eggs and larvae were mainly distributed in Bowers Basin and its adjacent waters, and Bogoslof Island Area.
- The abundance and species of fish eggs and larvae increased distinctly when the surface water temperature was above 9.0 °C.



- Age and growth based on the whole otolith (Song and Chen 1989a), fishing ground oceanography and fishery biology (Song and Chen 1989b) of yellowfin sole were investigated.
- Stock structure and growth characteristics of three commercial species of family Pleuronectidae (rock sole, flathead sole and Alaska plaice) from the eastern Bering Sea were studied (Su 1992).



- Third Institute of Oceanography, State Oceanic Administration
- Second Institute of Oceanography, State Oceanic Administration
- Polar Research Institute of China

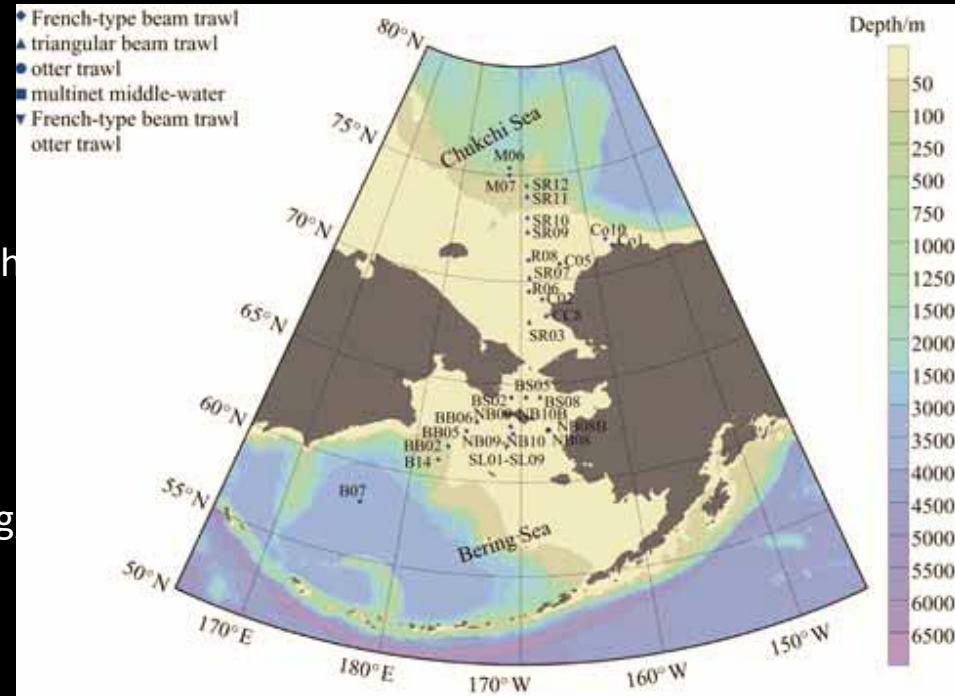


# Composition of fish species in Bering Sea and Chukchi Sea and its response to changes of ecological environment

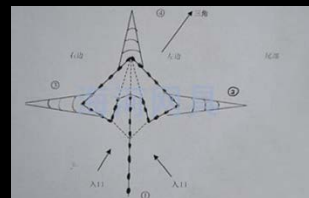
## Survey information in the 4<sup>th</sup> expedition

Survey period: July 1 to September 20, 2010

1. French-type beam trawl (2.5 m width, 0.5 m height, 9 m long, and 10 mm codend mesh size)
2. Triangle beam trawl (2.2 m width, 0.65 m height, 6.5 m long, and 20 mm codend mesh size)
3. Agassiz trawl (1.6 m width, 0.5 m height, 3 m long, and 20 mm codend mesh size)
4. IKMT net (9 m long, 4 m<sup>2</sup> mouth area, 10 mm codend mesh size)



## Sampling stations in the Bering Sea and Chukchi Sea





# Composition and distribution of fish species collected during the fourth Chinese National Arctic Research Expedition in 2010

- 41 fish species belonging to 14 families in 7 orders were collected during the expedition. Among them, the Scorpaeniformes, including 17 species, accounted for almost one third of the total number (34.8%), followed by 14 species of the Perciformes (27.0%), 5 species of the Pleuronectiformes (22.3%), and 2 species of the Gadiformes (15.4%).
- Abundant species varied according to the different fishing methods; numbers of families and species recorded did not differ with the various fishing methods; species and abundances decreased with depth and latitude; and species extending over their known geographic ranges were observed during the expedition.





# Composition of fish species in Bering Sea and Chukchi Sea and its response to changes of ecological environment

- A total of 41 species in 14 families have been recorded in Bering Sea and Chukchi Sea.
- The dominant species are Bering flounder, Arctic cod, shorthorn sculpin, Slender Eelblenny, and Hamecon.
- There are 35 cold water species and 6 cold temperate species.
- The habitat types of fish can be grouped as follows: 35 demersal fishes, 5 benthopelagic fishes, and 1 pelagic fish, respectively.



**Not the end**  
**Thank you for your attention**

Macrobenthos

# Macrobenthos in the Chukchi Sea and Bering Sea

- Only **1 paper** has been published with Chinese in China.
- Li R G, Zheng F W, Jiang J, et al. Macrobenthos in the Chukchi Sea and Bering Sea. Biodiversity Science, 2003, 11(3): 204-205.

# Macrobenthos in the Chukchi Sea and Bering Sea

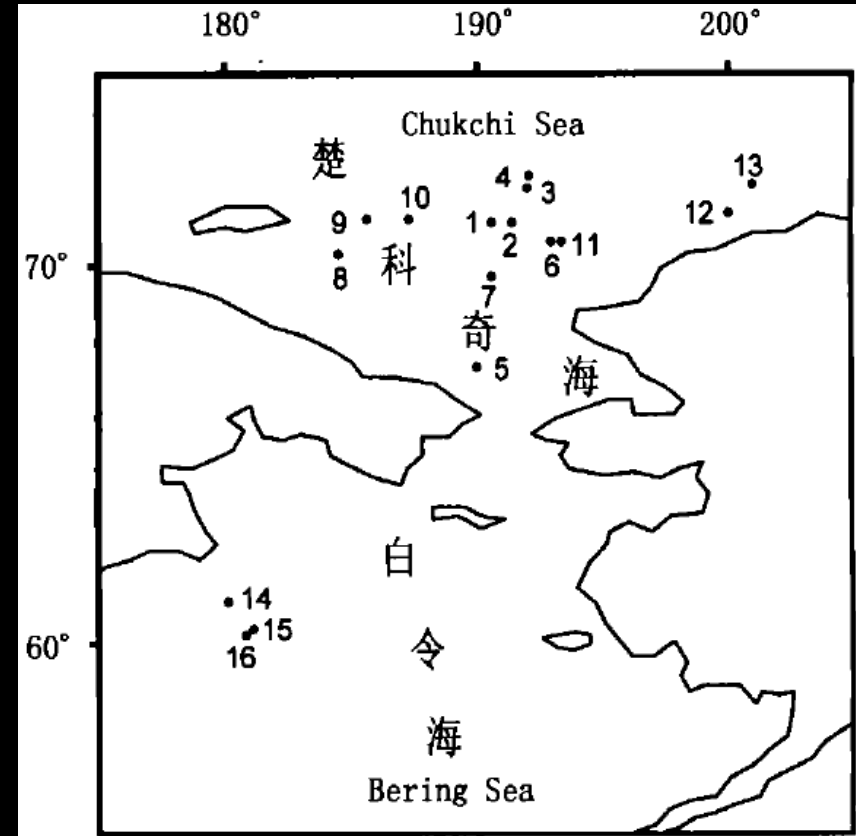
In the 1<sup>st</sup> Arctic expedition

Survey period: July to August, 1999

16 stations were deployed in Chukchi Sea (13 stations) and Bering Sea (3 stations) for benthos survey

30cm\*30cm Box type dredge

Metal sieve with 1.00 mm and 0.5 mm.



Sampling stations of macrobenthos

# Macrobenthos in the Chukchi Sea and Bering Sea

- There were in all 92 families and 164 species, of which Polychaeta comprised 62 species, Mollusca 42 , Crustacea 37 , Echinodermata 14 and other groups 9 species.
- Polychaeta, Mollusca and Crustacea occupy 88.41 % of all species. *Cossurella sp.*, *Tharyx sp.*, *Maldane sarai* , *Nephtys caeca* , *Phascolion sp.*, *Ennucula tenuis*, *Nuculana pernula pernuloides*, *Clinocardium (Ciliatocardium) ciliatum* , *Astheno thaerus sp.*, *Eudorella pacifica* , *Lepideopcreum sp.*, *Harpiniopsis sp.*, *Bybljaponicus* , and *Ophiura sarsii* were dominant species and key species.
- The average biomass was 111.83 g/m<sup>2</sup> and individual density was 2538 inds./m<sup>2</sup> in Chukchi Sea and Bering Sea.



# Phytoplankton

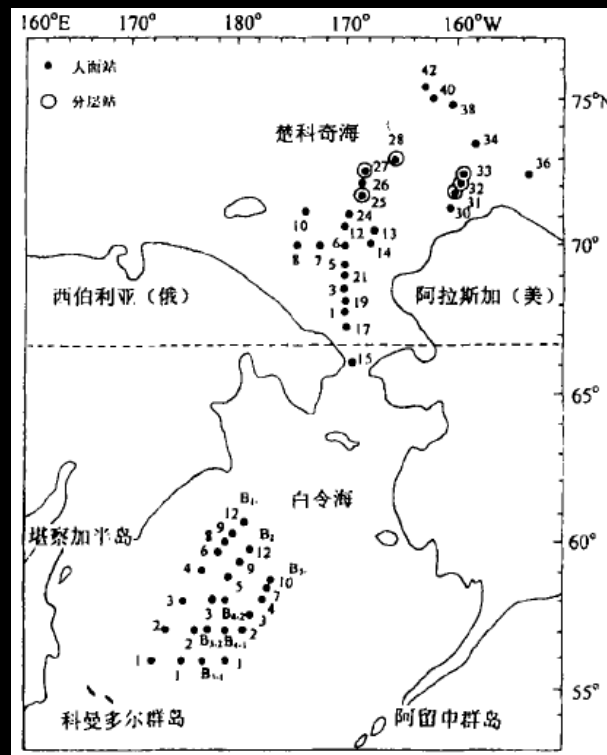
# Distribution pattern of microphytoplankton in the Bering Sea

- **7 papers** has been published with Chinese in China.
- Yang Q L, Lin G M, Lin M, et al. Species composition and distribution of phytoplankton in Chukchi Sea and Bering Sea. Chinese Journal of Polar Research, 2002, 14(2): 113-125.
- He J F, Chen B, Zeng Y X, et al. Biomass and distribution characteristics of bacteria and protozoa in the Bering Sea in summer. Acta Oceanologica Sinica, 2005, 27(4): 127-134.
- He J F, Wang G Z, Li S J, et al. Community structure and biomass of ice algae and phytoplankton in the Laptev Sea (Arctic) in spring. Chinese Journal of Polar Research, 2005, 17(1): 1-10.
- Lin L, He J F, Zhang F, et al. Heterotrophic bacterial abundance and distribution in the Bering Sea and the Arctic Ocean in the summer of 2008. Acta Oceanologica Sinica, 2011, 33(2): 166-174.
- Zhang F, He J F, Lin L, et al. Distribution of picophytoplankton and environmental correlation analysis in Bering Sea shelf during the summer of 2008. Acta Oceanologica Sinica, 2011, 33(2): 134-145.
- Liu Y, Zhang F, Ling Y, et al. Diversity and community composition of bacterioplankton in the Bering Sea during summer 2010. Chinese Journal of Polar Research, 2013, 25(2): 113-123.
- Lin G M, Yang Q L, Wang Y. Distribution pattern of microphytoplankton in the Bering Sea during the summer of 2010. Chinese Journal of Applied Ecology, 2013, 24( 9) : 2643-2650.

# Species composition and distribution of phytoplankton in Chukchi Sea and Bering Sea

The 1<sup>st</sup> Arctic expedition

Survey period: July to August, 1999  
56 stations were deployed in the Chukchi Sea and Bering Sea



Sampling stations in the Chukchi Sea and Bering Sea Yang et al. 2002

# Species composition and distribution of phytoplankton in Chukchi Sea and Bering Sea

- 121 phytoplankton species (including varieties and forms) in 43 genera of 3 phyla have been identified. Among them, 103 species in 33 genera were from Chukchi Sea, 71 species in 25 genera were from Bering Sea, and 49 species were from both two seas.
- The average abundance ( $8.32 \times 10^7$  cells/m<sup>3</sup>) of phytoplankton from Chukchi Sea was higher than that ( $1.58 \times 10^6$  cells/m<sup>3</sup>) in Bering Sea.

# Biomass and distribution characteristics of bacteria and protozoa in the Bering Sea in summer

The 1<sup>st</sup> Arctic expedition

Survey period: July 21 to August 1, 1999  
28 stations were deployed in Bering Sea



Sampling stations in the Bering Sea

## Biomass and distribution characteristics of bacteria and protozoa in the Bering Sea in summer

- Bacterial carbon biomass in the surface waters ranges from 1.5 to 20.2  $\mu\text{g}/\text{dm}^3$ , which accounts for 30% of phytoplankton biomass on average.
- As a main protozoan assemblage, the integrated biomass of dinoflagellates constitutes 39% of the total biomass of protozoa
- The biomass of bacteria and protozoa decreases from western to northeastern and eastern regions of the Bering Sea, and the biomass of these organisms also decreases with depth.

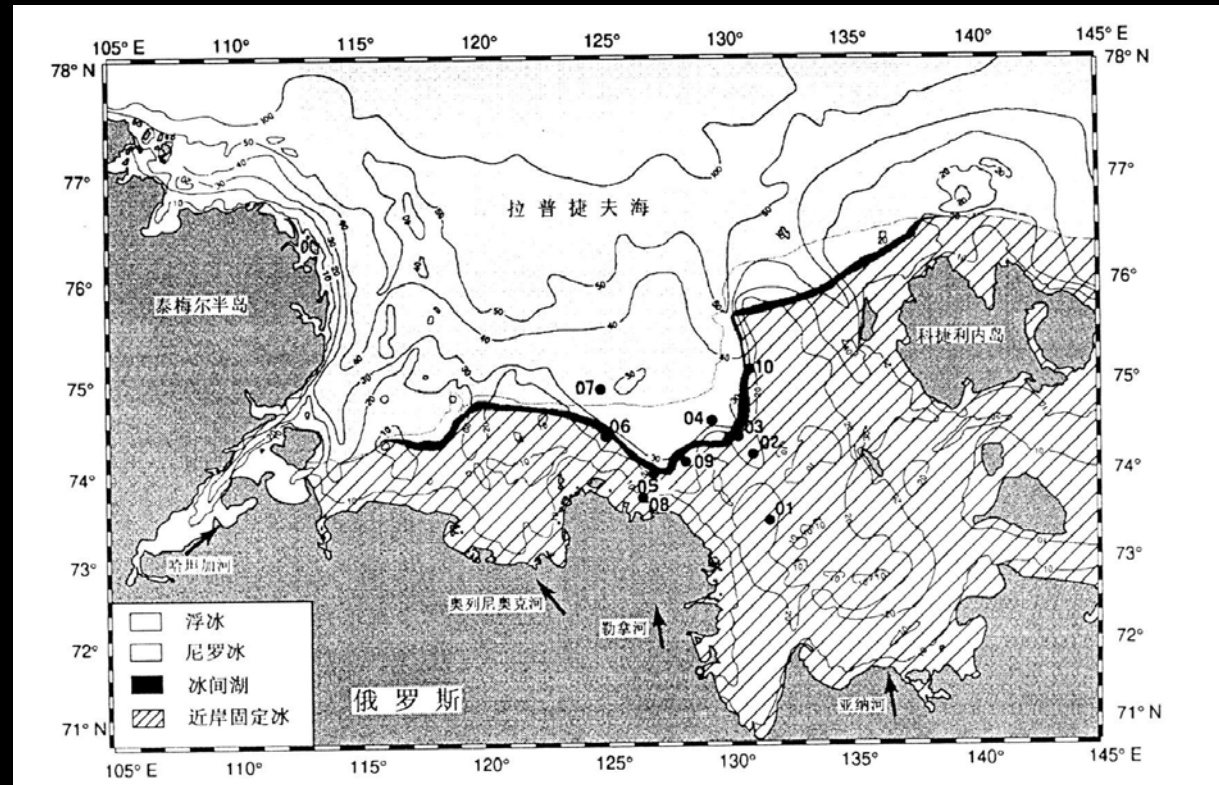


# Community structure and biomass of ice algae and phytoplankton in the Laptev Sea (Arctic) in spring

The 1<sup>st</sup> Arctic expedition

Survey period: April 17 to May 6, 1999

10 stations were deployed in southeastern Laptev Sea



Sampling stations in the southeastern Laptev Sea He et al. 2005

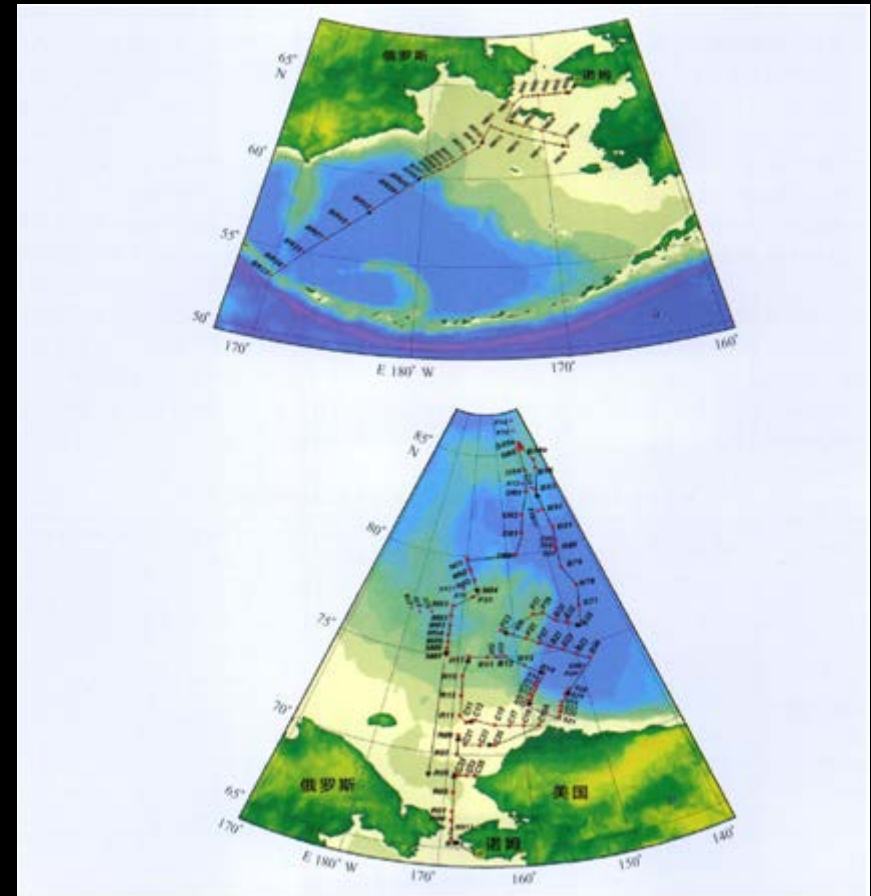
# Community structure and biomass of ice algae and phytoplankton in the Laptev Sea (Arctic) in spring

- Diatoms were predominant in algal species and pennate diatoms were dominant in diatom species.
- 12 dominant algal species occurred in ice and underlying water column, which included *Fragilariopsis oceanica*, *F. cylindrus*, *Nitzschia frigida*, *N. promare*, and others.
- The ice algae might play an important role in maintaining the coastal marine ecosystem before the melting of sea ice.

# Biomass and distribution characteristics of bacteria and protozoa in the Bering Sea in summer

The 3<sup>rd</sup> Arctic expedition

Survey period: July 18 to September 8, 2008

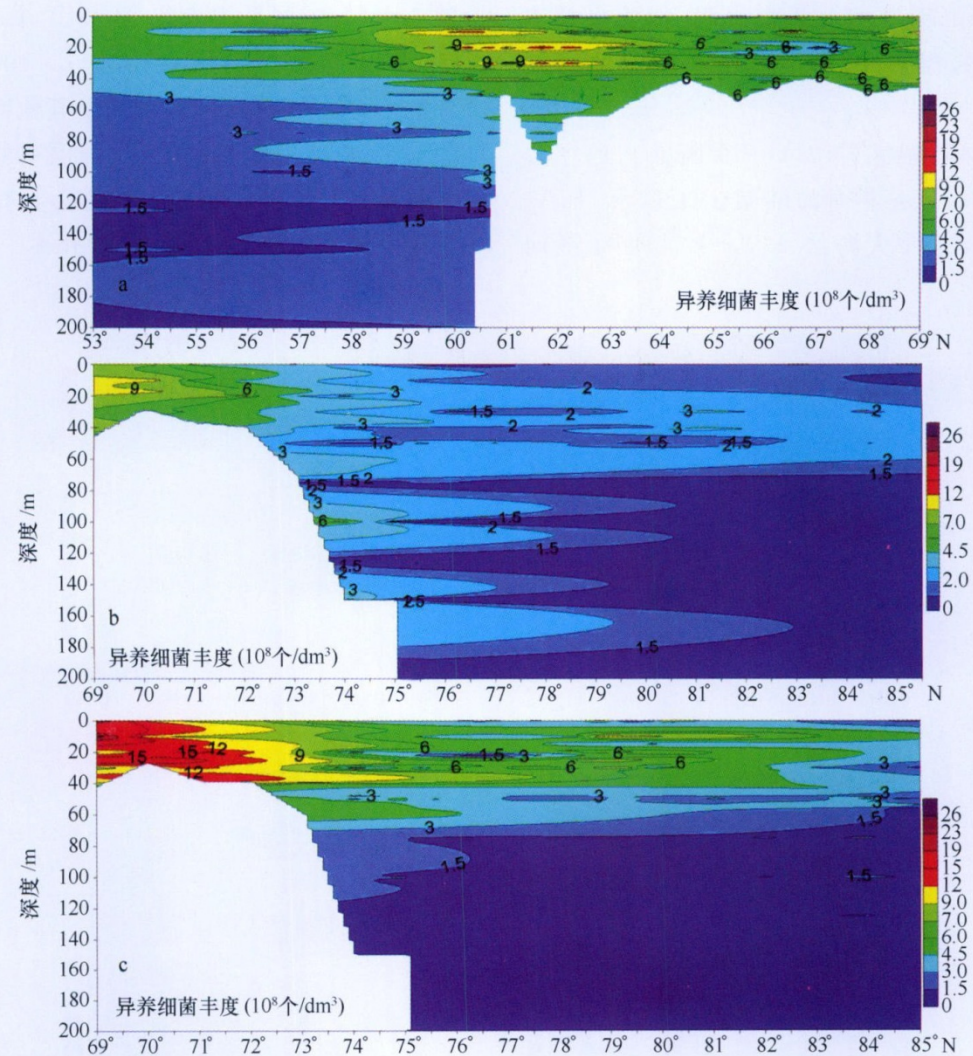


Sampling stations in the Bering Sea and Chukchi Sea

Lin et al. 2011

# Heterotrophic bacterial abundance and distribution in the Bering Sea and the Arctic Ocean in the summer of 2008

- The abundance ranged from  $0.14$  to  $22.10 \times 10^8$  ind./dm<sup>3</sup>, in which the abundance were  $0.72$  to  $17.02 \times 10^8$  ind./dm<sup>3</sup> in the Bering Sea.
- The abundance in the continental shelves is significant higher than that in the basin.
- The abundance in the sub-arctic ocean is higher than that of Arctic Ocean, and the similar result can be found for the open sea to ice-covered area
- The spatial distribution from highest to lowest can be described as continental shelf of Chukchi Sea, continental shelf of Bering Sea, Chukchi Sea, Bering Sea Basin, Mendeleev Ridge, Canada Basin, continental slope of Chukchi Sea and Plateau of Chukchi Sea.



Profile of latitudinal distribution of Heterotrophic bacteria from 0 to 200 m of upper ocean. a, Bering Sea Basin to Bering Strait; b, Bering Strait to Canada Basin; c, Canada Basin to Chukchi Sea

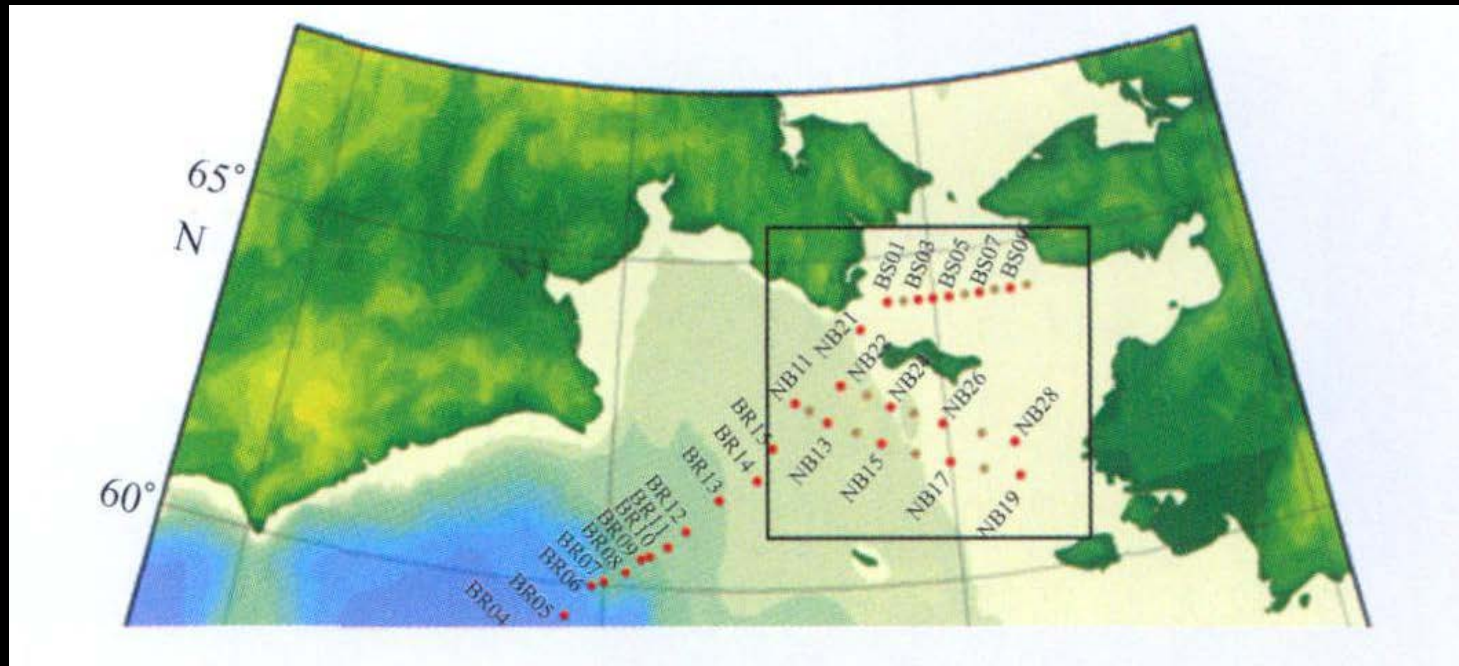


# Distribution of picophytoplankton and environmental correlation analysis in Bering Sea shelf during the summer of 2008

The 3<sup>rd</sup> Arctic expedition

Survey period: July 2008

11 stations were deployed in Bering Sea

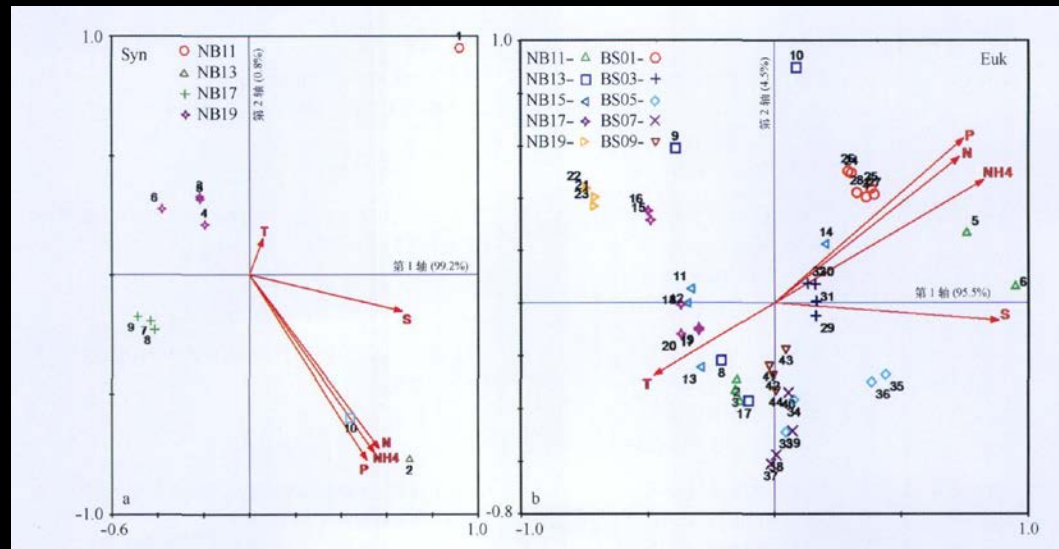


Sampling stations in the Bering Sea



# Distribution of picophytoplankton and environmental correlation analysis in Bering Sea shelf during the summer of 2008

- Synechococcus and picoeukaryotes were the only type of the picophytoplankton community; and their respective cell abundance was  $0.01 \times 10^6 \sim 2.69 \times 10^6$  and  $0.47 \times 10^6 \sim 13.20 \times 10^6$  cells/dm<sup>3</sup>. The abundance in the continental shelves is significantly higher than that in the basin.
- The paper also analyzed the effects of environmental factors (temperature, salinity) on the chlorophyll a, phycoerythrin, and the cell size (cellular carbon content).



Synechococcus

Picoeukaryotes

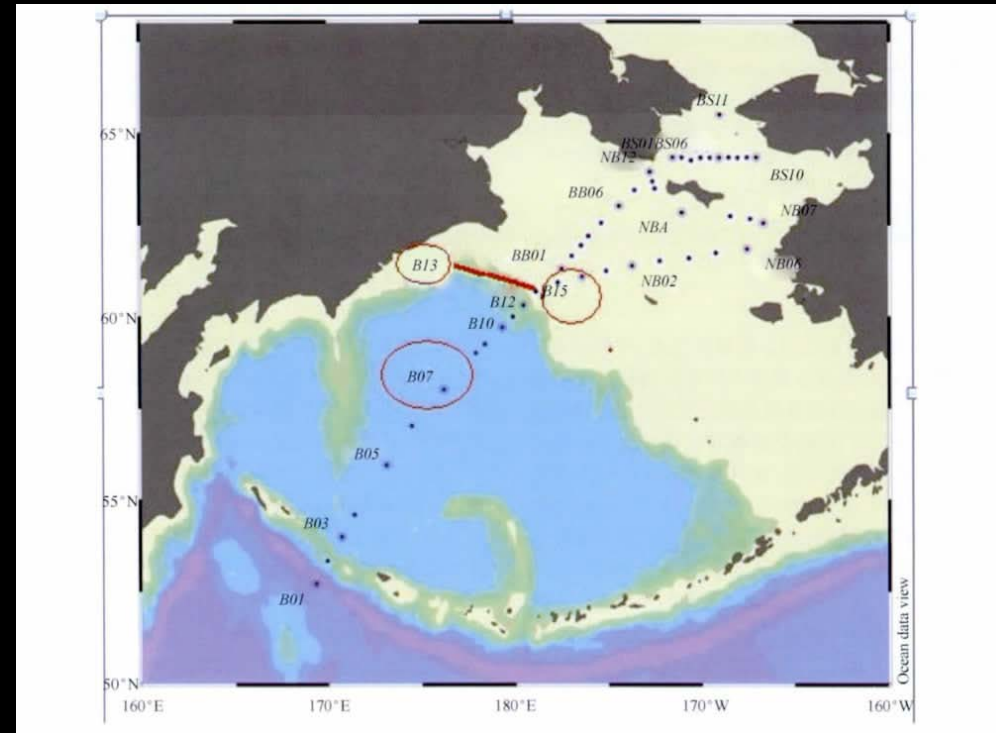
Zhang et al. 2011

# Diversity and community composition of bacterioplankton in the Bering Sea during summer 2010

The 4<sup>th</sup> Arctic expedition

Survey period: July 2010

3 stations were deployed in Bering Sea  
Samples were analyzed using DGGE and clone libraries



Sampling stations in the Bering Sea  
Red mark is the experiment site

Liu et al. 2013

# Diversity and community composition of bacterioplankton in the Bering Sea during summer 2010

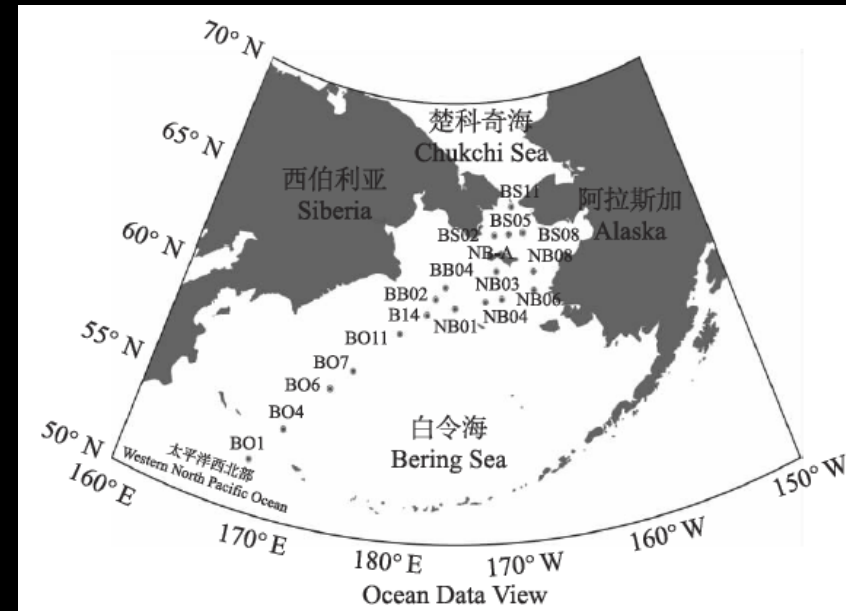
- There was greater variability in bacterial diversity within the basin than on the shelf of the Bering Sea.
- Gammaproteobacteria dominated the samples, accounting for 53% of all bacteria, with another 37% identified as Bacteroides.

# Distribution pattern of microphytoplankton in the Bering Sea during the summer of 2010

The 4<sup>th</sup> Arctic expedition

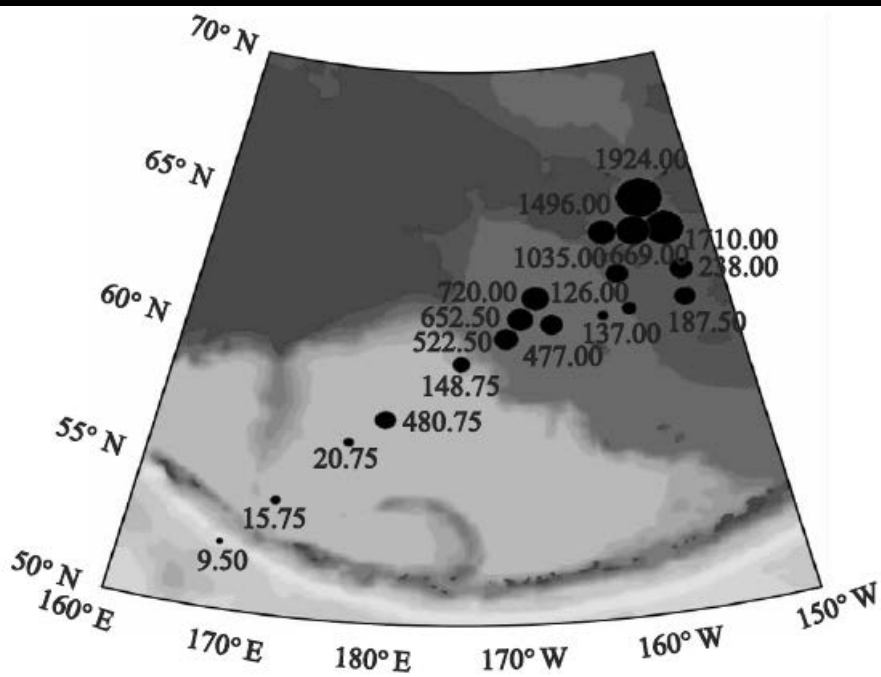
Survey period: July 2010

70 waters samples were collected in Bering Sea

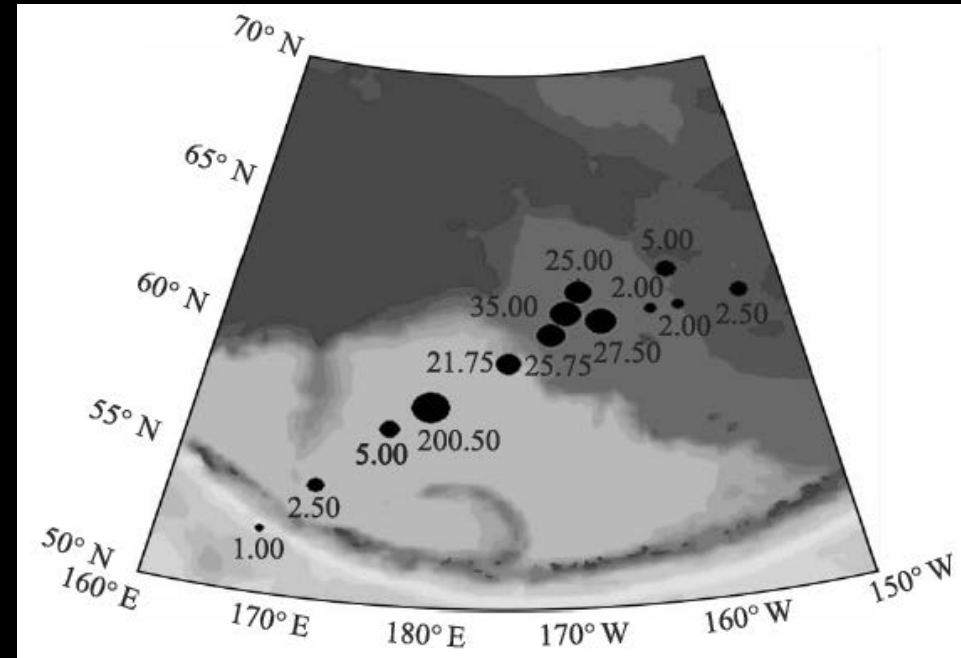


Sampling stations in the Bering Sea

# Distribution pattern of microphytoplankton in the Bering Sea during the summer of 2010



Spatial distribution of phytoplankton abundance  
( 102 cells·L<sup>-1</sup> ) .



Spatial distribution of *Neodenticula seminae* abundance  
( 102 cells·L<sup>-1</sup> )

# Distribution pattern of microphytoplankton in the Bering Sea during the summer of 2010

- A total of 143 phytoplankton species were identified, including 95 diatom species belonging to 37 genera, 44 dinoflagellate species belonging to 15 genera, 2 Chlorophyta species belonging to 2 genera, 1 Euglenophyta belonging to 1 genus, and 1 Chrysophyta species belonging to 1 genus.
- The oceanic group found in the western North Pacific Ocean and the Bering Basin was dominated by the boreal oceanic species such as *Neodenticula seminae* and *Chaetoceros atlanticus* and the cosmopolitan species such as *Thalassionema nitzschioides* and *Chaetoceros compressus*, with the characteristics of low abundance and high evenness of diversified species.
- Horizontally, the abundance distribution trend was decreased in the order of the Bering Sea shelf, the Bering Sea slope, the Bering Sea basin, and the western North Pacific Ocean.
- Vertically, the abundance was lower in surface layer and maximized in the thermocline.

# Zooplankton

# Distribution pattern of zooplankton in the Bering Sea

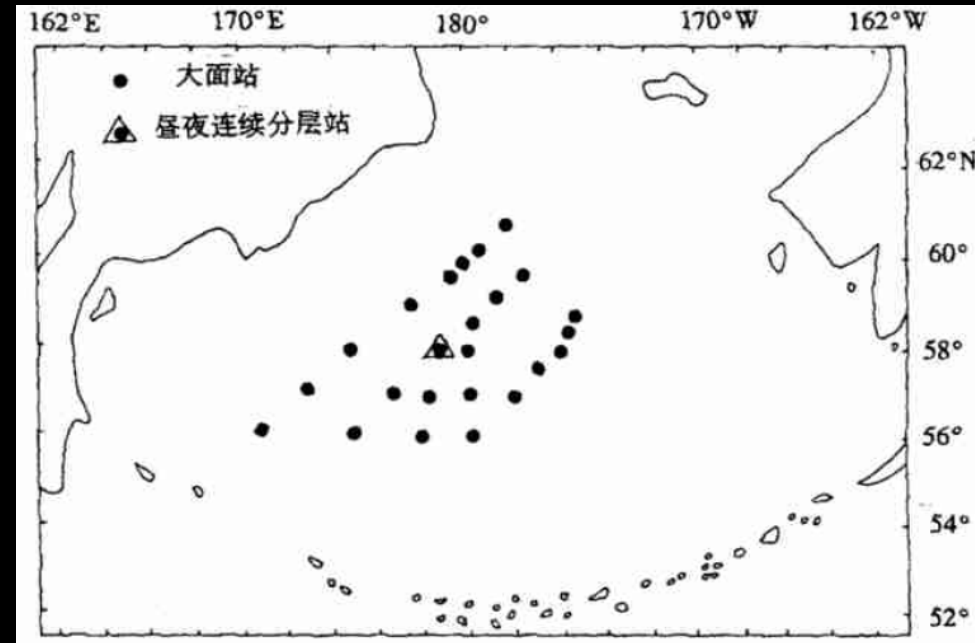
- **1 paper** has been published with Chinese in China.
- Lin J H, Dai Y Y, Lin M, et al. Distribution of the zooplankton in Bering Sea in Summer. Chinese Journal of Polar Research, 2002, 14(2): 126-135.



# Distribution of the zooplankton in Bering Sea in Summer

In the 1<sup>st</sup> Arctic expedition

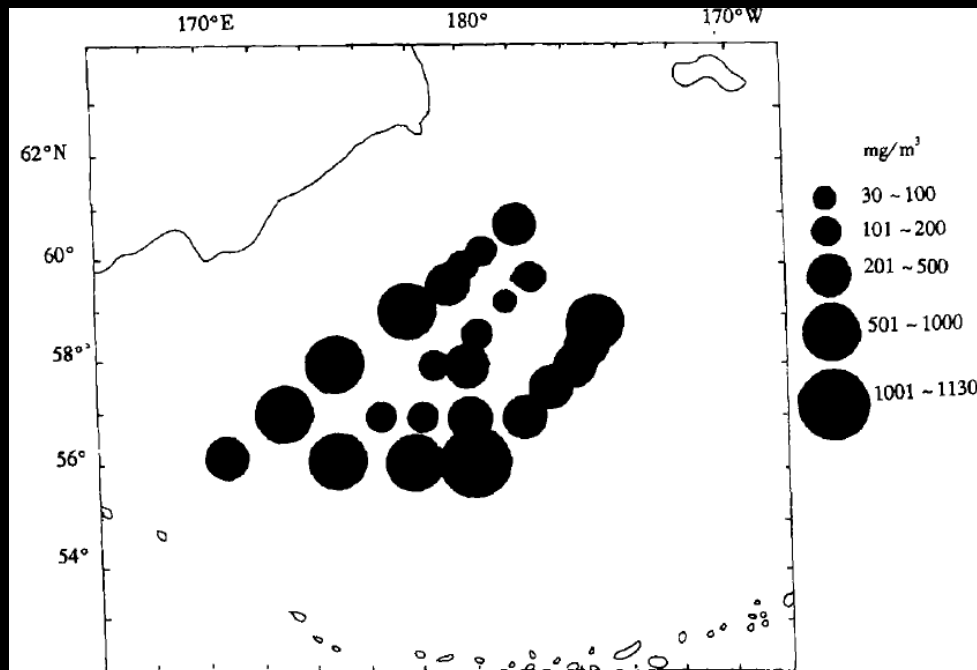
Survey period: July to August, 1999  
Plankton net (Diameter of net mouth, 80 cm; long 270 cm; silk screen aperture 0.505 mm)



Sampling stations of zooplankton

# Distribution of the zooplankton in Bering Sea in Summer

- A total of 90 species of zooplankton were found and recorded in samples collected in the Bering Sea.
- 4 ecological groups of arctic, sub-arctic, oceanic cool water and world-wide eurytherma, the most important group was sub-arctic which was dominated by *Eucalanus bungii*, *calanus plumchrus*, *C. cristatus* and *Metridia pacifica*.



The horizontal distribution of the total biomass of zooplankton

**The End**  
**Thank you for your attention**