Long-term variations of macrobenthic communities in the Yellow Sea and East China Sea, under the climate change

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Outline

What is happening in the Yellow Sea and East China Sea? --Status of the ecosystem in the Yellow Sea and East China Sea

Whether macrobenthos changes? How does it change? And why?

Conclusion

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Whether macrobenthos changes? How does it change? And why?

Conclusion

What is happening in the Yellow Sea and East China Sea?

Marine disasters !


Red
tide

“Green tide”

"White tide"

Next

X tide？

Hypoxia

Nanjing
Shanghai
Chengdu
Wuhan
Chongqing
Taipei
Guangzhou
(Canton)
Kowloon
Central
(Hanoi)
Hà Noi
Central Hong Kong
Macau
Taiwan
(Vientiane)
Viang Chan
Khonkhaen
Paracel Islands
Vietnam
Philippines
Cambodia
Manila
Phnum Penh
(Phnom Penh)
N
© 2006 Europa Technologies
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So many marine disasters are happening!

Outline

What is happening in the Yellow Sea and East China Sea? --Status of the ecosystem in the Yellow Sea and East China Sea

Whether macrobenthos changes? How does it change? And why?

Conclusion

① Long-term variations of macrobenthic community in the southern Yellow Sea

② Influence of the Kuroshio Current on the East China Sea shelf

③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea

⑤ Influence of the region in 32°~33°N on the distribution of macrobenthos.

⑥ Long-term variations of macrobenthic community in the Yangtze river estuary and its adjacent area

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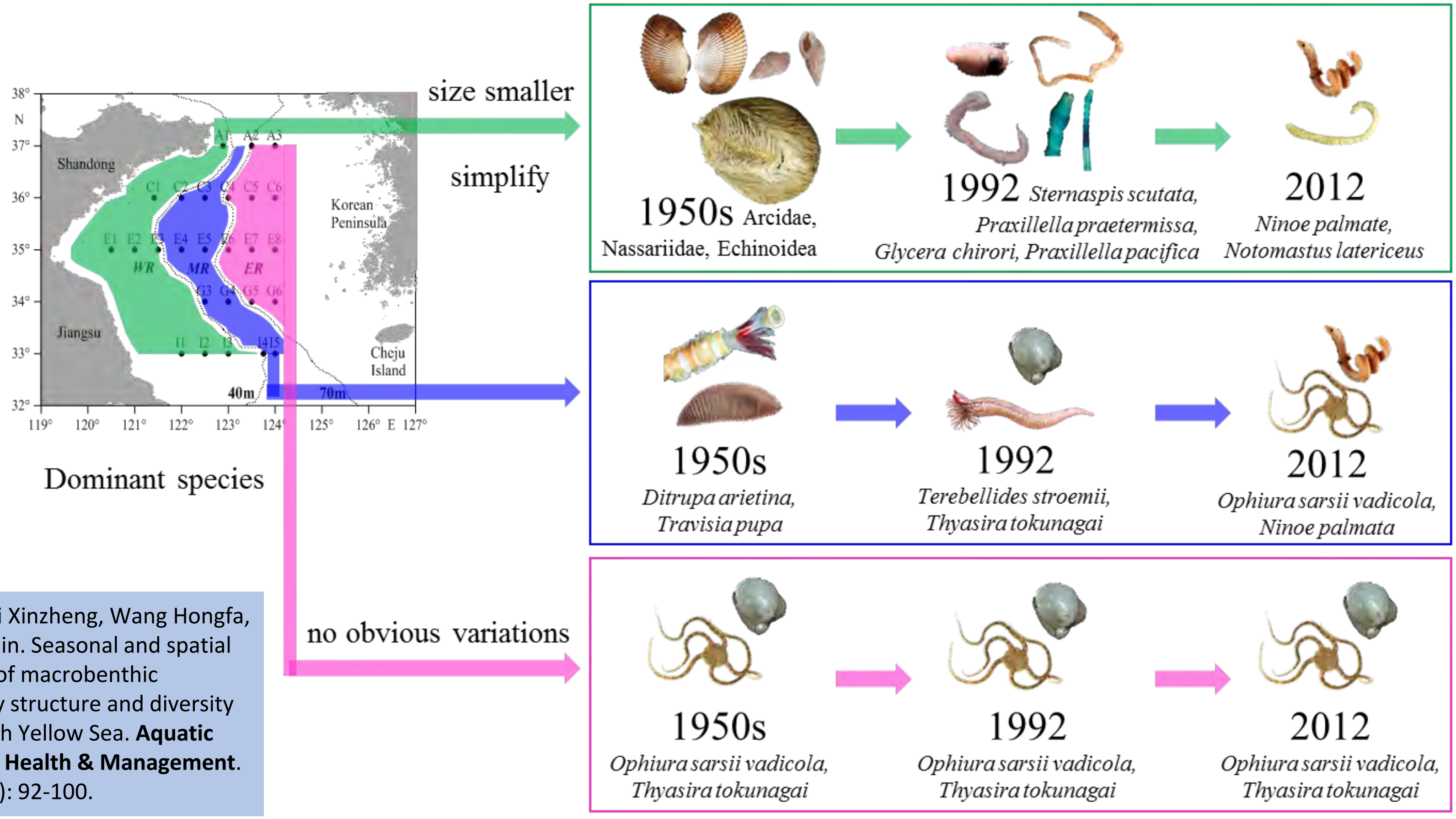
Long-term variation of dominant species in each region -- literature analysis

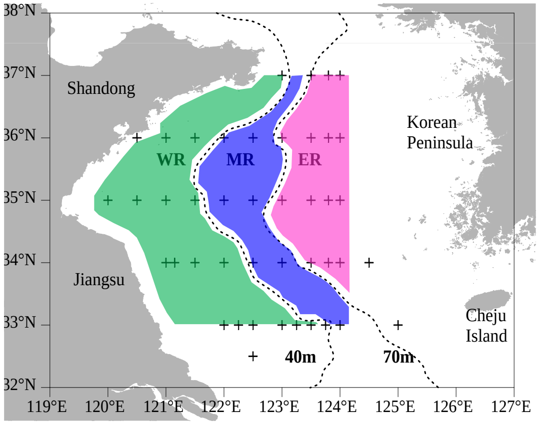


Xu Yong, Li Xinzheng, Wang Hongfa, Zhang Baolin. Seasonal and spatial variations of macrobenthic community structure and diversity in the South Yellow Sea. **Aquatic Ecosystem Health & Management**. 2016, 19(1): 92-100.

Variations of dominant macrobenthic species in the southern Yellow Sea
(WR: western region, MR: middle region, ER: eastern region of the southern Yellow Sea)

① Long-term variations of macrobenthic community in the southern Yellow Sea

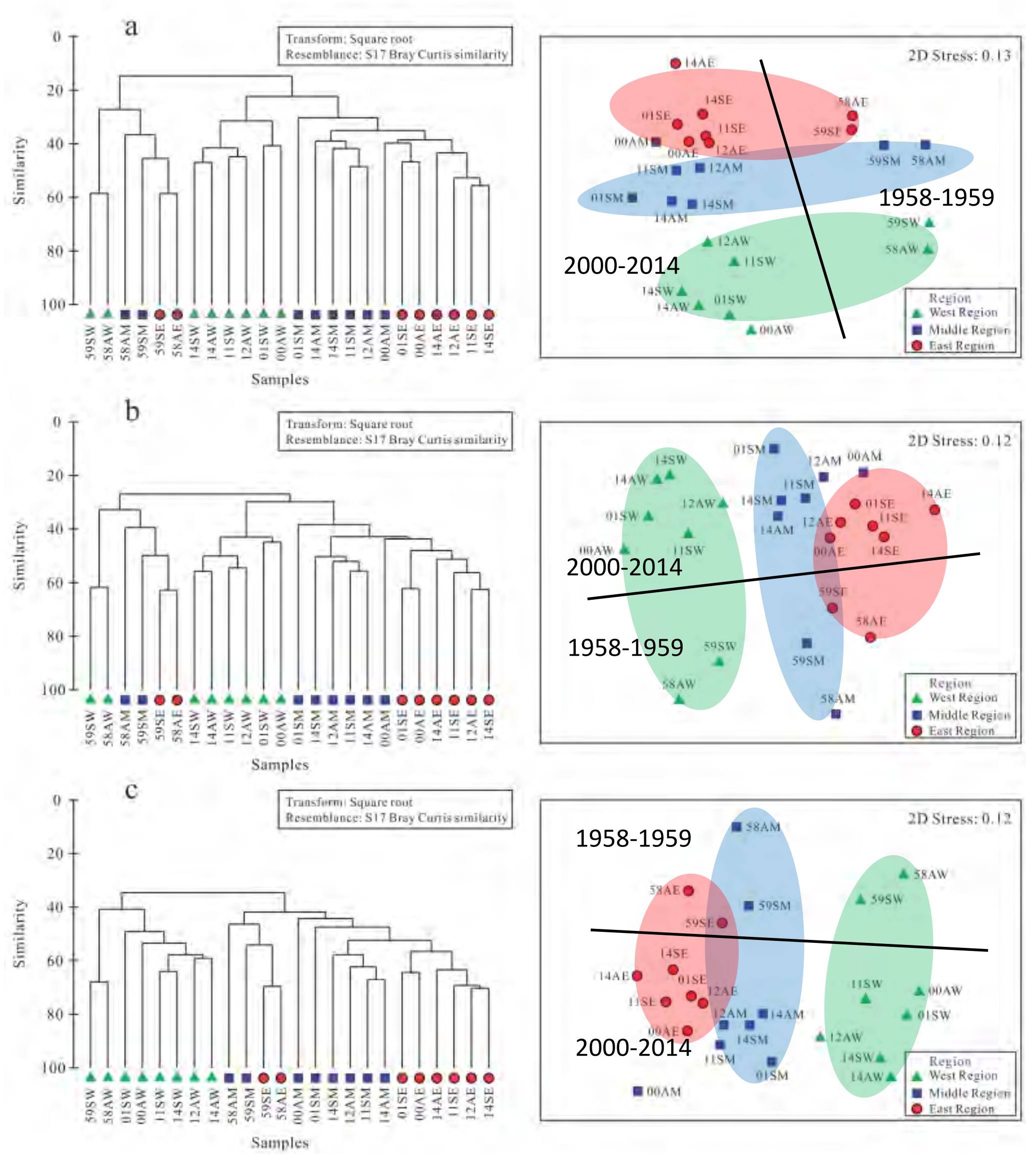
Community structure -- data analysis



Species

Genus

Family



Cluster analysis and nMDS ordination

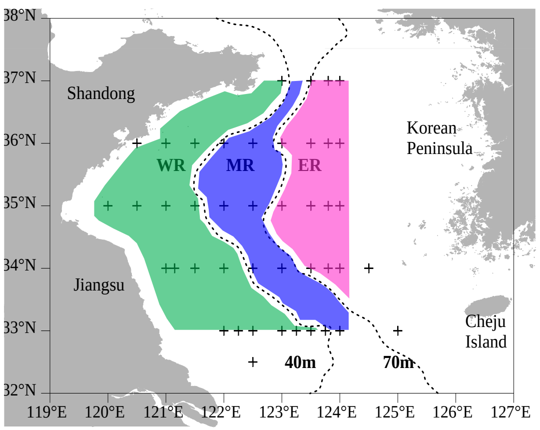
Community structure showed **significant differences** among regions (**green**/**blue**/**red circle**) and among periods (**black line**, 1958-1959 vs 2000-2014)

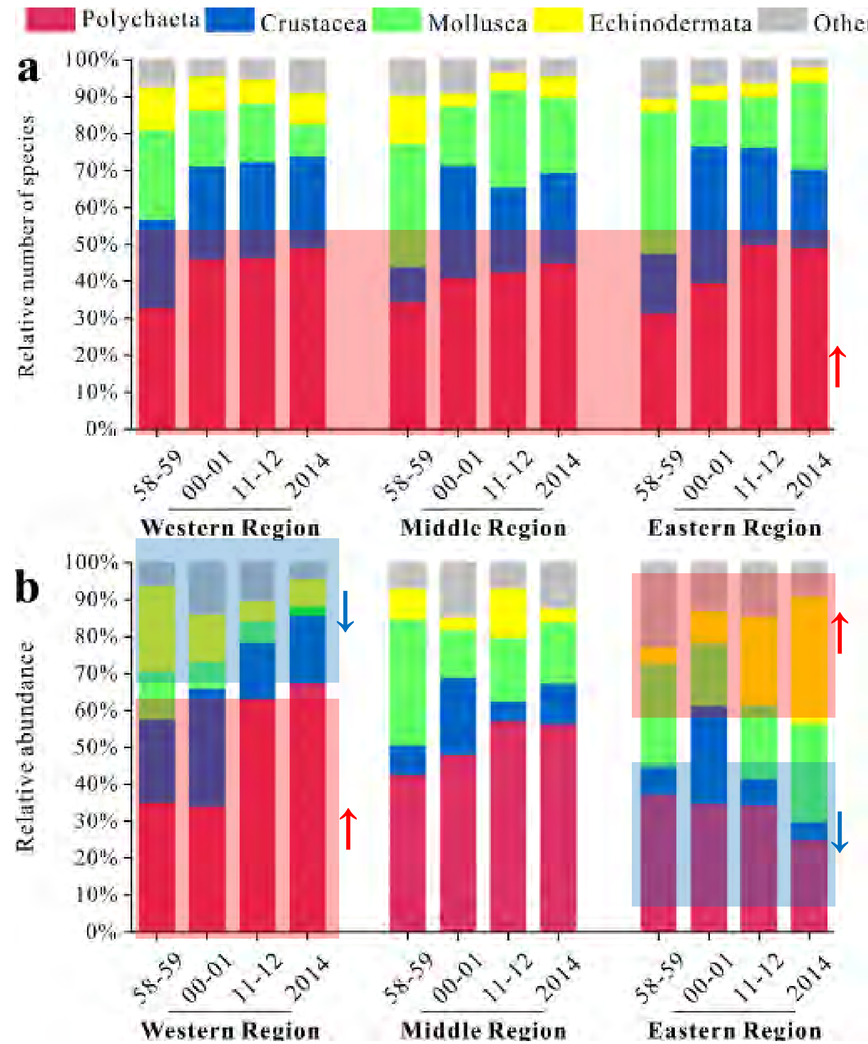
Sampling time:

1958-1959 / **2000-2001** / **2011-2012** / **2014**

① Long-term variations of macrobenthic community in the southern Yellow Sea

Relative number of species and relative abundance -- data analysis





Relative number of species:

Polychaeta↑， Echinodermata stable

Relative abundance:

Polychaeta Eastern Region↓， Western Region↑

Echinodermata opposed

Sampling time:

1958-1959 / 2000-2001 / 2011-2012 / 2014

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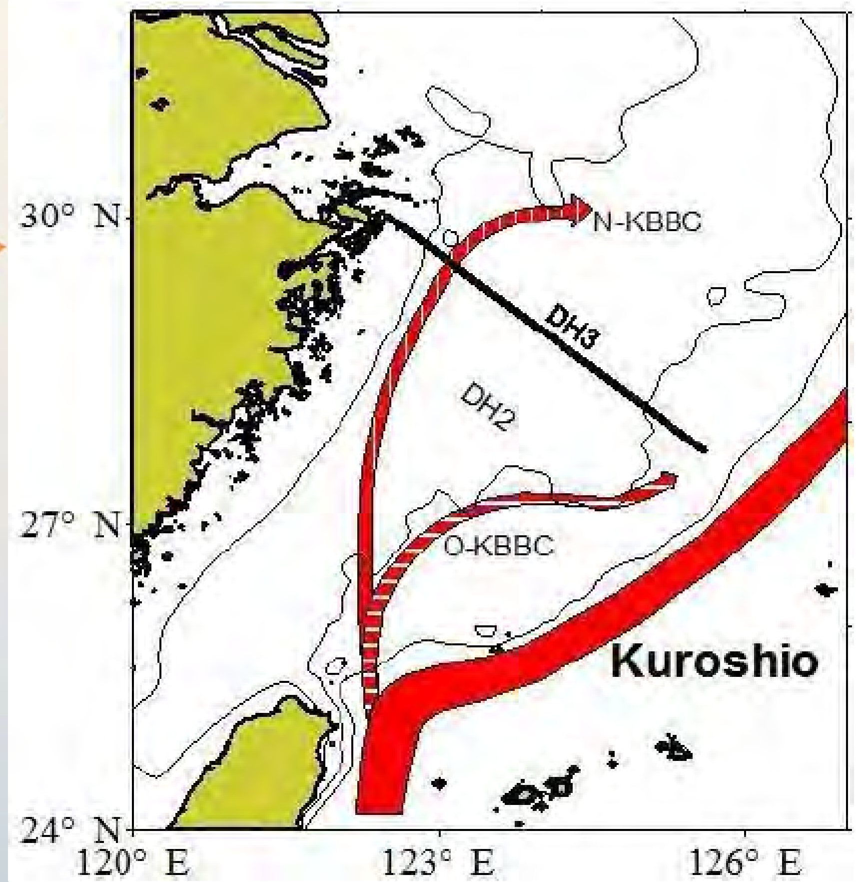
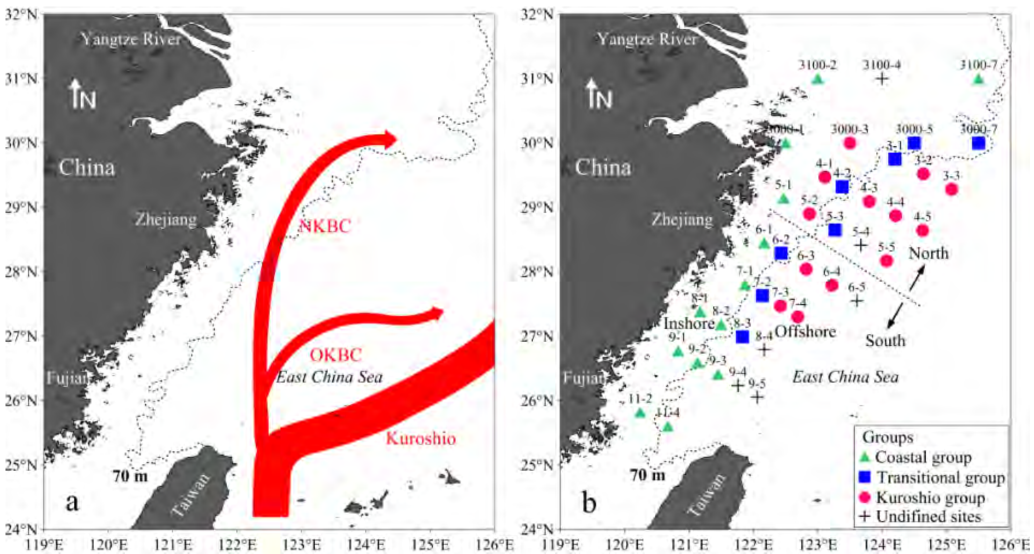


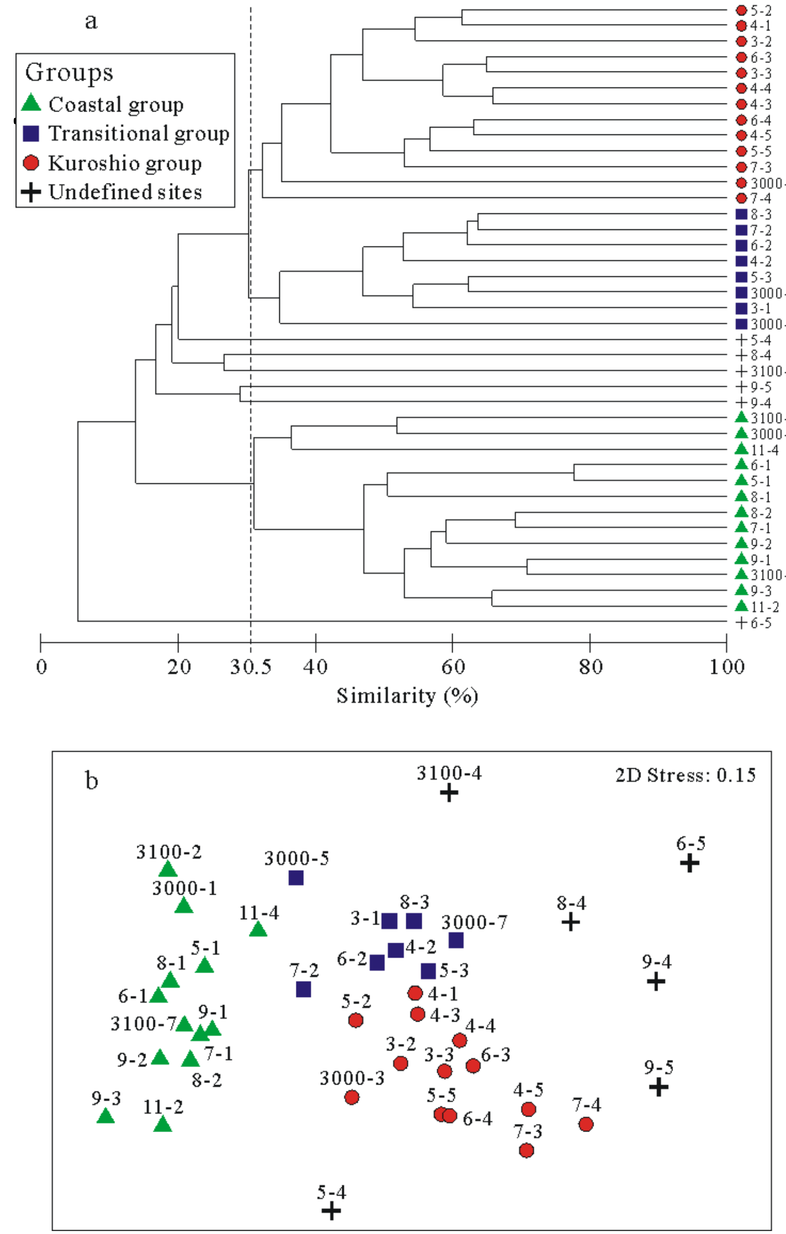
② Influence of the Kuroshio Current on

Community structure of demersal fish --
Agassiz trawl in the East China Sea



The position of the left edge of the kuroshio group was consistent with the Nearshore Kuroshio Branch Current (NKBC)

Sampling time
August-September, 2015

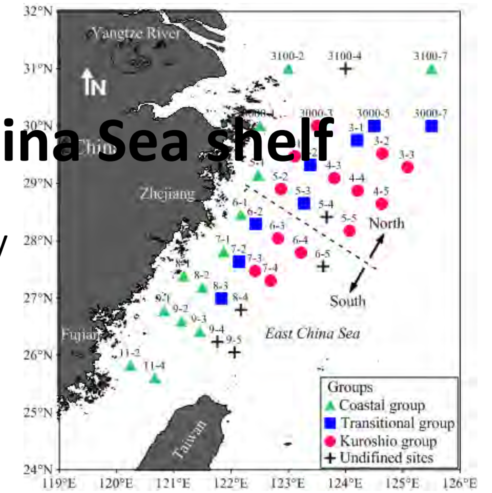


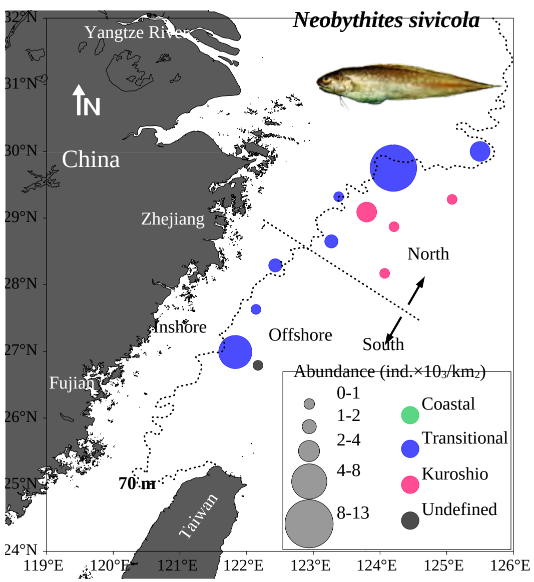
Cluster analysis and nMDS ordination

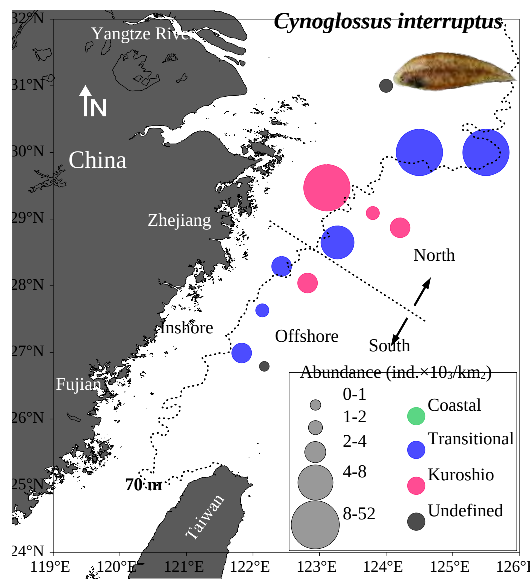
② Influence of the Kuroshio Current on the East China Sea shelf

Distribution of typical species in the transitional group -- Agassiz trawl in the East China Sea

Community structure





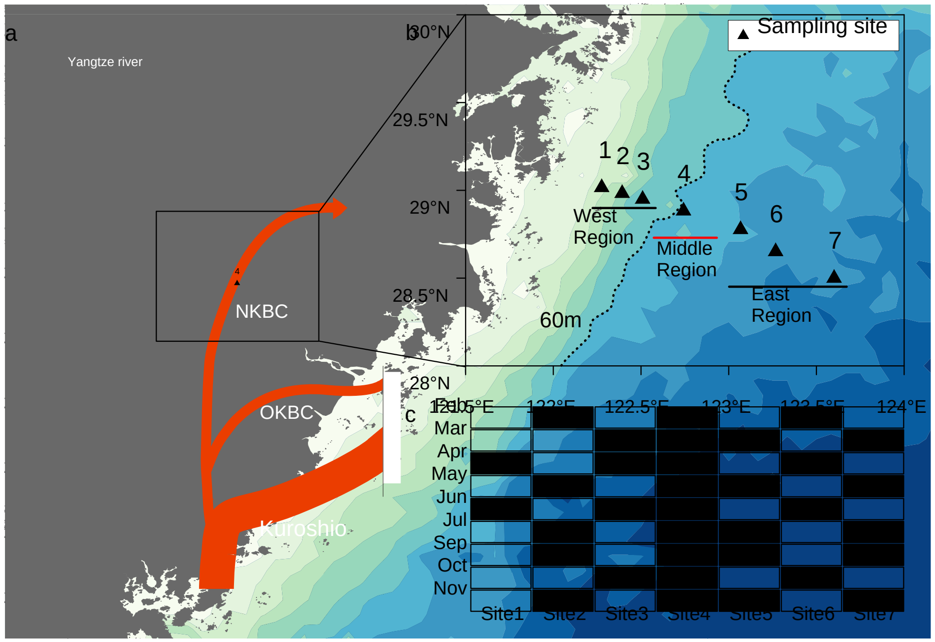


Sampling time

August-September, 2015

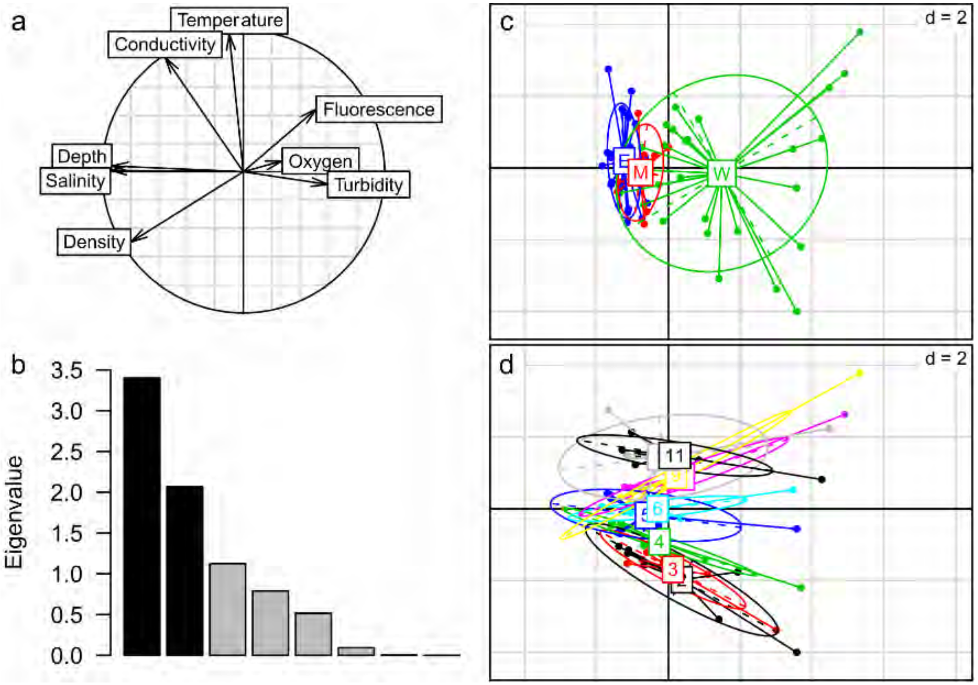
② Influence of the Kuroshio Current on the East China Sea shelf (February-November, 2015)

Principal component analysis (PCA) plots for environmental variables.



Location map of sampling sites in the East China Sea. (a) Kuroshio and its branches (NKBC: Nearshore Kuroshio Branch Current; OKBC: Offshore Kuroshio Branch Current) suggested by Yang (2012) and Wang (2016). (b) Seven sampling sites corresponding to three regions (Site 1-3: the West Region; Site 4: the Middle Region; Site 5-7: the East Region). (c) Sampling procedure for each month (the black rectangle: physical, chemical and biological site; the white rectangle: only physical and chemical site).

Correlations of environmental variables (a), eigenvalue (b), and mutlivariate analyses of environmental variables through a scatter diagram by regions (c) and months (d), respectively.



Sampling time

February-November, 2015

Depth, **salinity** and **density** were highly correlated with each other, but negatively associated with **turbidity**.

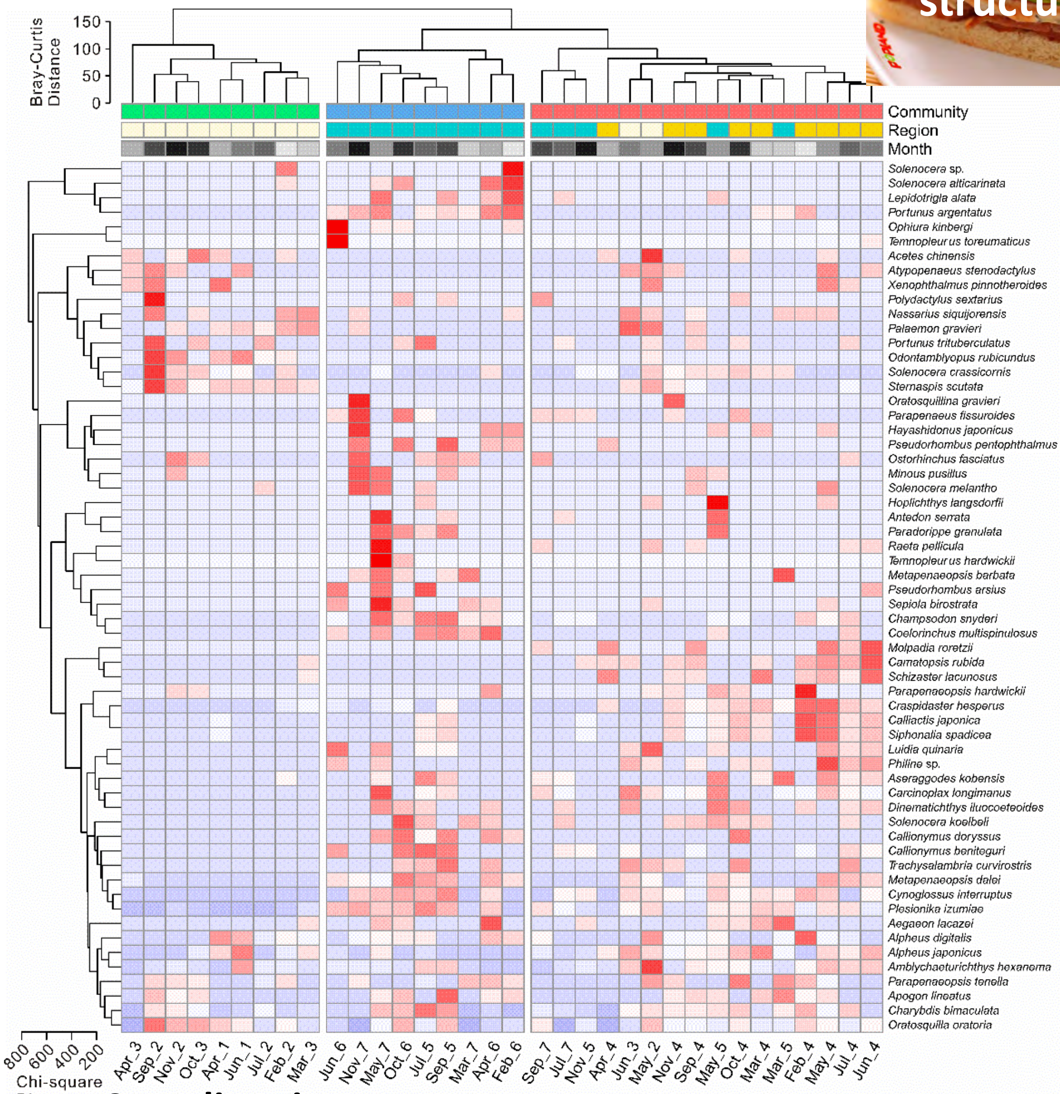
East Region and **Middle Region** were characterized by high water depth and salinity, whereas **West Region** was featured by high turbidity

February, March and April were characterized by low temperature, and **the rest months (except May and June)** were opposed

② Influence of the Kuroshio Current on the East China Sea shelf

(February-November, 2015)

Community structure

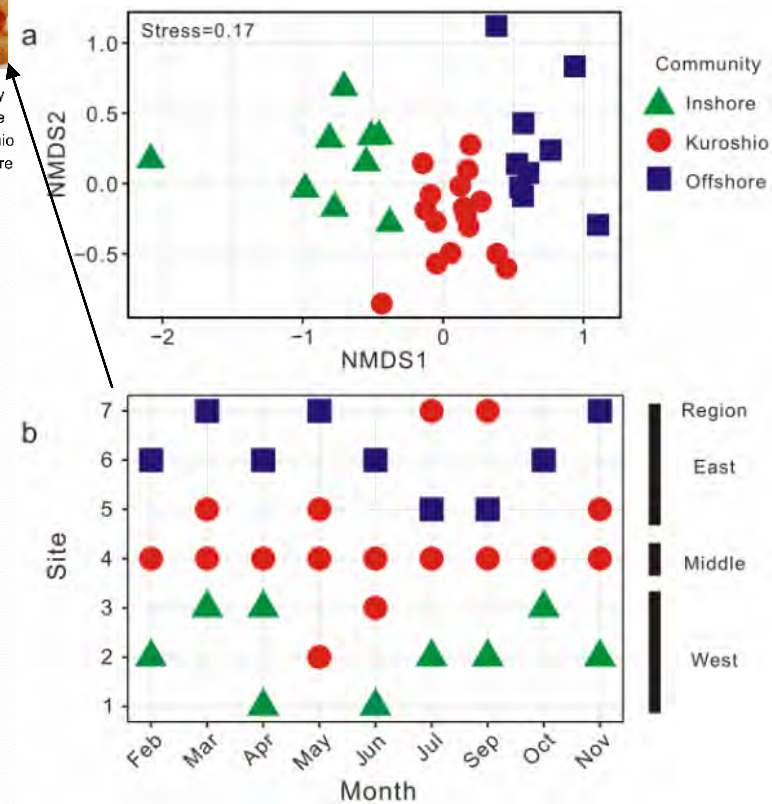


Sampling time Ward's hierarchical cluster analysis

February-November, 2015

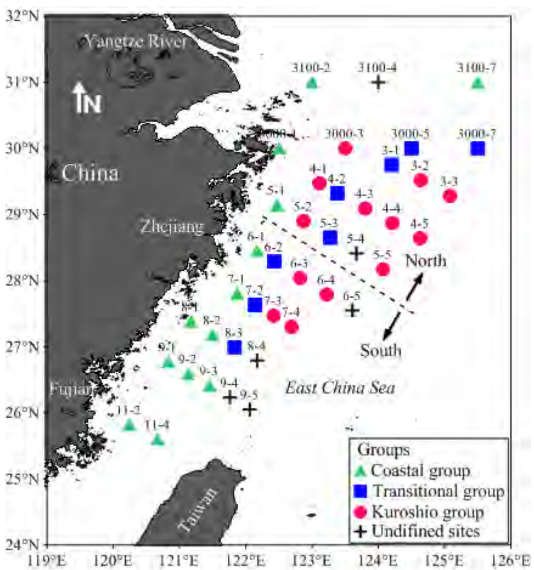
(a) Non-metric multidimensional scaling ordinations (nMDS) for macrofauna.

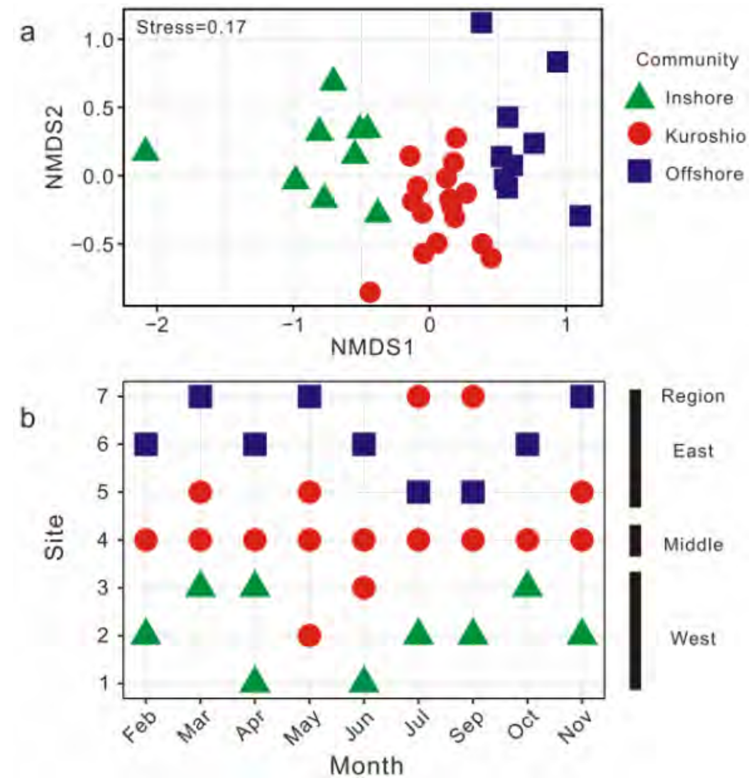
(b) Spatial distribution of different communities.



Ward's hierarchical cluster analysis and nMDS ordination suggested **three communities** existing in the study area, named as: **Inshore Community, Kuroshio Community** (because of the pass of NKBC), **Offshore Community.** **Kuroshio community existed during the survey (Fig. b).**

② Influence of the Kuroshio Current on the East China Sea shelf





We could preliminary confirm the existence of NKBC from the angle of macrobenthic community, with species collected by Agassiz trawl in the East China Sea shelf and a section off Yangtze river estuary. The kuroshio did influence the East China Sea shelf.

Evidence

① **Agassiz trawl in the East China Sea shelf**： **The position of the left edge of the kuroshio group was consistent with the Nearshore Kuroshio Branch Current (NKBC).**

② **Agassiz trawl in the section off Yangtze river estuary**： **The species composition in middle sites (Kuroshio community) were different from other sites, this phenomenon existed all year round.**

① Long-term variations of macrobenthic community in the southern Yellow Sea

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③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

1950s-2010s

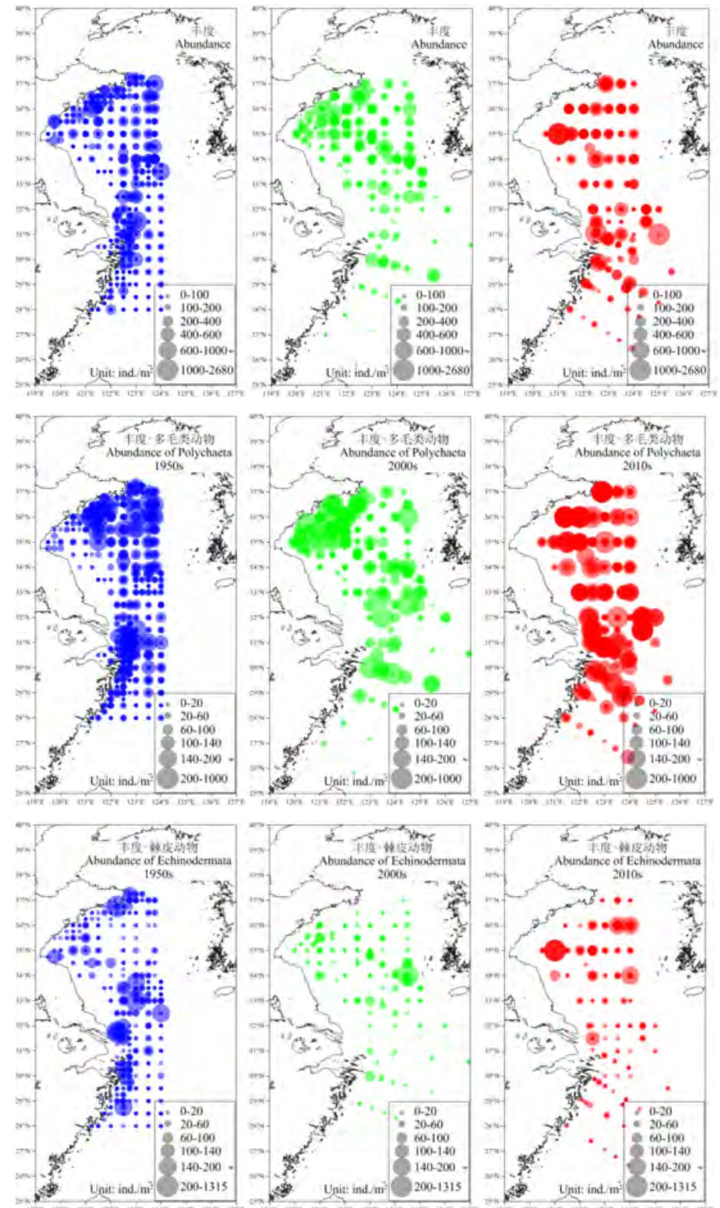
Macrobenthic abundance → Not obvious →

Abundance of polychaete → Increasing obviously →

Abundance of echinoderm → Decreasing obviously →

Abundance of mollusk and crustacean, not obvious.

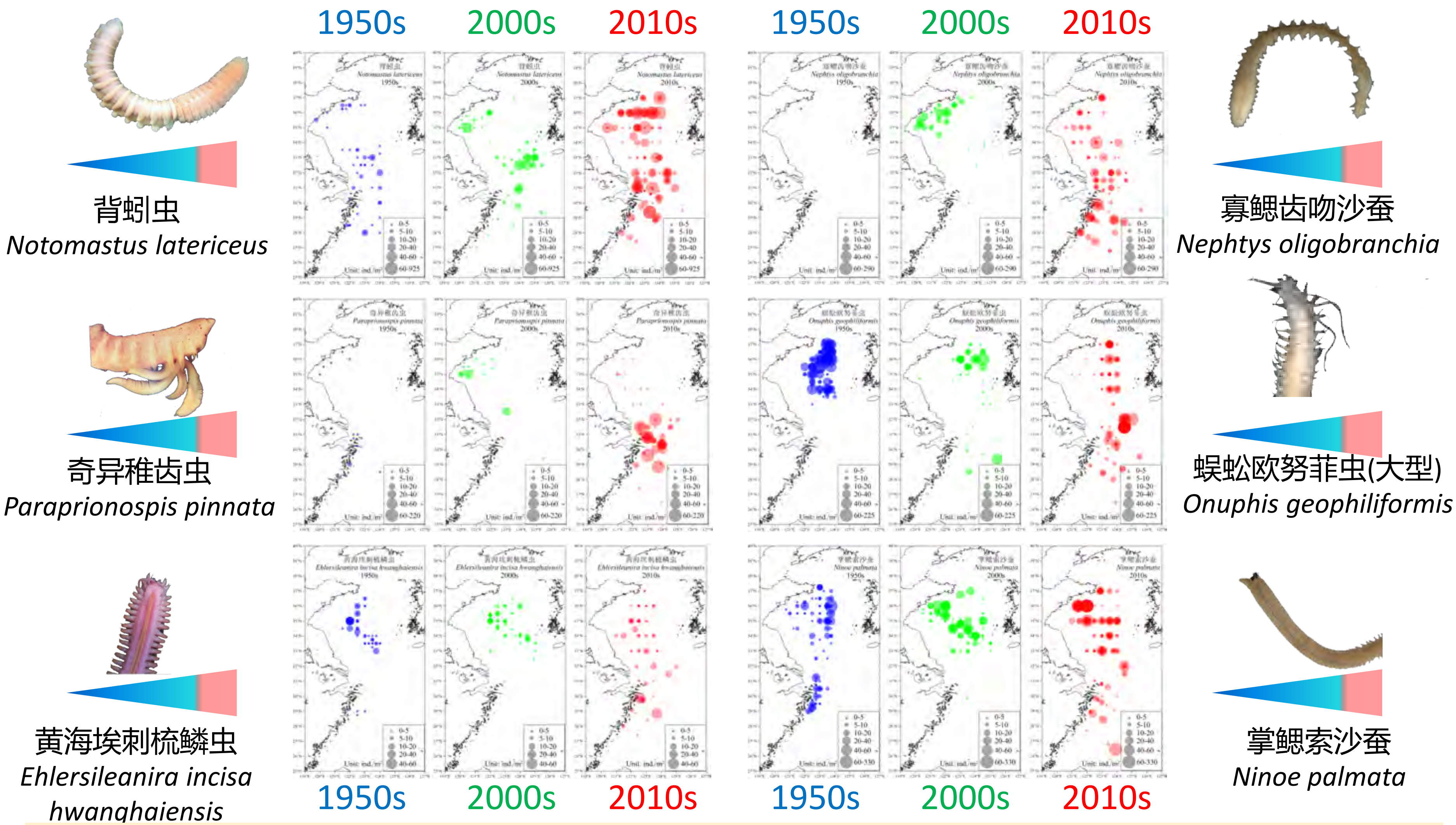
1950s 2000s 2010s



1950s 2000s 2010s

③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

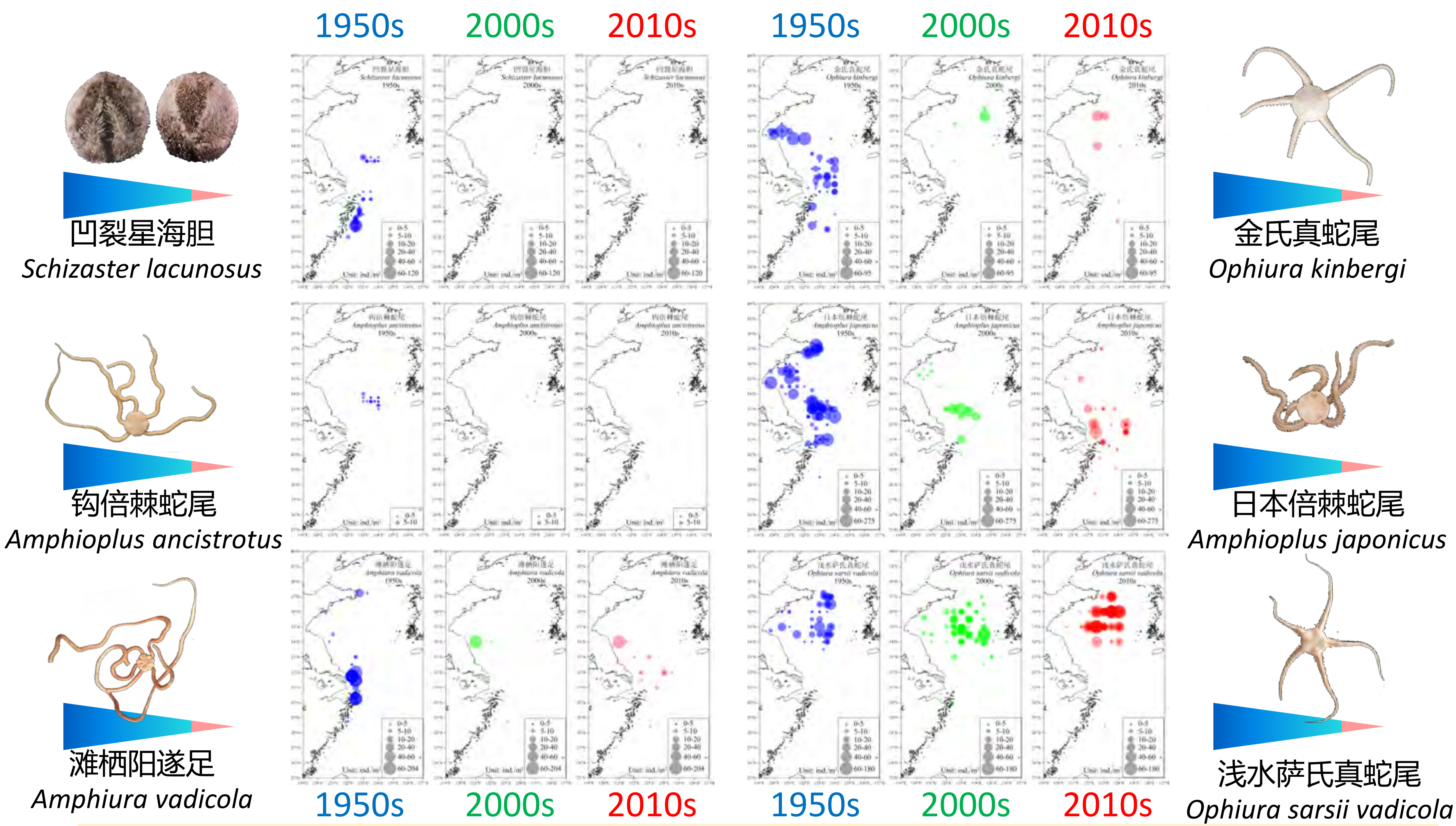
Polychaetes 1950s-2010s



From 1950s to 2010s, **most opportunistic polychaete species with small size** increased in abundance and distribution range. **Large size species** like *Onuphis geophiliformis* also increased in diatribuion range, but decreased in abundance.

③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

Echinoderms 1950s-2010s

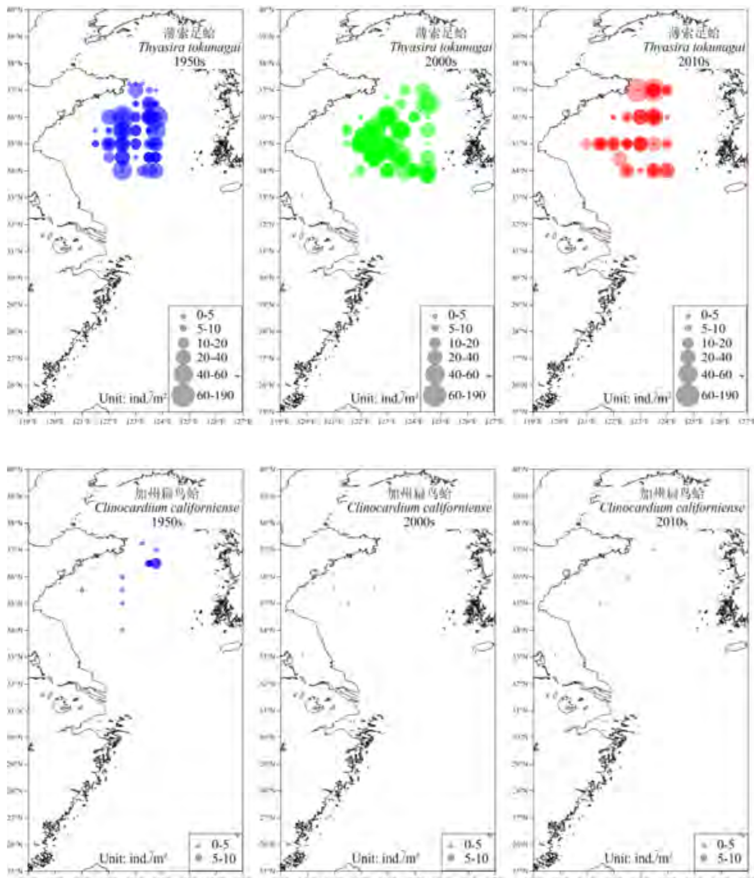


From 1950s to 2010s, **most echinoderm species** decreased in abundance and distribution range. ***Ophiura sarsii vadicola*** decreased in distribuion range, but increased obviously in abundance.

③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

Mollusks 1950s-2010s

1950s 2000s 2010s

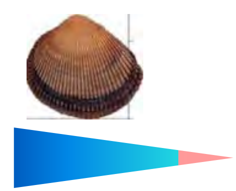


1950s 2000s 2010s

薄索足蛤 *Thyasira tokunagai*

Distribution range: **No obvious variation**

Abundance: **Increased in 2000s**



加州扁鸟蛤 *Clinocardium californiense*

Distribution range: **Fragmentated**

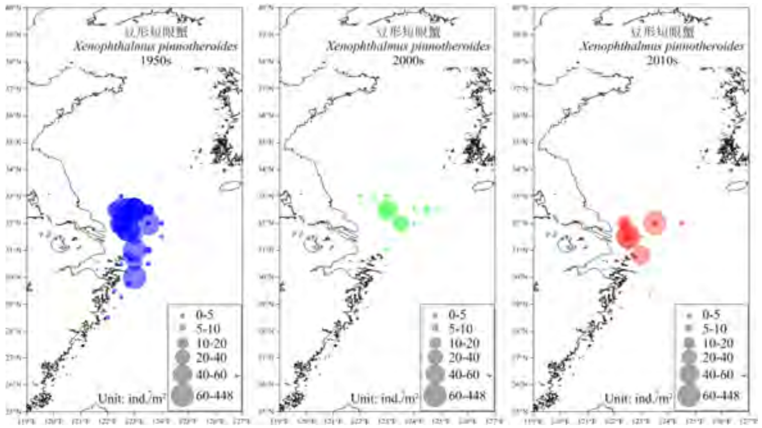
Abundance: **Decreased**

From 1950s to 2010s, **Small size cold water species mainly distributed in the Yellow Sea Cold Water Mass**. Large size species decreased in abundance whose distribution was fragmented.

③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

Crustaceans 1950s-2010s

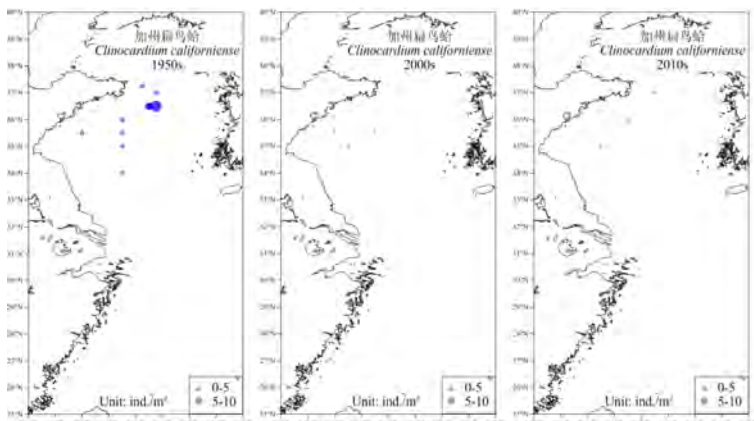
1950s 2000s 2010s



豆形短眼蟹 *Xenophthalmus pinnotheroides*

Distribution range: **No obvious variation**

Abundance: **Decreased**



1950s 2000s 2010s

泥足隆背蟹 *Carcinoplax vestita*

Distribution range: **Fragmentated**

Abundance: **Decreased**

From 1950s to 2010s, **the distribution range of crustaceans decreased or not changed, with abundance decreased.**

Distribution area of warm water algae **moved northward**

厚网藻
Pachydictyon coriaceum

Distributed in the south area of Zhoushan, Zhejiang Province originally.

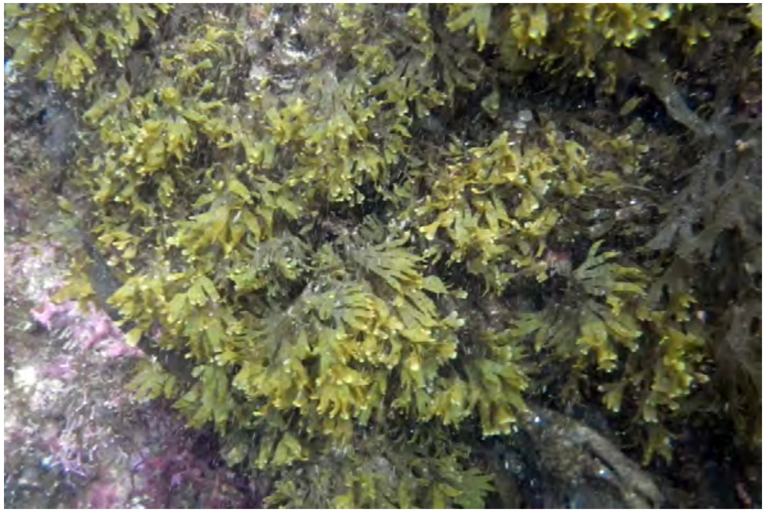
Pingdao island, Rizhao, Shandong Province, July, 2015

Qingdao, Shandong Province, June, 2015

Distribution area of warm water algae <u>moved northward</u>

厚缘藻
Rugulopteryx okamurae

Distributed in the south area of Nanji island, Zhejiang Province originally.



Gouqi island, Zhejiang Province,
July, 2015

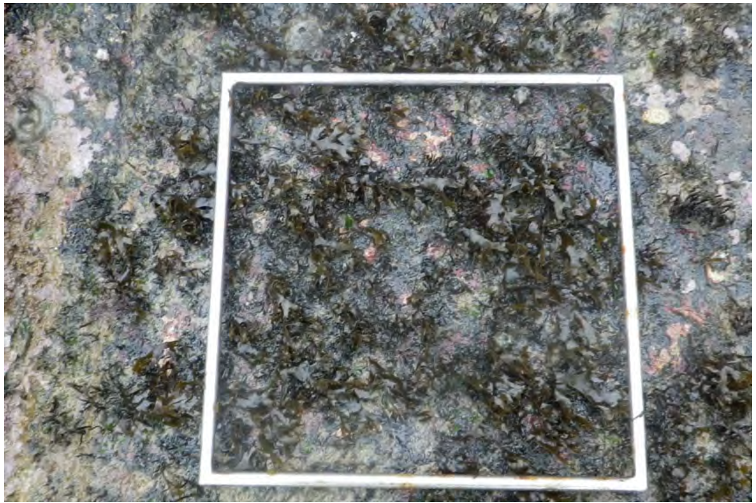
Investigation results during first half year of 2015

(1) Found the distribution area of some algae move northward, which may be related to the increase of the sea water tempreture.

(2) Diversity and biomass of macroalgae increased.

(3) The increase of transparency of sea water may be the main reason for the recovery of macroalgae.






Distribution area of reef coral <u>move northward</u>

Zhican Tang and Jianzhang Sun found the north boundary of the distribution area of reef coral moved northward from Dongshan, Fujian Province to Nanji island, Zhejiang Province in 2007, and the boundary vanished for a time.

皱齿星珊瑚 *Oulastrea crispata* was found in Nanji island again in May, 2015

Nanji island, Zhejiang Province,
May, 2015

③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

Conclusion

Polychaetes: **most opportunistic polychaete species with small size increased** in abundance and distribution range; **some species** trended to distribute along the coastal line and the sea area off Yangtze river estuary with large abundance; these species could indicate the environment condition in this area.
Echinoderms: **most echinoderm species** decreased in abundance and distribution range.
Cold water species like ***Ophiura sarsii vadicola*** **decreased** in distribuion range, but increased obviously in abundance. The decrease of distribution range of cold water species may be related to **global warming**.
Mollusks: **Small size cold water species mainly distributed in the Yellow Sea Cold Water Mass**. Large size species decreased in abundance whose distribution was fragmented.
Crustaceans: no obvious variation in distribution range and abundance.

From above results we could concluded that the **polychaetes** had the superiority in adaptation to environment and trended to be dominant in the Yellow Sea and East China Sea.

We found **some macroalgaes** with **distribution area moving northward**, which may be related to the increase of the sea water tempreture.

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- **Sampling sites**

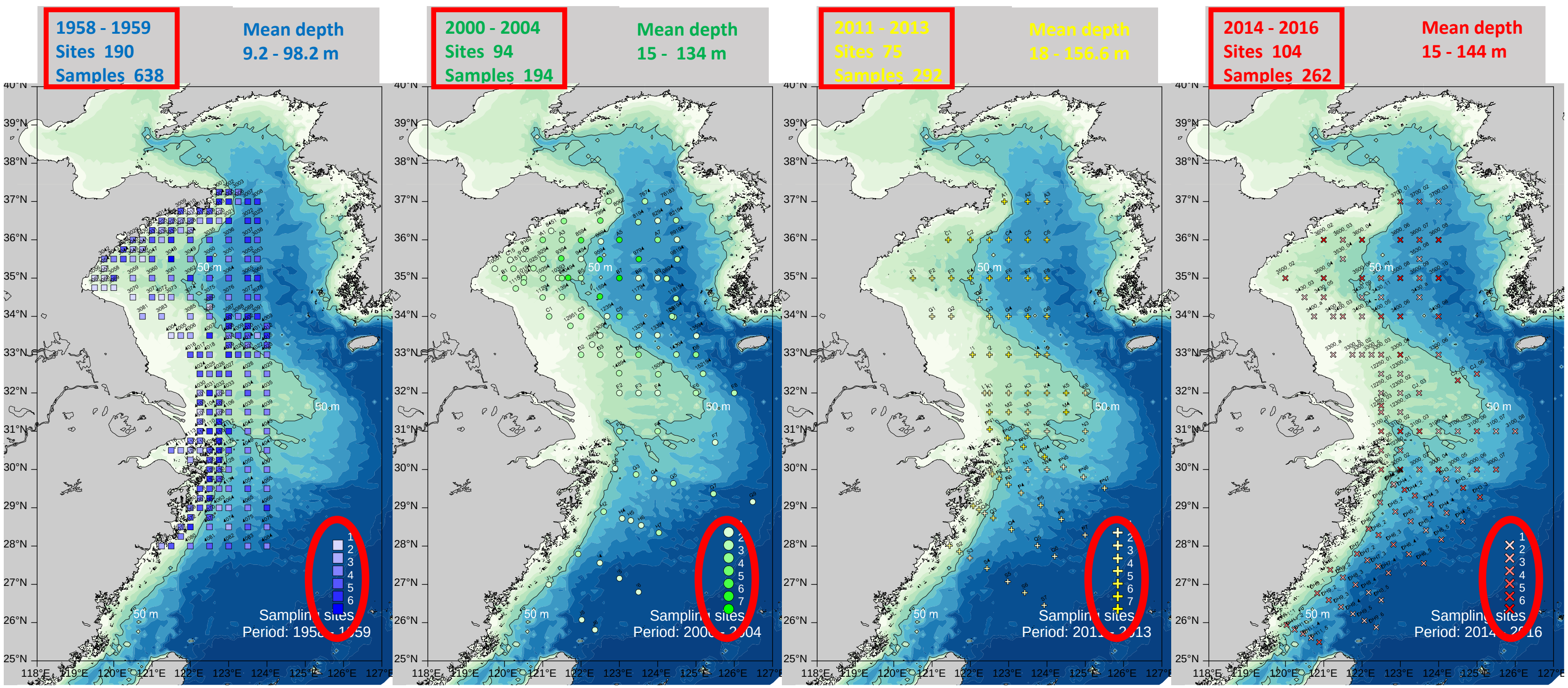


Figure Sampling sites in the Yellow Sea and East China Sea. The color shades indicate the times of sampling repeated during different periods. The darker the color is, the more the sampling repeated. 1958-1959: 1-6 times; 2000-2004: 1-7 times; 2011-2013: 1-7 times; 2014-2016: 1-6 times.

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea

- ① 1958-1959

A total of 190 sites were classified into **25 communities** (4 sites were not classified for their occurrence alone as significant sites)

The characteristic species were identified by SIMPER analysis (the top two species in the contribution to community similarity)

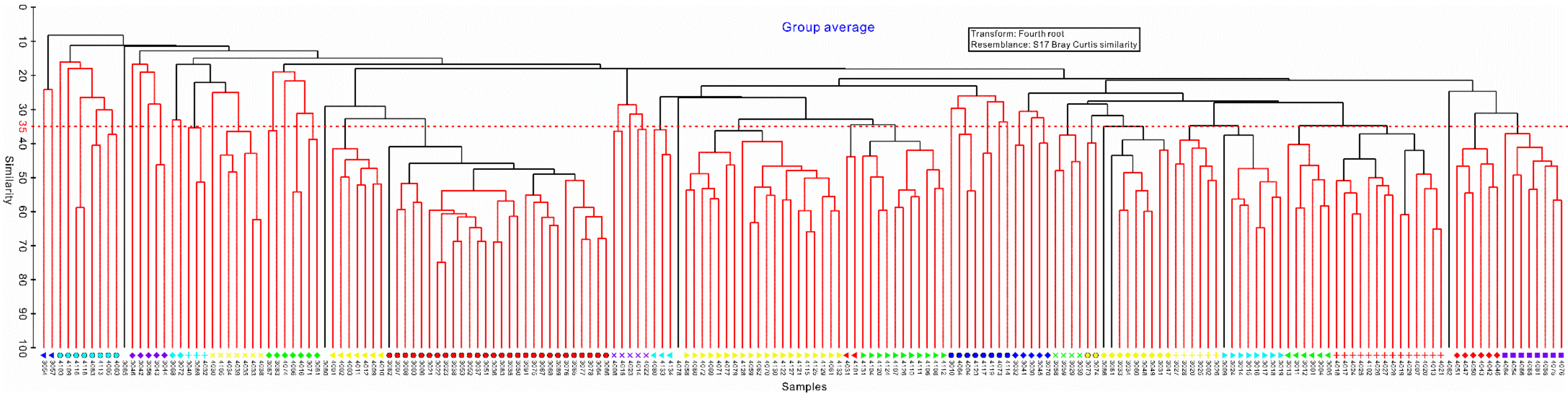
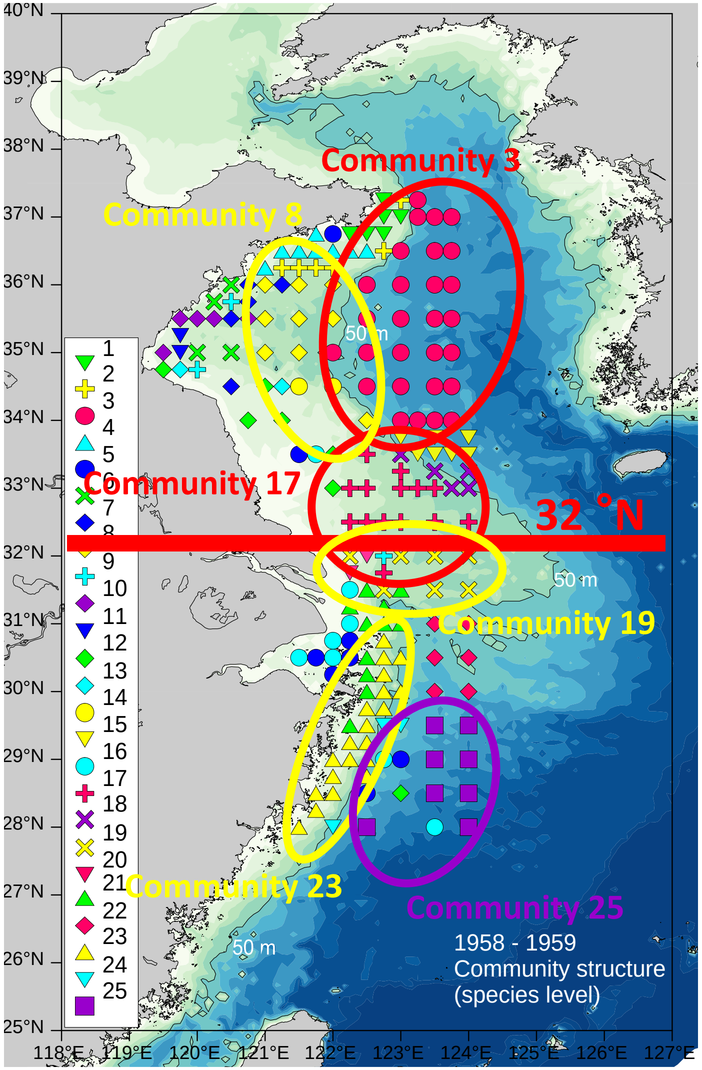


Figure The result of cluster analysis based on the fourth root transformed abundance data of macrozoobenthos in the Yellow Sea and East China Sea during 1958-1959. The macrozoobenthic communities were identified based on the prerequisite of significant clusters (SIMPROF test, $P < 0.05$) with at least 35% of the similarity level.

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea



- ① 1958-1959

Community 1 (▼) *Amphioplus japonicus* and Maldanidae
Community 2 (✚) *Lumbrineris* sp. and *Entricoplax vestita*
Community 3 (●) *Onuphis geophiliformis* and *Lumbrineris* sp.
Community 4 (▲) *Eriopisella* sp.a and *Ampelisca* sp.f
Community 5 (●) *Sternaspis scutata* and Polychaeta
Community 6 (✕) *Ampelisca* sp.e and *Callianassa* sp.c
Community 7 (◆) *Glycera rouxii* and *Amphioplus japonicus*
Community 8 (◆) *Labidoplax dubia* and Maldanidae
Community 9 (✚) *Terebellides stroemii* and *Tellina* sp.
Community 10 (◆) *Synthecium elegans* and Hydrozoa
Community 11 (▼) Sabellidae
Community 12 (◆) *Lumbrineris* sp. and *Amphioplus japonicus*
Community 13 (◆) Ampeliscidae and *Ophiura kinbergi*
Community 14 (●) *Nucula* sp.1 and *Ophiura kinbergi*
Community 15 (▼) *Amphioplus ancistrotus* and *Onuphis geophiliformis*
Community 16 (●) Nemertinea and Amphiuridae
Community 17 (✚) *Amphioplus japonicus* and Polychaeta
Community 18 (✕) *Amphioplus ancistrotus* and *Schizaster lacunosus*
Community 19 (✕) *Xenophthalmus pinnotheroides* and *Ophiura kinbergi*
Community 20 (▼) *Amphiura vadicola* and Polychaeta
Community 21 (▲) *Capitella capitata* and Polychaeta
Community 22 (◆) Polychaeta and Maldanidae
Community 23 (▲) Nemertinea and *Aglaophamus jeffreysii*
Community 24 (▼) *Sternaspis scutata* and *Pelecyora nana*
Community 25 (■) *Callianassa* sp.c and *Onuphis eremita*

Figure The spatial distribution of community structure during 1958-1959. The macrozoobenthic communities were identified based on the prerequisite of significant clusters (SIMPROF test, $P < 0.05$) with at least 35% of the similarity level.

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea

- ② 2000-2004

A total of 94 sites were classified into **12 communities** (9 sites were not classified for their occurrence alone as significant sites)

The characteristic species were identified by SIMPER analysis (the top two species in the contribution to community similarity)

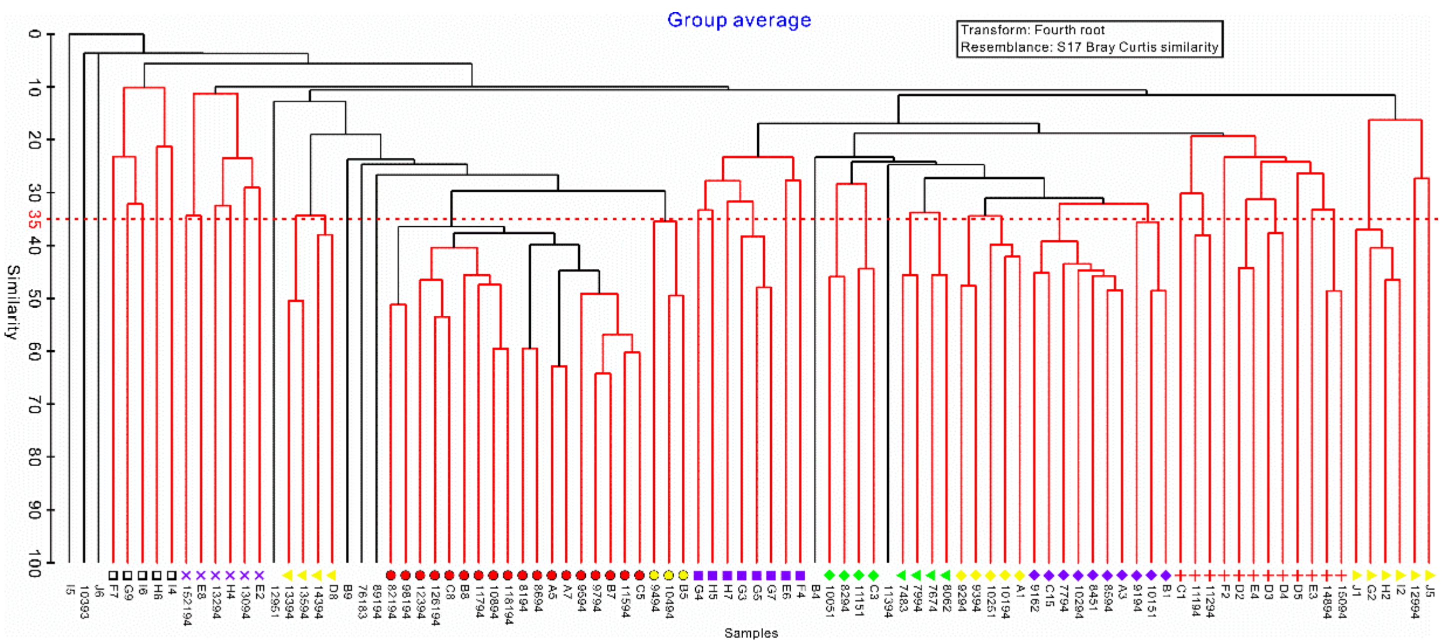


Figure The result of cluster analysis based on the fourth root transformed abundance data of macrozoobenthos in the Yellow Sea and East China Sea during 2000-2004. The macrozoobenthic communities were identified based on the prerequisite of significant clusters (SIMPROF test, $P < 0.05$) with at least 35% of the similarity level.

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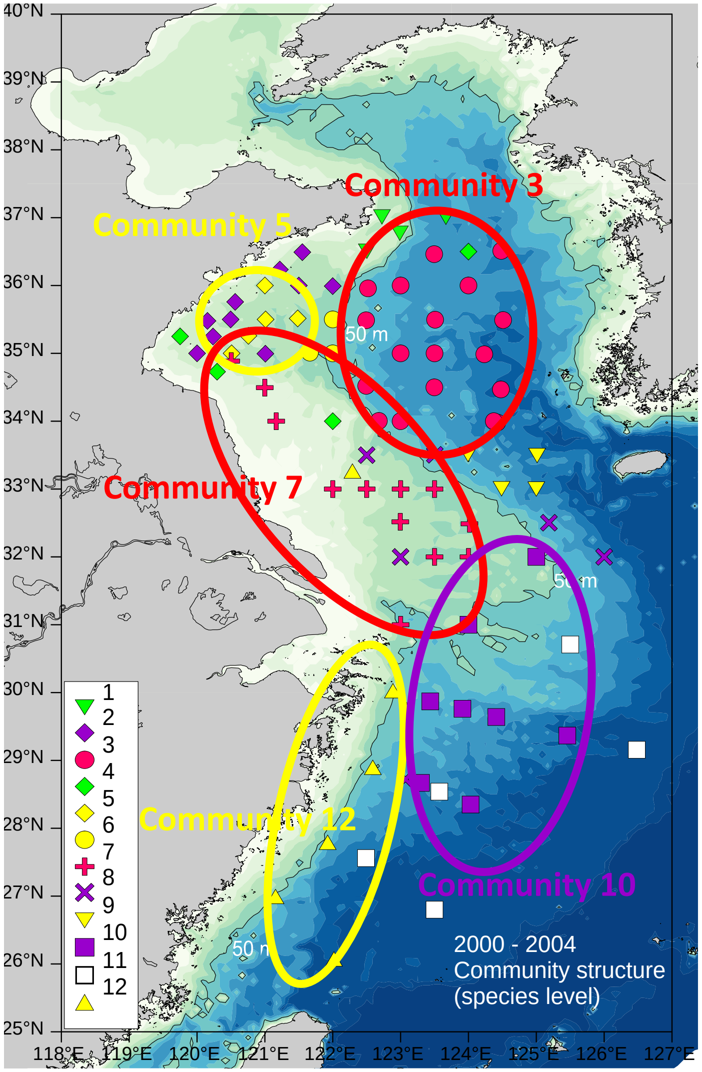


- ② 2000-2004

Community 1 (▼) *Sternaspis scutata* and *Ampelisca miops*

Community 2 (◆) *Glycera chirori* and *Nephtys oligobranchia*

Community 3 (●) *Thyasira tokunagai* and *Nucula tenuis*

Community 4 (◆) *Callianassa japonica* and Nemertinea

Community 5 (◆) *Glycera chirori* and *Ophiopholis mirabilis*

Community 6 (●) *Ophelina acuminata* and *Periploma japonicum*

Community 7 (✚) *Glycera chirori* and *Amphioplus japonicus*

Community 8 (✕) *Amphicteis gunneri* and *Callianassa* sp.

Community 9 (▼) *Notomastus latericeus* and Actiniaria

Community 10 (■) *Glycera chirori* and *Callianassa japonica*

Community 11 (□) Amphiuridae and *Magelona japonica*

Community 12 (▲) *Sternaspis scutata* and *Aglaophamus dibranchis*

Figure The spatial distribution of community structure during 2000-2004. The macrozoobenthic communities were identified based on the prerequisite of significant clusters (SIMPROF test, $P < 0.05$) with at least 35% of the similarity level.

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea

- ③ 2011-2013

A total of 75 sites were classified into **14 communities** (4 sites were not classified for their occurrence alone as significant sites)

The characteristic species were identified by SIMPER analysis (the top two species in the contribution to community similarity)

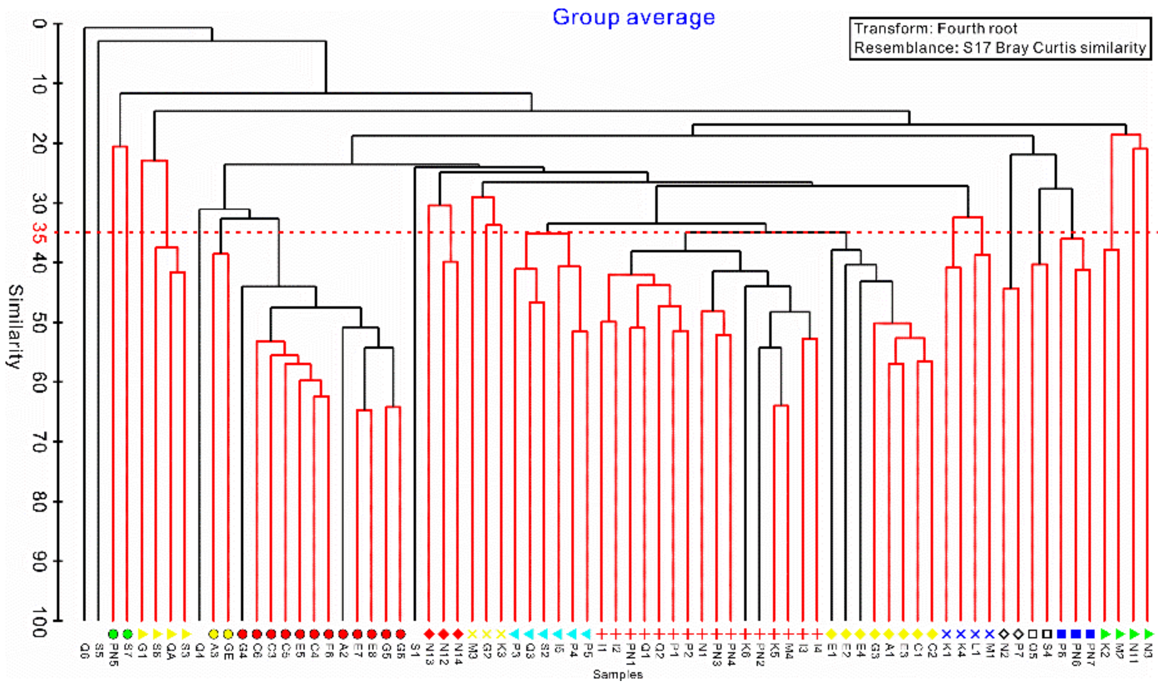
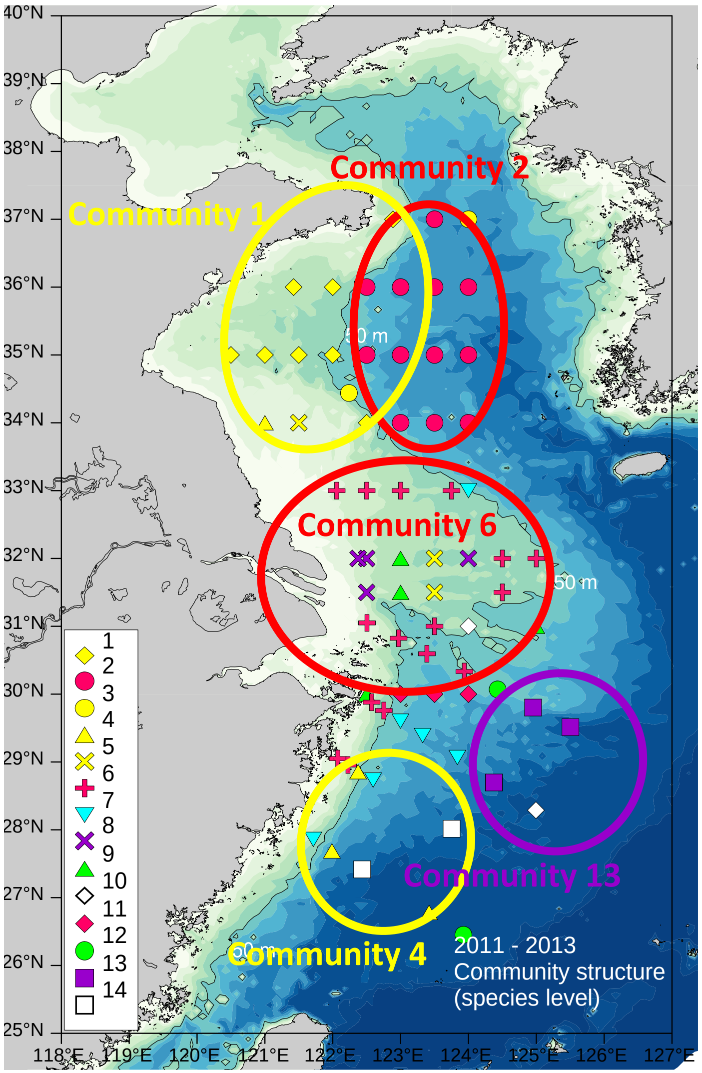


Figure The result of cluster analysis based on the fourth root transformed abundance data of macrozoobenthos in the Yellow Sea and East China Sea during 2011-2013. The macrozoobenthic communities were identified based on the prerequisite of significant clusters (SIMPROF test, $P < 0.05$) with at least 35% of the similarity level.

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea



- ③ 2011-2013

Community 1 (◆) *Glycera chirori* and *Nephtys oligobranchia*

Community 2 (●) *Ophiura sarsii vadicola* and *Thyasira tokunagai*

Community 3 (●) *Notomastus latericeus* and *Ampharete acutifrons*

Community 4 (▲) *Nephtys oligobranchia* and *Ninoe palmata*

Community 5 (✕) *Nephtys oligobranchia* and *Harpiniopsis vadiculus*

Community 6 (✚) *Lumbrineris longifolia* and *Notomastus latericeus*

Community 7 (▼) *Ophelina acuminata* and *Magelona cincta*

Community 8 (✕) *Nephtys oligobranchia* and *Notomastus latericeus*

Community 9 (▲) *Glycera chirori* and *Glycinde gurjanovae*

Community 10 (◆) *Glycera tenuis* and *Paralacydonia paradoxa*

Community 11 (◆) *Paraprionospio pinnata, Eriopisella sechellensis* and *Notomastus latericeus*

Community 12 (●) *Nereis longior* and *Onuphis geophiliformis*

Community 13 (■) *Onuphis geophiliformis* and *Magelona cincta*

Community 14 (□) *Callianassa exilimaxilla* and *Nephtys oligobranchia*

图 2011-2013年黄东海大型底栖动物群落结构的空间分布。群落的划分以聚类结果差异显著为前提，以35%的相似性水平划分。

Figure The spatial distribution of community structure during 2011-2013. The macrozoobenthic communities were identified based on the prerequisite of significant clusters (SIMPROF test, $P < 0.05$) with at least 35% of the similarity level.

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea

- ④ 2014-2016

A total of 104 sites were classified into **18 communities** (8 sites were not classified for their occurrence alone as significant sites)

The characteristic species were identified by SIMPER analysis (the top two species in the contribution to community similarity)

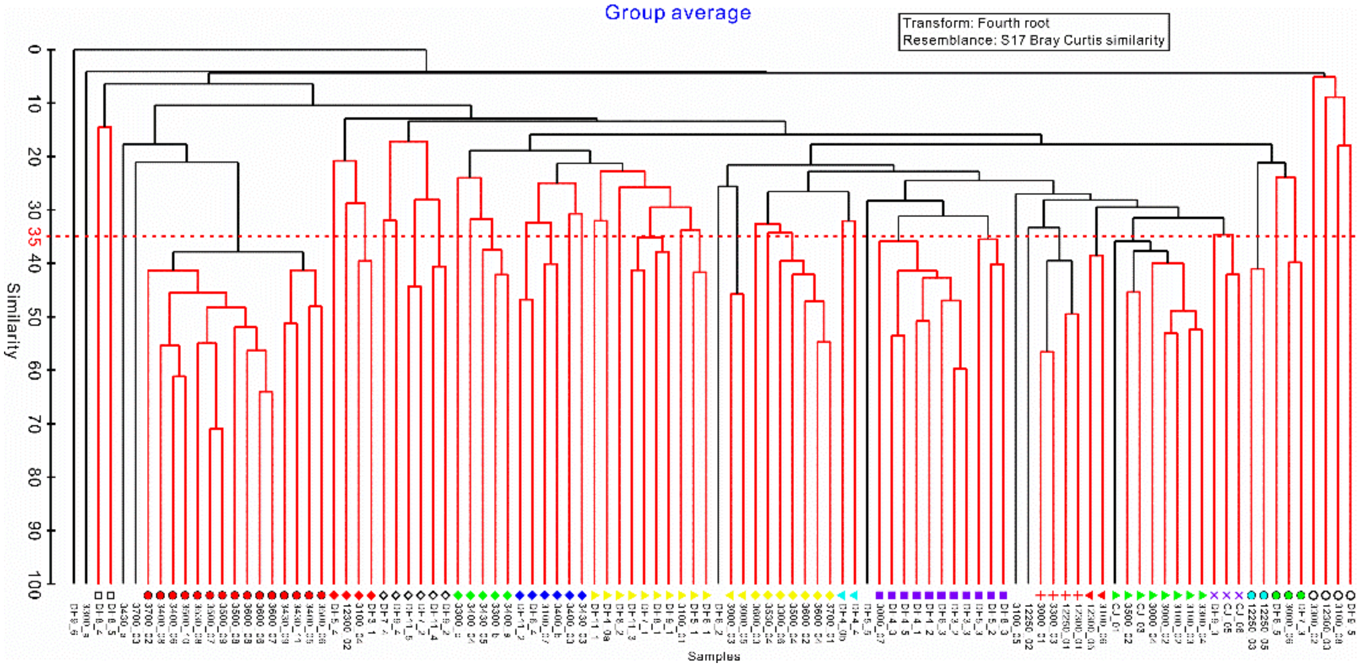
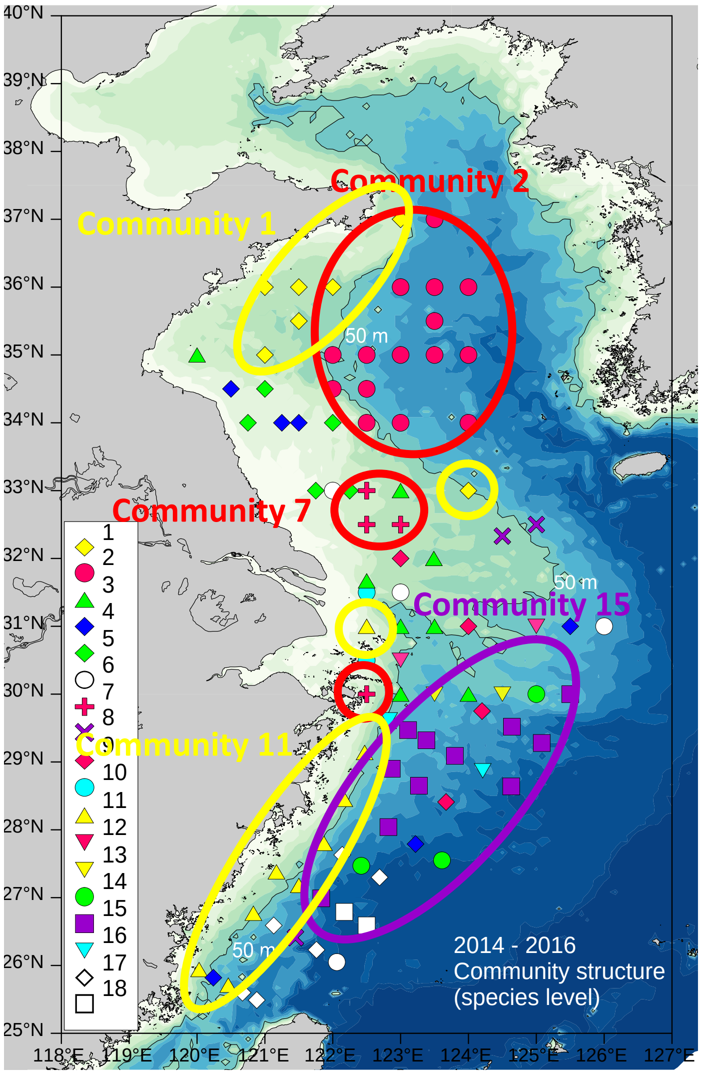


Figure The result of cluster analysis based on the fourth root transformed abundance data of macrozoobenthos in the Yellow Sea and East China Sea during 2014-2016. The macrozoobenthic communities were identified based on the prerequisite of significant clusters (SIMPROF test, $P < 0.05$) with at least 35% of the similarity level.

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea



- ④ 2014-2016

Community 1 (◆) *Glycera chirori* and *Ninoe palmata*

Community 2 (●) *Ophiura sarsii vadicola* and *Thyasira tokunagai*

Community 3 (▲) *Notomastus latericeus* and *Paralacydonia paradoxa*

Community 4 (◆) *Nephtys oligobranchia* and *Sternaspis scutata*

Community 5 (◆) *Paralacydonia paradoxa* and *Nephtys oligobranchia*

Community 6 (●) Lumbrineridae and *Ophiura* sp.

Community 7 (✚) *Sternaspis scutata* and *Lumbrineris sinensis*

Community 8 (✕) *Notomastus latericeus* and *Magelona japonica*

Community 9 (◆) Amphiuridae and Nemertinea

Community 10 (●) *Heteromastus filiformis* and *Prionospio paradisea*

Community 11 (▲) *Nephtys oligobranchia* and *Sternaspis scutata*

Community 12 (▼) Phascolosomatidae and Sipuncula

Community 13 (▼) *Notomastus latericeus* and *Nereis longior*

Community 14 (●) *Goniada japonica* and *Glycera chirori*

Community 15 (■) *Magelona cincta* and *Notomastus latericeus*

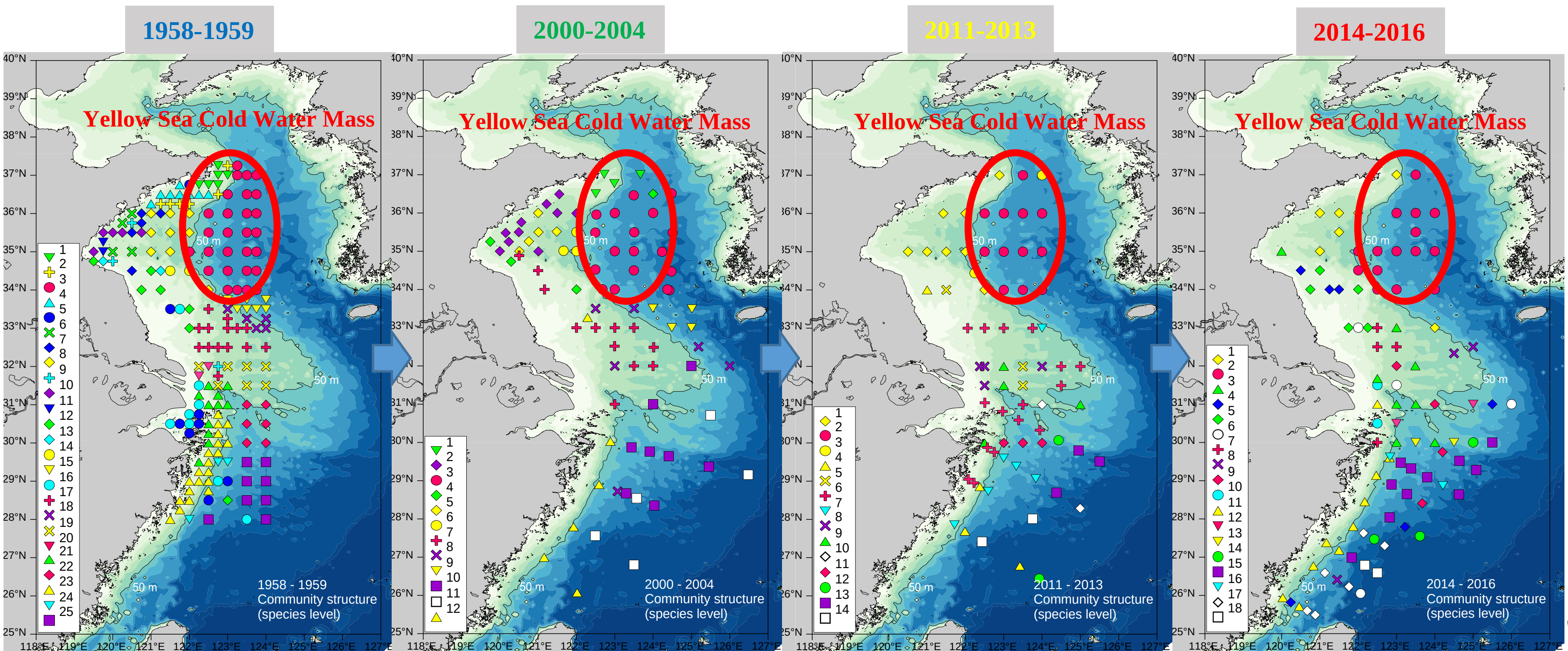
Community 16 (▼) *Glycinde gurjanovae* and *Magelona cincta*

Community 17 (◆) *Amphioplus* sp. and *Magelona japonica*

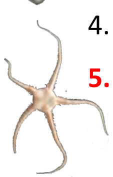
Community 18 (■) Decapoda

Figure The spatial distribution of community structure during 2014-2016. The macrozoobenthic communities were identified based on the prerequisite of significant clusters (SIMPROF test, $P < 0.05$) with at least 35% of the similarity level.

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea



Characterized species (listed according to the contribution to the similarity of the community, circled)



1958-1959

1. **Polychaete *Onuphis geophiliformis***
2. Polychaete *Lumbrineris* sp.
3. **Bivalve *Thyasira tokunagai***
4. Bivalve *Nuculana yokoyamai*
5. **Brittle star *Ophiura sarsii vadicola***

2000-2004

1. **Bivalve *Thyasira tokunagai***
2. Bivalve *Nucula tenuis*
3. **Brittle star *Ophiura sarsii vadicola***

⋮

9. **Polychaete *Onuphis geophiliformis***

2011-2013

1. **Brittle star *Ophiura sarsii vadicola***
2. **Bivalve *Thyasira tokunagai***

⋮

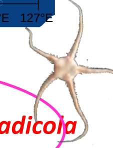
8. **Polychaete *Onuphis geophiliformis***

2014-2016

1. **Brittle star *Ophiura sarsii vadicola***
2. **Bivalve *Thyasira tokunagai***

⋮

10. **Polychaete *Onuphis geophiliformis***



④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea

Conclusion

The spatial pattern of most macrobenthic communities in the Southern Yellow Sea varied a lot from 1958 to 2016.

The Yellow Sea Cold Water Mass Community varied a little in the spatial pattern from 1958 to 2016. However, the characterized species of this community varied a lot.

In 1958-1959, the characterized species were polychaetes, but during 2000 and 2016, the characterized species became brittle star and a kind of bivalve mollusk.

① Long-term variations of macrobenthic community in the southern Yellow Sea

② Influence of the Kuroshio Current on the East China Sea shelf

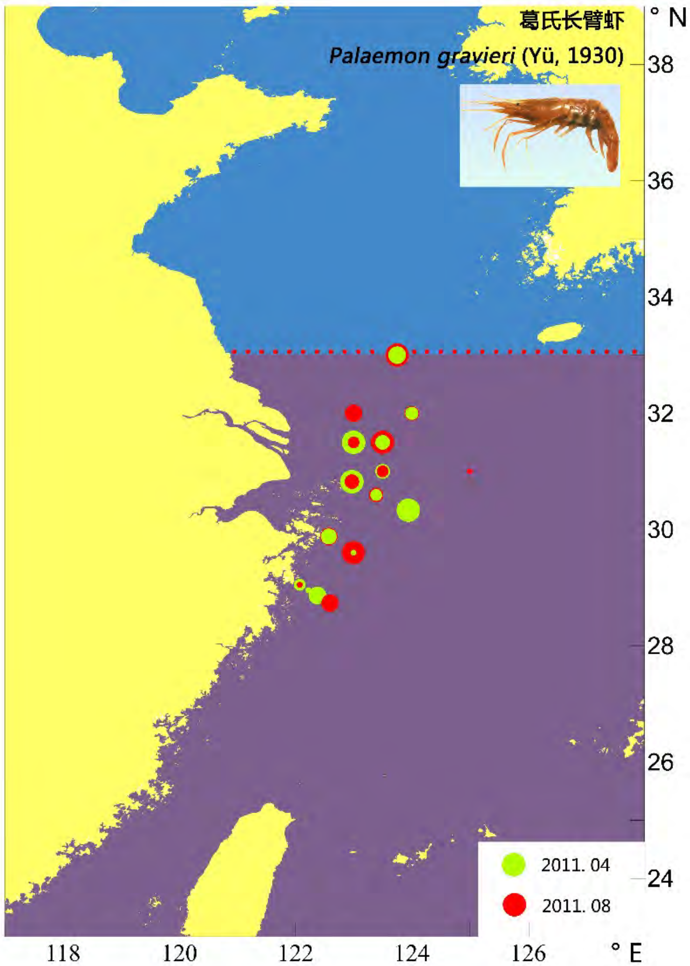
③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea

⑤ Influence of the region in 32°~33°N on the distribution of macrobenthos.

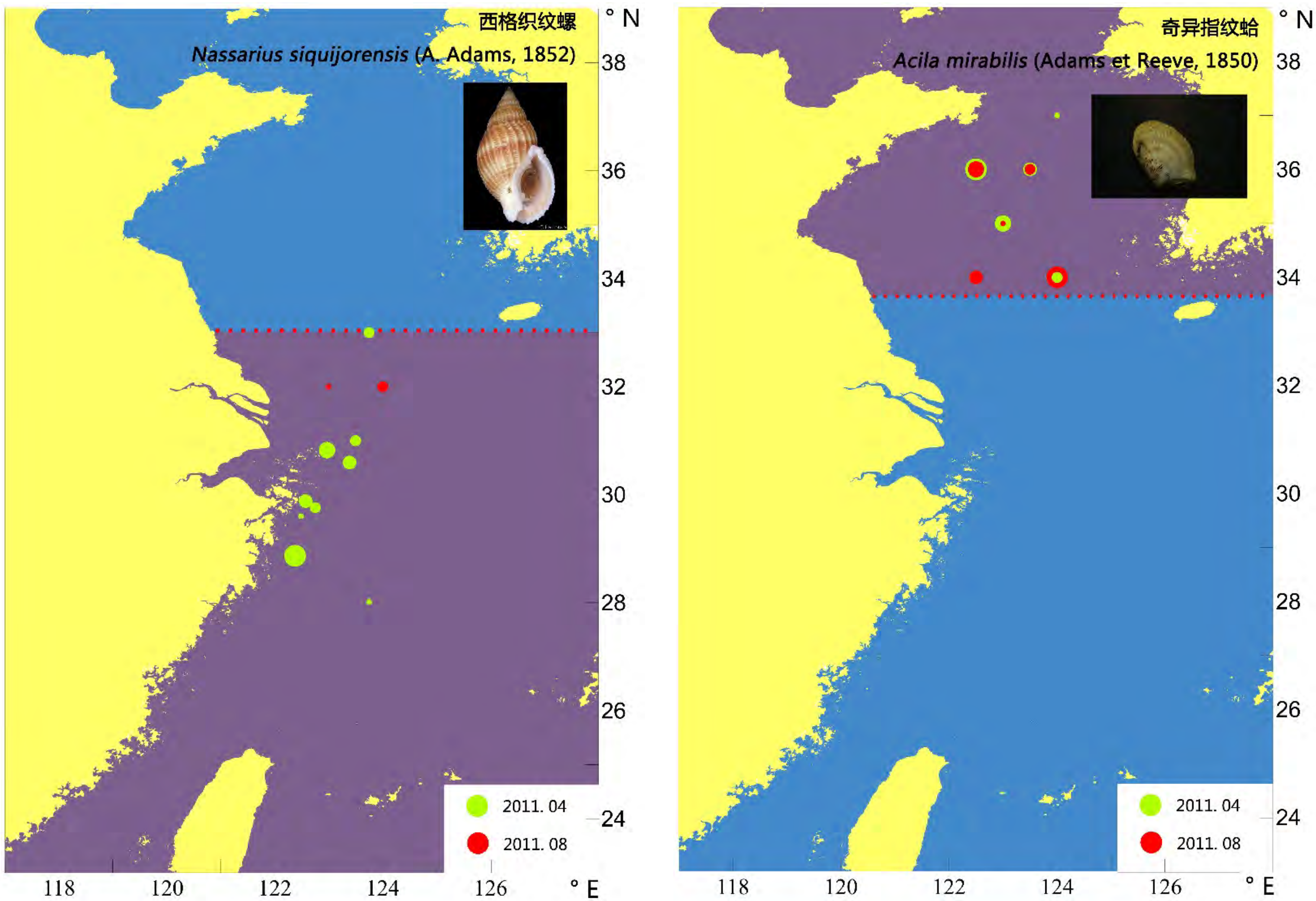
⑥ Long-term variations of macrobenthic community in the Yangtze river estuary and its adjacent area

⑤ Influence of the region in 32°~33°N on the distribution of macrobenthos



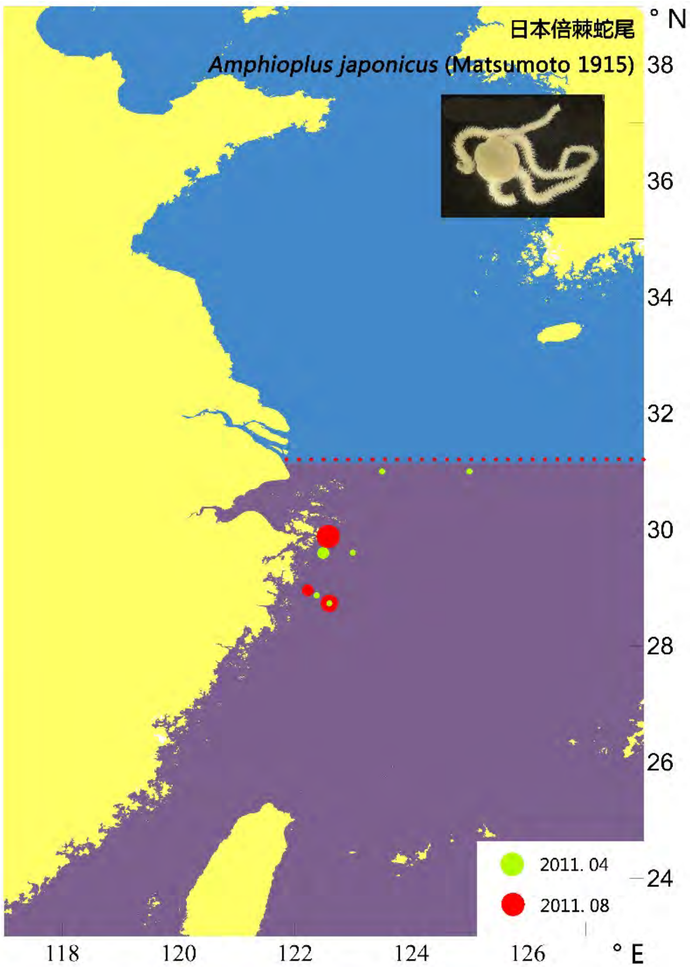
Crustaceans: We found two crustaceans (*Palaemon gravieri*) distributed in the south of the latitude 33°N in the Yellow Sea and East China Sea in spring and summer.

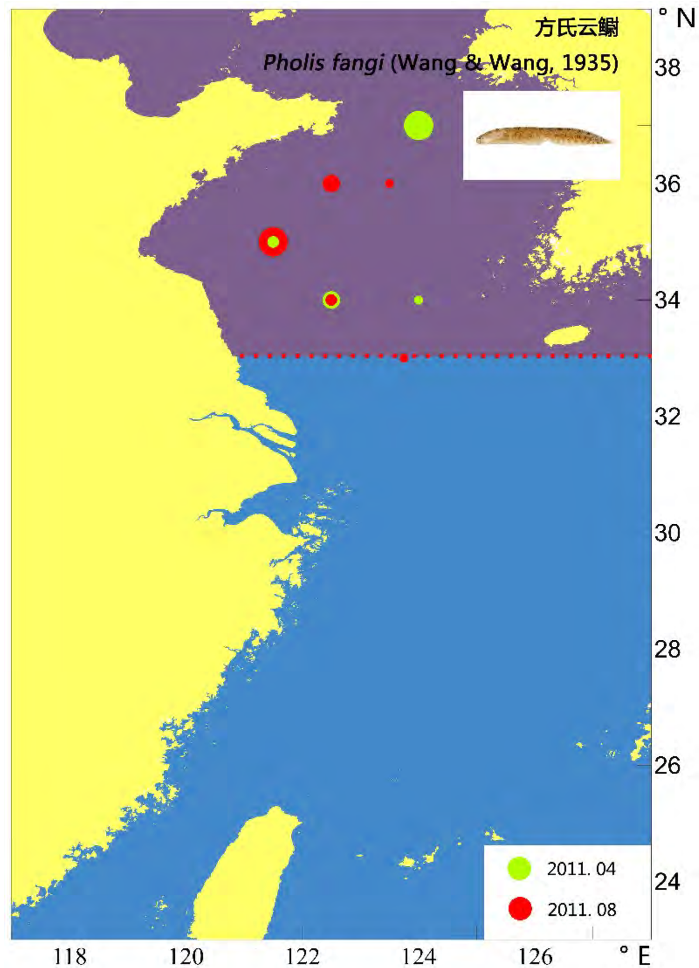
⑤ Influence of the region in 32°~33°N on the distribution of macrobenthos



Mollusks: *Nassarius siquejrensis* distributed in the south of 33° N, while *Acila mirabilis* distributed in the north of 33° N.

⑤ Influence of the region in 32°~33°N on the distribution of macrobenthos



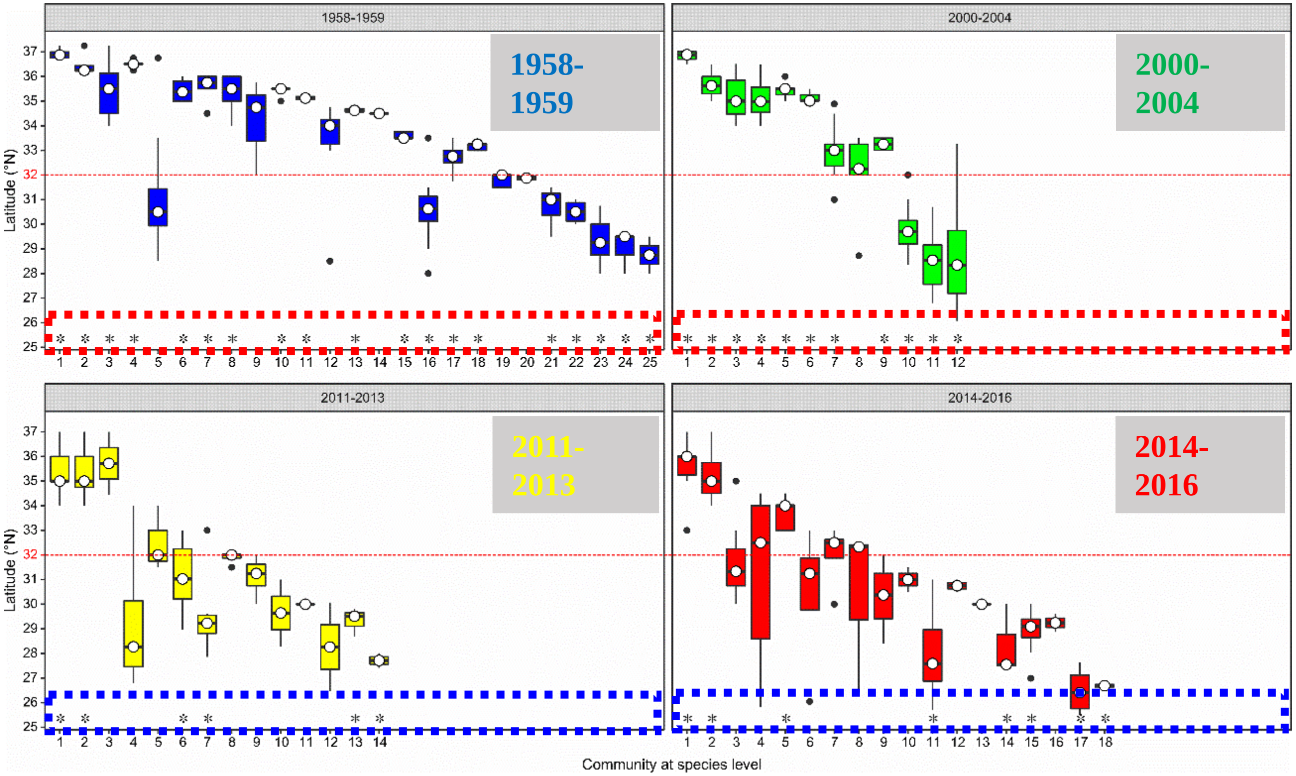


Echinoderm: *Amphioplus japonicus* distributed in the south of the Yangtze river estuary.

Fish: *Enedrias fangi* distributed in the north of 33° N.

⑤ Influence of the region in 32°~33°N on the distribution of macrobenthos

- Difference between the latitude of communities in Section 4 and latitude 32 °N (T test)



During 1958-1959 and 2000-2004 the latitude of most macrobenthic communities showed significant difference with latitude 32 °N (more than 76.00% of all communities).

During 2011-2013 and 2014-2016 the number of communities whose latitude having significant difference with latitude 32 °N decreased (less than 45%).

Figure Boxplots of the range of latitude of macrobenthic communities in the Yellow Sea and East China Sea during 4 periods. The white dot in this figure indicates the average value of the latitude and * indicates the significant difference between the latitude of community and 32 ° N. The code of macrobenthic communities are the same as those in Chapter 3.

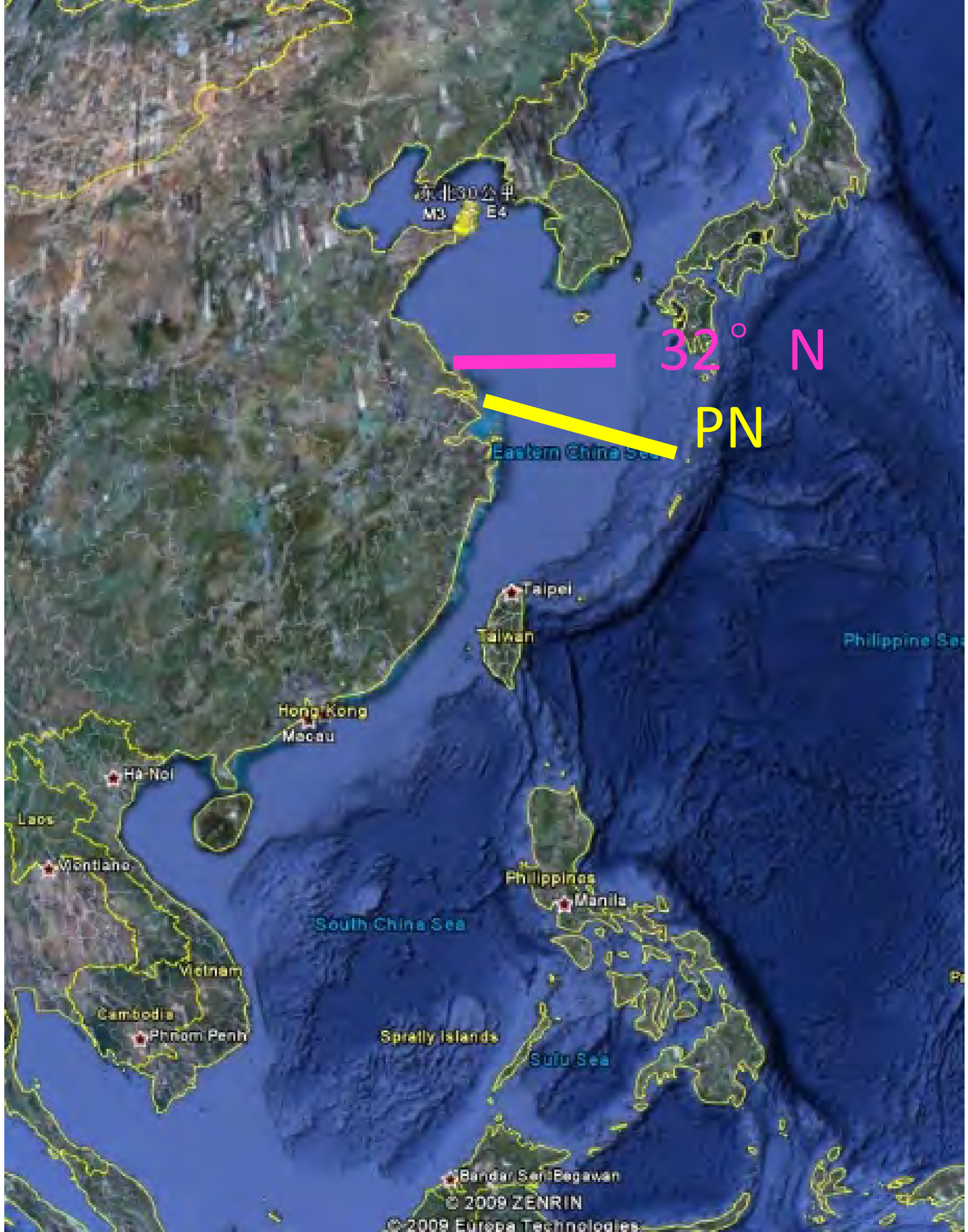
⑤ Influence of the region in 32°~33°N on the distribution of macrobenthos

Conclusion

Based on the investigation data in spring and summer, 2011, we found the distribution of crustacean (*Palaemon gravieri*), mollusks (*Nassarius siquejrensis* and *Acila mirabilis*), echinoderm (*Amphioplus japonicus*) and fish (*Enedrias fangi*) had relationship with **32°-33°N**.

The region in 32°-33°N obstructed the distribution of some macrobenthos, and it may be useful for studying the distribution of macrobenthos.

The percentage of communities whose latitude having significant difference with latitude 32 °N decreased from 1958 to 2016.



M3
E4
32° N
PN
Eastern China Sea
Taipei
Taiwan
Philippine Sea
Hong Kong
Macau
Ha Noi
Laos
Vientiane
Philippines
Manila
South China Sea
Vietnam
Cambodia
Phnom Penh
Spratly Islands
Sulu Sea
Bandar Seri Begawan
© 2009 ZENRIN
© 2009 Europa Technologies

Eastern China Sea
Taipei
Taiwan
Philippine Sea
Hong Kong
Macau
Ha Noi
Laos
Philippines
Manila
South China Sea
Vietnam
Cambodia
Phnom Penh
Spratly Islands
Sulu Sea
Bandar Seri Begawan
© 2009 ZENRIN
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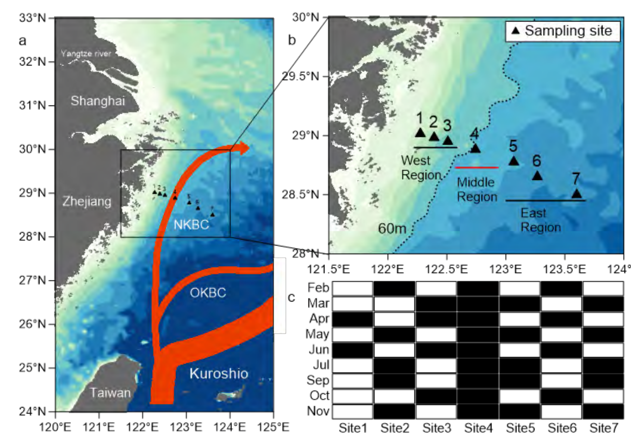


a
b
c
Yangtze river
Shanghai
Zhejiang
NKBC
OKBC
Kuroshio
Taiwan
33°N
32°N
31°N
30°N
29°N
28°N
27°N
26°N
25°N
24°N
120°E 121°E 122°E 123°E 124°E 125°E
▲ Sampling site
1 2 3 4 5 6 7
West Region
Middle Region
East Region
60m
30°N
29.5°N
29°N
28.5°N
28°N
121.5°E 122°E 122.5°E 123°E 123.5°E 124°E
Feb
Mar
Apr
May
Jun
Jul
Sep
Oct
Nov
Site1 Site2 Site3 Site4 Site5 Site6 Site7

① Long-term variations of macrobenthic community in the southern Yellow Sea

② Influence of the Kuroshio Current on the East China Sea shelf

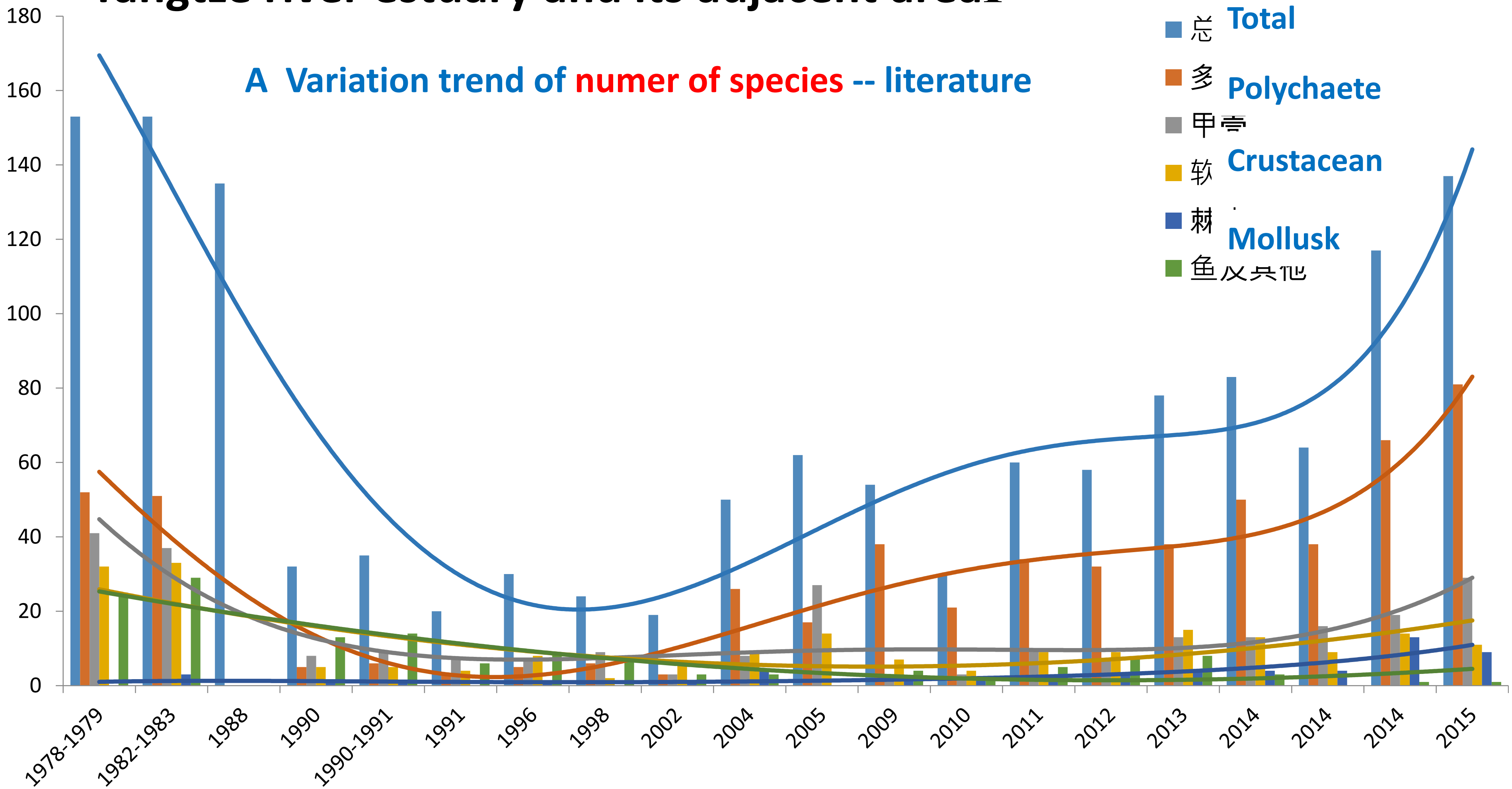
③ Global change and long-term variations of the species distribution pattern in the Yellow Sea and East China Sea

④ Long-term variations of the macrobenthic community distribution pattern in the Yellow Sea and East China Sea

⑤ Influence of the region in 32°~33°N on the distribution of macrobenthos.

⑥ Long-term variations of macrobenthic community in the Yangtze river estuary and its adjacent area

⑥ Long-term variations of macrobenthic community in the Yangtze river estuary and its adjacent areaI



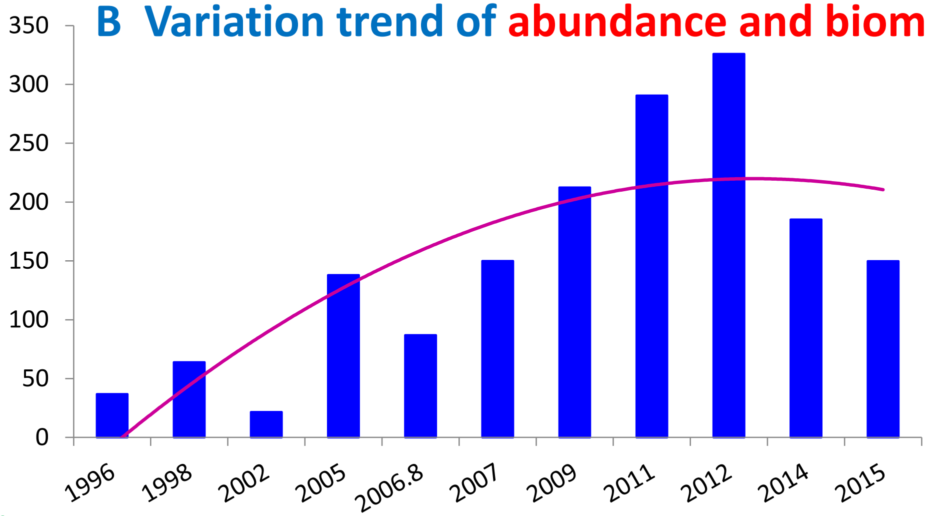
1 Number of species had low values during 1990-2000, increased during 2004-2009, and increased rapidly during 2013-2015.

2 Number of polychaete species increased during 2004-2009 and 2013-2015, with other species not obvious.

3 Number of fish species and others (species not belonging to polychaete, crustacean, mollusk and echinoderm) decreased.

⑥ Long-term variations of macrobenthic community in the Yangtze river estuary and its adjacent areaI

B Variation trend of abundance and biomass -- literature

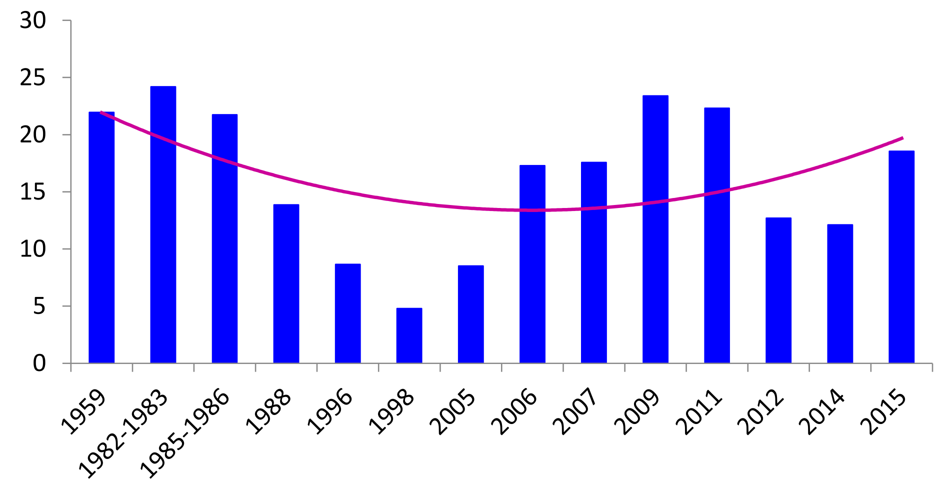


Abundance:

Low value in 2002; increased significantly since 2005, perhaps because of the increase of small size polychaetes; highest value in 2012.

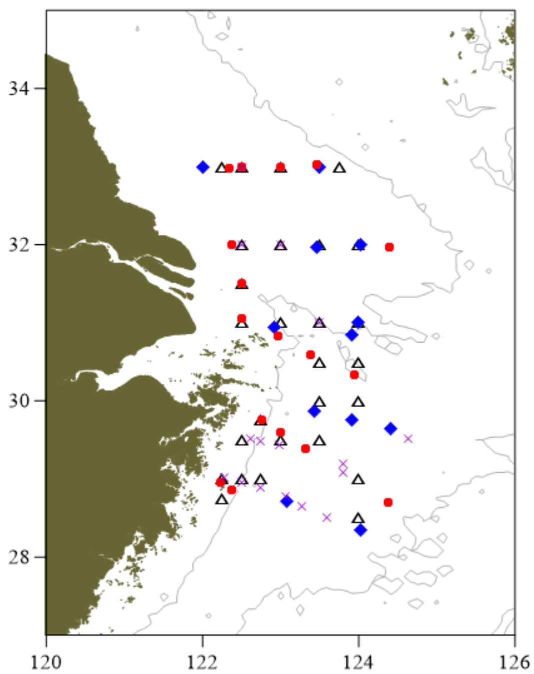
Biomass:

In late 1990s, biomass decreased sharply because of human activity; increased gradually during 2000; most increased species were polychaetes, and contributed little to the biomass.

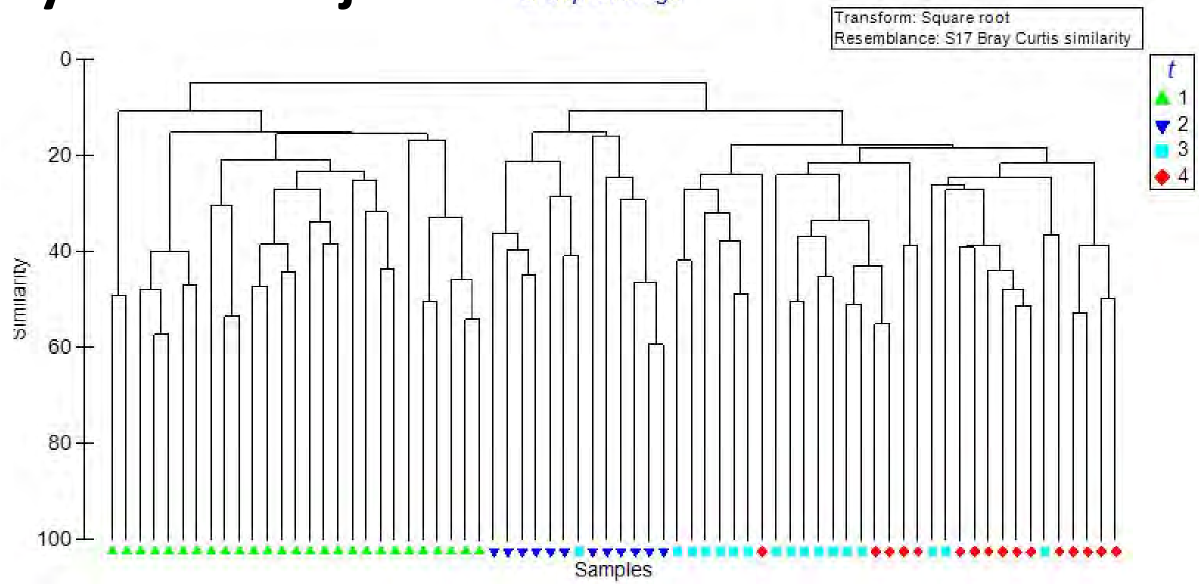


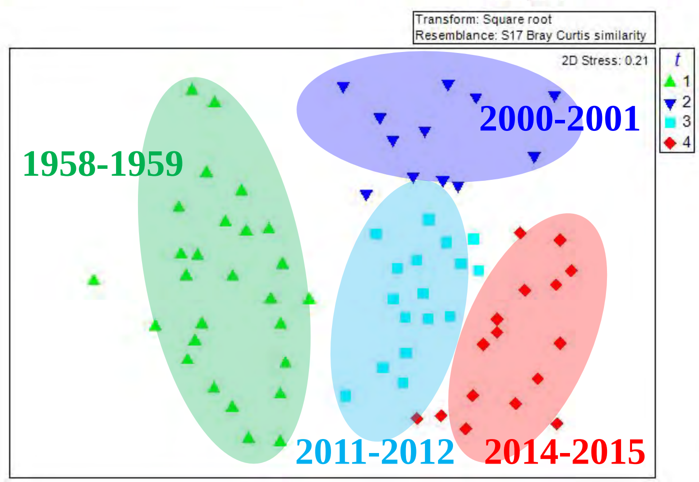
⑥ Long-term variations of macrobenthic community in the Yangtze river estuary and its adjacent area Ⅱ

Data analysis



Sampling sites



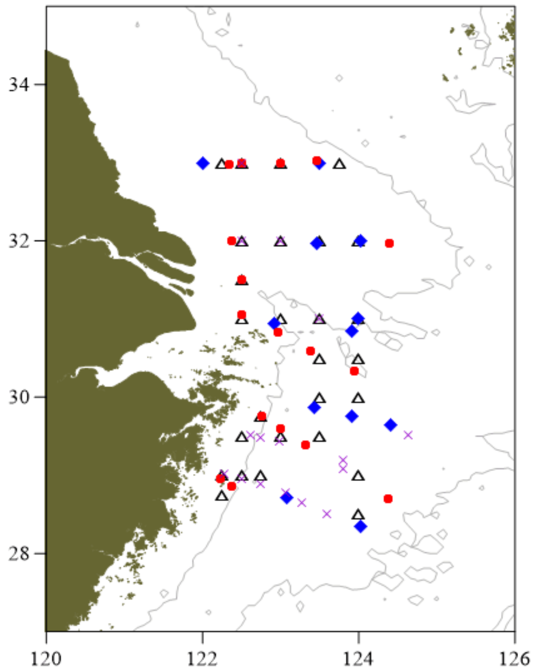


Cluster analysis and nMDS ordination

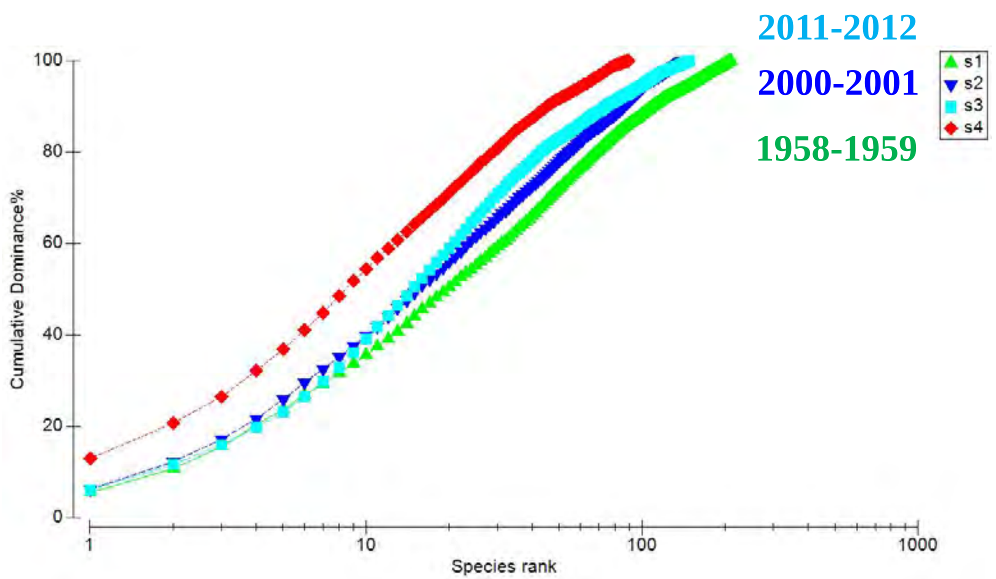
Cluster analysis and nMDS ordination showed the macrobenthic community structure changed significantly in the past 60 years.

⑥ Long-term variations of macrobenthic community in the Yangtze river estuary and its adjacent areaII

Data analysis



Sampling sites



K-dominance curves in different periods:

K-dominance curves had the lowest height during 1958-1959, showing the highest diversity and the slightest disturbance, and had the highest height during 2014-2015, showing the lowest diversity and the most serious disturbance.

⑥ Long-term variations of macrobenthic community in the Yangtze river estuary and its adjacent area

Literature

- **Number of species** had low values during 1990-2000, increased during 2004-2009, and increased rapidly during 2013-2015. Number of fish species and others decreased.
- **Abundance**： Low value in 2002; increased significantly since 2005, perhaps because of the increase of small size polychaetes; highest value in 2012.
- **Biomass:** In late 1990s, biomass decreased sharply because of human activity; increased gradually during 2000; most increased species were polychaetes, and contributed little to the biomass.

Data analysis

- From 1958 to 2015, the **macrobenthic community structure changed significantly**; diversity decreased with the increase of disturbance.

Outline

What is happening in the Yellow Sea and East China Sea? --Status of the ecosystem in the Yellow Sea and East China Sea

Whether macrobenthos changes? How does it change? And why?

Conclusion

Conclusion

The ecosystem in the Yellow Sea and East China Sea is undergoing fundamental and irreversible change;

Climate change and human activity together influenced the variation of marine ecosystem;

For macrobenthic community, the variation in coastal area was caused by human activity, while the variation in offshore area by climate change;

As time goes on, the northward movement and fragmentation of macrobenthic distribution range is inevitable;

Conclusion(continued)

In coastal community, polychaetes increased in abundance; echinoderms increased in offshore area;

The Yellow Sea Cold Water Mass Community varied a little in the spatial pattern from 1958 to 2016, but the characterized species varied a lot.

32° N was the boundary for the distribution of macrobenthos in the Yellow Sea and East China Sea, like the PN line formed by the Yangtze river diluted water;

The macrobenthos in the coastal area of the East China Sea was influenced by branches of Kuroshio Current, and the response of macrobenthos to the branch is not occasionally, but always.

The variation of macrobenthic abundance in low oxygen region was not obvious, but the community structure had changed fundamentally.

Acknowledgement

Funding:

1. The Strategic Priority Research Program of the Chinese Academy of Sciences(A):

Western Pacific Ocean System: Structure, Dynamics and Consequences

2. 973 program

the Dynamics of Ecosystem and Sustainable Use of Biological Resources from the East China Sea and Yellow Sea, the Key Processes, Mechanism and Ecological Consequences of Jellyfish Bloom in Chinese Coastal Waters

3. The National Natural Science Foundation of China:

The variation of macrobenthic community over 50 years and its mechanism

… …

Acknowledgement