Vertical distribution and reproductive aspects of caridean shrimps in the deep-water of the East Sea, Korea

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Contents

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Introduction - Distribution

Distribution may depend on a variety of environmental factor (Boschi, 2000).

Organic matter content

Salinity, temperature

Sediment texture

Evironmental Factors

Spatial and seasonal distribution

(Costa et al., 2005 a, b; Castro et al., 2005)

Depth is a multicomponent factor related to the major biotic and abiotic gradients found in the ocean (Company and Sarda, 1997).

Introduction - Effects of depth

As their own reproductive strategy of each species, distribution will be able to vary according to sex and stage of development.

Reproductive Strategies

by depth

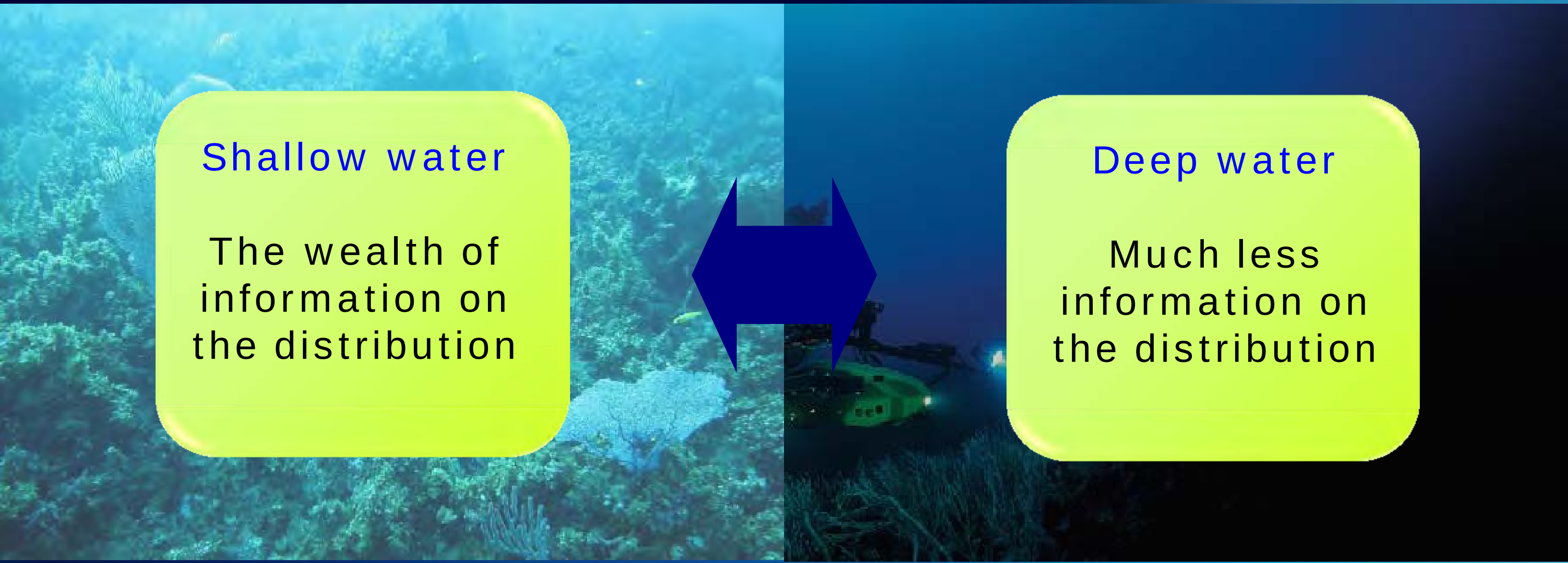
Sex ratio

As a function of depth reflects differential migration between sexes, related to egg incubation and hatching (Abello and Cartes, 1992).

Reproductive behaviour

Migration be related to the physiological demands for copulation and spawning (Castilho et al., 2008).

Purpose of this study



Ⅰ The first aim of the present paper is to reveal the distribution pattern, as well as the differences in the size structure of their populations related to depth.

Ⅱ The other aim is to compare the reproductive traits of deep-sea shrimp through distributions among 4 species.

Characteristics of 4 species

Of 14 species (4 in the Hippolytidae, 3 in the Pandalidae and 7 in the Crangonidae) found in the study area the four dominant shrimps was used to examine (Kim and Kim, 1997; Cha et al., 2001)**.**

Family Crangonidae ***Neocrangon communis*** **(Rathbun, 1899)**

Argis toyamaensis **(Yokoya, 1933)**

Family Pandalidae ***Pandalus eous*** **Makarov, 1938**

Family Hippolytidae ***Eualus biunguis*** **(Rathbun, 1902)**

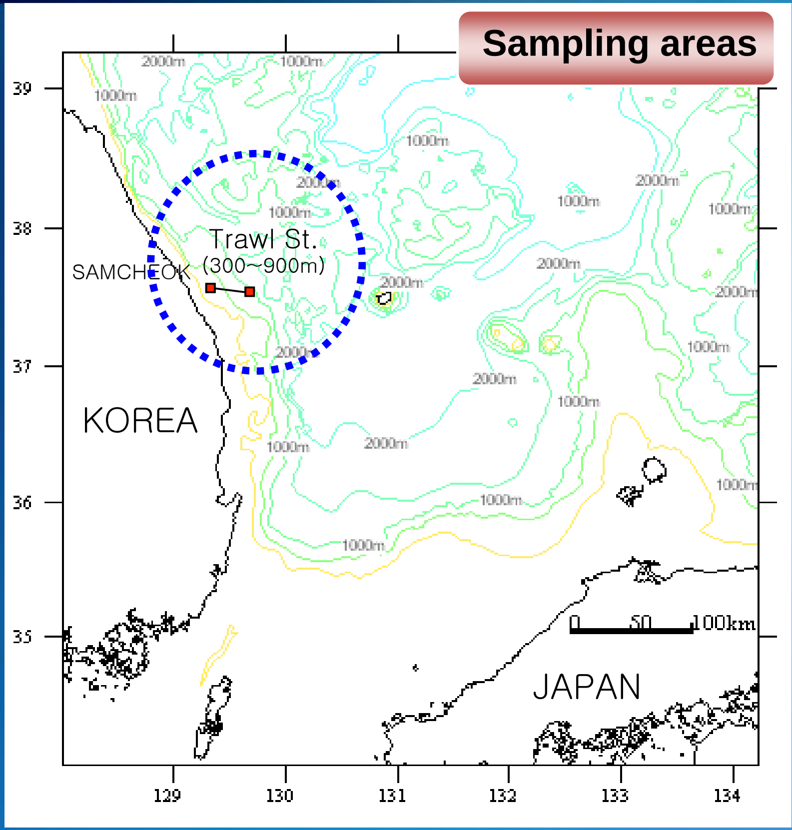



Materials and Methods

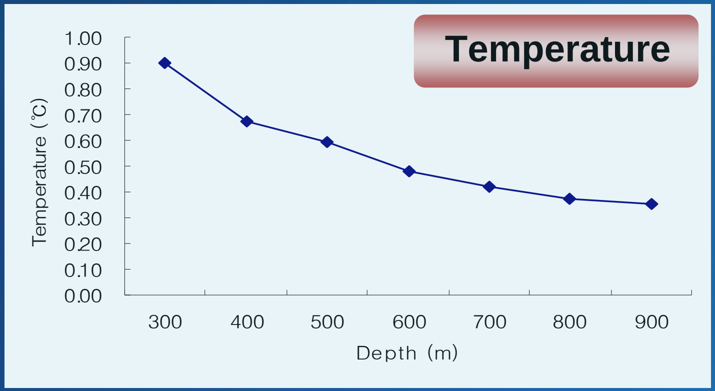
Sampling

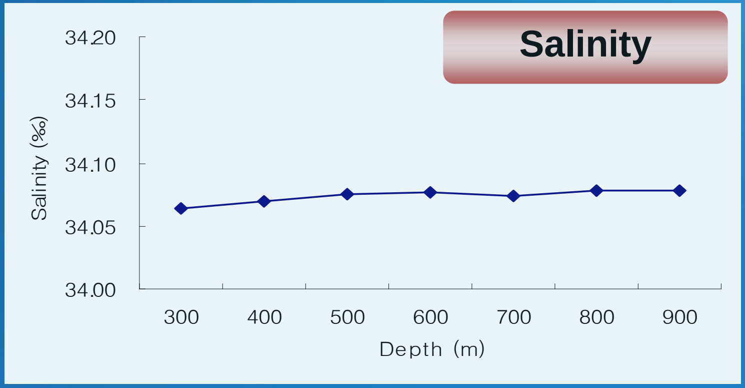
Four species were collected from East sea off Samcheok (37°22´N 129°19´E, 37°36´N 129°47´E)

2004→ June, December
2005→ May, November
2006→ March, September
2007→ April, October
2008→ June, November



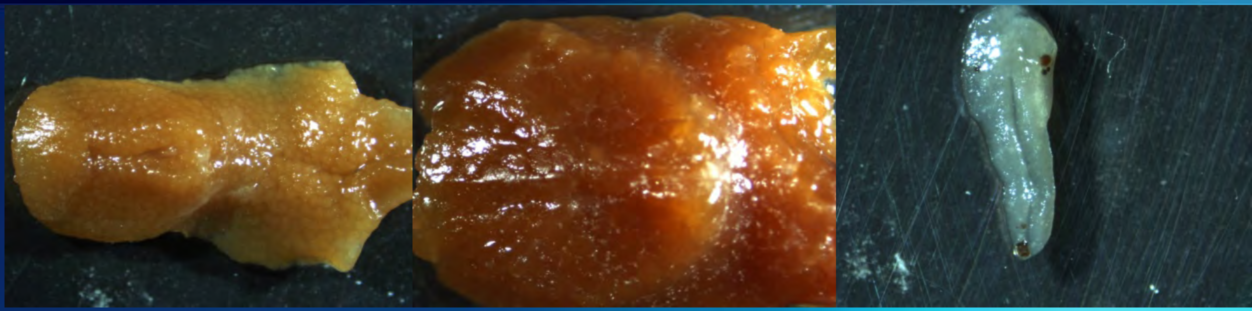
Temperature : 0.90℃ (300m) ~ 0.35℃ (900m)





Materials and Methods

Ovary examination

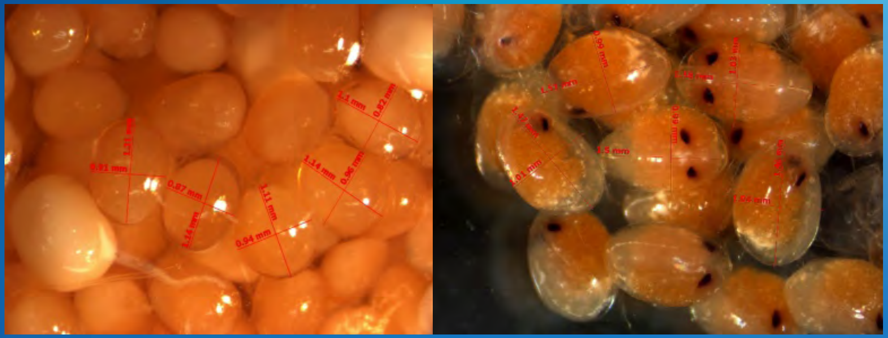


1. Immature (Stage 1)
2. Maturing (Stage 2)
3. Ripe (Stage 3)
4. Spent (Stage 4) (Meredith,1952)

GSI= Ovarian dry weight / (Body dry weight-Ovarian dry weight) x 100

Egg size $4/3\,\pi\, r_1 r_2^{\,2}$

Where r_1 is half the major axis and r_2 half the minor axis.



Statistical analysis

- **Chi - square test**
- **Kolmogorov - Smirnov two sample test**
- **Analysis of variance (ANOVA)**
- **Kruskal - Wallis test**
- **Analysis of covariance (ANCOVA)**

Statistical analyses were accomplished in MINITAB Version 12 and SYSTAT Version 10.

3. Results

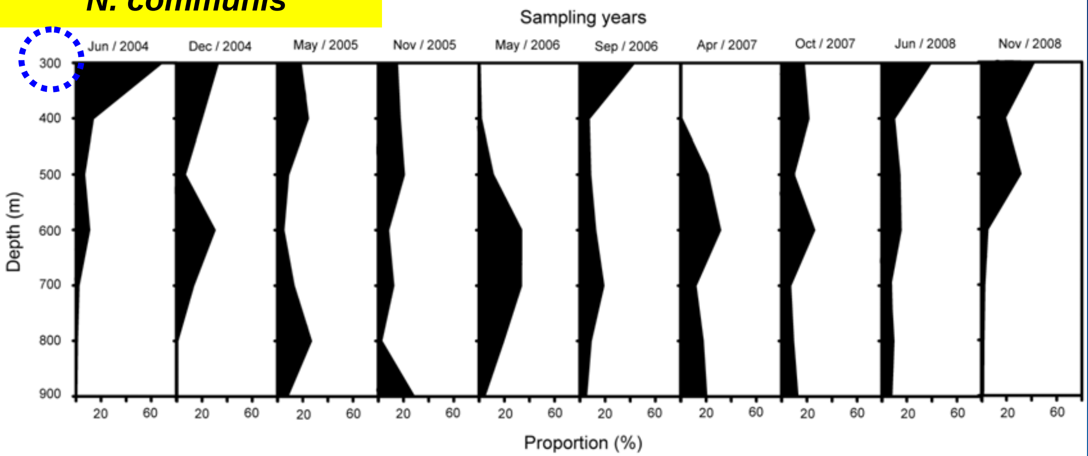
3-1 Distribution of shrimps by depth

- Depth distribution
- Sex ratio by depth
- Length frequency distribution

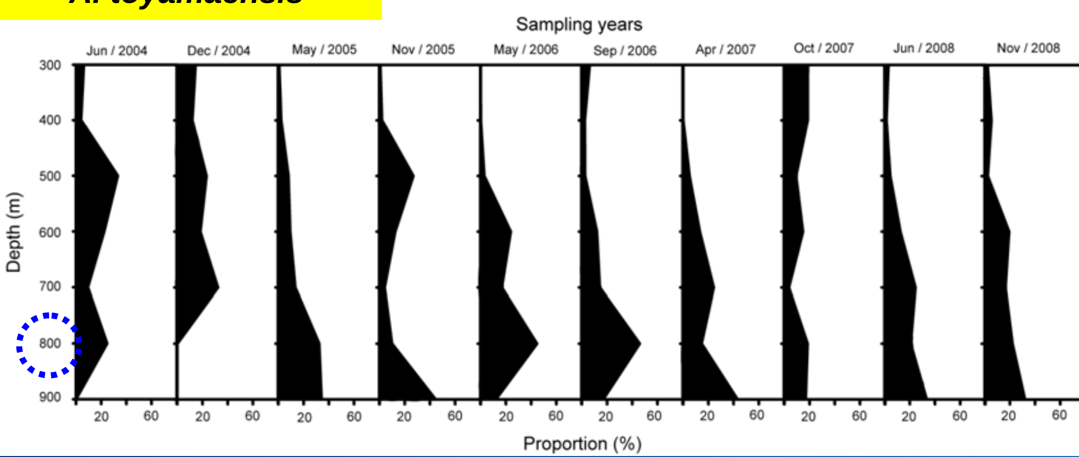
Results

Depth distribution

N. communis

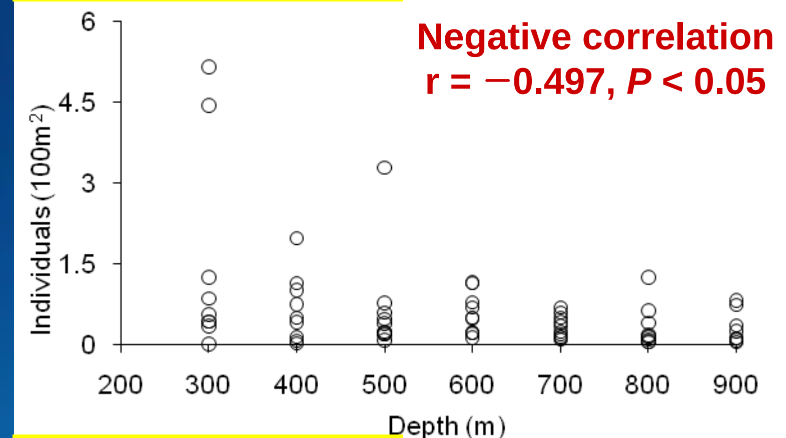


A. toyamaensis

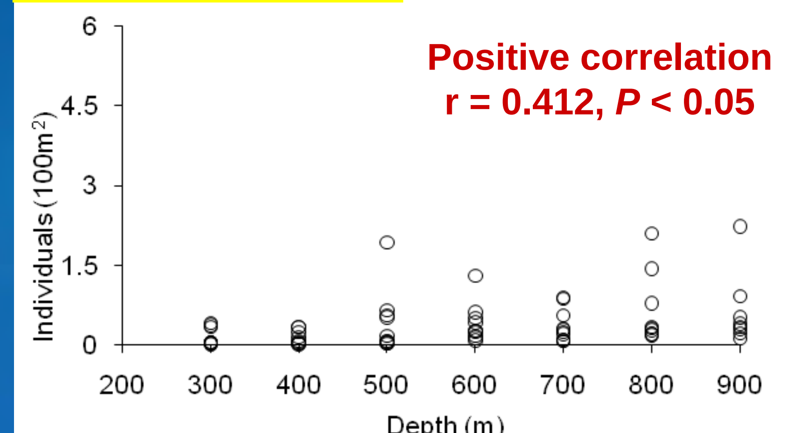


< Proportion of individuals with depth >

N. communis



A. toyamaensis

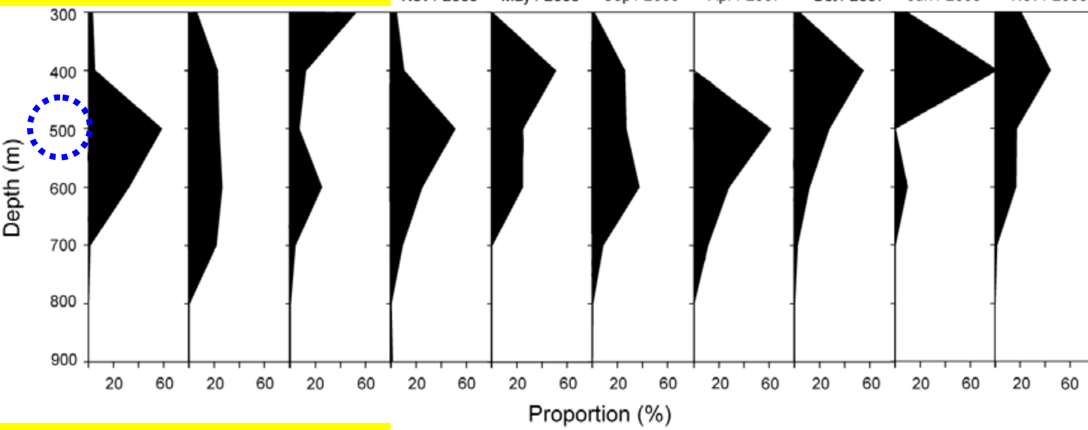


< Correlation between the abundance and depth>

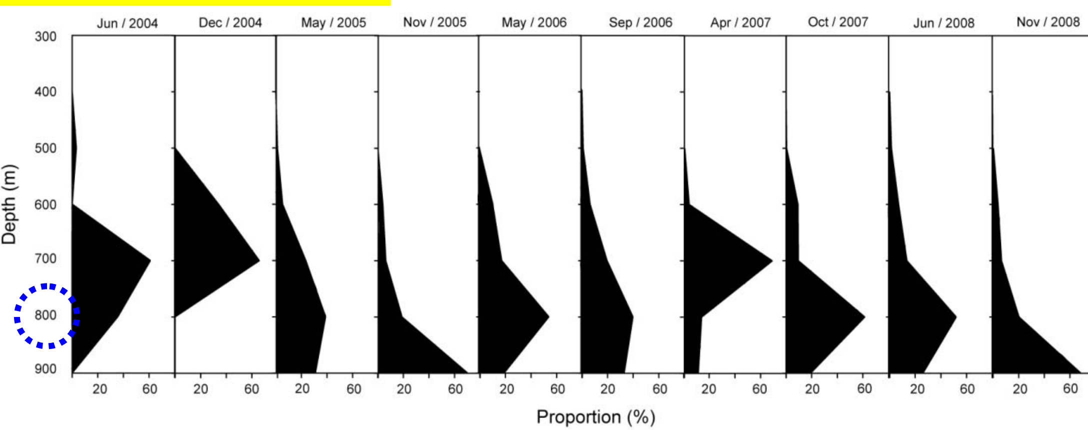
Results

Depth distribution

P. eous

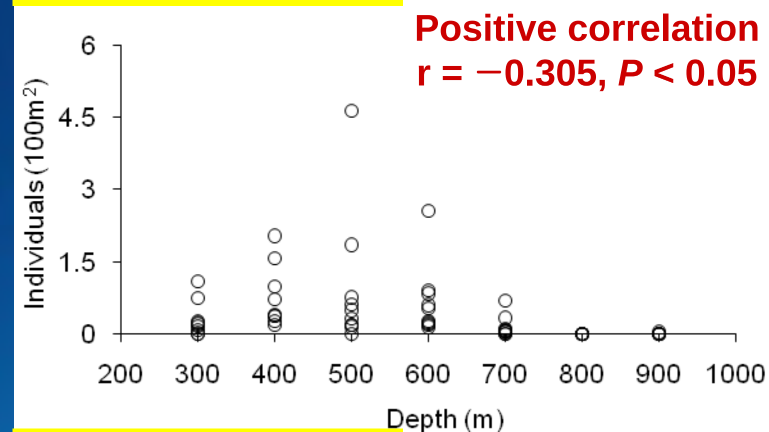


E. biunguis

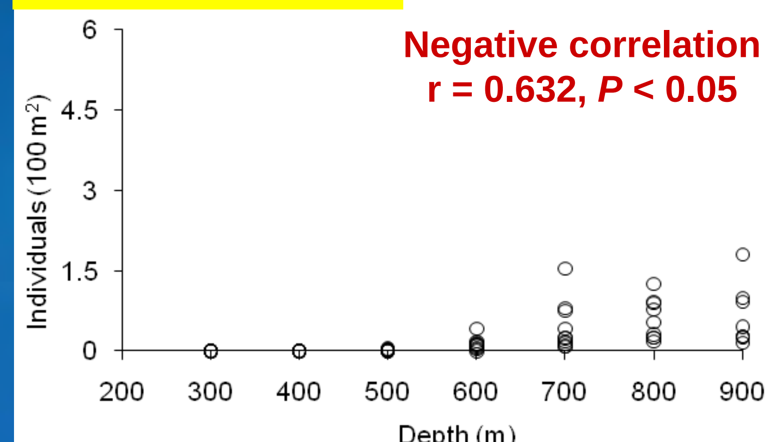


< Proportion of individuals with depth >

P. eous



E. biunguis

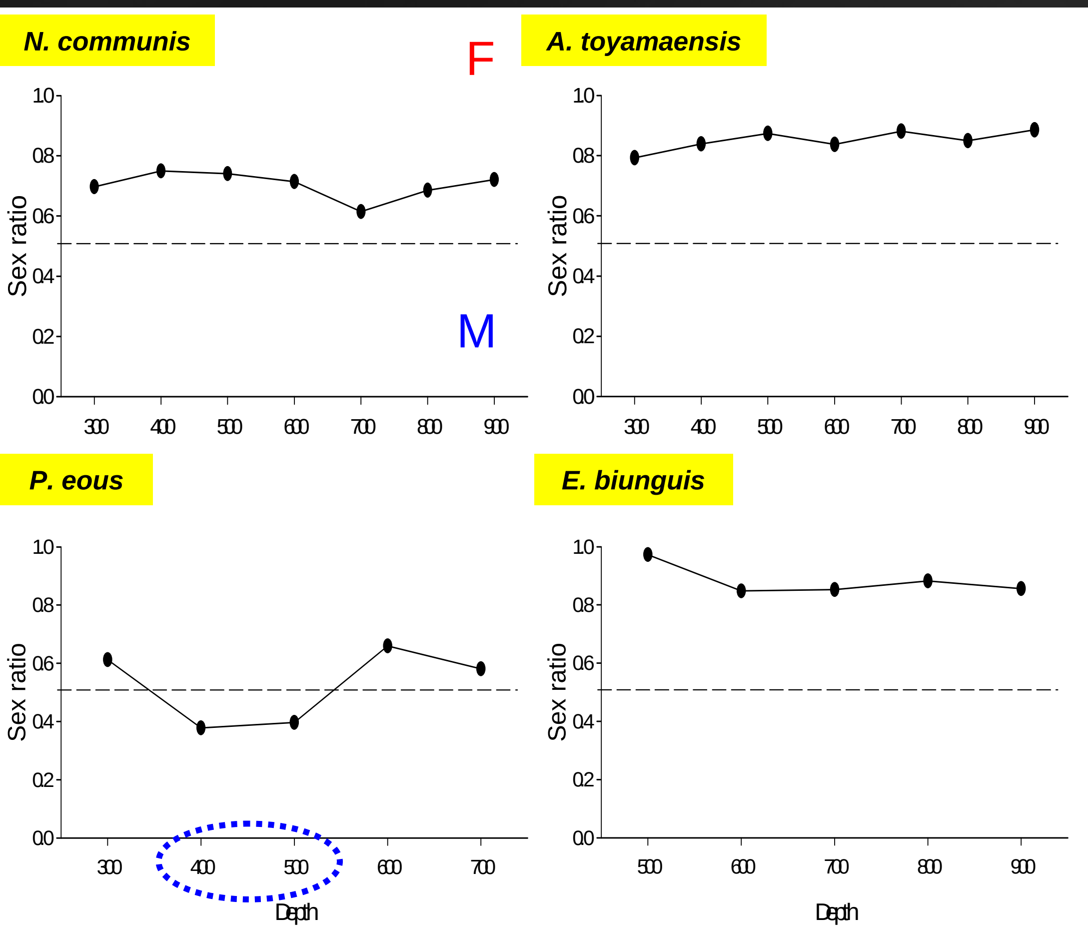


< Correlation between the abundance and depth>

Results

Sex ratio by depth

• A significant **difference in sex ratio by depth** of 4 species (Chi - square test, $P < 0.05$).



• **Predominance of females**

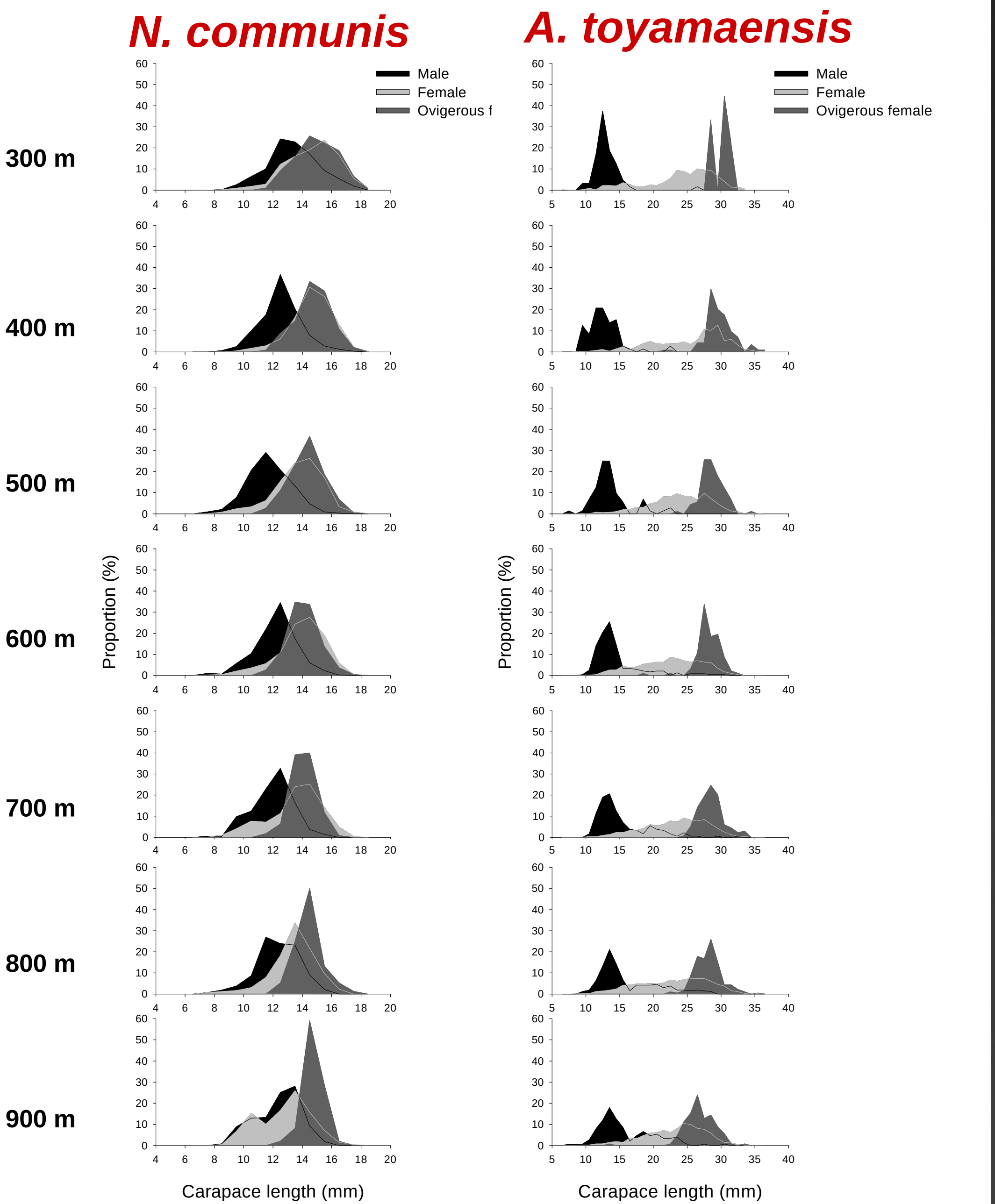
at all depth range

in *N. communis* (61.47 % ~ 74.94 %)
in *A. toyamaensis* (79.28 % ~ 88.55 %)
in *E. biunguis* (84.80 % ~ 97.25 %)

• **Overall sex ratio of *P. eous* was male dominant unlike other species in 400 m ~ 500 m depth.**

Results

Length frequency distribution



N. communis

Largest male, female, ovigerous female distributed at 300 m.

Female : Decreasing size with depth.

A. toyamaensis

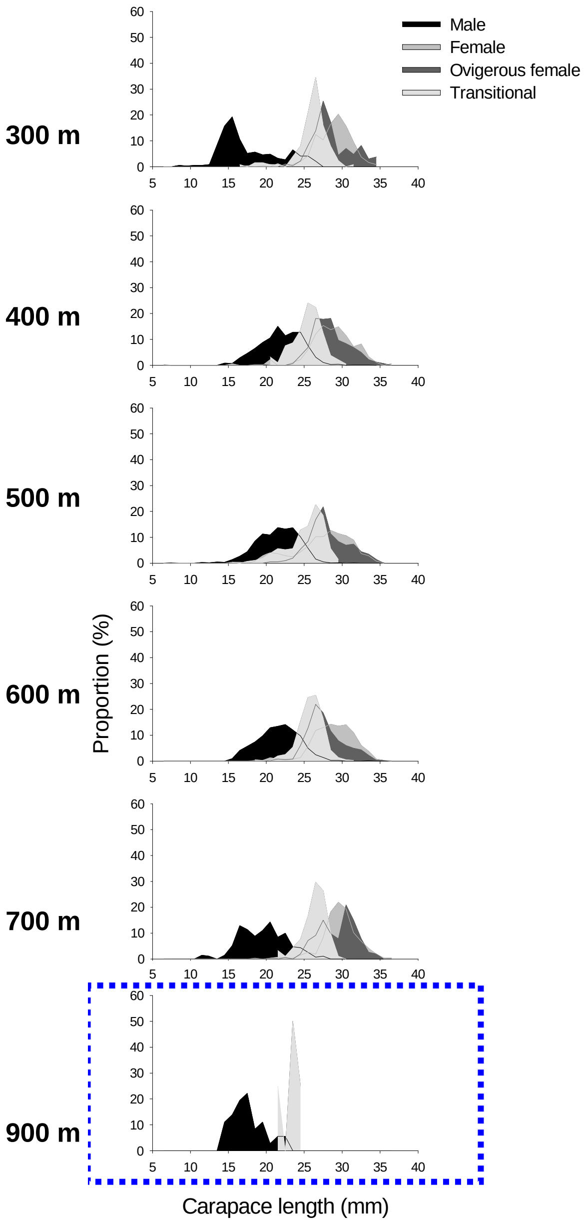
Male : Increasing size with depth.

Female, ovigerous female : Decreasing size with depth.

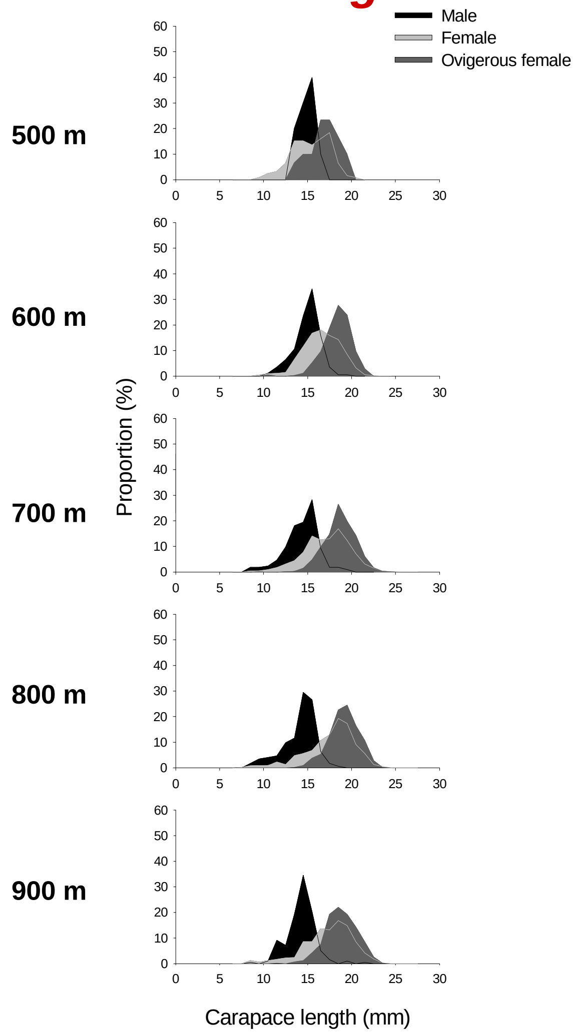
Results

Length frequency distribution

P. eous



E. biunguis



Small number of individuals were caught.

P. eous

Male : Decreasing size with depth

Largest individuals of transitional, female and ovigerous female → 700 m

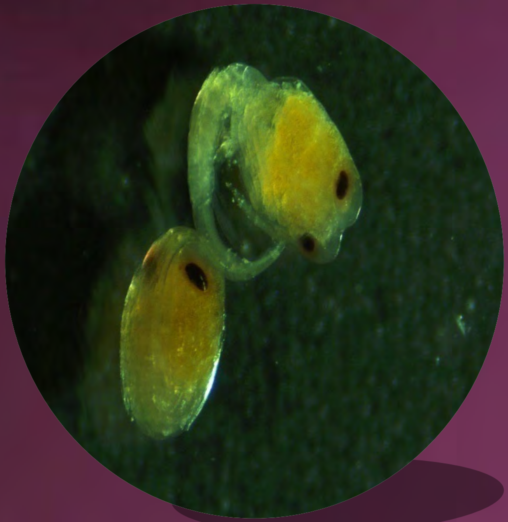
E. biunguis

Female, ovigerous female : Increasing size until 800m depth.

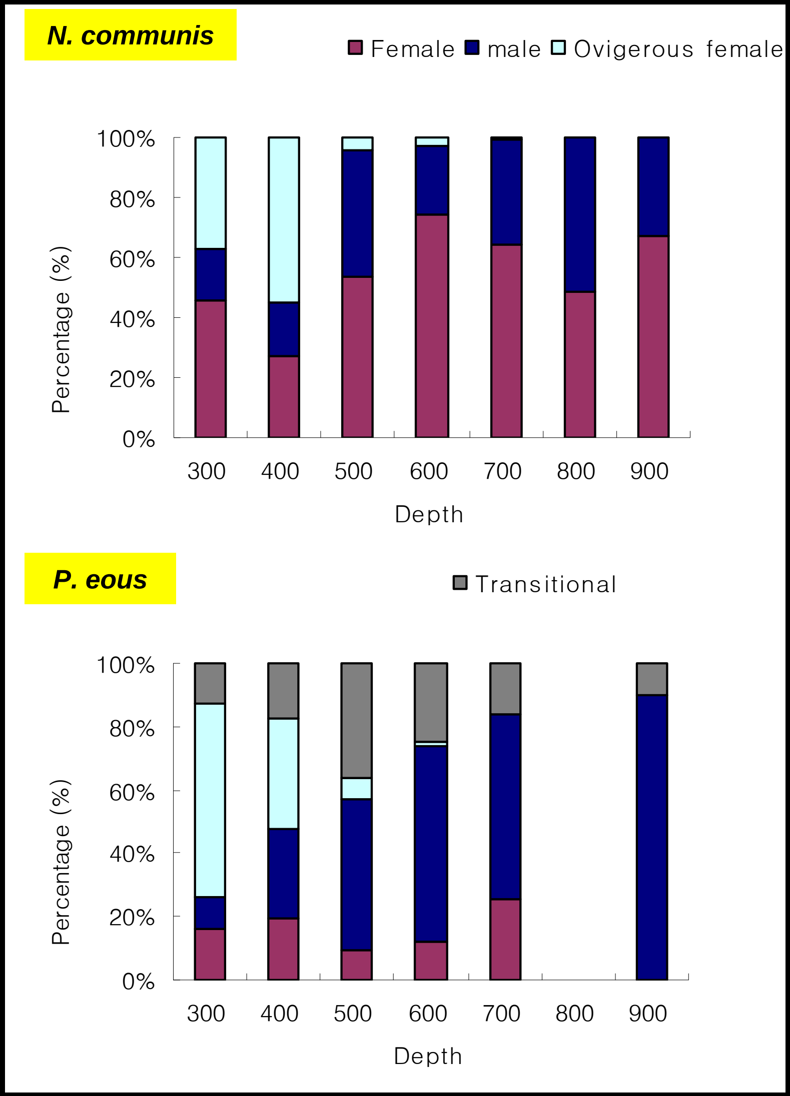
2. Results

3-2 Reproductive pattern

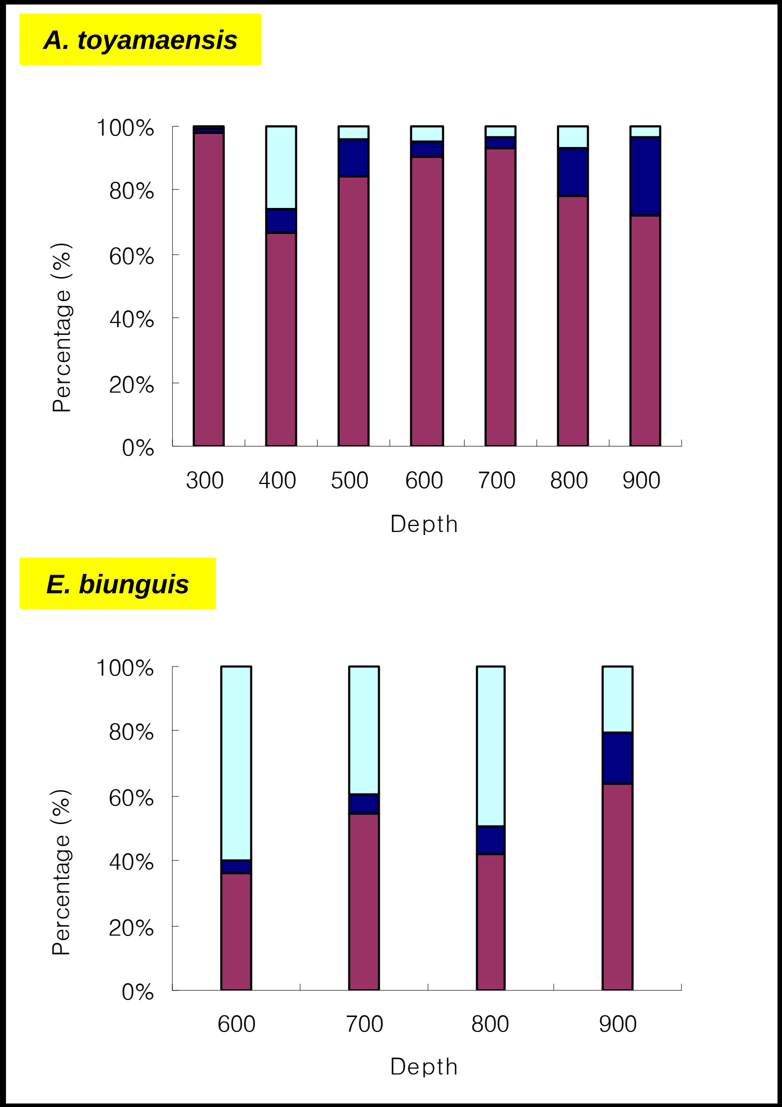
- Distribution in winter season
- Reproductive characteristics
- Egg size



Results **Distribution in winter season**



Shallow - dwelling species



Deep - dwelling species

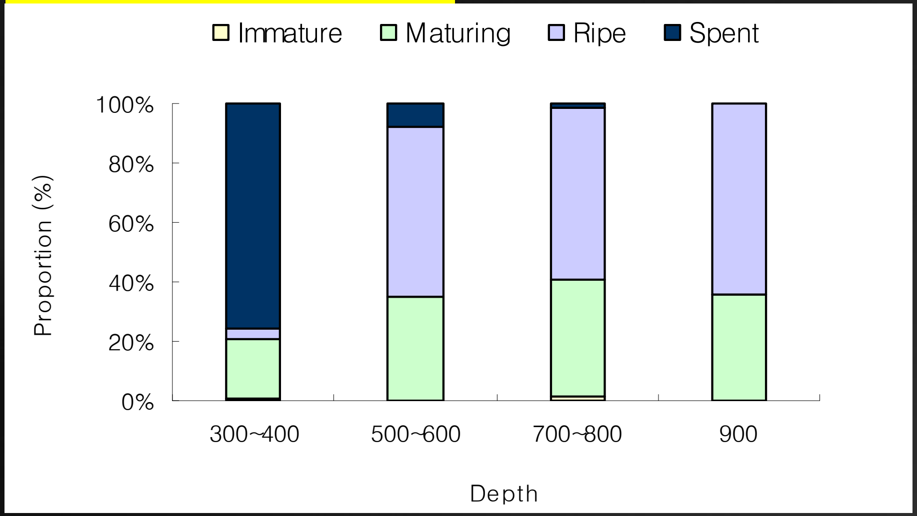
Ovigerous female mainly distributed at shallow water around 300 ~ 400 m depth.

Ovigerous female distributed from 300 m to 900 m depth (all depth range).

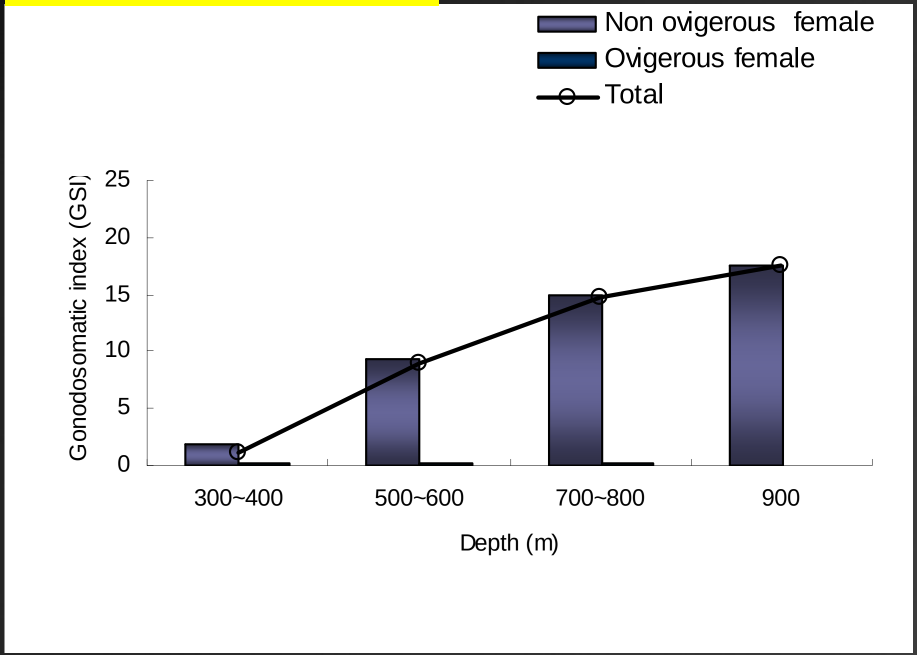
Results

Reproductive characteristics

Ovary stage



GSI



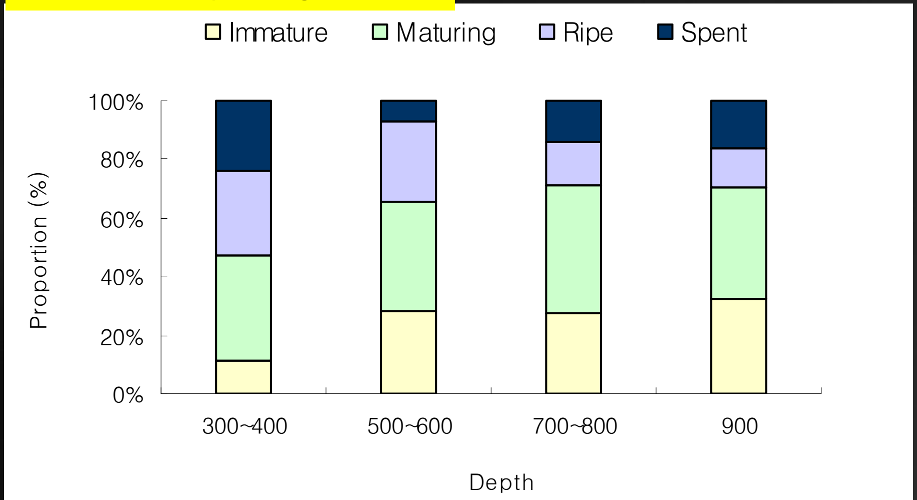
Femily Crangonidae - *N.communis*

1. **Females with spent stage ovaries distributed in shallow depth range (75.51 %), decreased with depth.**
2. **Females with ripe stage ovaries distributed at deepest depth.**
3. **Ovarian development and GSI significantly increased with depth.**
4. **The GSIs differed significantly with depth (K - W test, *P* < 0.05).**

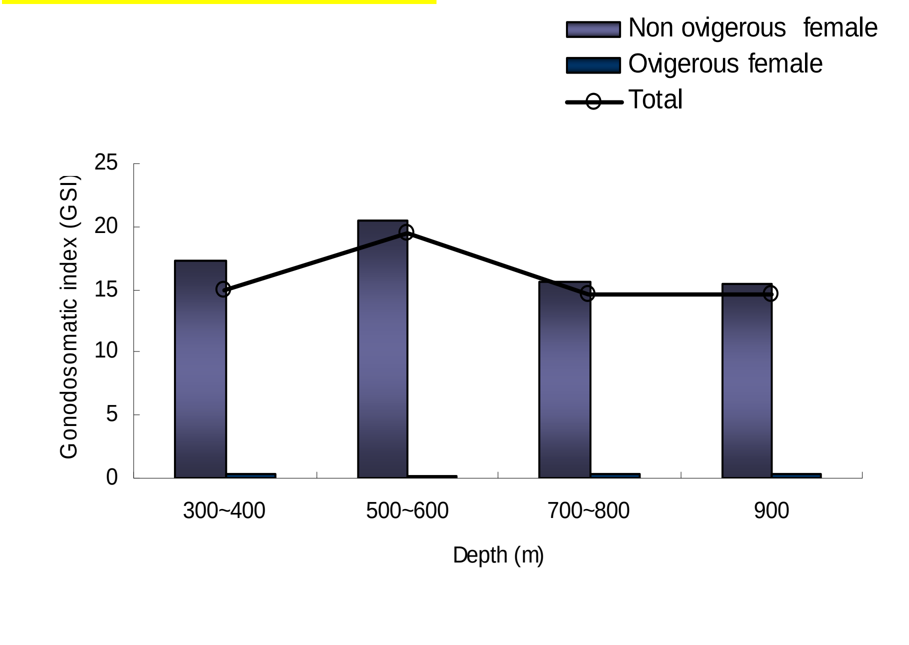
Results

Reproductive characteristics

Ovary stage



GSI

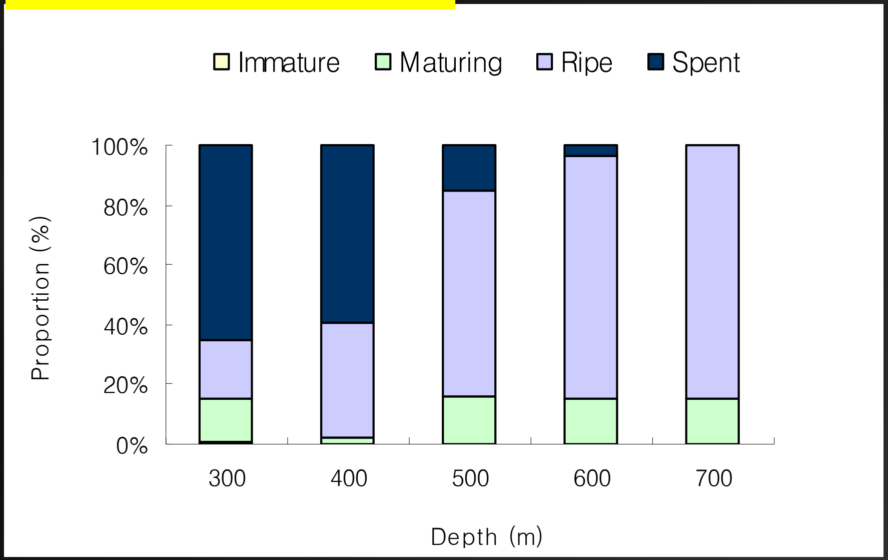


Femily Crangonidae - *A. toyamaensis*

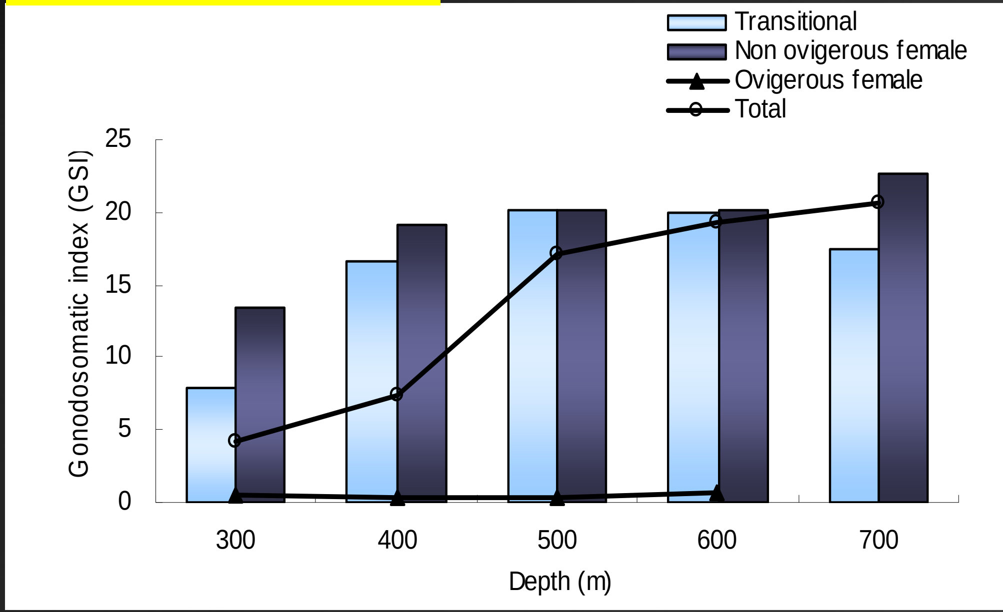
1. **Females with ripe stage ovaries uniformly distributed over all depth.**
2. **The GSIs were not significantly different with depth (K - W test, *P* > 0.05).**

Results **Reproductive characteristics**

Ovary stage



GSI



Femily Pandalidae - *P. eous*

1. **Decreased proportion of spent ovaries stage with depth implies that ovigerous females mainly distributed in shallow water.**

2. **Females with ripe stage ovaries and GSI increased with depth,** **immature female has rarely appeared.**

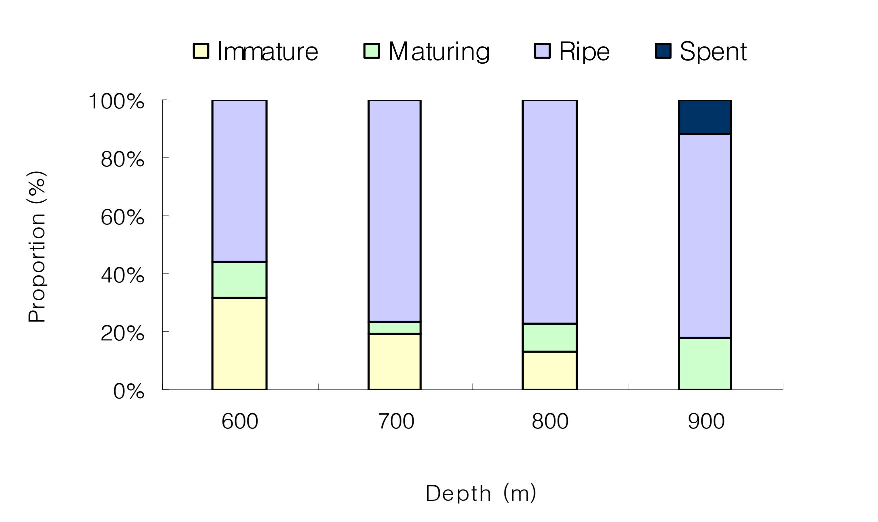
3. **The GSIs differed significantly with depth (K - W test, *P* < 0.05).**

Results

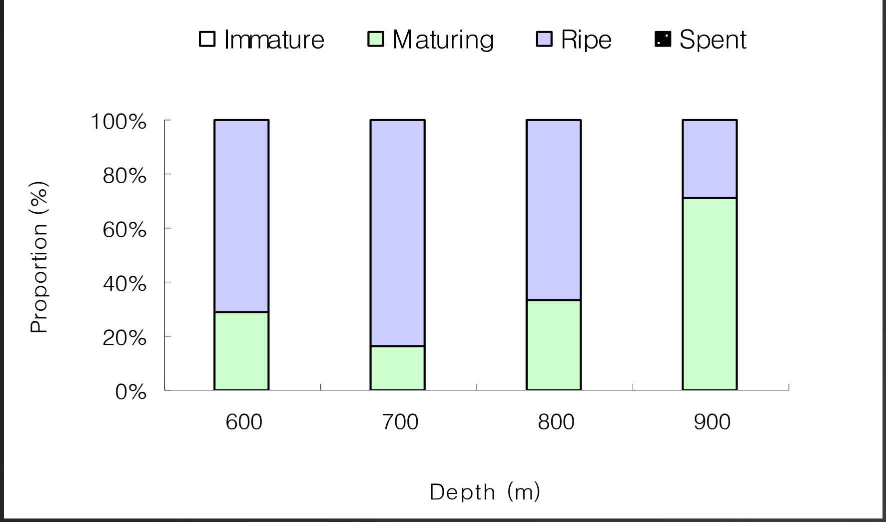
Reproductive characteristics

Ovary stage

<Non - ovigerous female>



<Ovigerous female>

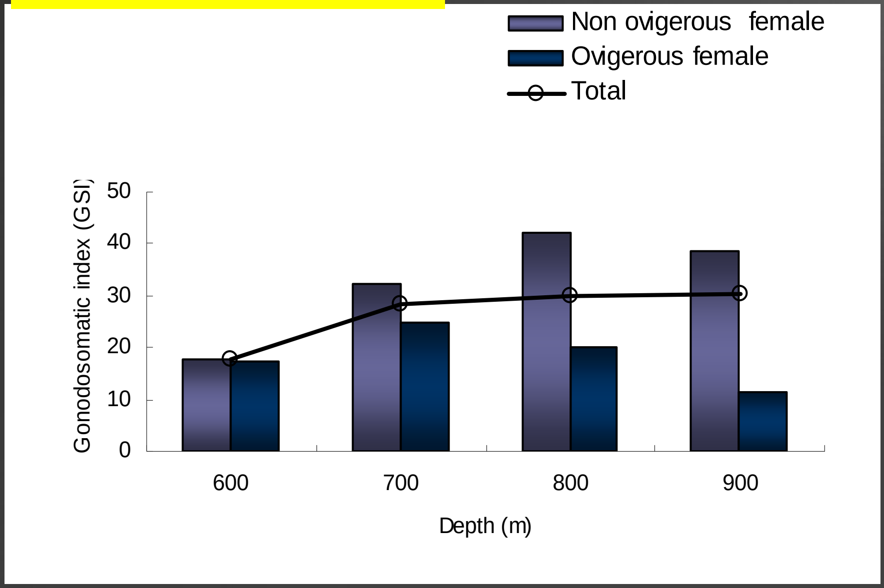


Femily Hippolytidae - *E. biunguis*

1. **Proportion of ovigerous female with ripe stage ovaries was highest at 700 m depth.**

2. **The GSIs differed significantly with depth (K - W test *P* < 0.05).**

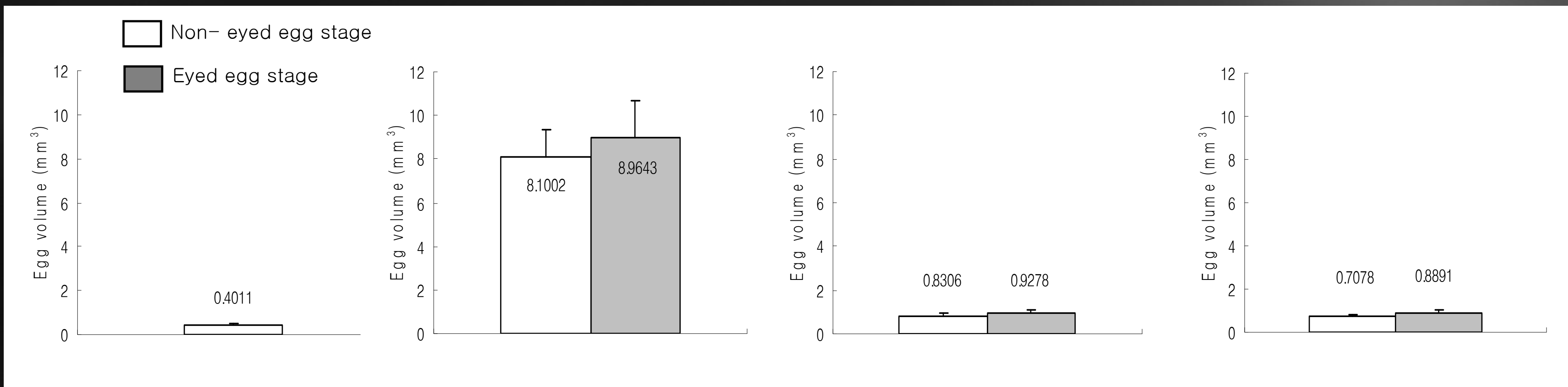
GSI



Results

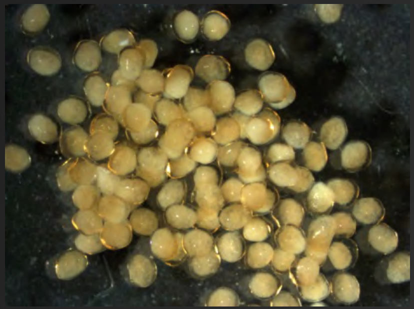
Egg size

Egg volume was significantly different between species (K - W test, $P < 0.001$).



Females with eyed egg stage did not appear during winter season

Non eyed stage : 0.4011 mm^3



Non eyed stage : 8.1002 mm^3
Eyed stage : 8.9643 mm^3

Non eyed stage : 0.8306 mm^3
Eyed stage : 0.9278 mm^3

Non eyed stage : 0.7078 mm^3
Eyed stage : 0.8891 mm^3

Discussion

Distribution

N. comminus

P. eous

Shallow-dwelling species

A. toyamaensis

E. biunguis

Deep-dwelling species

Internal factors

External factors

Distribution in <u>deep sea environment</u>

Segregation by depth

An adaptation that allows co-existence in deep water shrimps

Food resources are limited for species of similar morphology and trophic habitat

(Company and Sarda, 1997)

Discussion

Sex ratio by depth

Female dominant in all depth

Male dominant at 400 - 500 m depth

Politou(2008) confirmed the primordial role that <u>depth plays in the distribution of different life stage of deep-water shrimps.</u>

The average depth of distribution of *P. eous* increases with the advance of sexual stage (Maeda and Nishiuchi, 1999).

Size Segregation

Size segregation by depth in 4 species may have originated from the difference of either longevity or growth rate related to food conditions or physiological mechanism of growth (Ohtomi, 1997).

Discussion

Reproductive pattern in winter seasons

Shallow-dwelling species

N. Communis

P. eous

Ovigerous female and non-ovigerous female with spent ovaries stage distributed at shallow water depth.

❖**A number of species do show pre-hatching migration** (Hazlett, 1983).

❖**Vertical migration common to many species serve not only for feeding, and locating in the preferred environment for survival, but also for locating mates for breeding purposes** (Sastry, 1983).

Discussion

Reproductive pattern in winter seasons

A. toyamaensis

E. biunguis

Deep-dwelling species

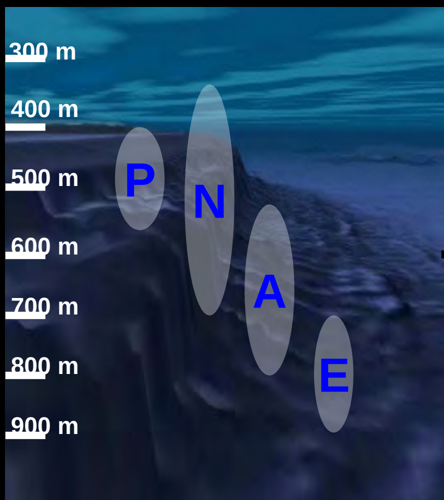
These two species did show that ovigerous females were widely distributed in all depth ranges.

❖**The decrease in larval survival probabilities with increasing depth is offset by laying larger eggs by shrimp species in deeper water and these risks of survival are reduced by the production of larger eggs in deeper water species** (King and Butler, 1985).

❖**Species with continuous brooding throughout a breeding season can maximize their egg production** (Oh and Hartnoll, 2004)

In conclusion

ZCM



Species	**Egg size** (Non eyed stage)	**Ovi CL** (mm)	
N. comminus	0.4011 mm^3	14.05~14.98	
			Shallow-dwelling species
A. toyamaensis	8.1002 mm^3	26.86~30.15	
			Deep-dwelling species

(The biology of crustacea vol.8, 1983)

❖**Our results showed that these four species have adapted different reproductive strategies by depth.**

❖**Under the deep water of the East Sea, Korea, optimal vertical distribution have close relationship with reproductive strategies for these four species related to survival efficiency.**

Thank you