Status of Korean Zooplankton Study

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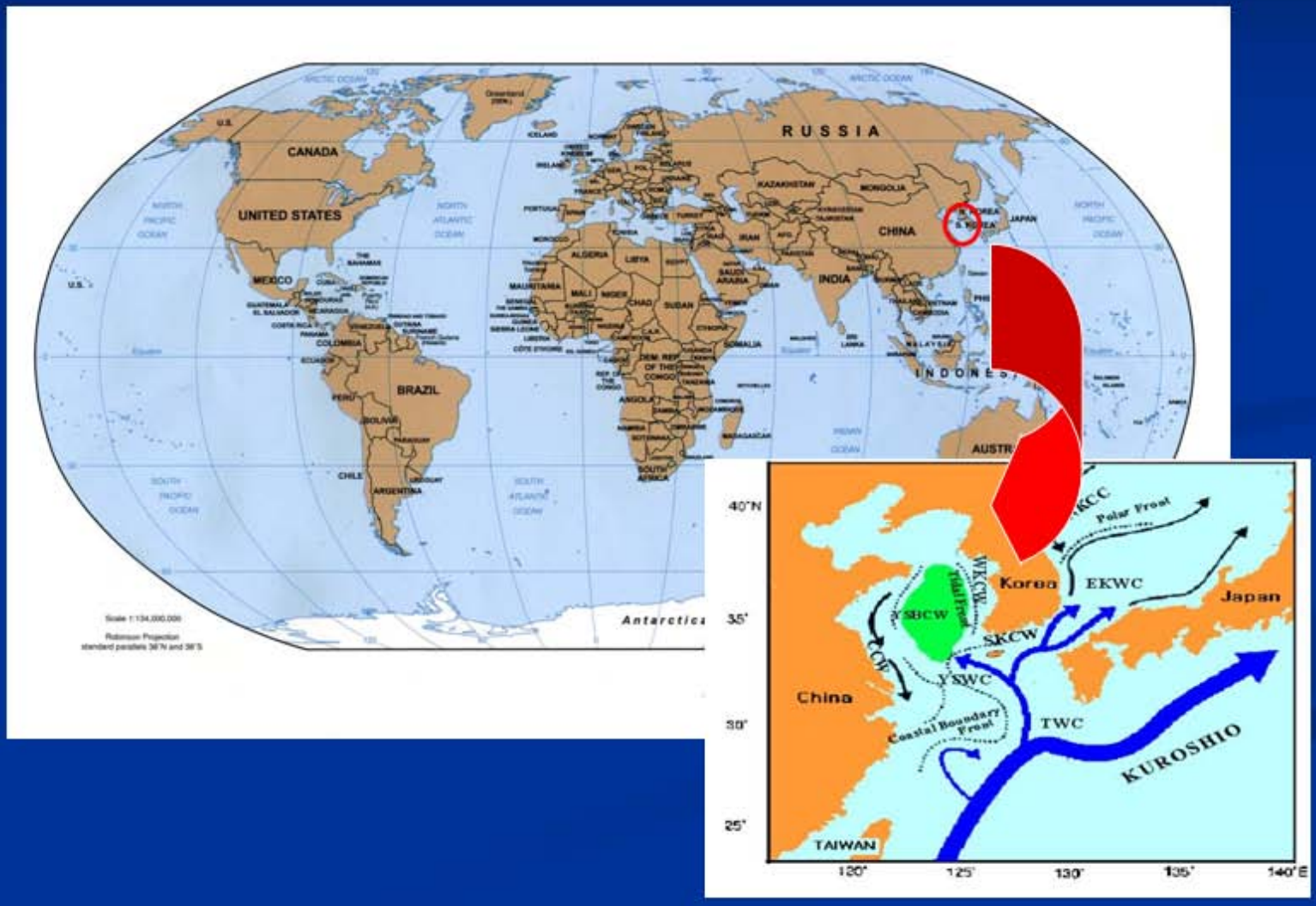
Introduction



◆ Three Seas with different oceanographic and geographic characteristics

- East/Japan Sea:
  - "a world ocean in miniature" (Ichiye, 1984) with deep depth
  - Tsushima Warm Current (Kuroshio Current) from East China Sea
  - North Korea Cold Current
  - Polar Front/ Coastal fronts and upwelling
- East China Sea:
  - -Tsushima Warm Current
  - Low-salinity Yangtze River water
  - Coastal fronts
- Yellow Sea
  - Basin scale sea (Semi-closed Sea) with 44 m in mean depth
  - Large tidal range, strong tidal fronts and tidal currents
  - Yellow Sea Warm Current intrudes from East China Sea episodically

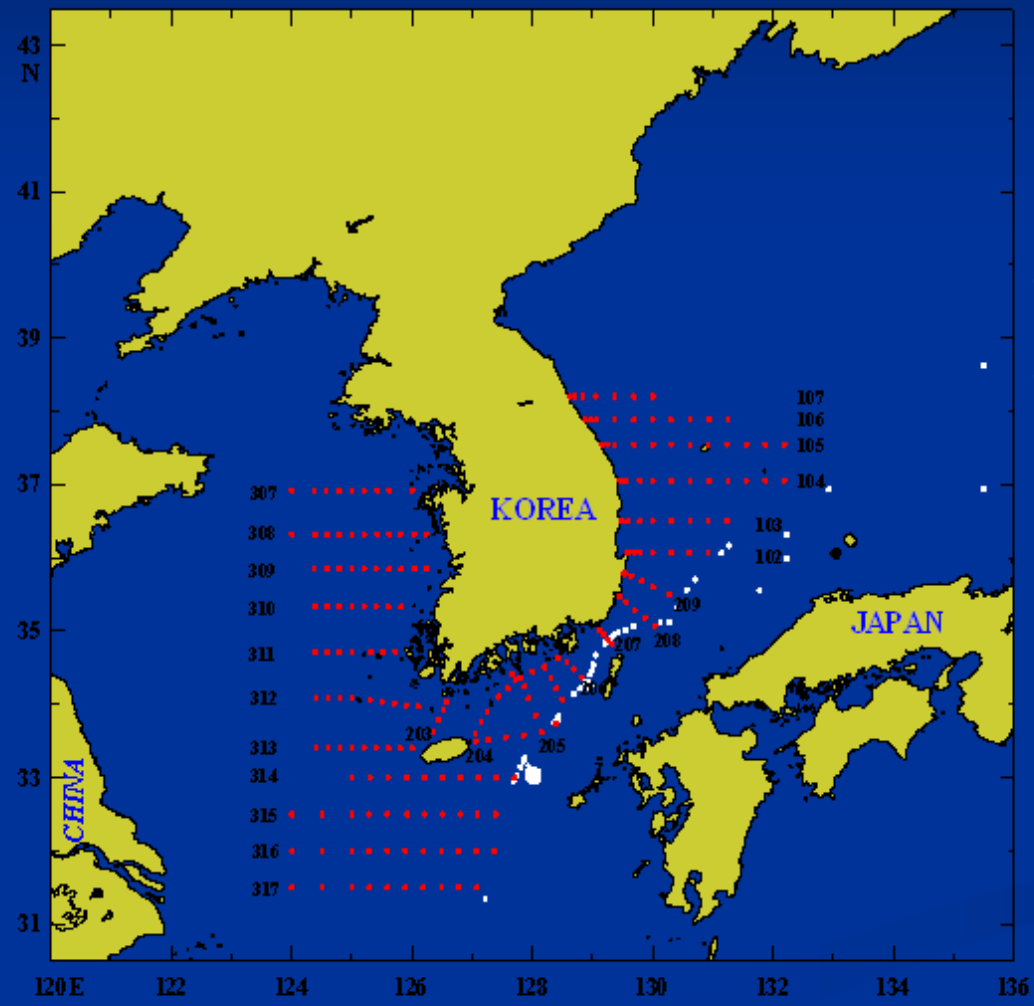
◆ Major zooplankton studies

- Spatial and temporal distribution of zooplankton (including indicator species) with concerning oceanographic and environmental conditions
  - Polluted coastal area, water masses, currents etc.
- Taxonomical studies : Chaetognaths, Euphausiids, and Copepods (*Acartica* spp., *Pseudodiamptomus* spp, and *Paracalanus* spp. etc.) etc.
- Production of some zooplankton, such as *Acartia hongi* and *Calanus sinicus*, with considering on food web (Chlorophyll)
- The relationship between zooplankton and fisheries
  - Mackerel, squid and anchovy
- Long-term changes in zooplankton with considering the climatic change

◆ Table . Number of papers in related to zooplankton in the South Sea of Korea

Content \ Decadal epoch	'60	'70	'80	'90	'00	Total
Spatio-temporal variations in zooplankton composition and abundacne		1	2	1	6	10
Indicator species and water mass, environmental condition	1	2	2	2	3	10
Zooplankton in the frontal area				1		1
Long-term changes in zooplankton		1			3	4
Biological characteristics of some zooplanktons		1		4	4	9
Total	1	5	4	7	16	34

Oceanographic monitoring system and data



- Period: 1965 ~ present
- Survey times: 6 times in a year (February, April, June, August, October and December)

- **Factors:**
  - Physical factors: water temperature, salinity etc.
  - Chemical factors: dissolved oxygen, nutrients
  - Biological factors: Zooplankton (Chlorophyll-a)

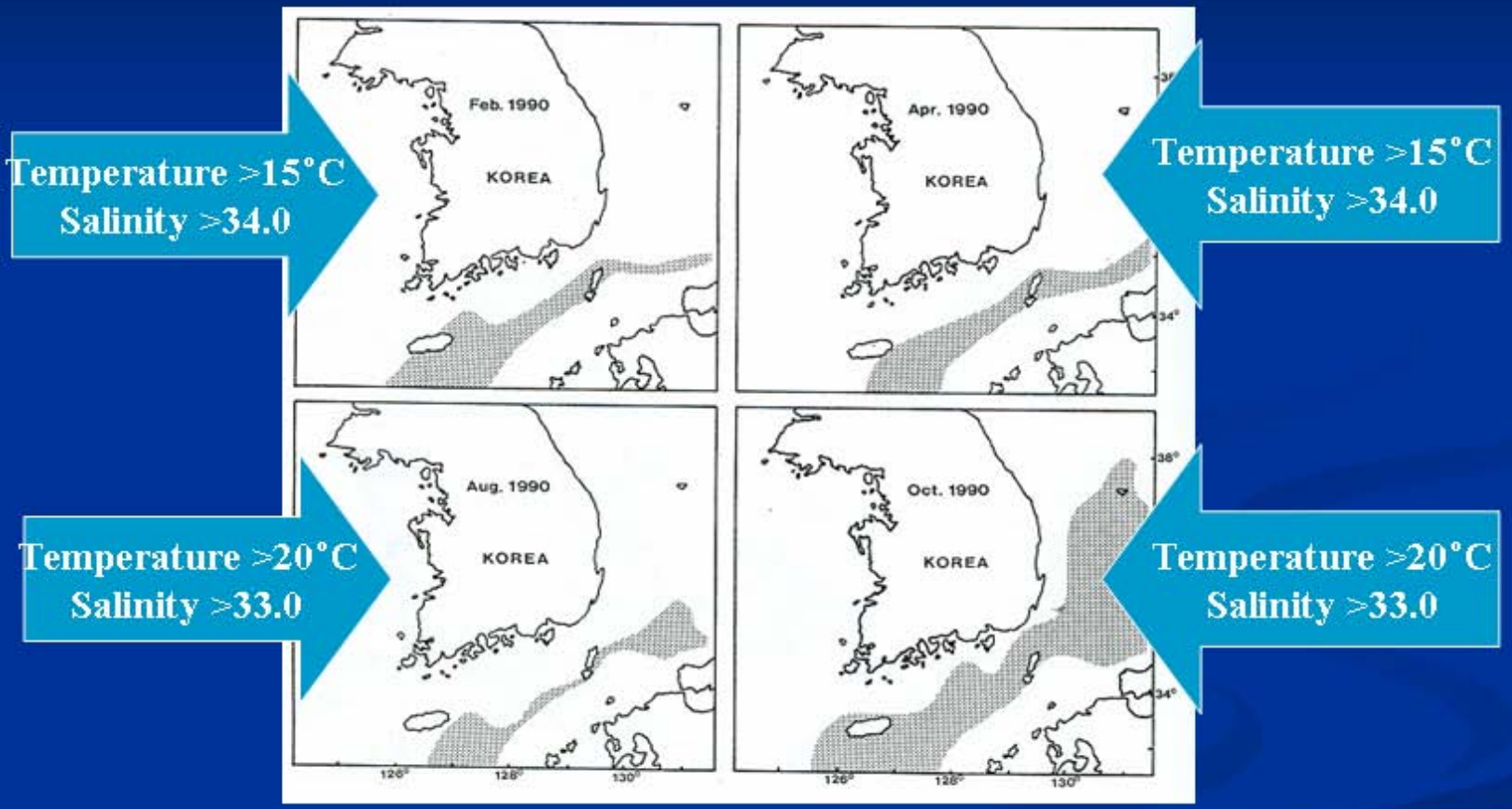
- **Data process:**
  - NFRDI web site service as a text-file: www.nfrdi.re.kr
  - Publication as an annual data book

Status of zooplankton studies in the Korean waters

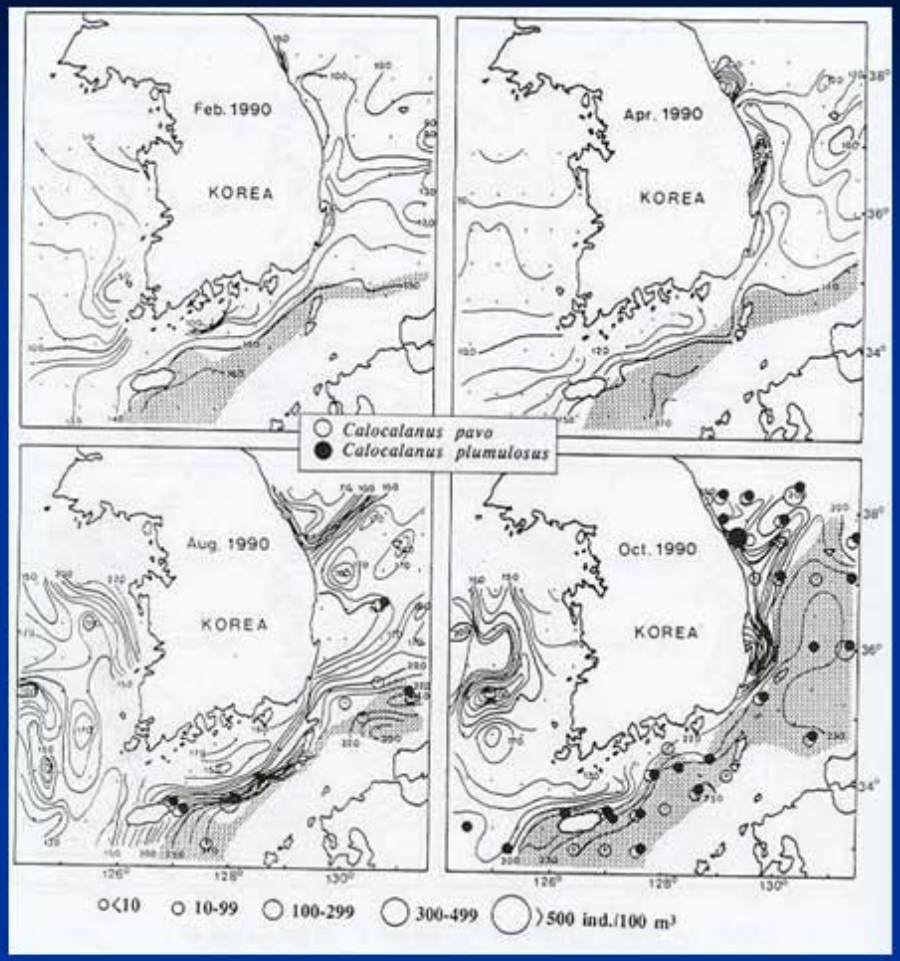
◆ Main topics

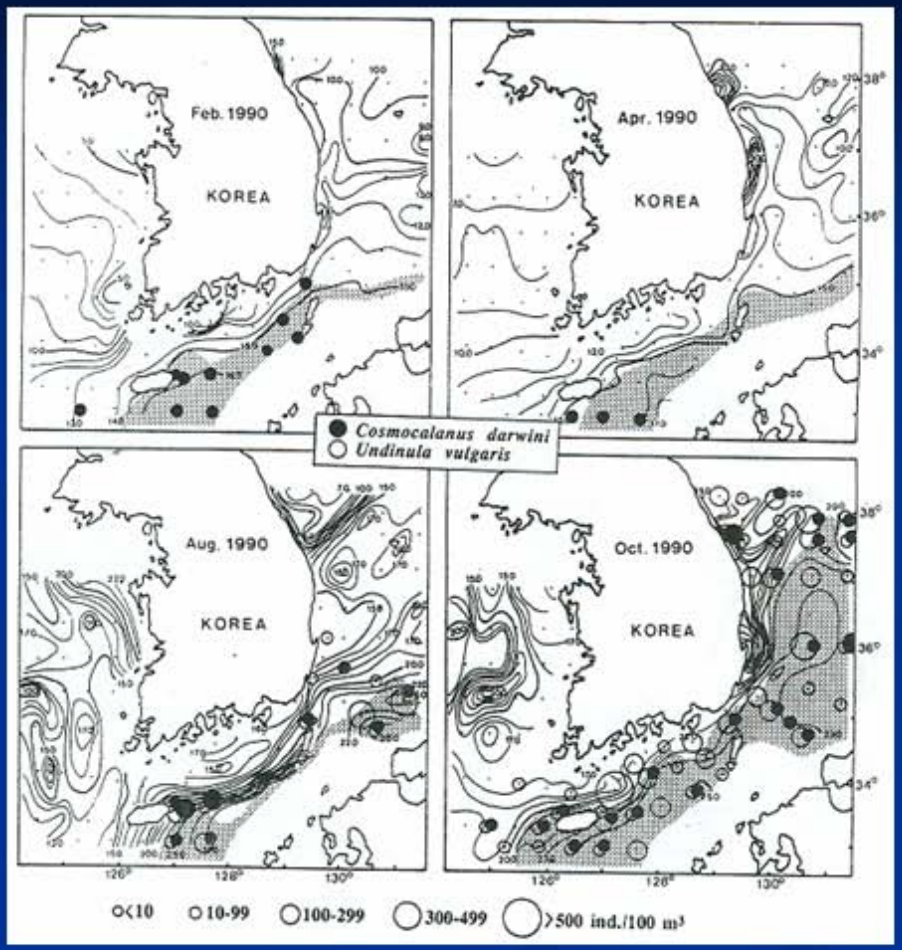
- Distribution of indicator species implicated to water masses
- Production of *Acartia hongi* at coastal area
- Zooplankton and fisheries
- Long-term changes of zooplankton with concerning on climatic change

◆ Distribution of indicator species implicated to water masses



<The water mass of the Tsushima Warm Current defined based on temperature -salinity diagram in February, April, August and October, 1990:>





<Geographical distribution of warm water indicator Calanoid species with temperature at 30 m depth and the water mass of the Tsushima Warm Current>

◆ Production of *Acartia hongi* at coastal area

Table . Comparison of zooplankton production (mg C/m^3) in various habitats.

Species	Production		Region	Reference
	Daily	Annual		
Acartia tonsa	19 ~ 23		Narragansett Bay	Durbin and Durbin (1981)
Acartia hudsonica	7.5 ~ 12		Narragansett Bay	Durbin and Durbin (1981)
Acartia omorii		163	Onagawa Bay	Uye (1982)
Copepods spp.	0.05 ~ 0.3		North Sea	Kiørboe and Johansen (1986)
Acartia hudsonica		373 ~ 437	Passamaquoddy Bay	Middleborrk and Roff (1986)
Acartia tranteri		130	Westernport Bay	Kimmerer and McKinnon (1987)
Copepods spp.		< 430	Kattegat	Kiørboe and Nielsen (1994)
Acaria omorii		749	Fukuyama Bay	Liang and Uye (1996)
Acartia steueri		25.2	Ilkwang Bay	Kang (1997)
Acartia spp.	13.1		Malaga harbour	Guerrero and Rodriguez (1997)
Copepods spp.	0.11 ~ 1.55		Yellow Sea	Shin (1997)
Mesozooplankton	4.35		Inland Sea of Japan	Uye and Shimazu (1997)
Mesozooplankton	1.87		Ise Bay	Uye *et al.* (2000)
Acartia hongi		33 ~ 293 (mean: 135)	Kyeonggi Bay	Present study

- **Conclusion (Production)**

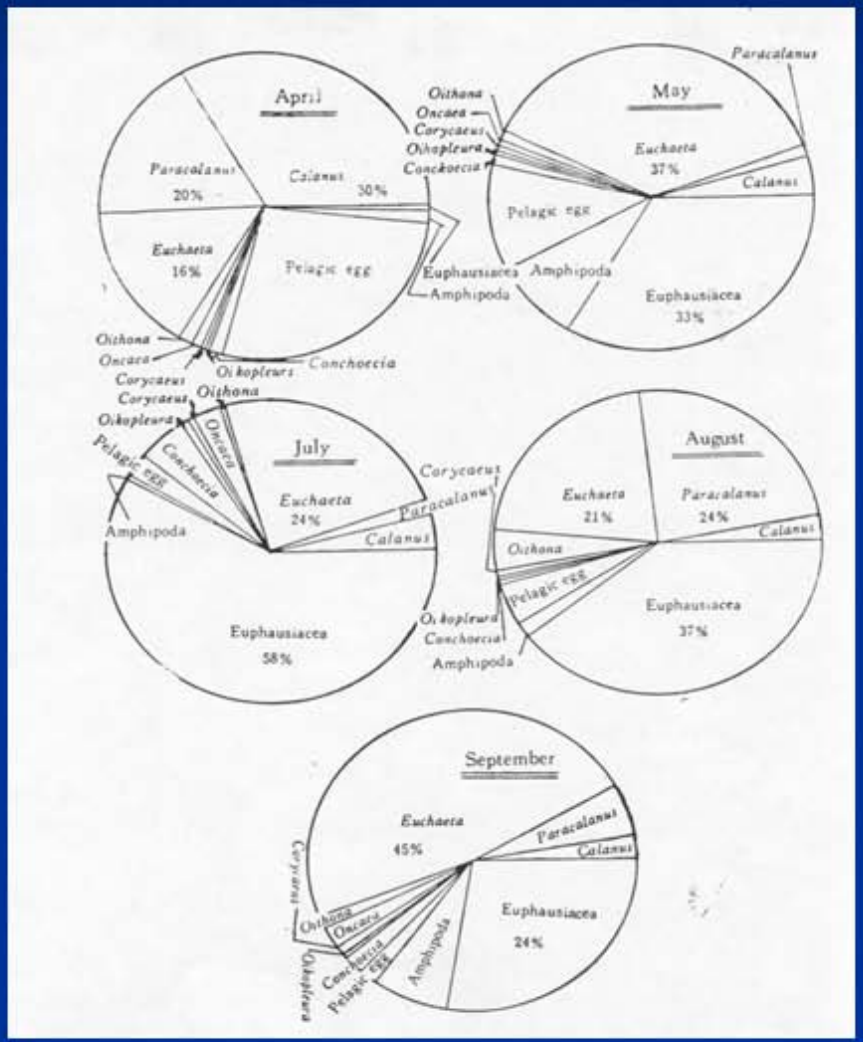
- Secondary production of *Acartia hongi* varied from 33 mg C/m^3/day to 293 mg C/m^3/day , with the mean value of 135 mg C/m^3/day in Kyeonggi Bay.

- Secondary production of *Acartia hongi* is primarily dependent on food availability in Kyeonggi Bay.

- Mean annual production of *Acartia hongi* was 2.8 gC/m^2/yr and 70% of the production occurred in spring.

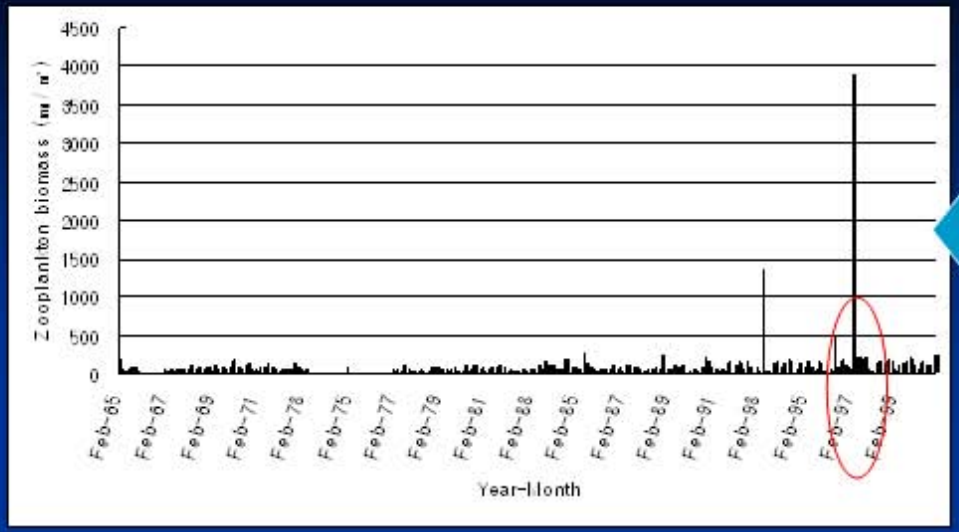
- Annual production of *Acartia hongi* attains only a few percent of the primary production.

◆ Zooplankton and fisheries



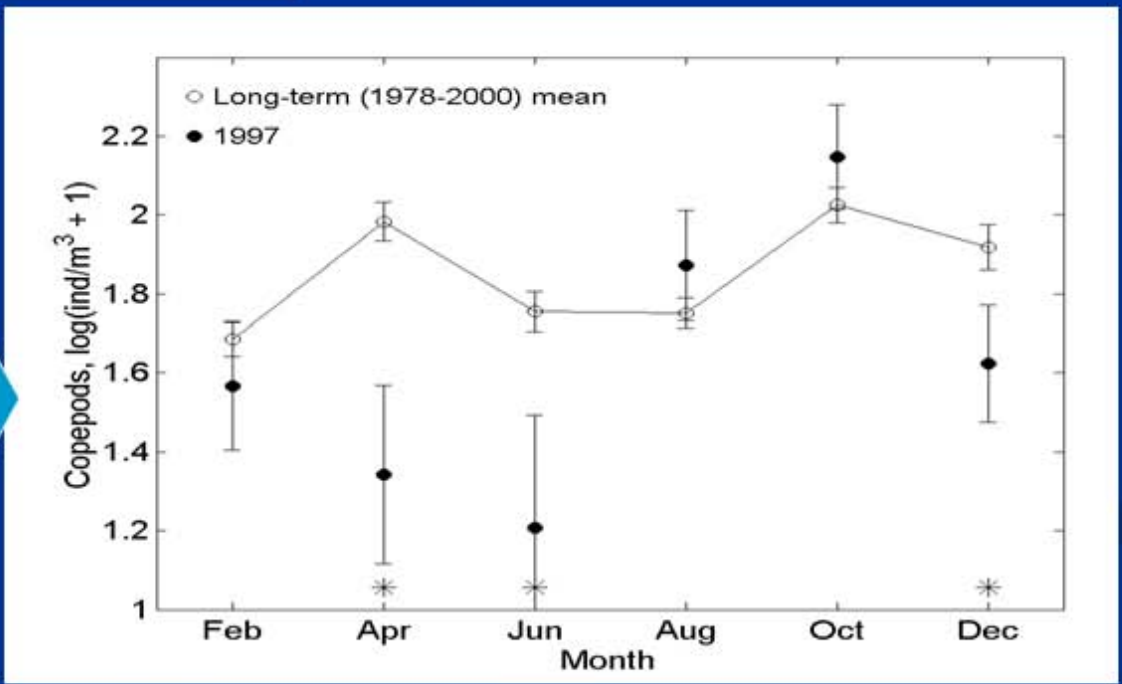
<Stomach contents of mackerel in the East China Sea in 1993>

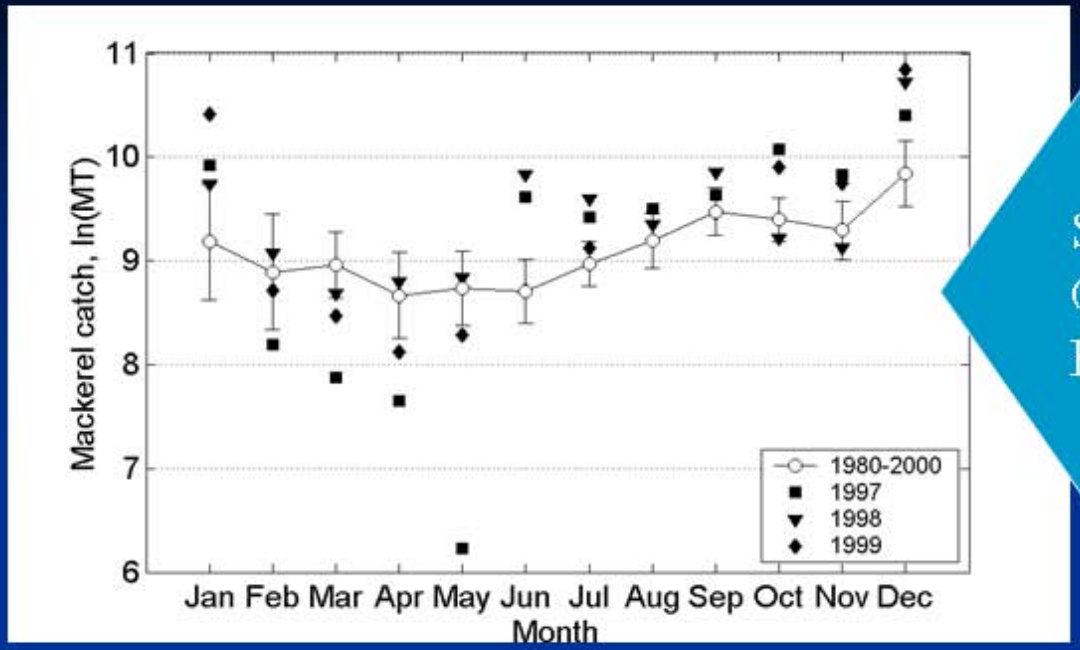
- Main food : Copepods and Euphausiids



Long-term changes in zooplankton Biomass in the South Sea of Korea (East China Sea)

Comparison between seasonal variations of long-term mean and 1997 mean of copepods





Seasonal changes in mean mackerel Catches in the south Sea of Korea (East China Sea)

- **Conclusion**
  - Food item is important to decide fisheries production even though zooplankton was abundant.
  - Mackerel catches are closely related to the copepods density.

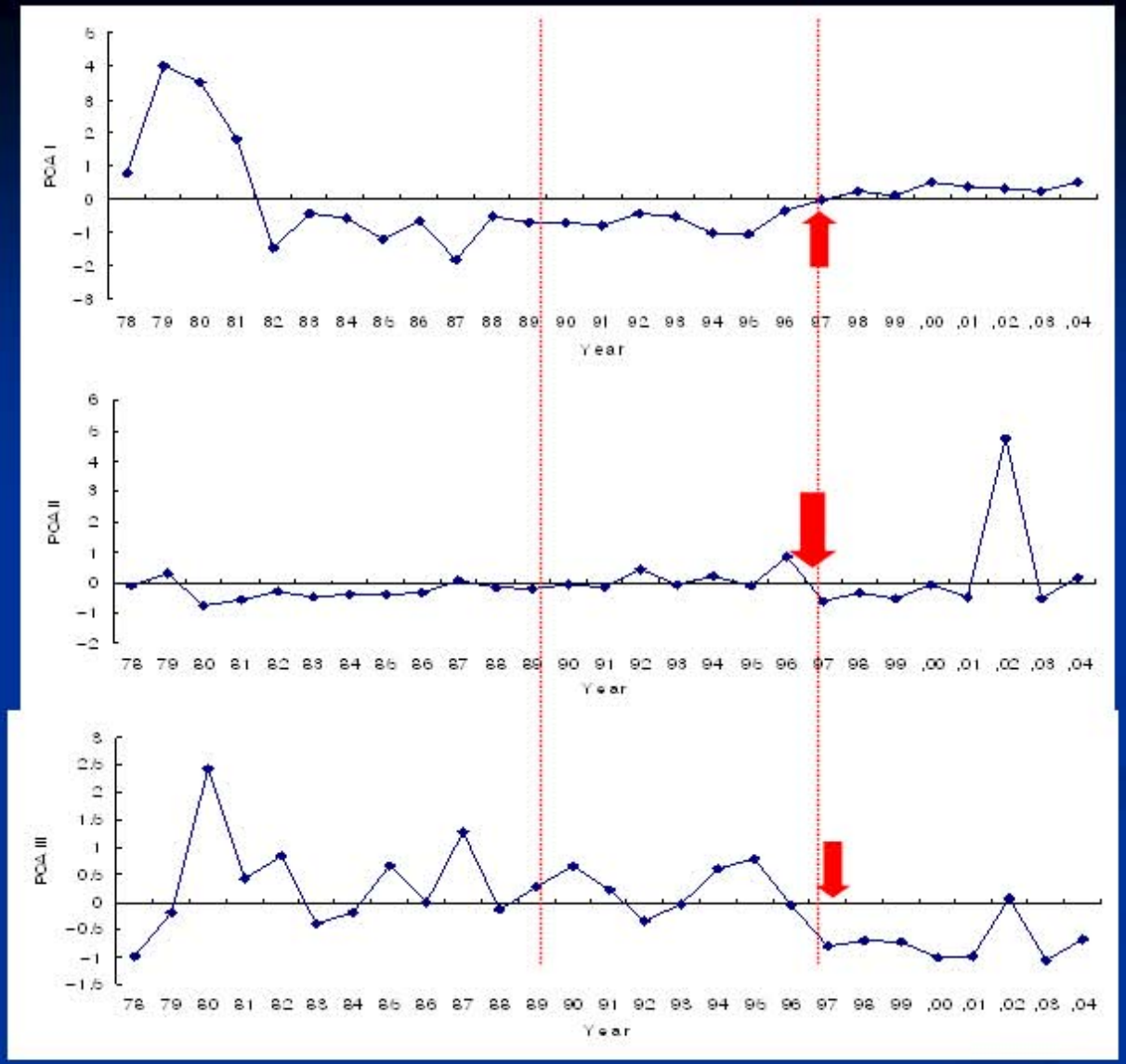
◆ Long-term change respond to regime shifts associated with oceanographic conditions in the eastern area of the Yellow Sea with concerning on the 1997/98 regime shift

- **Purpose:**

  To know zooplankton responses to regime shifts in 1977, 1989 and 1998 with concerning on oceanographic conditions, in particular, focusing on the new states after 1997/98 and an El Nino event in 2002/03

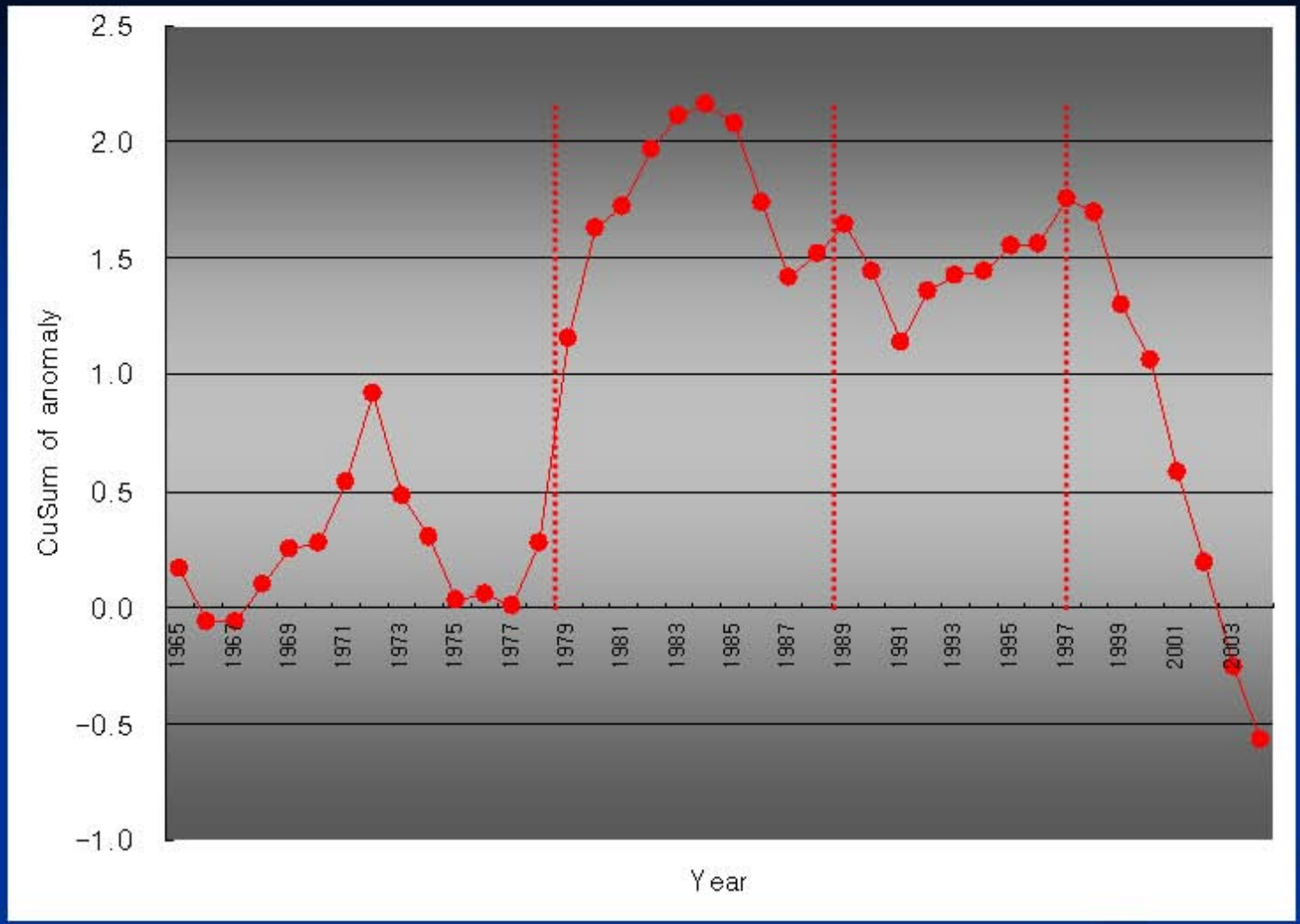
- **Method:**

  - Data : zooplankton biomass(wet weight) and abundance of four taxa, such as copepods, chaetognaths, amphipods and euphausiids during 1978~2004
    Sea surface temperature and salinity during 1978~2004
  - Statistics : PCA



< Long-term changes in 1st, 2nd and 3rd principal component calculated from 27-yr four major zooplankton groups, copepods, amphipods, chaetognaths and euphausiids, in the eastern area of Yellow Sea. 1st, 2nd and 3rd principal component explain 44.34%, 25.67% and 16.43% of the total variability, respectively.>

< Long-term change of cumulative sum plots for annual mean anomalies of zooplankton biomass from 1967 to 2004 in the eastern area of Yellow Sea>



<Long-term change of cumulative sum plots for annual mean anomalies of sea surface salinity from 1965 to 2004 in the eastern area of Yellow Sea>

- **Conclusion :**

  - Mesozooplankton responded to 1989, while not to 1977/78 and 1997/98. However, it showed stepwise changes in the 1978-1980, 1997 and 2002/03.
  - In addition, the increasing gradients between 1989-97 and 1998-2004 were very different.
  - Oceanographic condition also showed the striking changes in salinity and temperature in the periods 1989-97 and 1998-2004.
  - Salinity showed steep decrease after 1997/98.
  - In the 1998-2004, sea surface temperature sharply increased in April and sea surface salinity dramatically decreased in October.
  - Additionally, zooplankton biomass increased in April and October in the 1998-2004.

Thank you for your attention !!