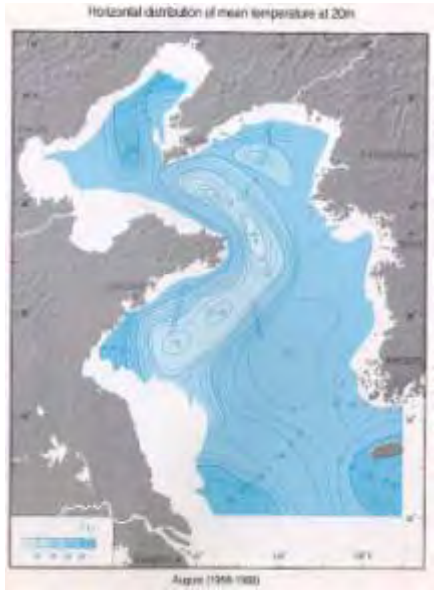
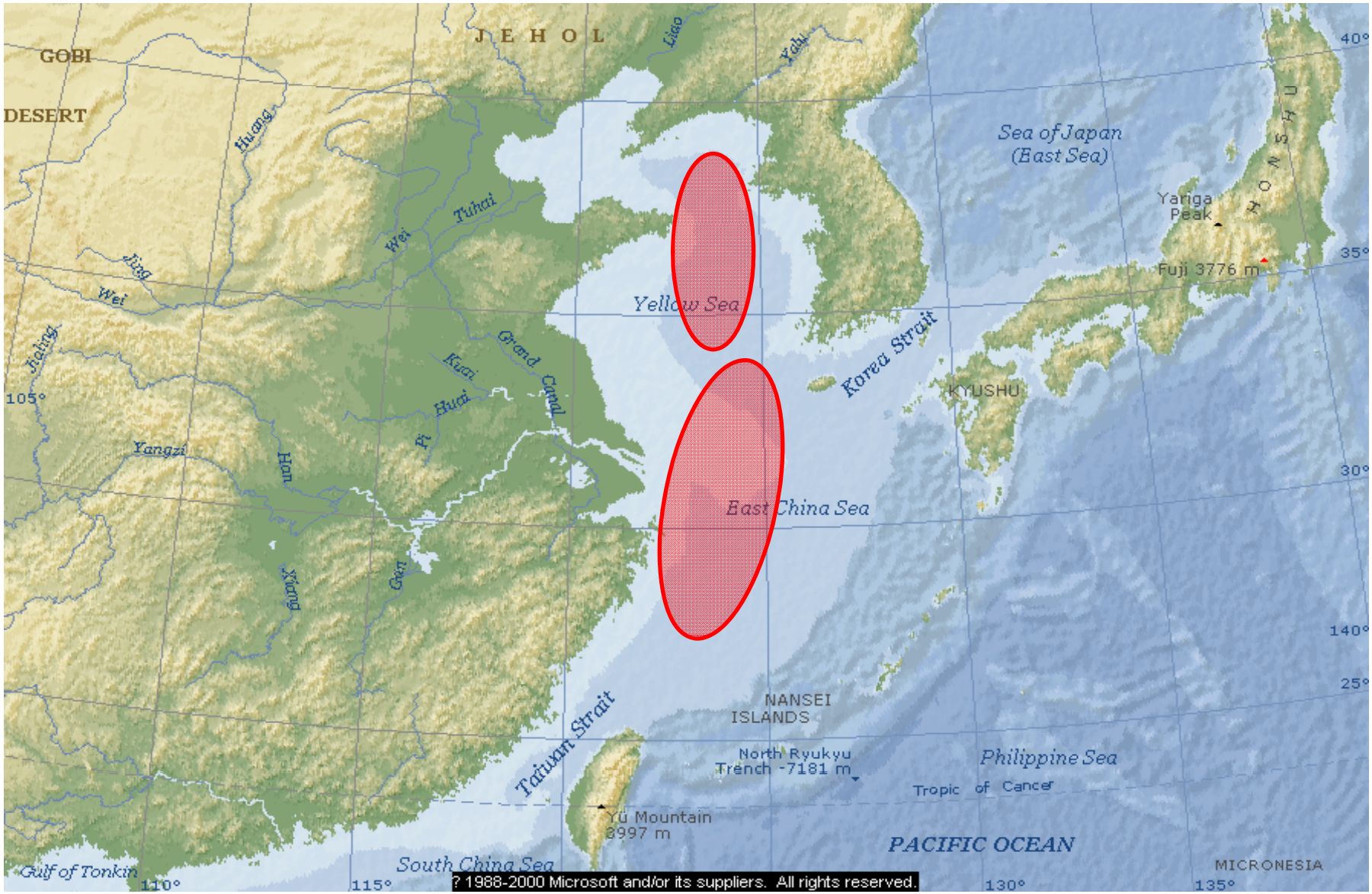
5th International Zooplankton Production symposium

The life history strategies of *Calanus sinicus* in the continental shelf ecosystem

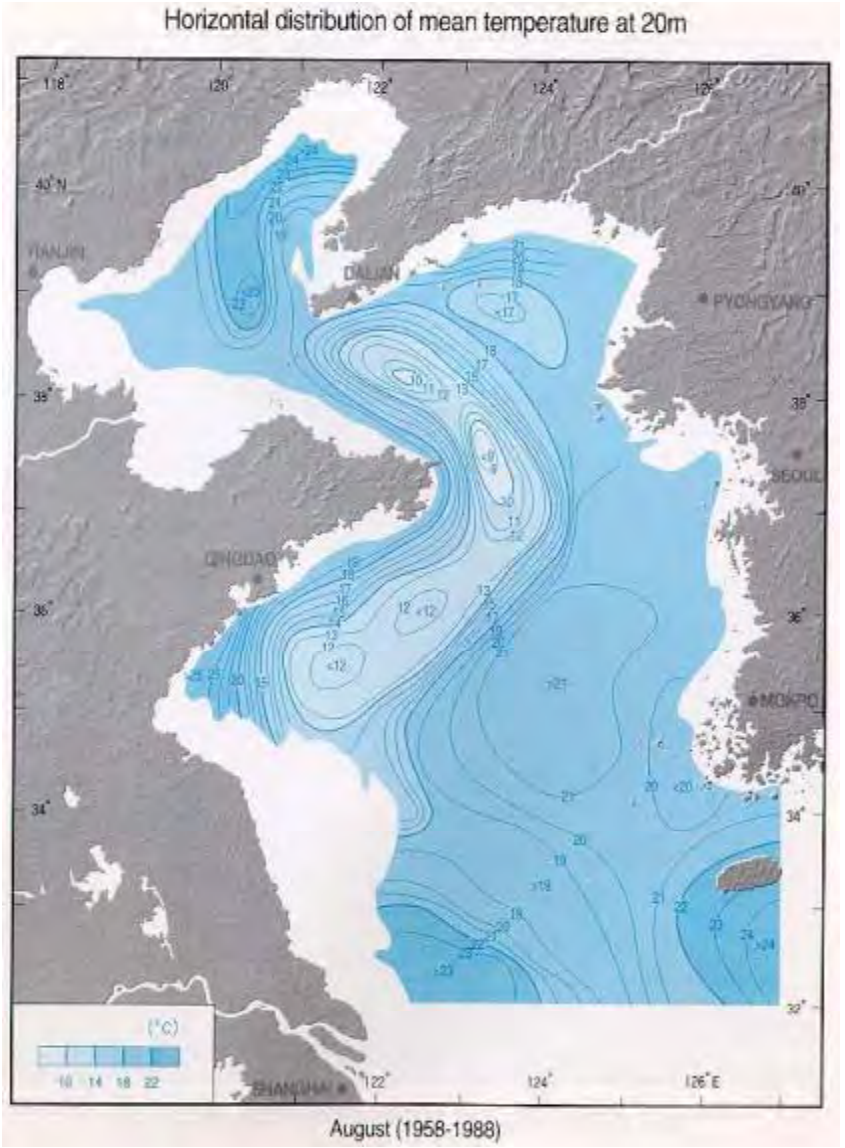
Song Sun, Shiwei Wang, Chaolun Li guangtao Zhang and Xiaoxia Sun



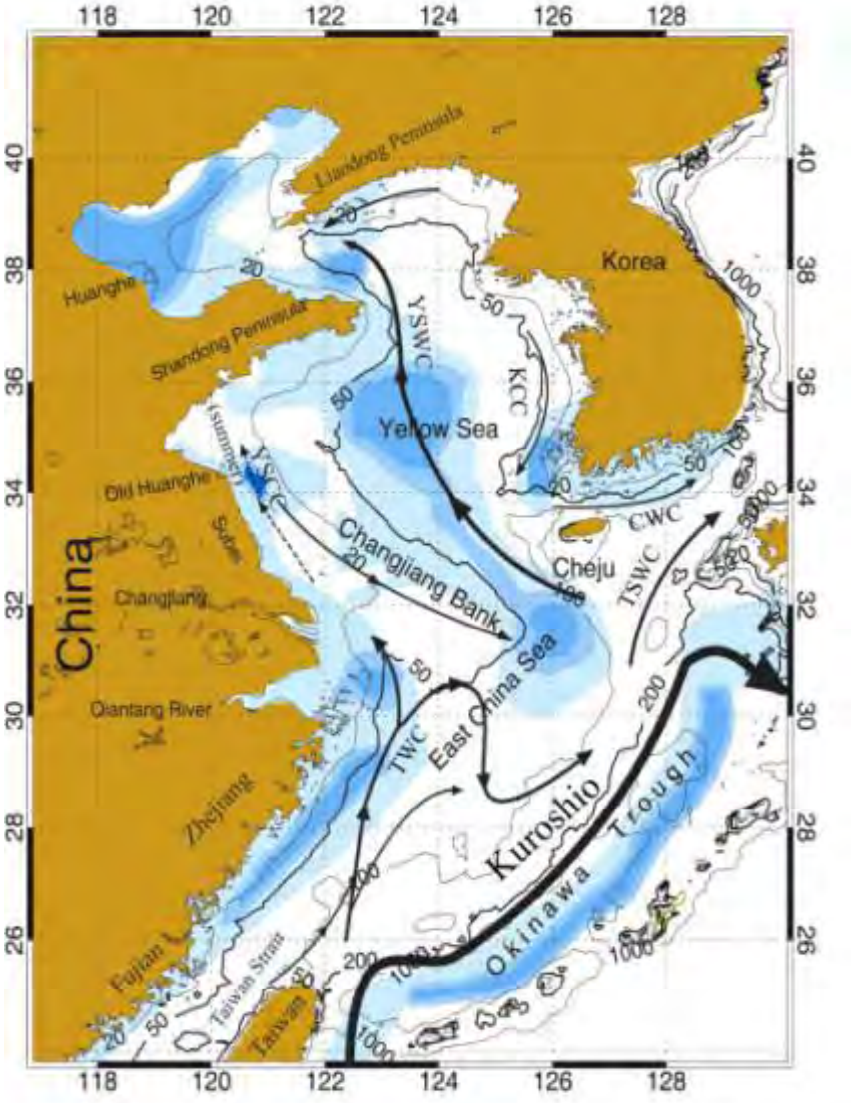
The Yellow Sea and East China Sea

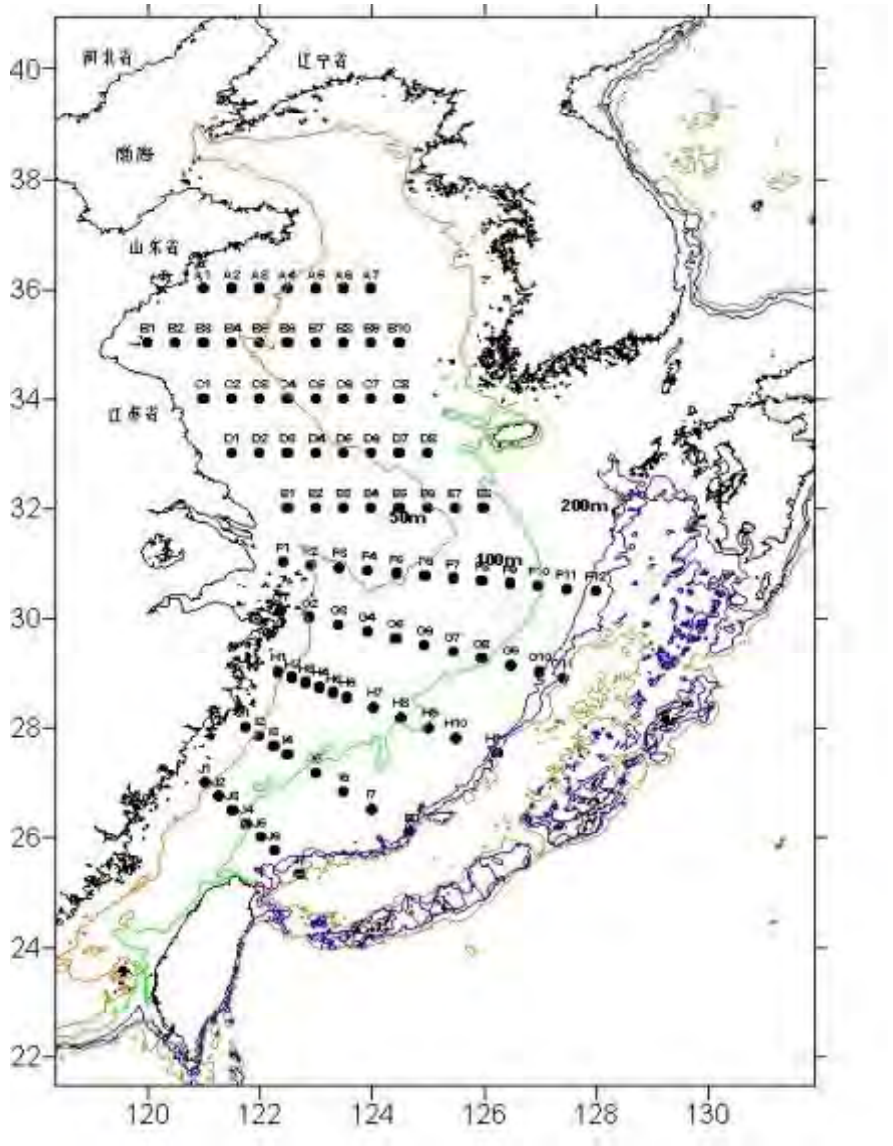


The Yellow Sea Cold Water Mass



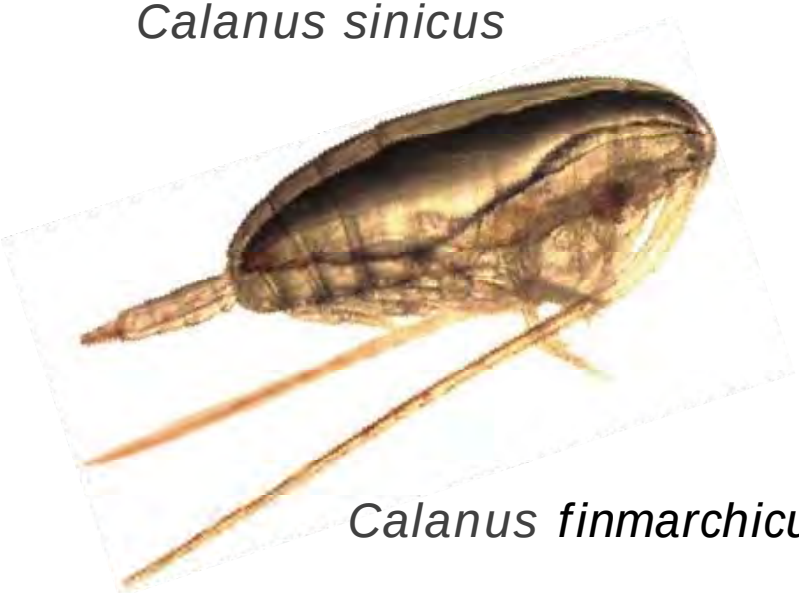
Complex current system





The role of the *Calanus sinicus* in the Yellow Sea and East China Sea ecosystem

Calanus sinicus

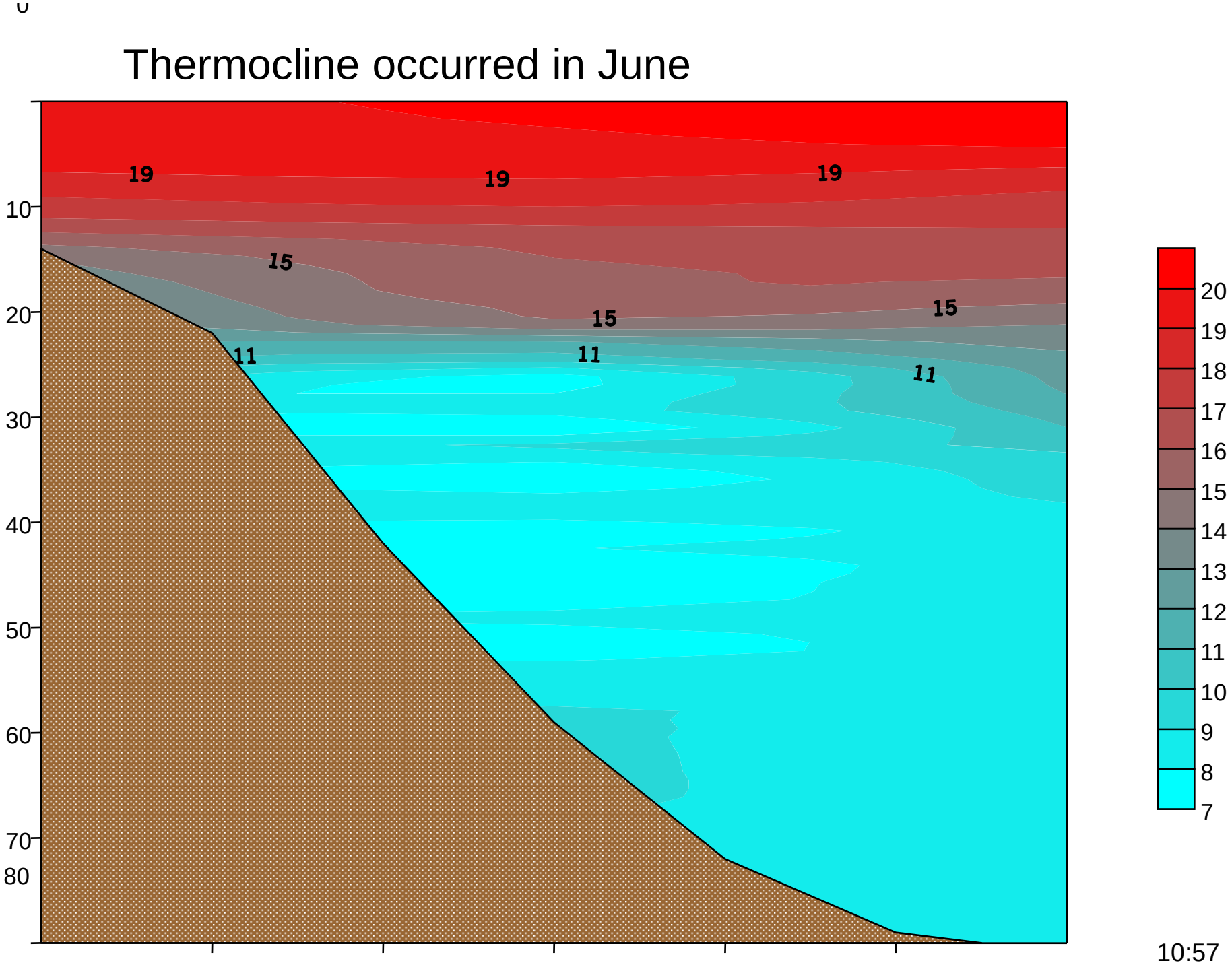


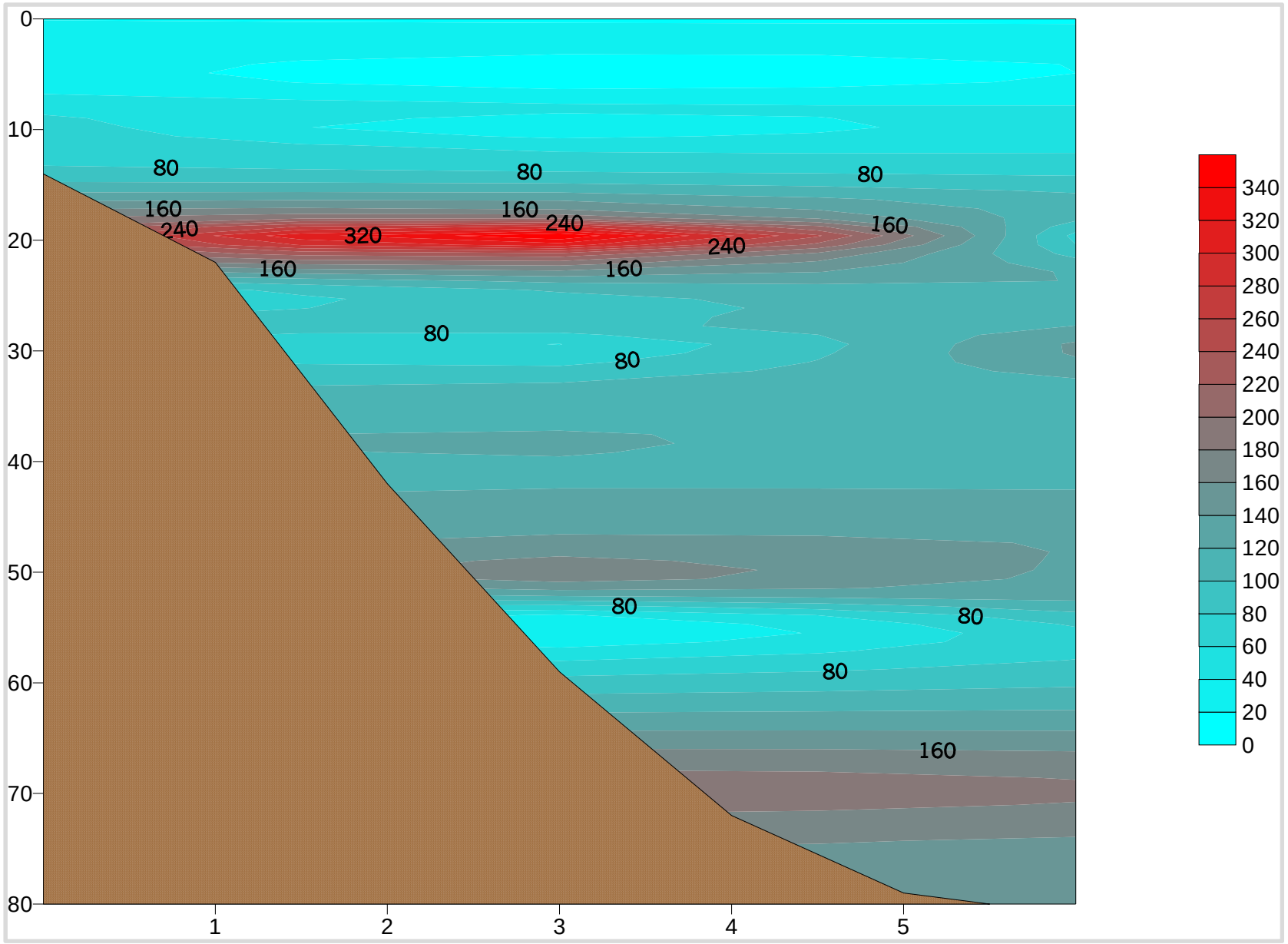
Calanus finmarchicus

- **The *Calanus sinicus* is the dominant species in the Yellow Sea and East China Sea ecosystem**
- **The role of the *C. sinicus* in the YS and ECS is similar to that of *C. finmarchicus* in the Atlantic**

Over summer strategy of *C. sinicus*

Thermocline occurred in June





C. sinicus vertical distribution in June

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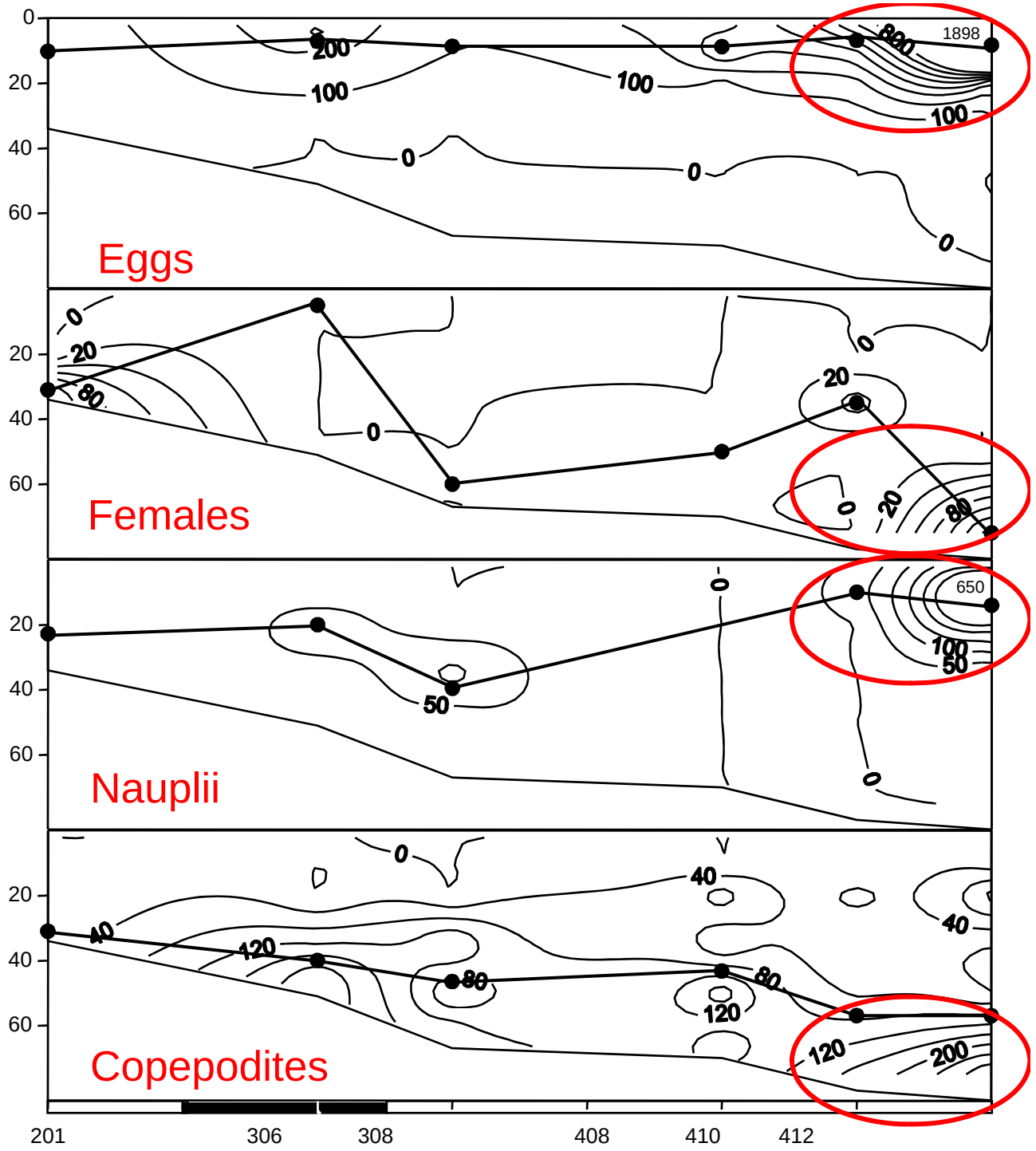
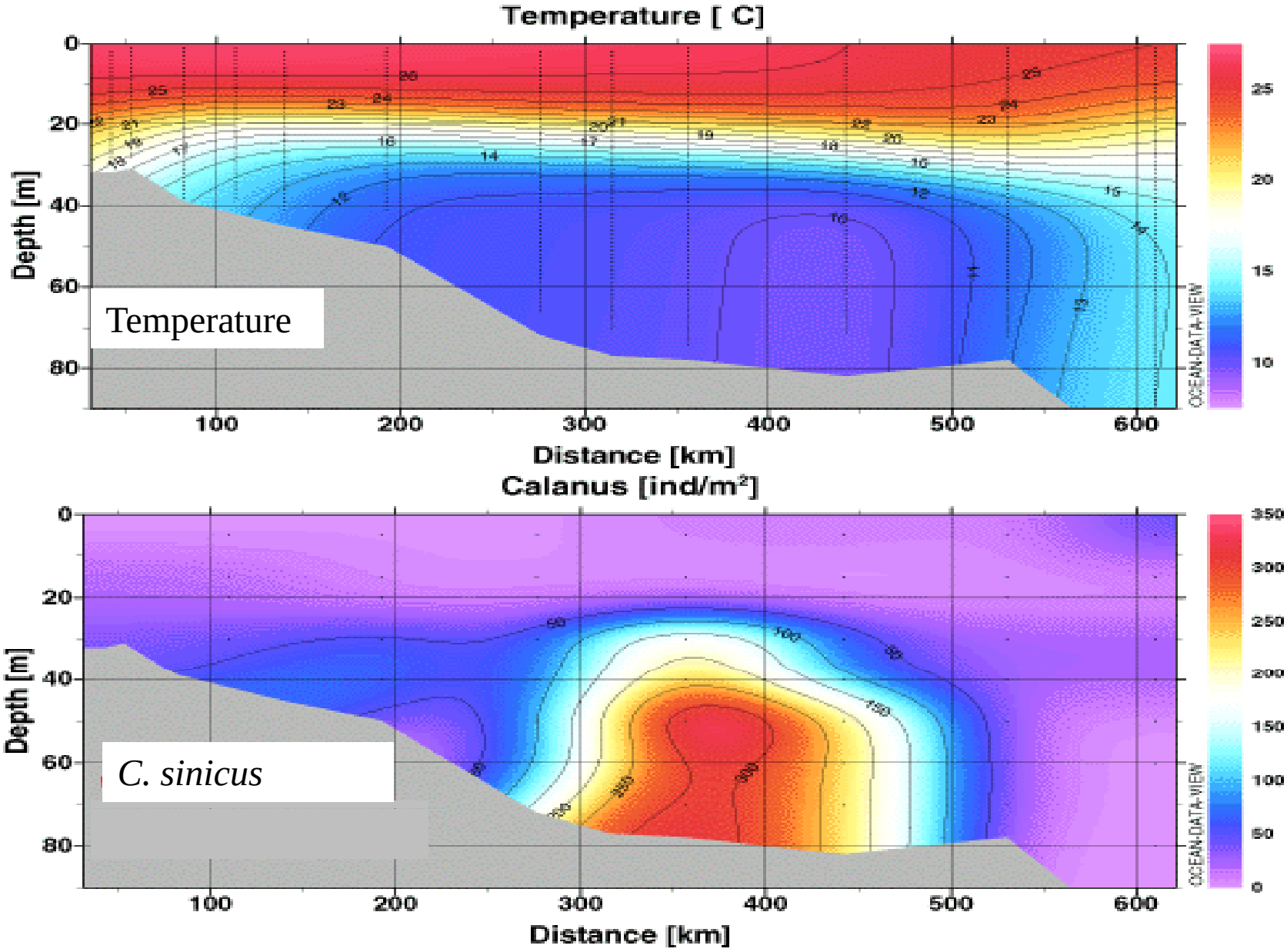
July

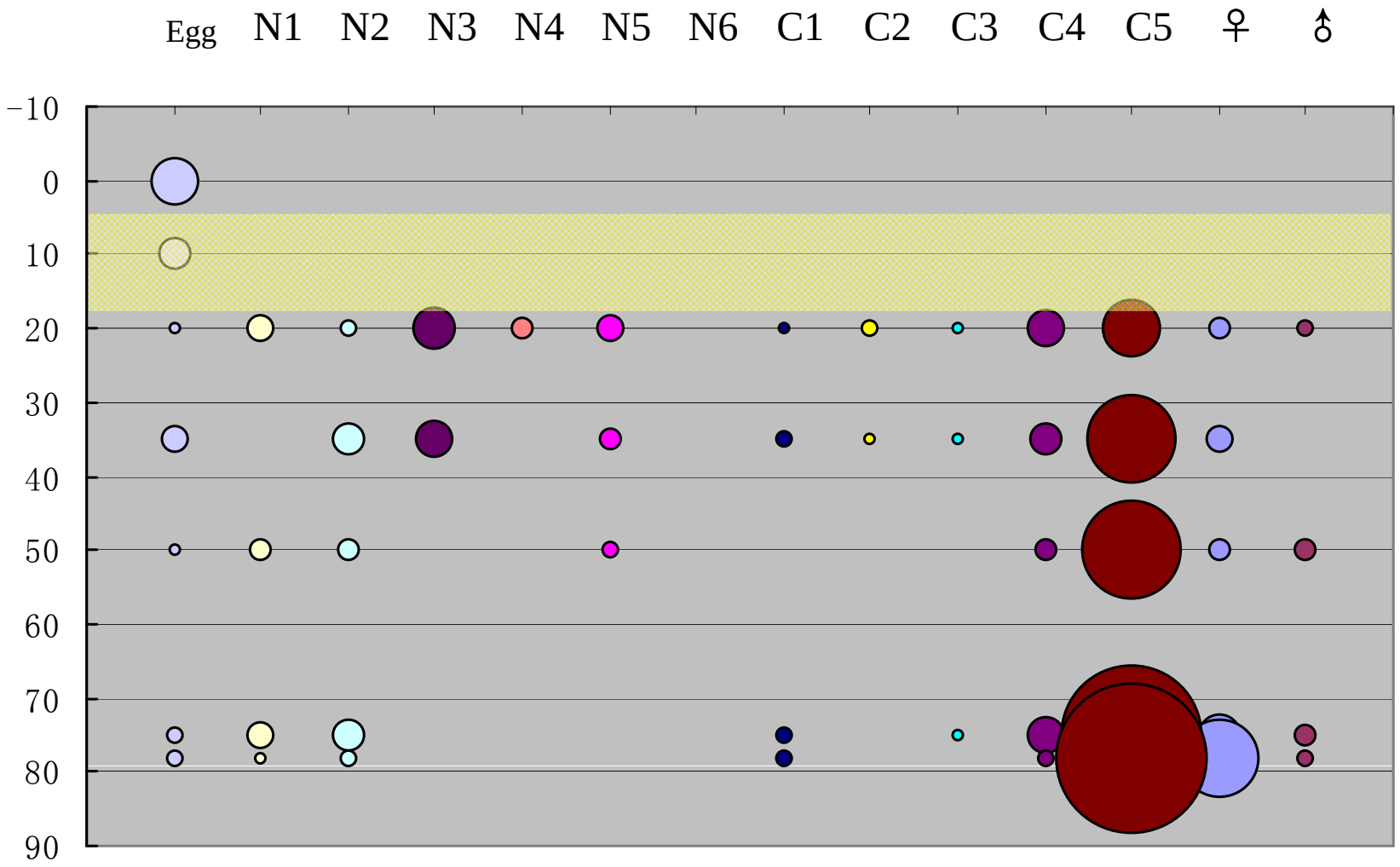
The distribution center of the *Calanus sinicus* was in the deep water side. Eggs and Nauplii were in high density and distribute in the surface, above the thermocline, the copepodites and the females distributed at the bottom, under the thermocline

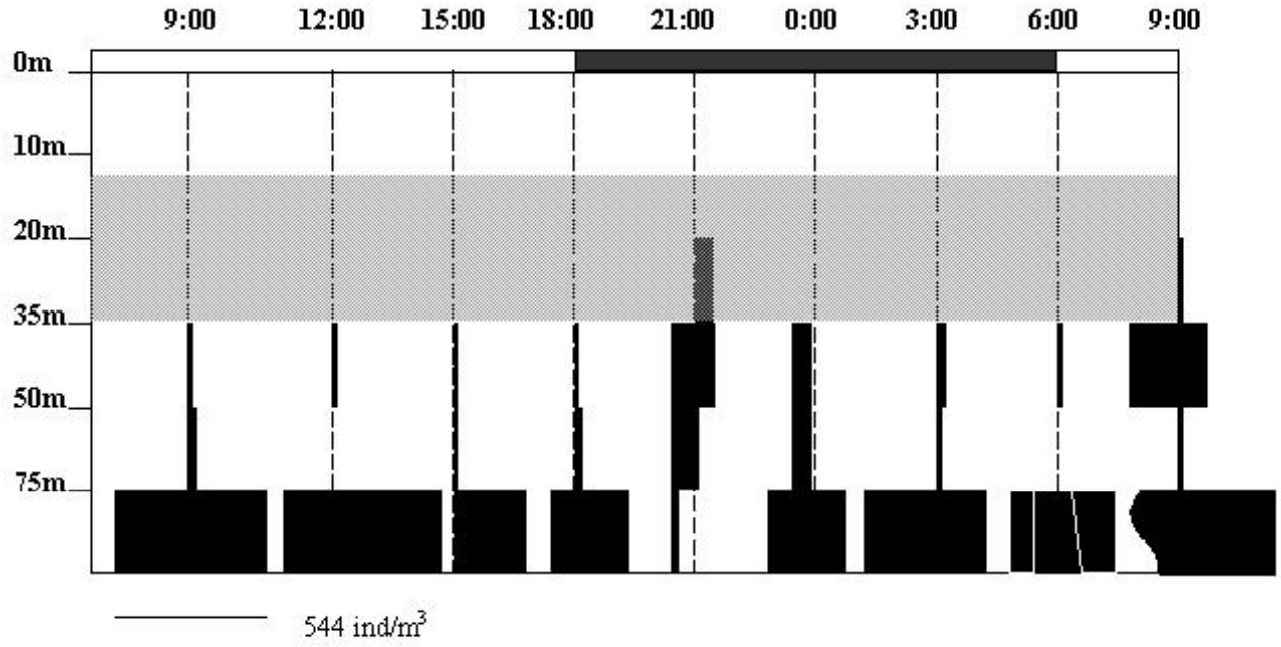


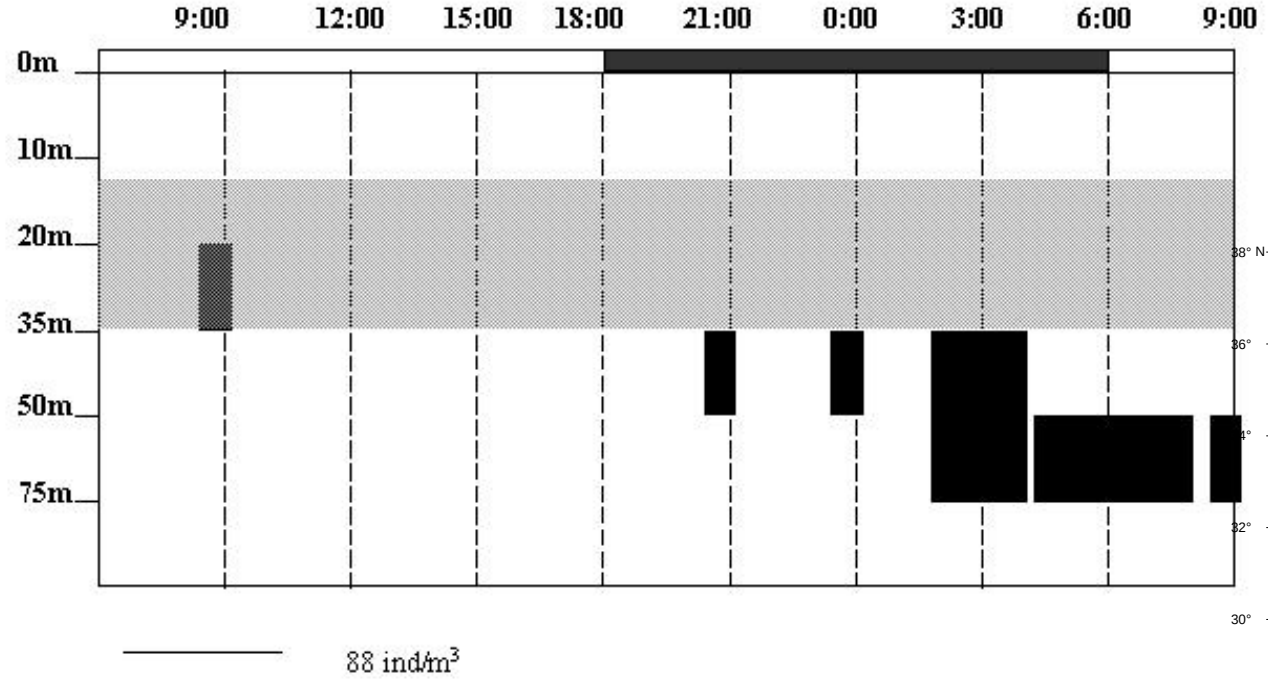
Most of the *C.sinicus* stay in the YCWM in summer



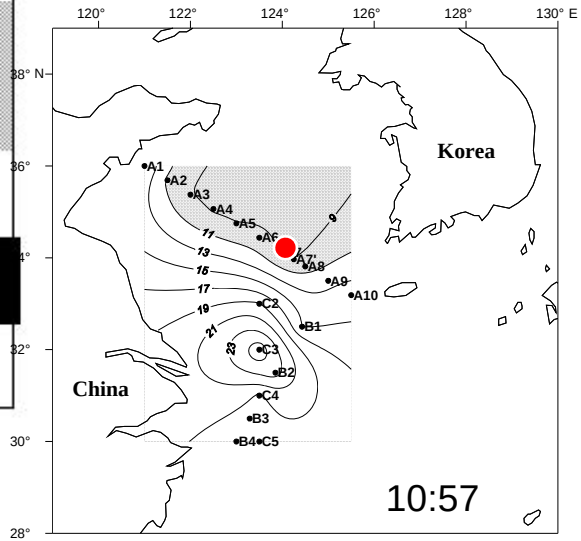
Population composition of the *Calanus sinicus* in the August





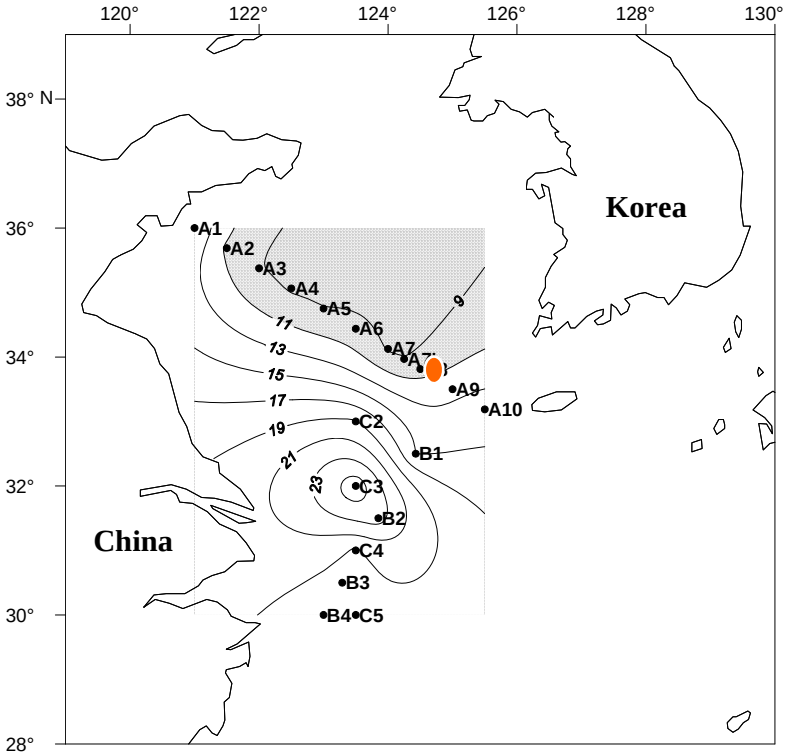


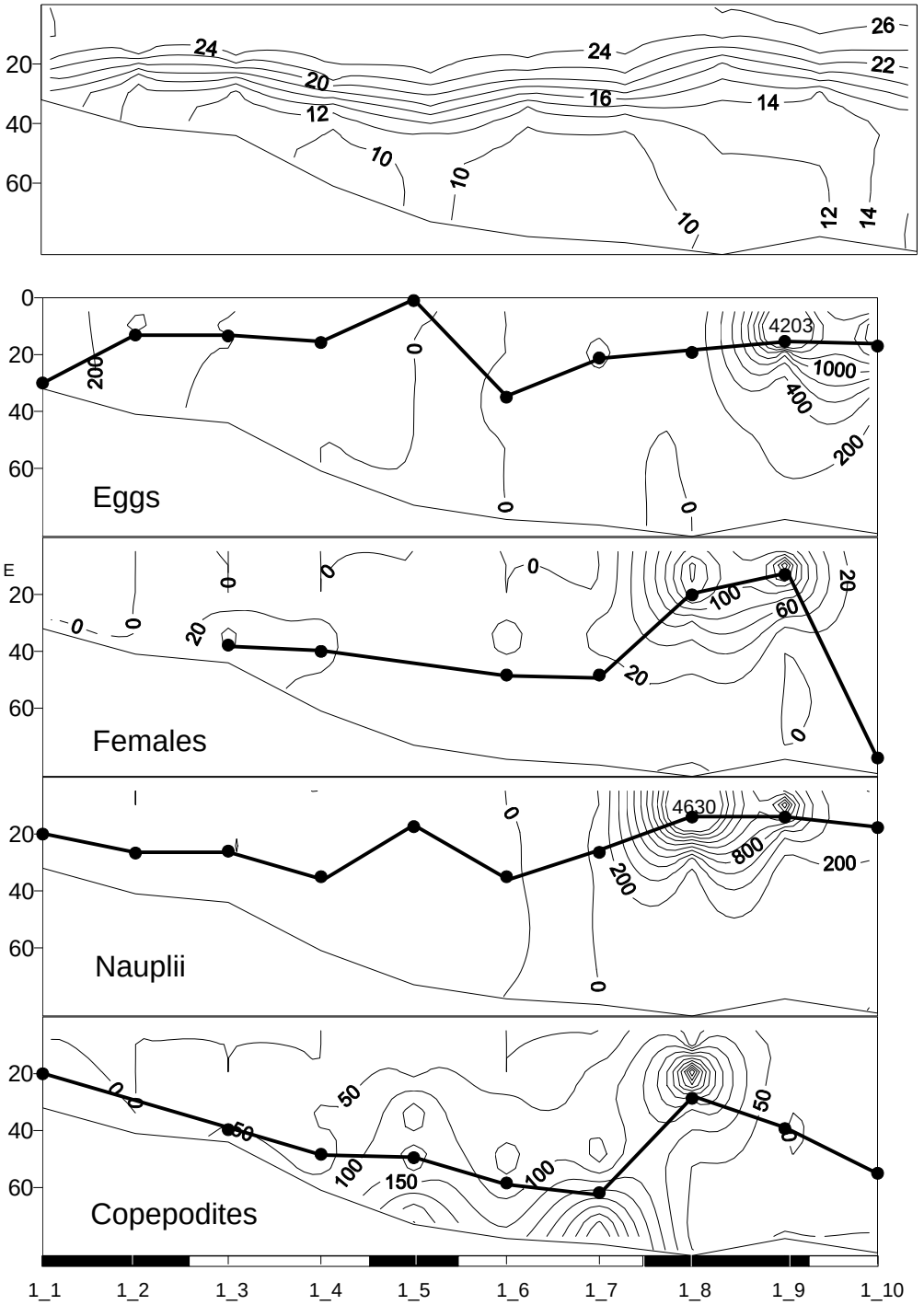
In the Yellow Sea Cold Water Mass，the female still keep diel vertical migration, but limited under the thermocline, but the copepodites stop the diel vertical migration, only stay at the bottom



August

At the marginal of the YCWM；the *C. sinicus* keep diel vertical migration, but in high mortality. Most of the animals distributed at the outer edge of the YCWM

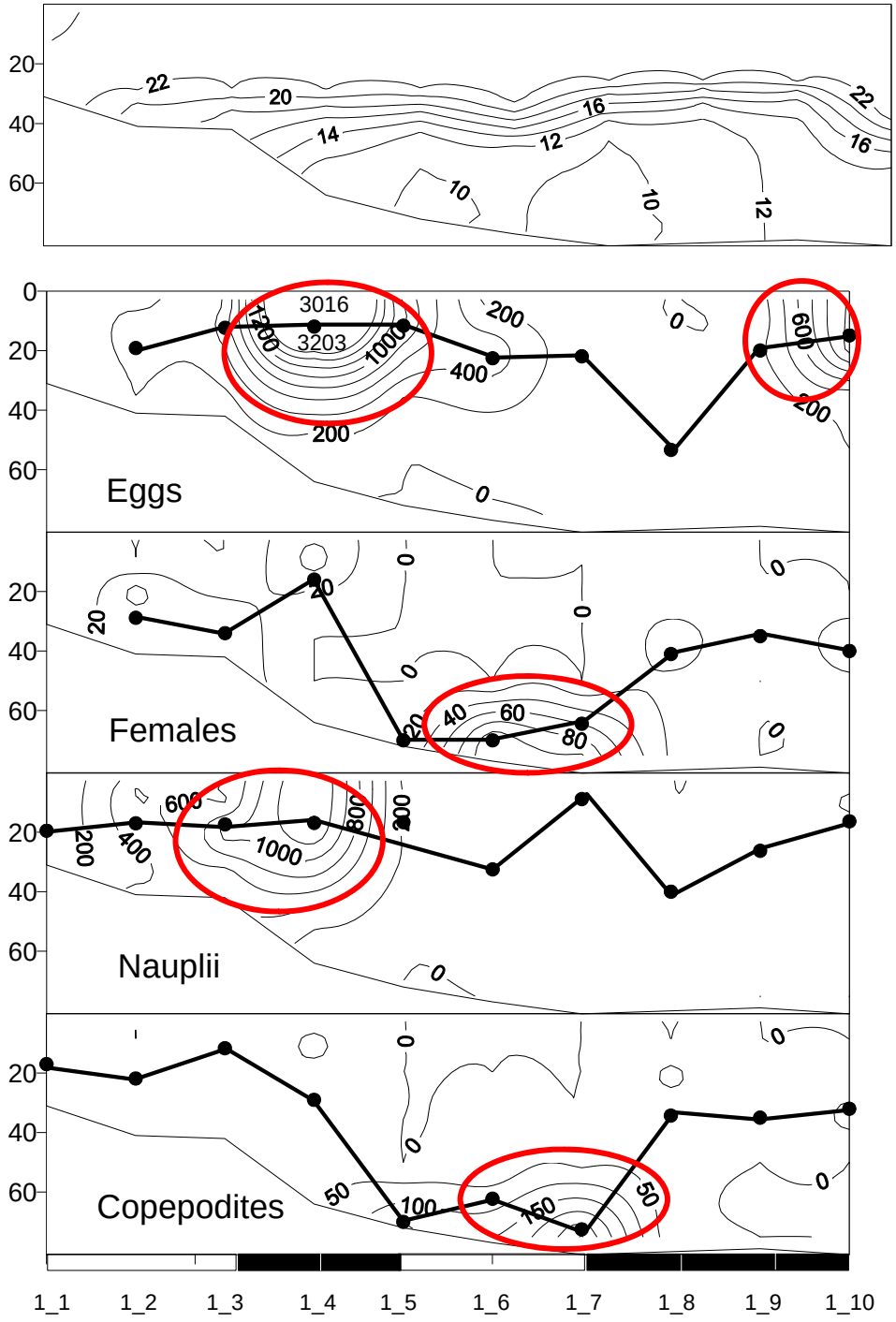




September:

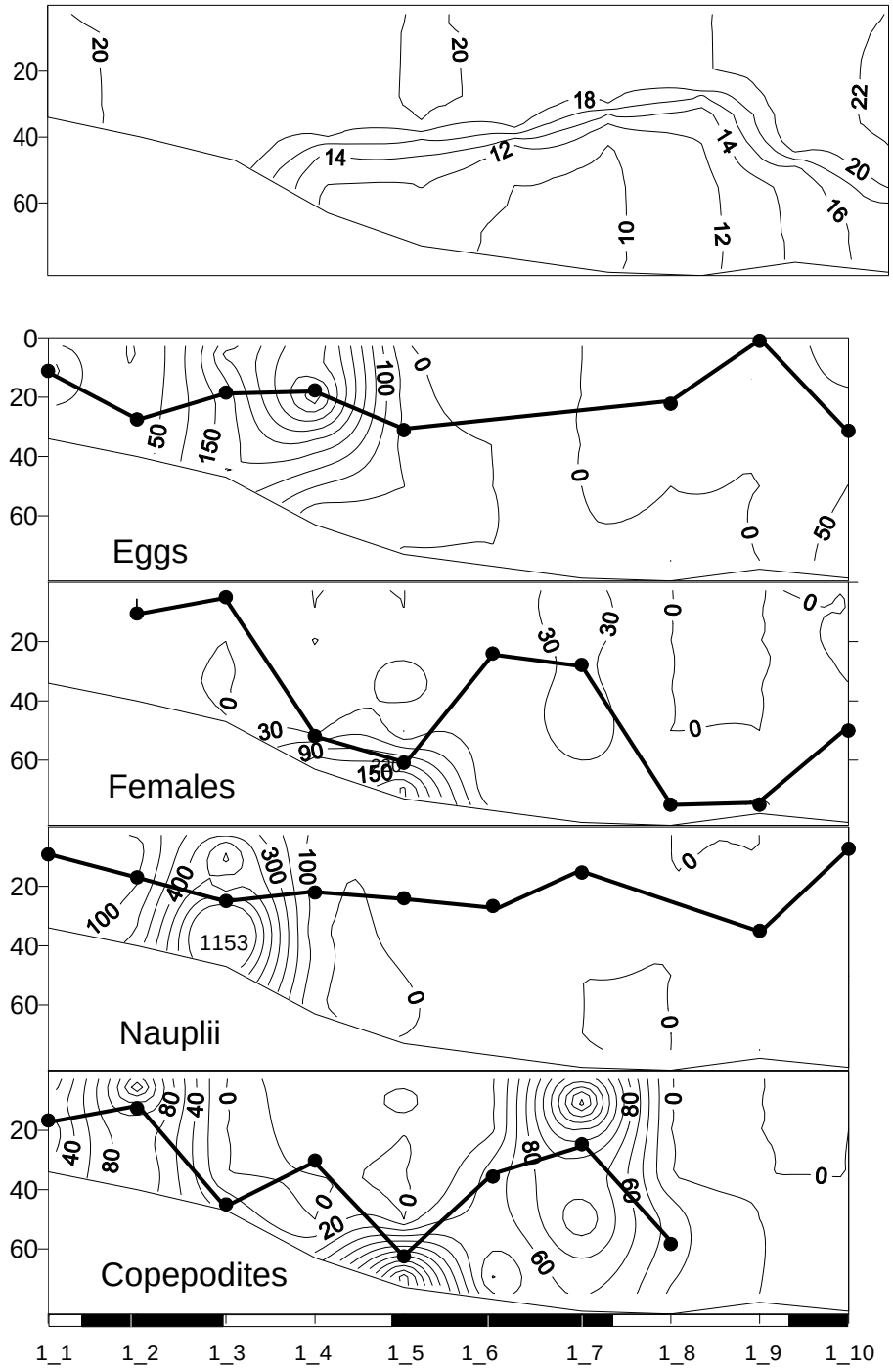
The distribution center of Egg and nauplii move toward the coastal area, there were some of the eggs distribute at the out margin of the YWCM

The copepodites and females still stay in the YWCM

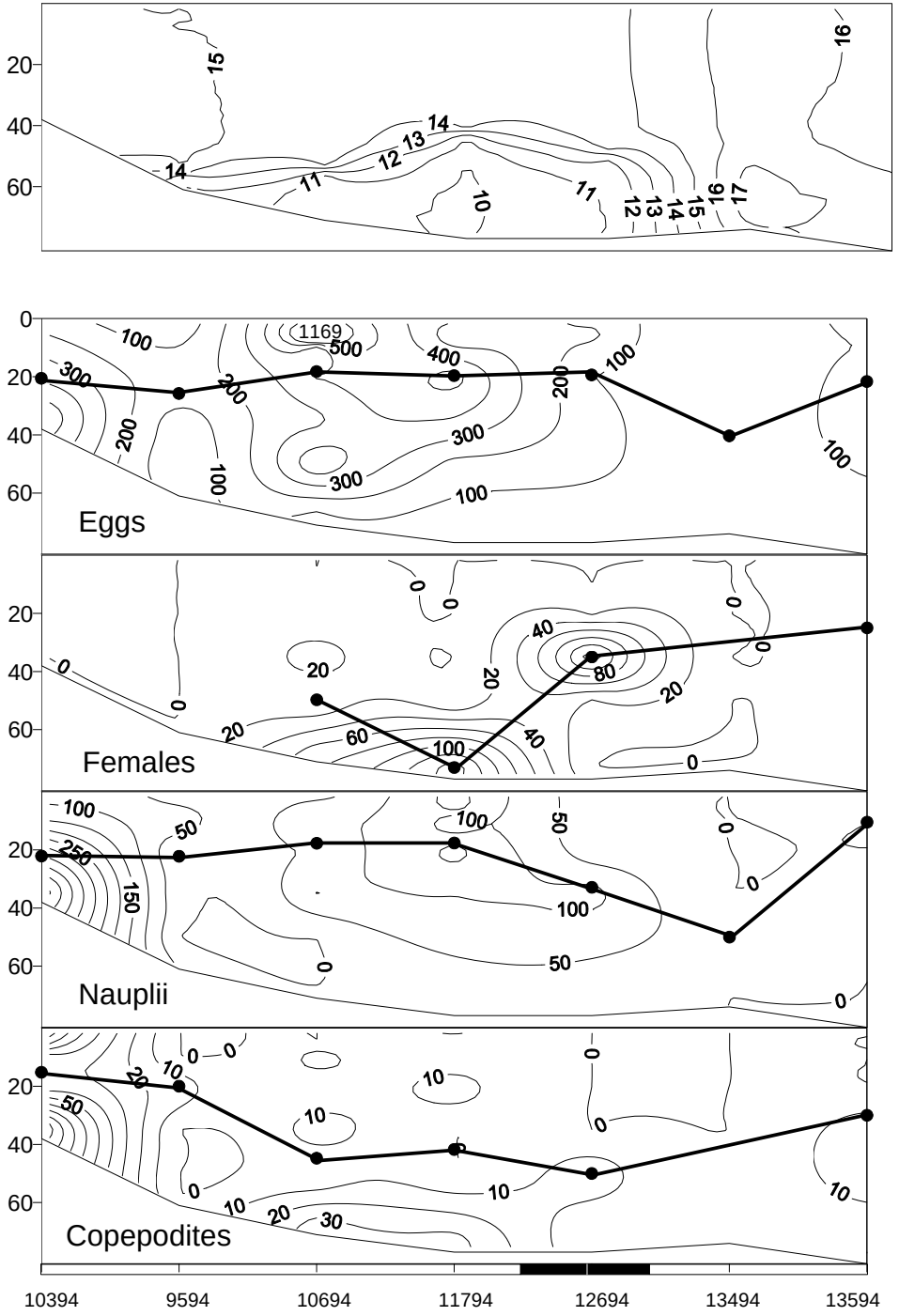


October

The *C. sinicus* population distributed in the coastal area, the copepodites and the adults began diel vertical migration



November



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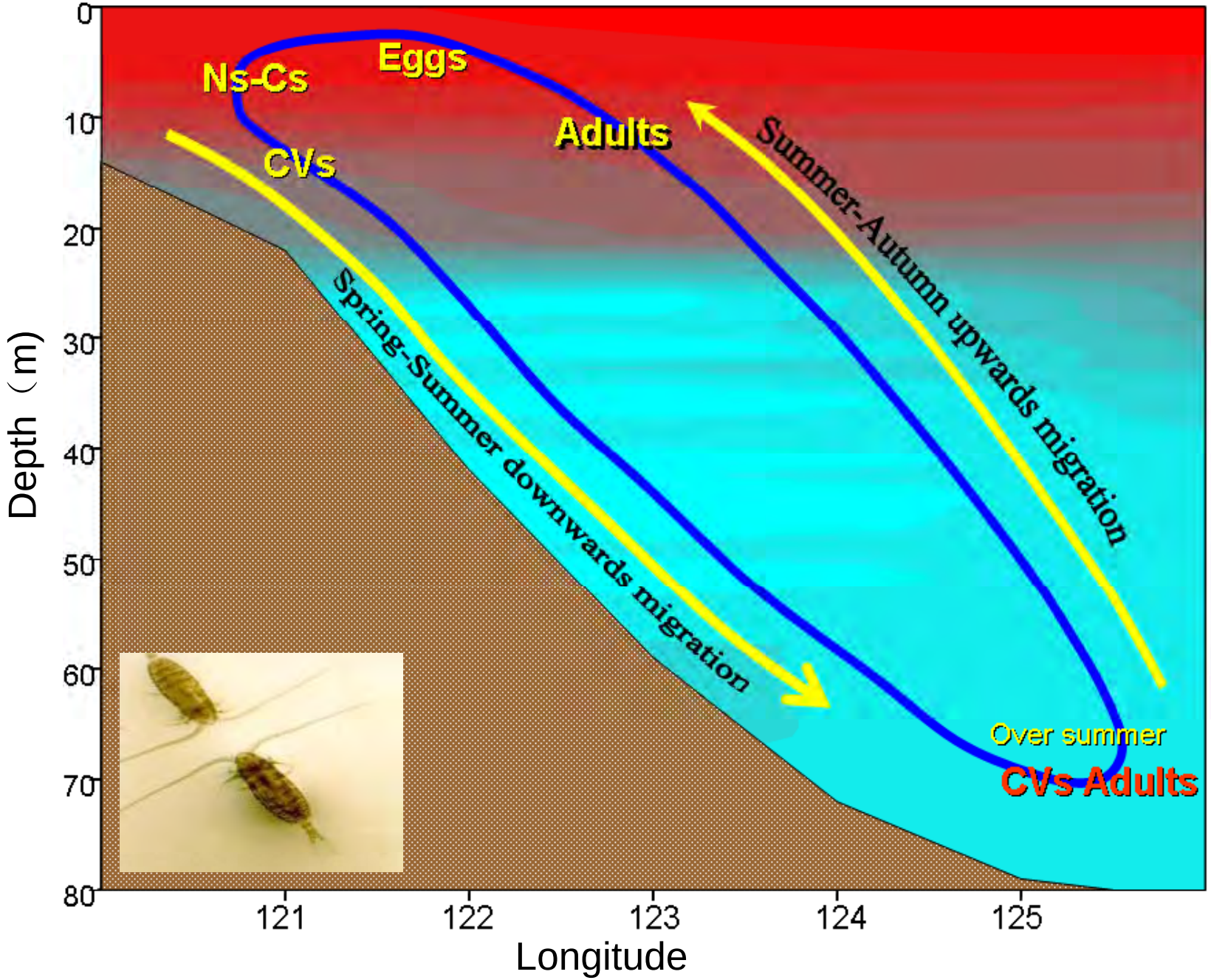
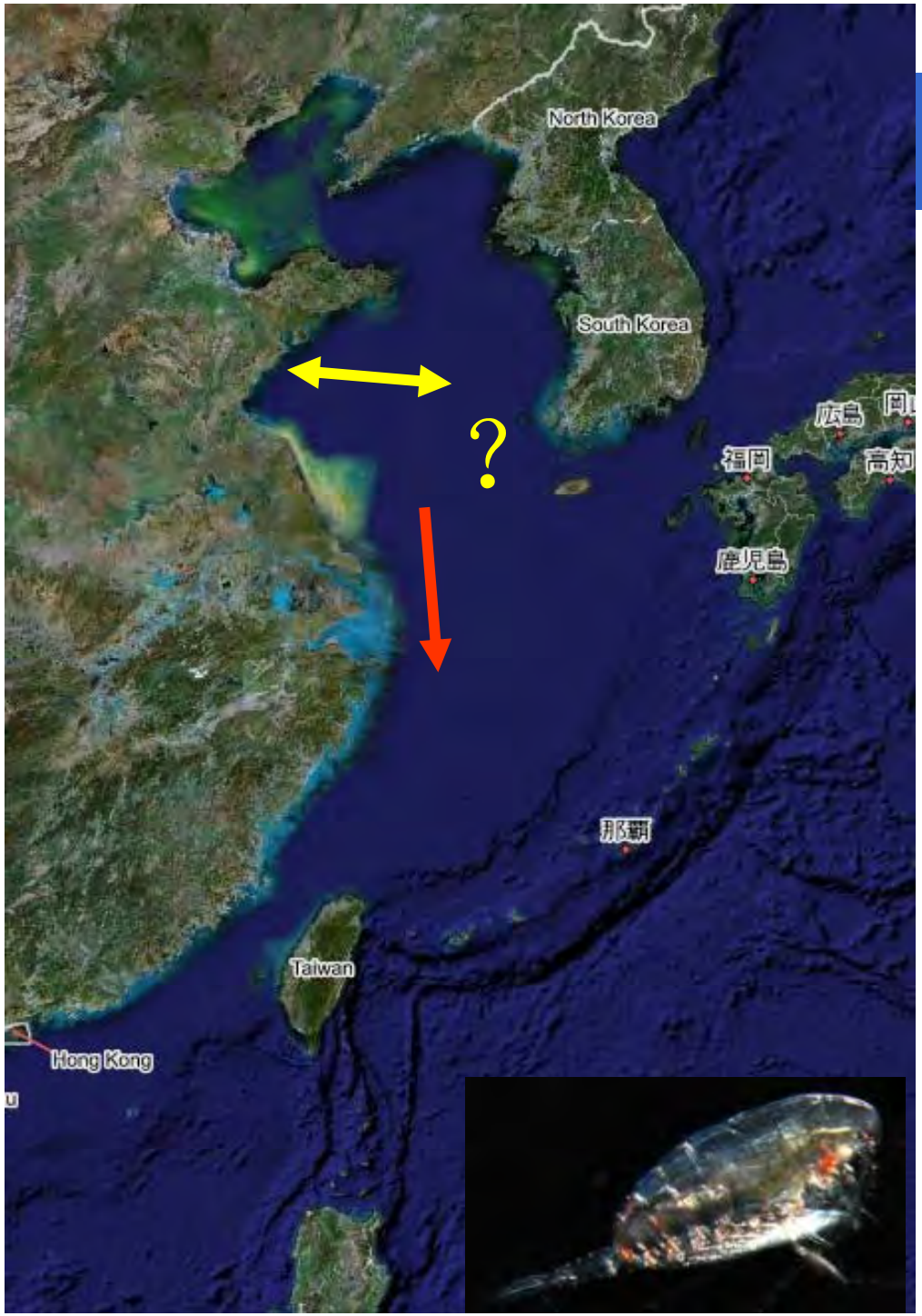
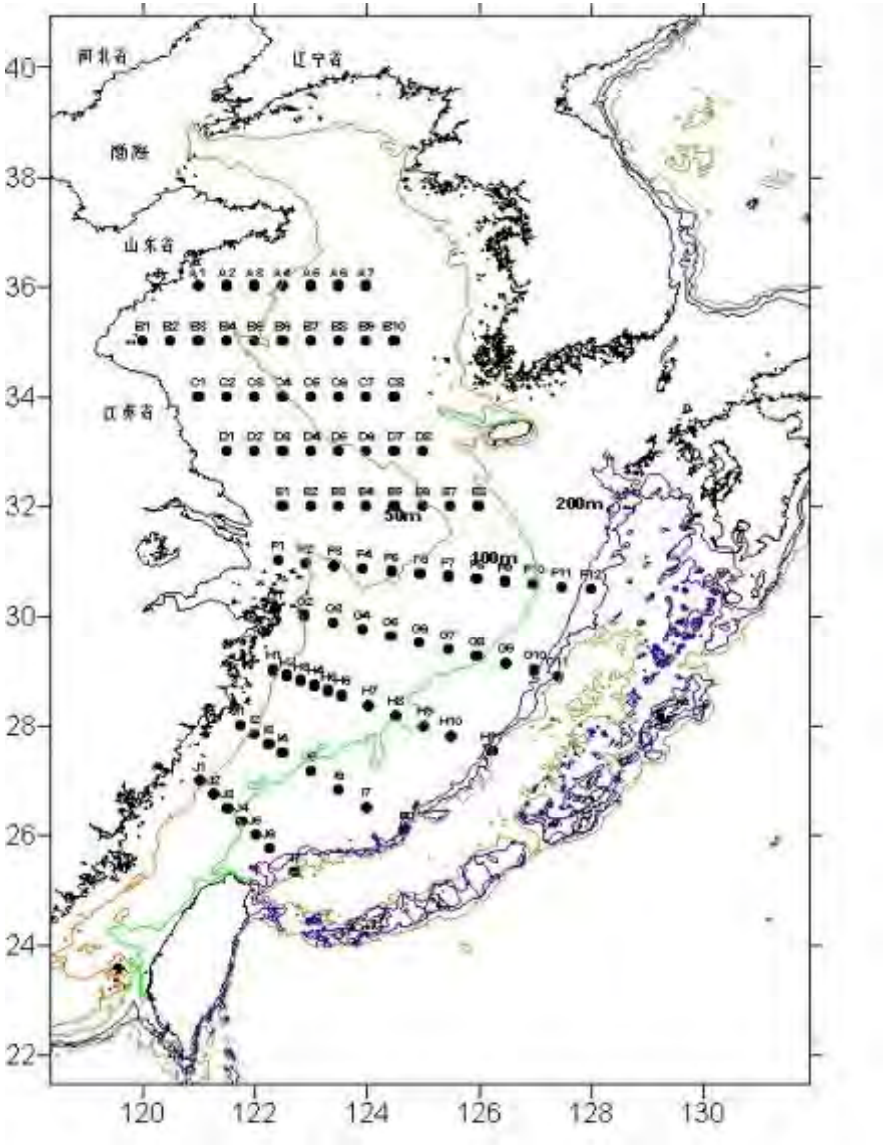

Calanus sinicus
Depth（m）
0
10
20
30
40
50
60
70
80
121
122
123
124
125
Longitude
Ns-Cs
Eggs
Adults
CVs
Summer-Autumn upwards migration
Spring-Summer downwards migration
Over summer
CVs Adults

Key questions:



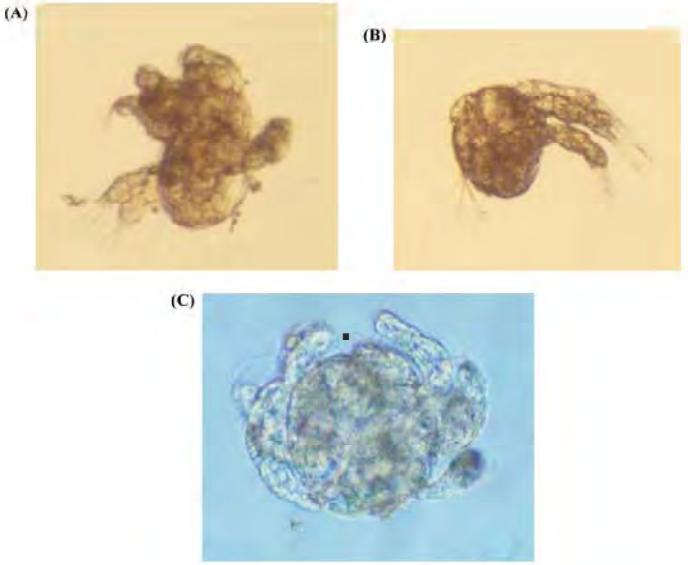
- **What control the distribution of the *C. sinicus?* Physical of Biological?**
- **The main factors which control the *C. sinicus* go to the deep water for diapauses in summer and wake up in Autumn**
- **The key processes for the *C. sinicus* population dynamics**

Analysis 10 years cruises and experiments



Over-summering – *reproduction and recruitment*

Population inside the YSCWM



Abnormal nuaplii under high temperature (27 ℃)

Bet

ma

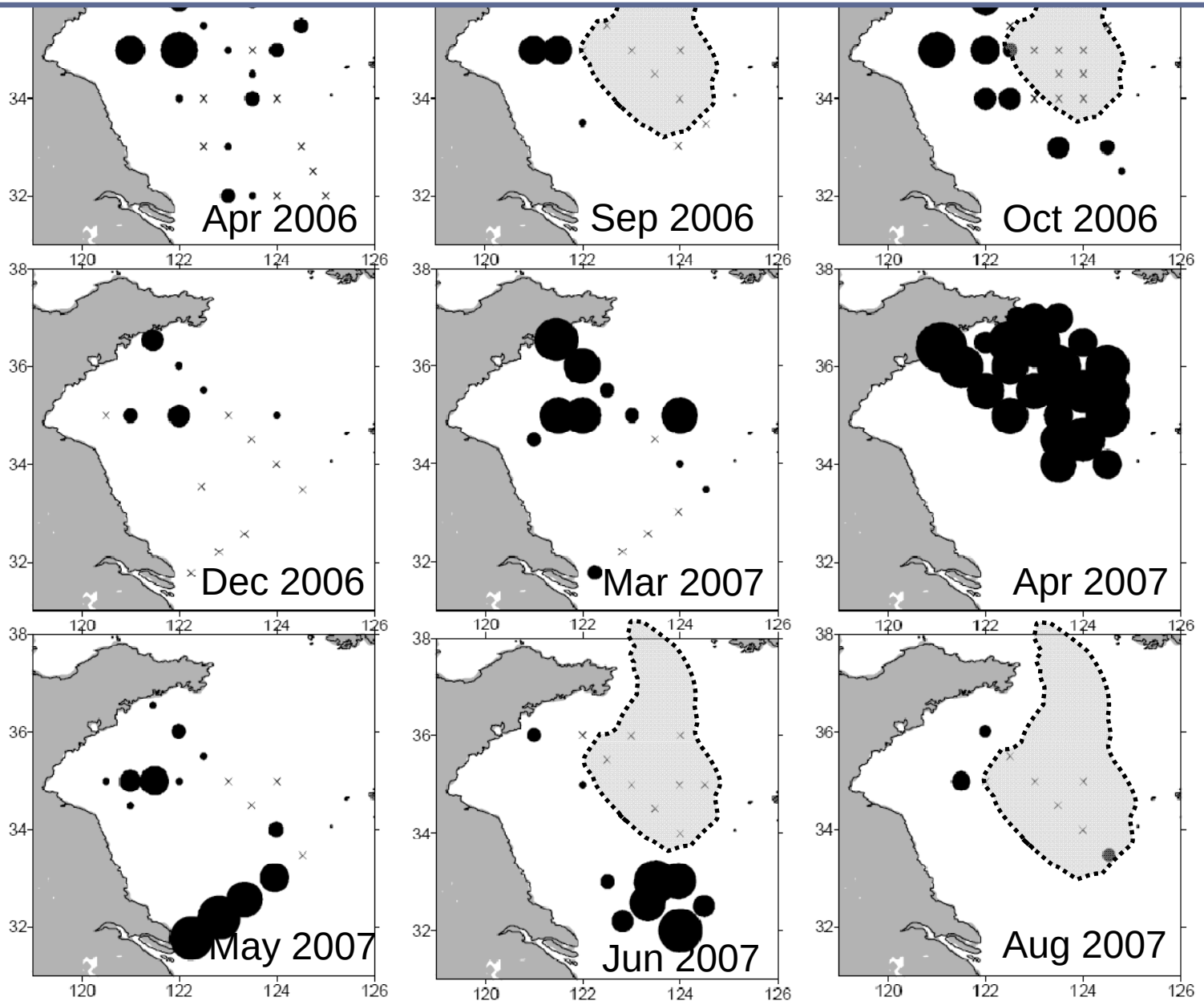
mperature

rep

rtality

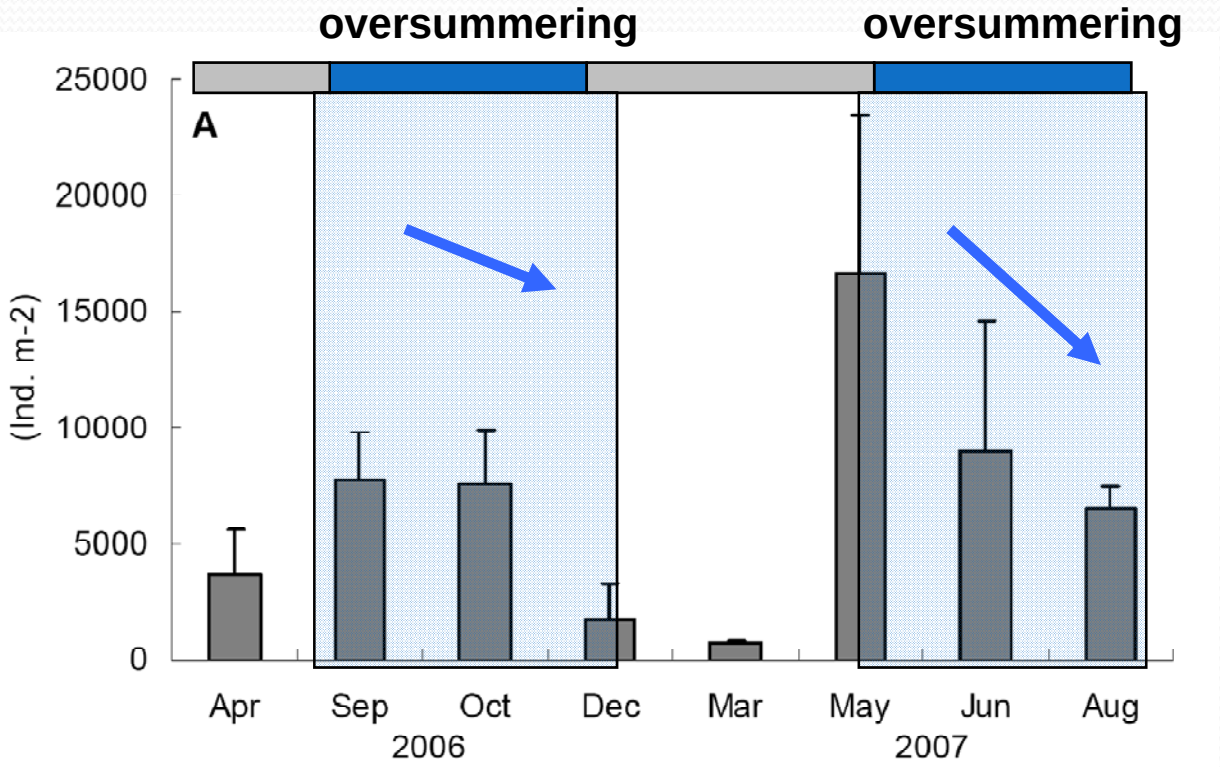
Null or unsuccessful recruitment

Null recruitment inside the YSCWM



Over-summering – *reproduction and recruitment*

Average abundance of *C. sinicus* in the YSCWM



The null recruitment inside the YSCWM could explain the decreasing trend of *C. sinicus* population

The role of the YSCWM is to "maintain" the population rather than stimulate recruitment.

Over-summering – *The accumulation of lipid reserve*

Population inside the YSCWM

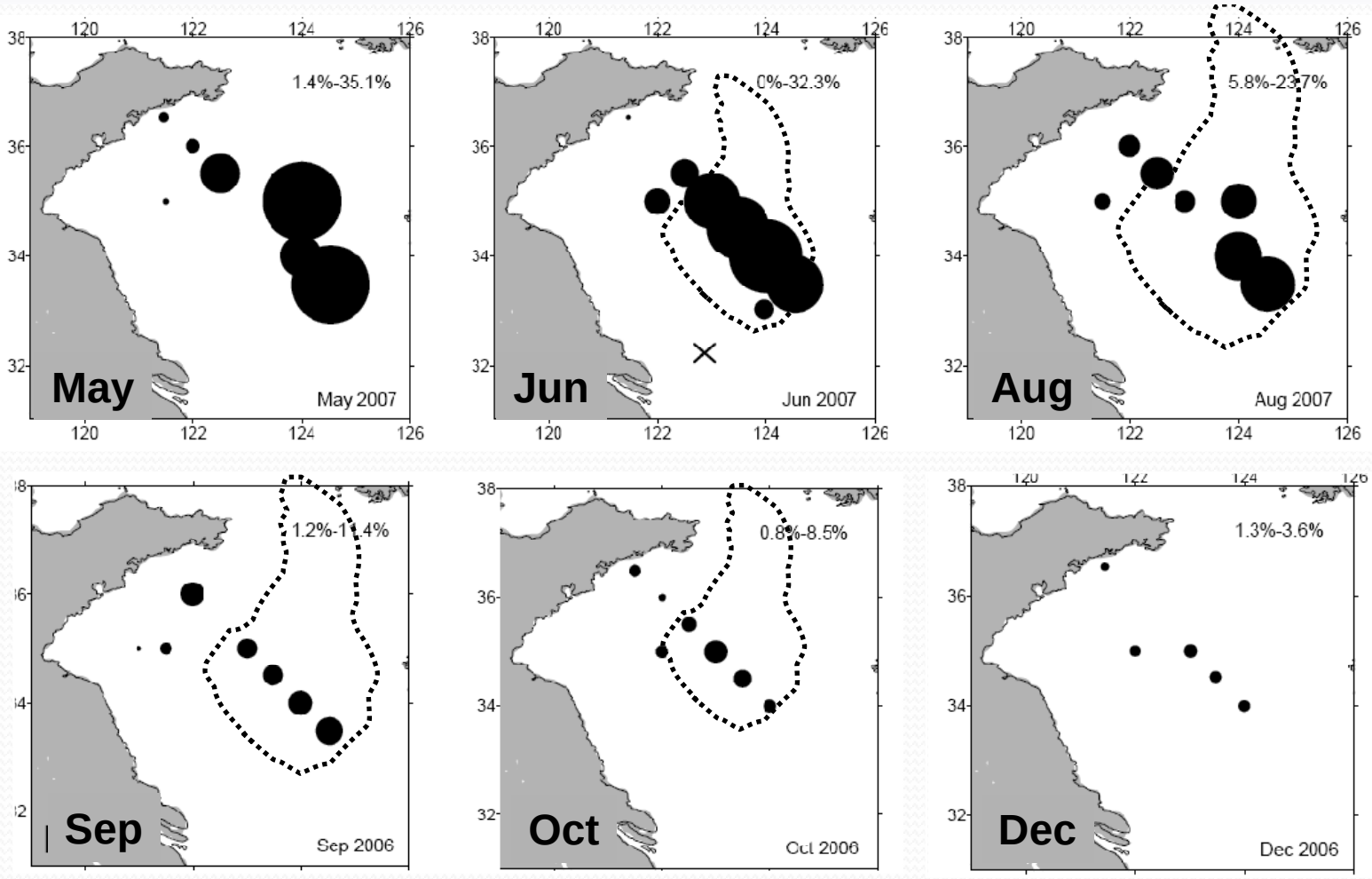
Large oil sac

Nearshore population

Small or no oil sac

Lipid storage mainly occurs in the Copepodite stage V

Over-summering – *The consumption of lipid reserve*



The lipid reserve amount in *C. sinicus* C5 in the YSCWM decreases evidently along the over-summering process.

Over-summering – *diapause or active?*

Population inside the YSCWM

NO Diel Vertical Migration

C5 dominant population

Large lipid reserve

Immature gonad

No reproduction

Low feeding rate

Low metabolic rate

Low molting rate of C5

Diapause…

Nearshore population

Diel Vertical Migration

No “C5 dominant”

Small lipid reserve

mature Gonad

Active reproducing

High feeding rate

High metabolic rate

High molting rate of C5

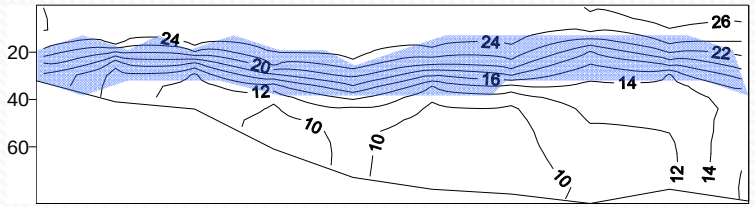
Active…

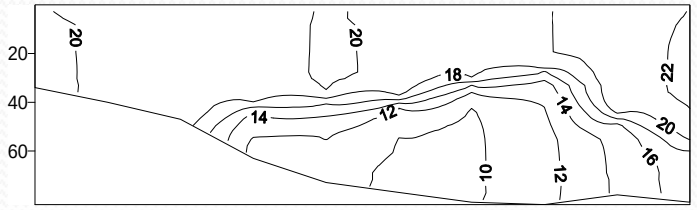
Molecular proofs are still needed to clarify if diapause occurs.

Autumn-winter - *nearshore population recovery*

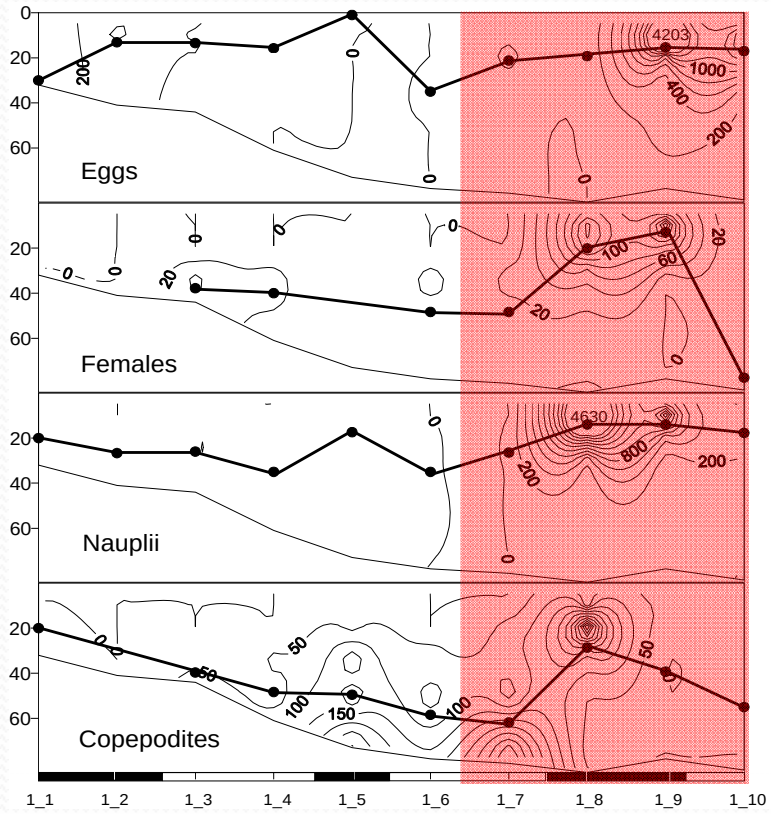
August

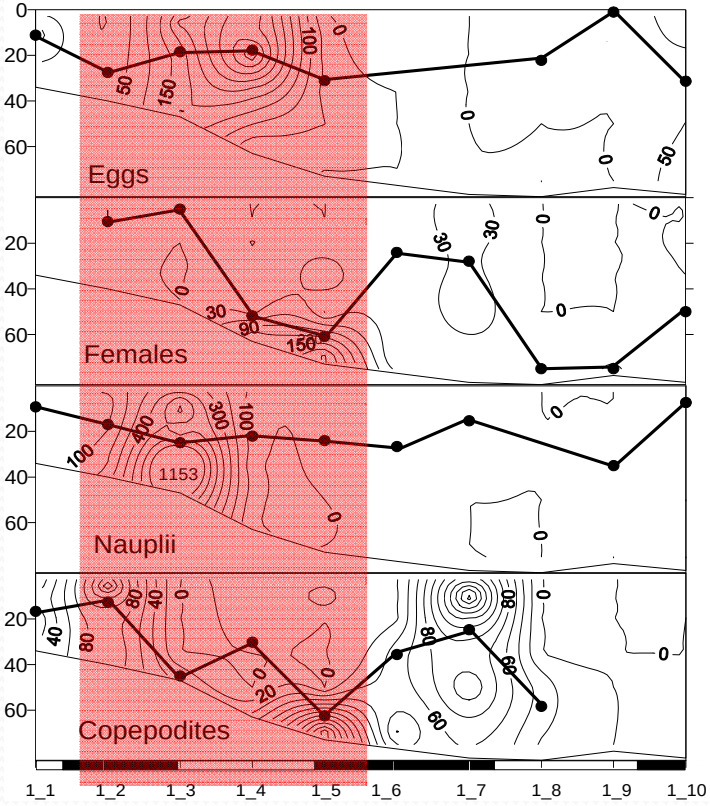
Oct-Nov





Temperature profile





Eggs

Female

Nauplii

Copepodites

Nearshore **Continental Shelf**

Nearshore **Continental Shelf**

Autumn-winter - *nearshore population recovery*

Possible mechanisms of recovery

A: The temperature and food conditions in the nearshore areas get more favorable than in summer time.

1) The deadly high temperature drops to be optimal for *C. sinicus*.

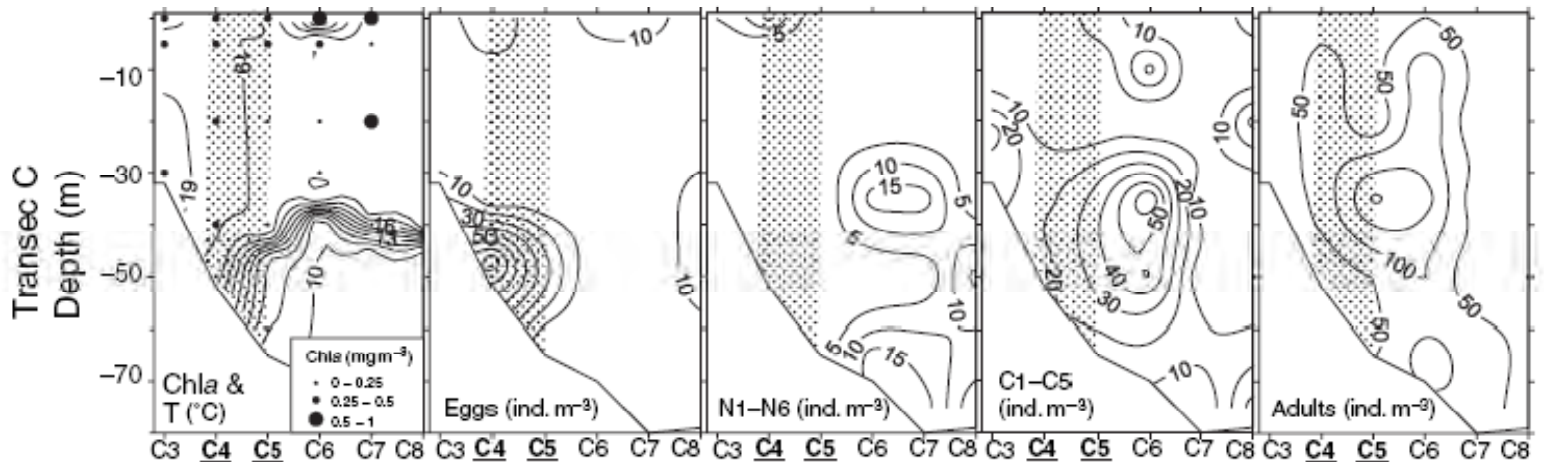
2) A second phytoplankton peak occurs in autumn.

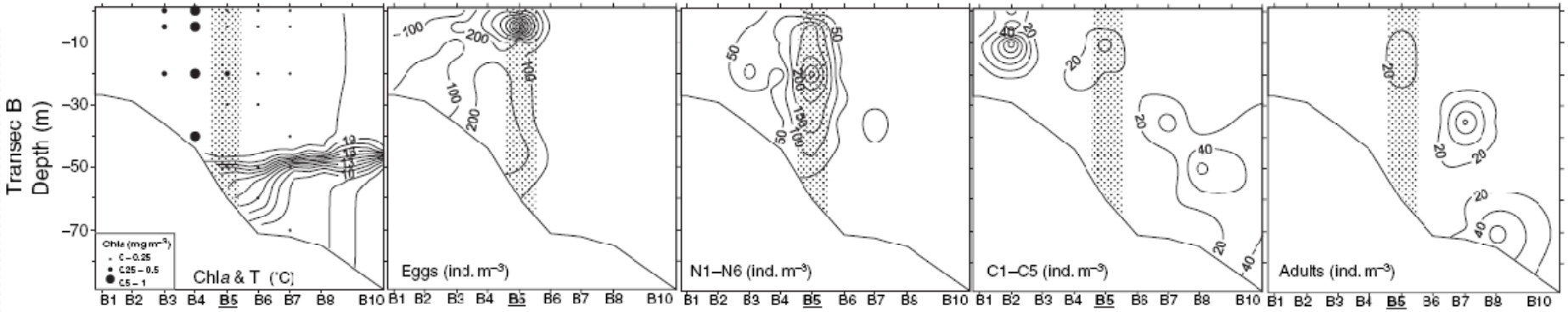
B: As the YSCWM shrinks to the central Yellow Sea, the *C. sinicus* population that once resides in the YSCWM is exposed in the tidal front area. This population will increase with the favorable conditions in the tidal fronts, from where the abundant population may be transported by currents into nearshore region.

The role of the tidal front is discussed in detail as follows.

Autumn-winter - *nearshore population recovery*

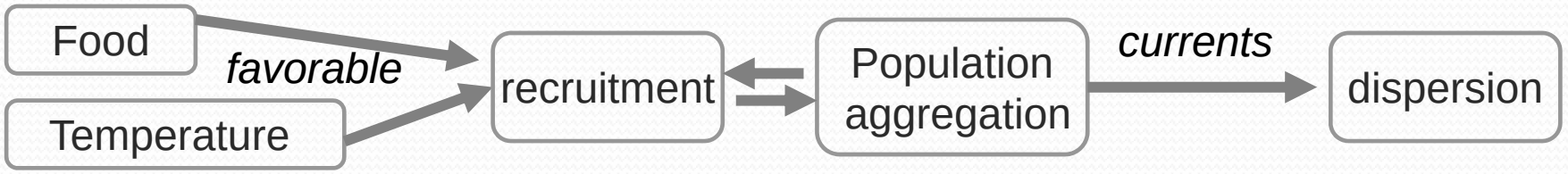
The probable role of tidal fronts





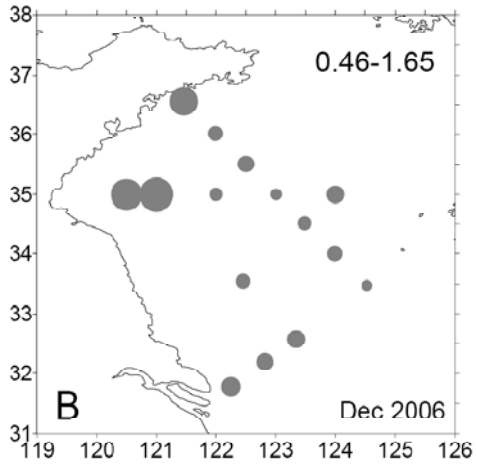
Population aggregation

Observed in Oct 2000

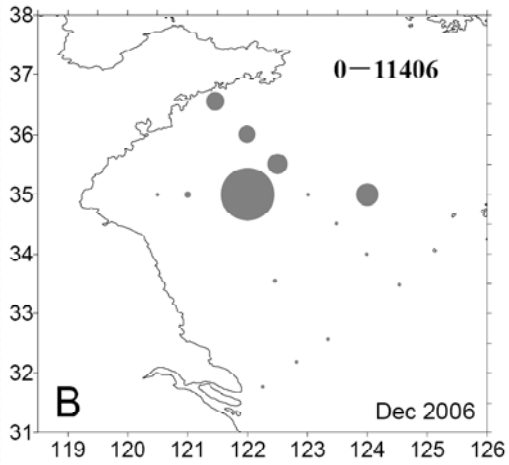


Autumn-winter – *winter recruitment*

Winter recruitment



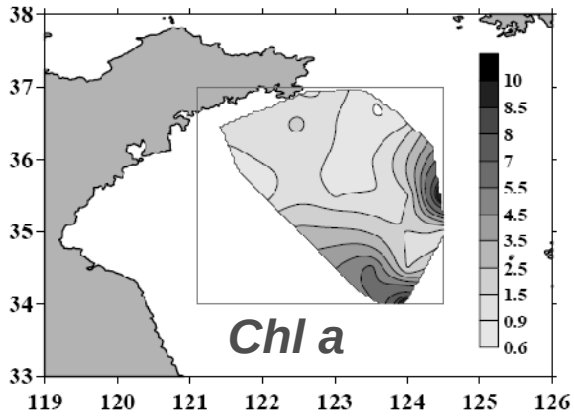
Egg production

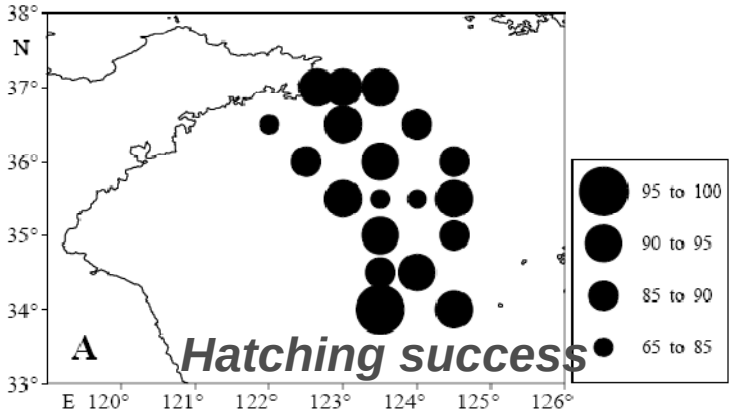


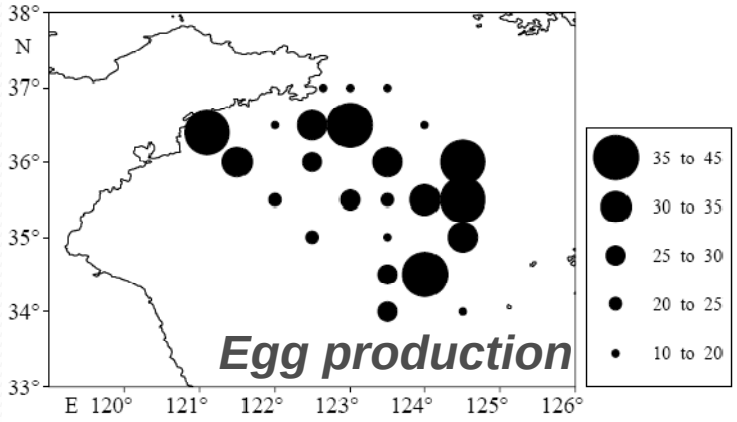
Recruitment rate

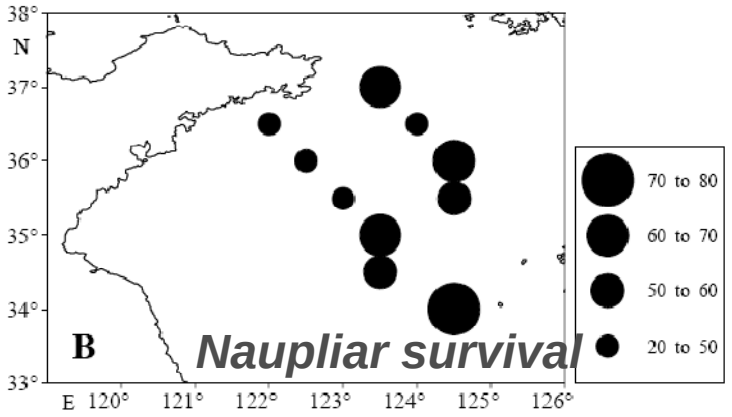
In winter, the *C. sinicus* population begins to mature, reproduce and recruit all over the Yellow Sea, whereas the recruitment rates remain relatively low until spring.

Spring population growth – ***diatom bloom***









The recruitment rate is generally high over the Yellow Sea in spring. Diatom bloom may increase population recruitment.

Spring recruitment is critical for the population increase in the Yellow Sea, especially for the continental shelf area where the major recruitment occurs in spring.

Conclusions

Population dynamics – *what controls it?*

Temperature

---very important factor during the life cycle of *C. sinicus*.

---the bottom cold water provides a “refuge” in summer.

----the effect of temperature is indirect to reproduction in the favorable temperature range (in spring & autumn).

Food

---food quantity and quality determines reproduction & growth

---the diatom bloom may increase population recruitment

Lipid reserve

---provide energy for the oversummering *C. sinicus* population.

---the lipid amount may be a “cue” for the beginning and emergence of diapause.

Population dynamics – *what controls it?*

Physical process

---thermocline and water masses

---tidal fronts

----current system

All these processes will affect the distribution of *C. sinicus*.

Many processes and mechanisms of the population dynamics of *C. sinicus* are still open to us…


Thank you!