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Distribution, abundance, and grazing impact of *Salpa fusiformis*, in relation to environmental conditions in Korean waters

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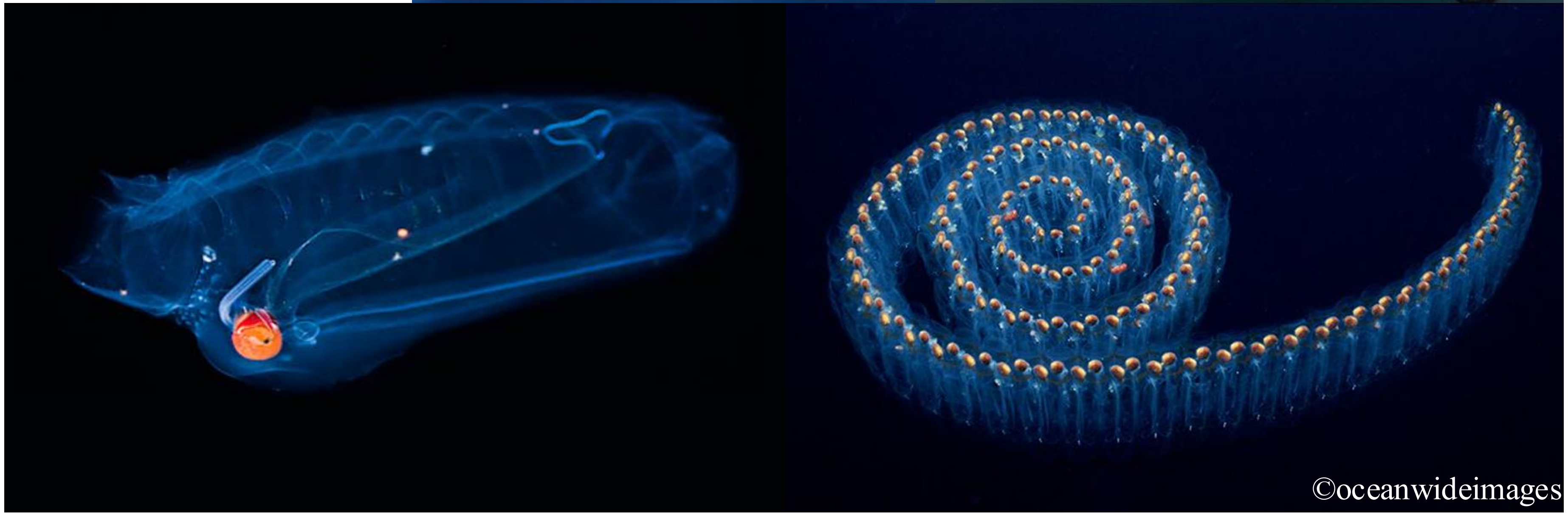
1.Background

Introduction

- Fast-growing pelagic tunicates
- Extremely high filtration rates
- Massive blooms in spring and summer
- Key players in carbon export
- Rapidly reshape plankton communities



- *S. fusiformis* blooms are increasing in Korean waters
- Transport linked to Kuroshio & Tsushima Warm Currents
- Favored by upwelling, freshwater inflow, and seasonal phytoplankton blooms

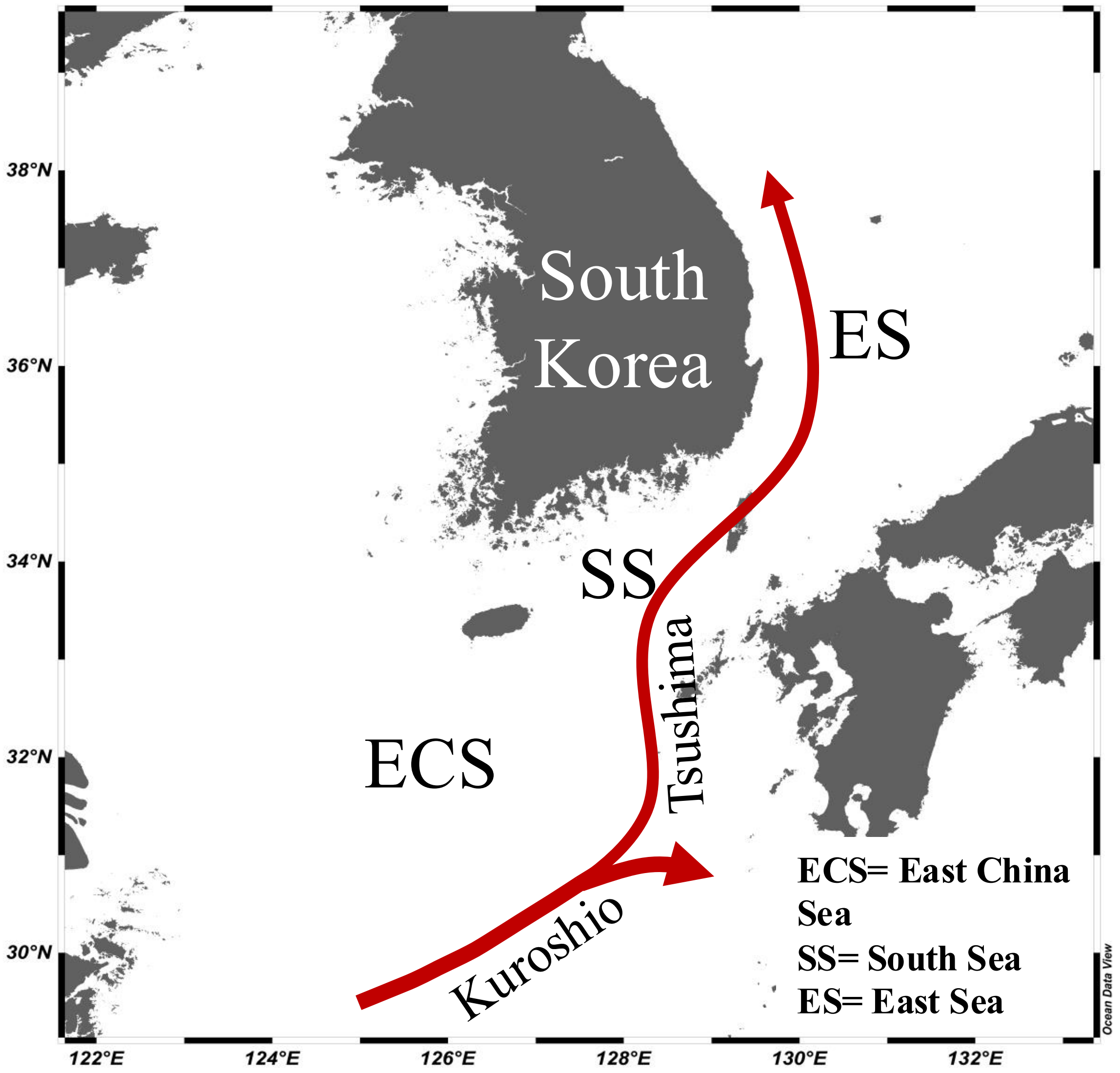


Fig: Water current transport *S. fusiformis* around Korea

What drives salp bloom dynamics?

?

- Environmental drivers still unclear
- Grazing impact and competition with copepods poorly quantified
- Patchy distribution patterns not well explained

Research Objectives

Research Objectives

1. **Assess spatial distribution and variability of *S. fusiformis* in Korean waters**
2. **Investigate environmental drivers (temperature, salinity, chlorophyll a) of salp blooms**
3. **Quantify grazing impact on primary producers and interactions with mesozooplankton**

2. Materials & Methods

- Sampling conducted across three regions around Korea.

- **East China Sea (ECS):** seasonal upwelling + Yangtze River influence.
- **East Sea (ES):** deep thermocline and nutrient-rich conditions due to Tsushima Warm Current.
- **South Sea (SS):** influenced by Kuroshio Current; high phytoplankton productivity.

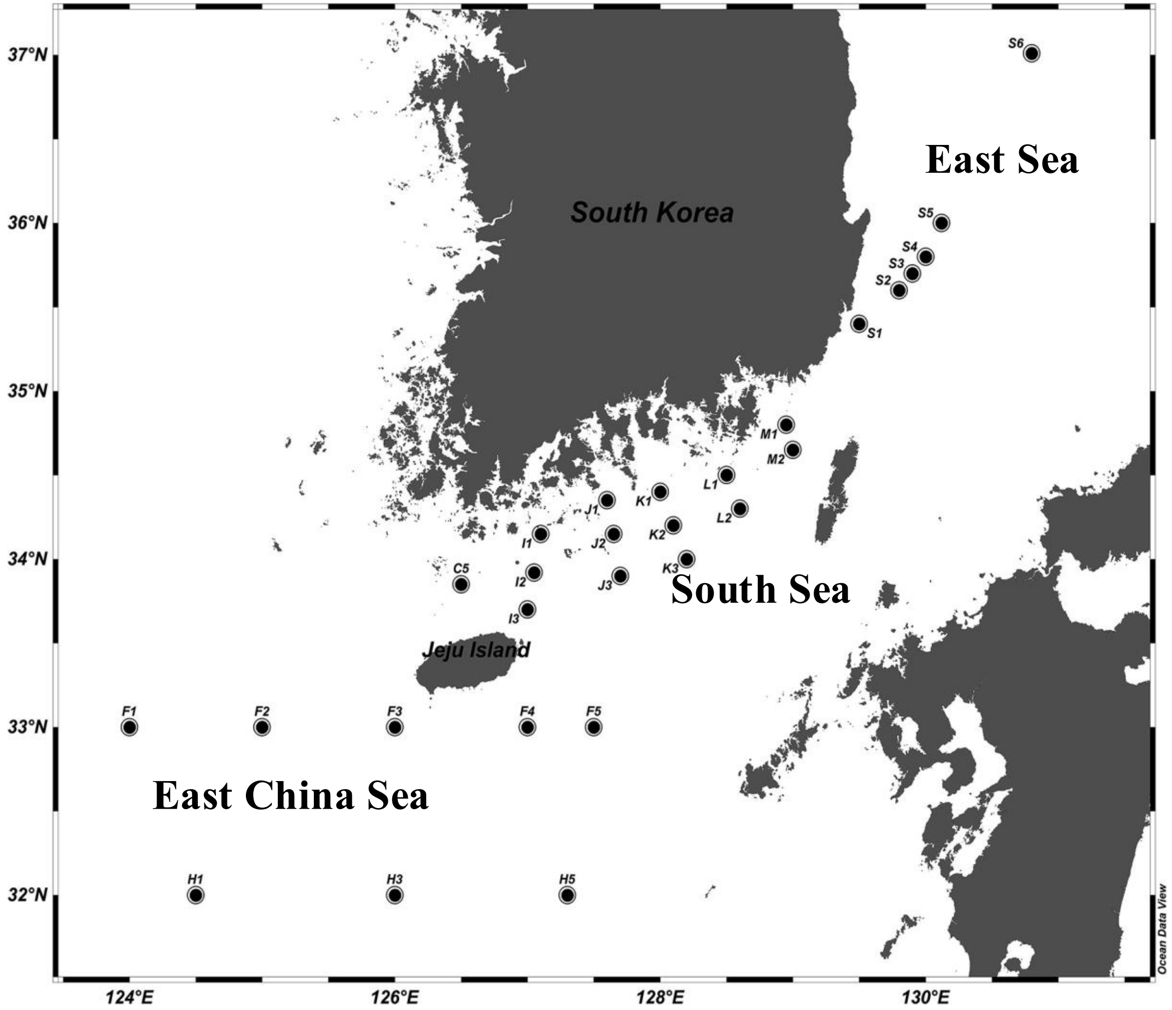


Fig. Sampling stations in the East China Sea, South Sea and East Sea.

Sample Collection & Preparation

- **Plankton net (200 µm)** used to collect salps & zooplankton.
- **CTD** used to measure temperature, salinity, and chlorophyll a.
- Salps collected and transferred to 20 L containers for feeding experiments.
- Gut pigment analysis to estimate ingestion rates.
- Statistical analyses to link salp abundance, environmental factors, and grazing rates.

Fig: *Salpa fusiformis* Collection

3. Results & Discussion

- **Temperature:** ECS>SS≥ES
- **Salinity**: ECS<SS≤ES
- **Chl *a*:** SS>ECS>ES
- Higher near coastal & upwelling areas (ECS, SS)

Regional patterns:

- **ECS:** Warmest, lowest salinity, low–moderate Chl-a
- **ES:** Moderate –low temp, high salinity, lowest Chl-a
- **SS:** Moderate temp, high salinity, highest Chl-a

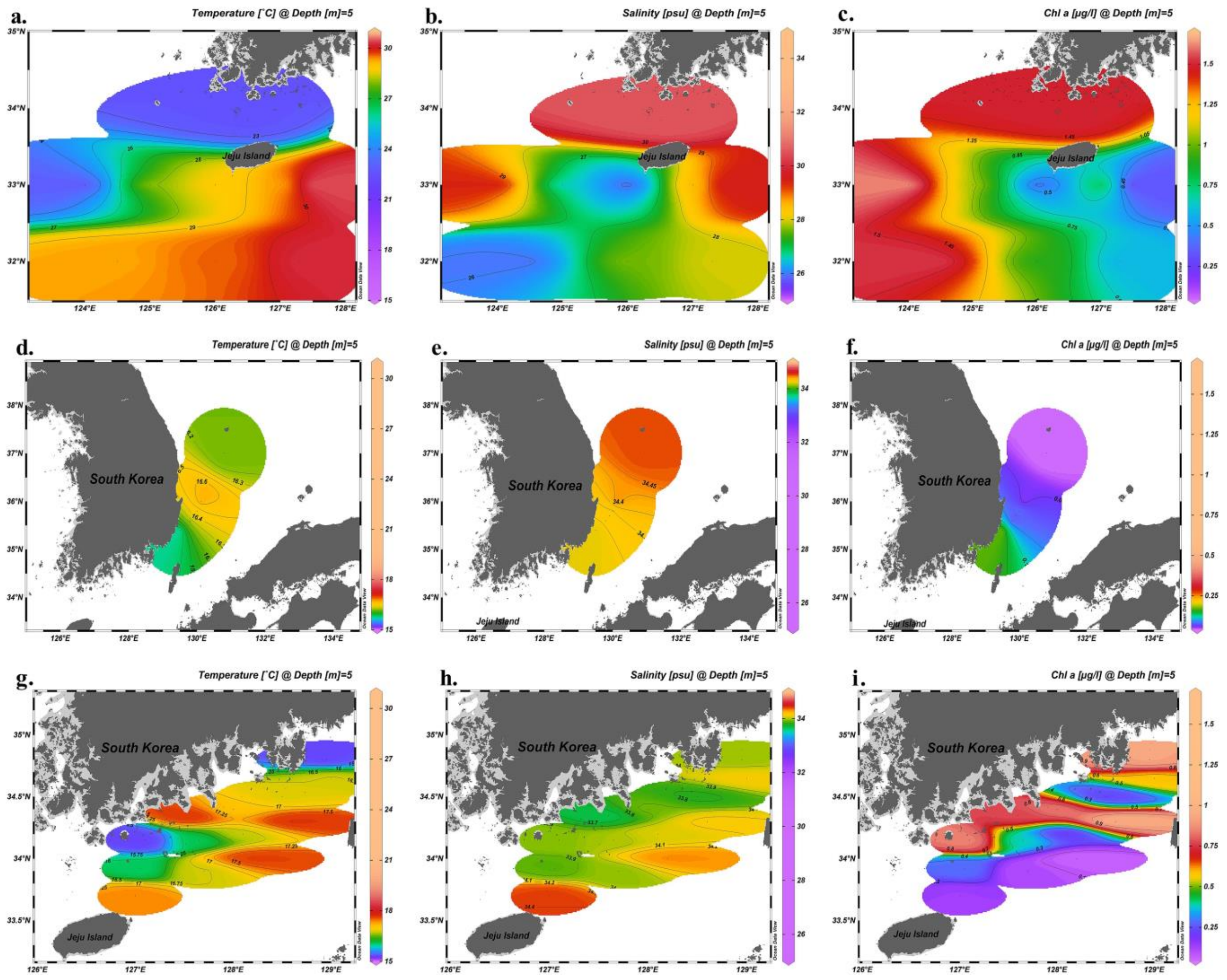


Fig: Surface temperature, salinity, and chlorophyll-a across study regions; ECS (a-c), ES (d-f), SS(g-i).

Hydrographic Conditions– Vertical Structure

Thermocline depth: ECS>ES>SS

ECS:

- Thermocline ~40–50 m
- Gradual temperature gradient
- Higher salinity

ES:

- Thermocline ~30 m
- Uniform salinity & Chl-a

SS:

- Thermocline ~20–30 m
- Warmer surface
- Higher salinity

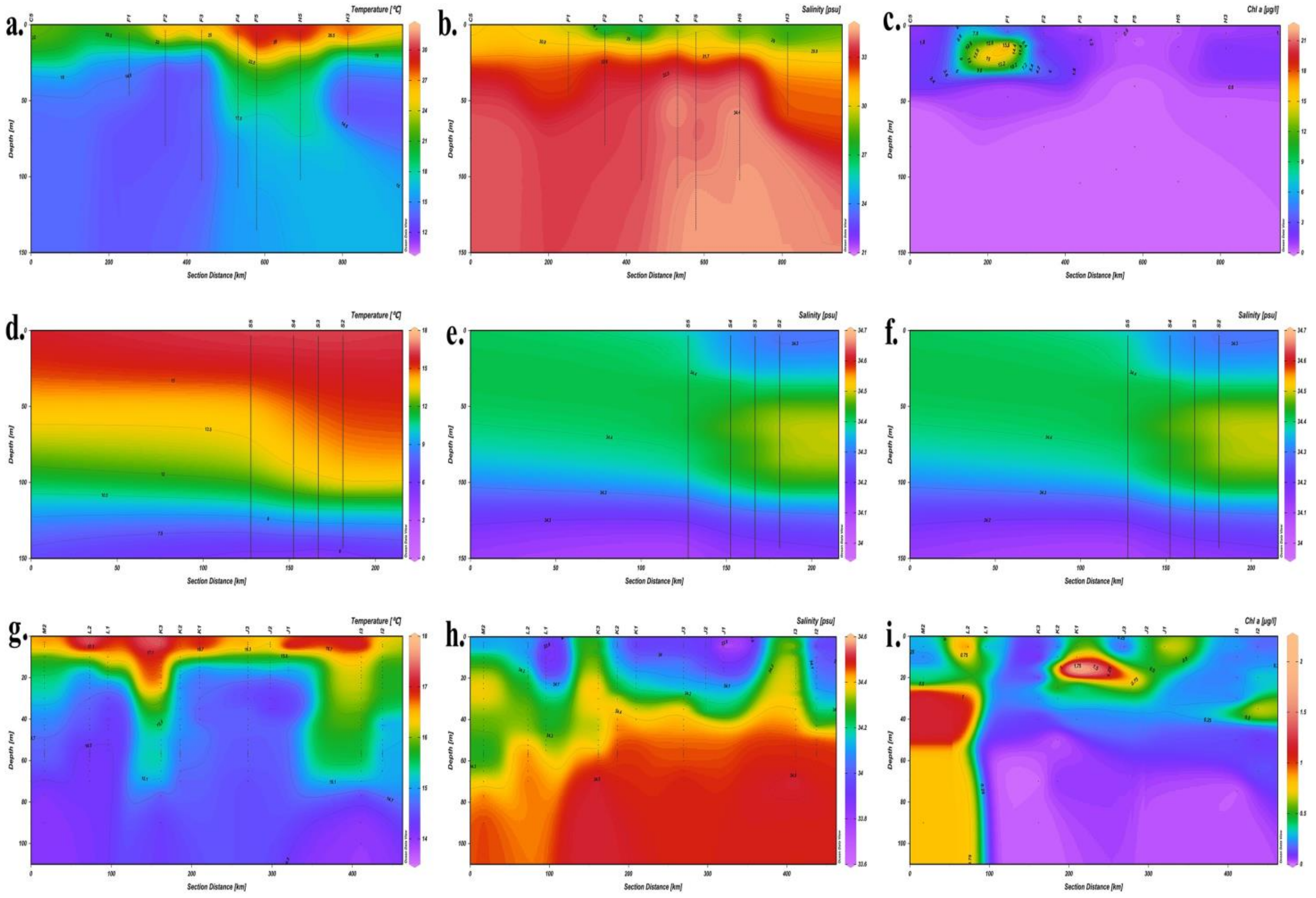


Fig. Vertical distribution of temperature (◦C), salinity (psu) and Chl a (µgL^{-1}) in the ECS (a-c), ES (d-f), and SS (g-i).

Salp Distribution & Abundance

- Significant spatial variation.
- **ECS:** up to ~550 ind. m^{-3} (largest bloom)
- **ES:** 0 - 161 ind. m^{-3} (moderate)
- **South Sea:** up to 124 ind. m^{-3} (lower)

Patterns:

- Highest abundance in warm, stratified waters
- Peaks at moderate Chl-a (<1.5 µg L^{-1})
- Negative relationship with copepod abundance.

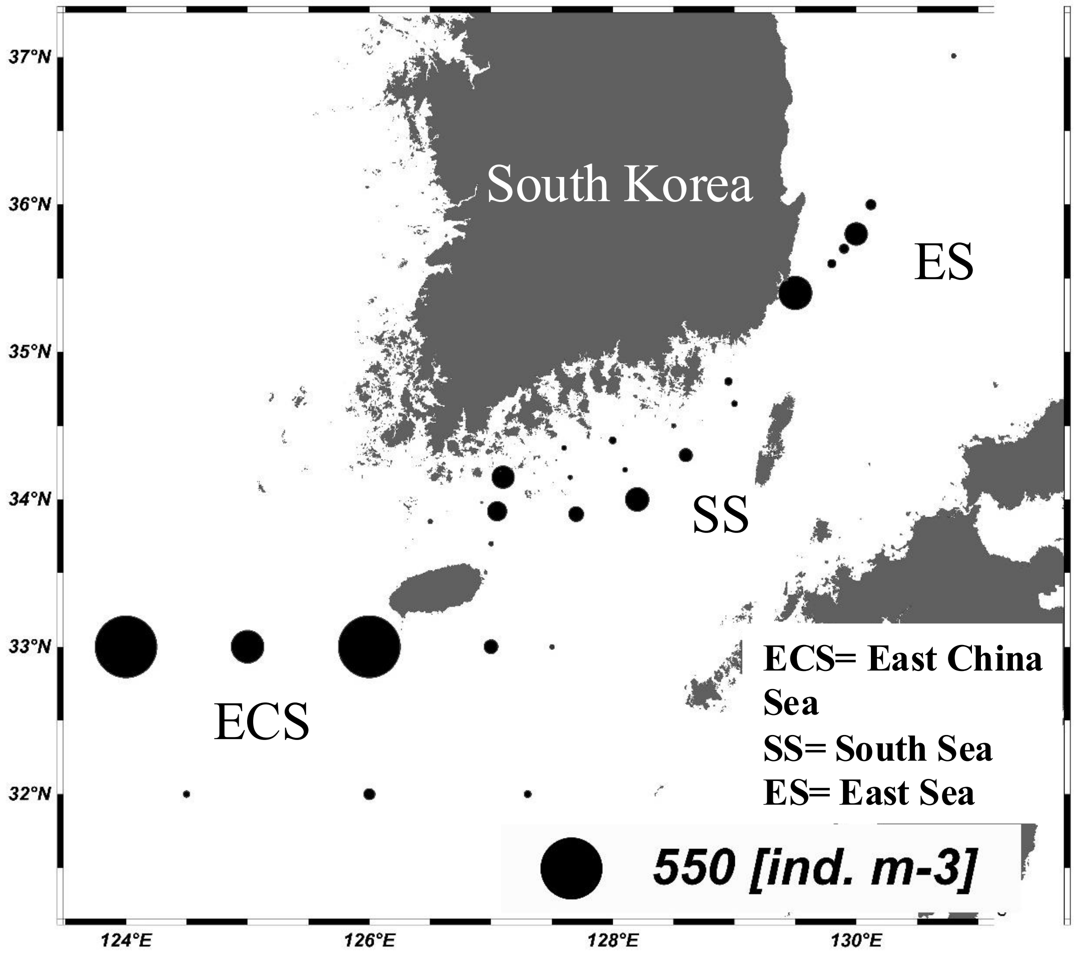


Fig: Salp Abundance in ECS, ES & SS

Salp Abundance & Chlorophyll *a*

- No simple linear correlation in the East China Sea and South Sea.
- **East Sea:** Positive salp–Chl *a* relationship
- **ECS:** High salp abundance → shallow thermocline → low & high Chl *a*
- Most salps occurred at Chl *a* <1 µg L^{-1}
- Occurrences rare above 1.5 µg L^{-1}

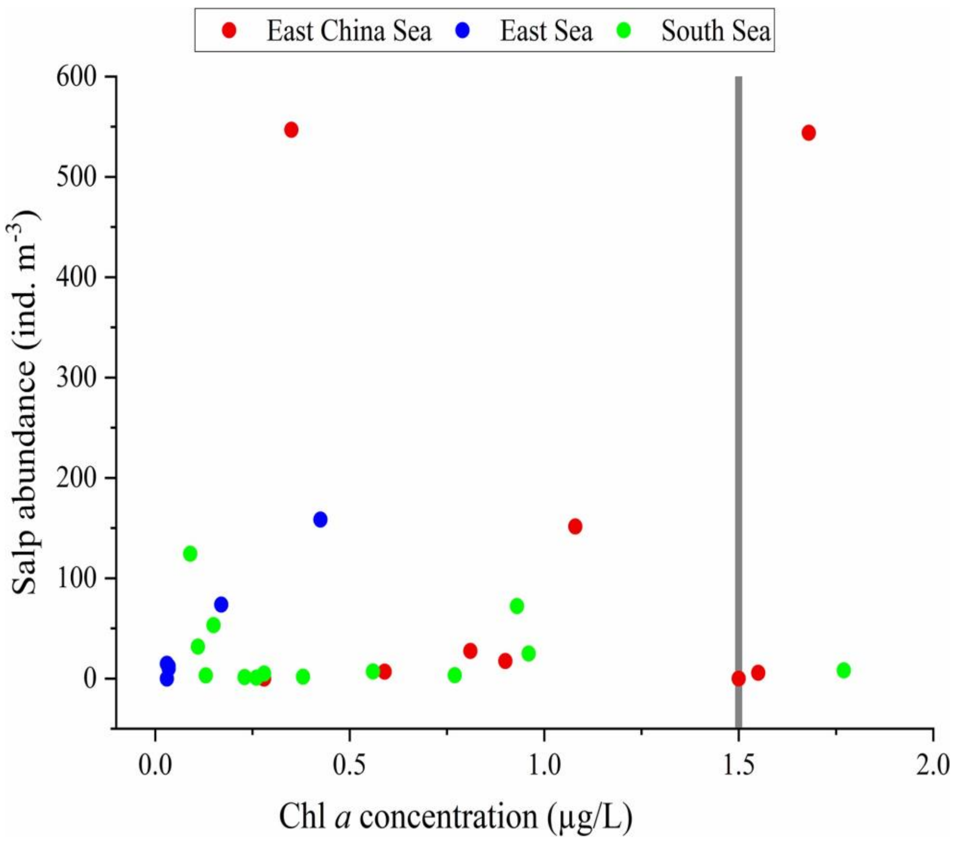


Fig. Scatter plot of salp abundance against surface chl *a* concentration in East China Sea, East Sea and South Sea.

Salp & Zooplankton Abundance Patterns

- Negative relationship between salps and copepods across regions.
- Copepod abundance reduced by ~50% in areas with high salp density (ECS).
- Similar negative trend observed with other mesozooplankton groups.

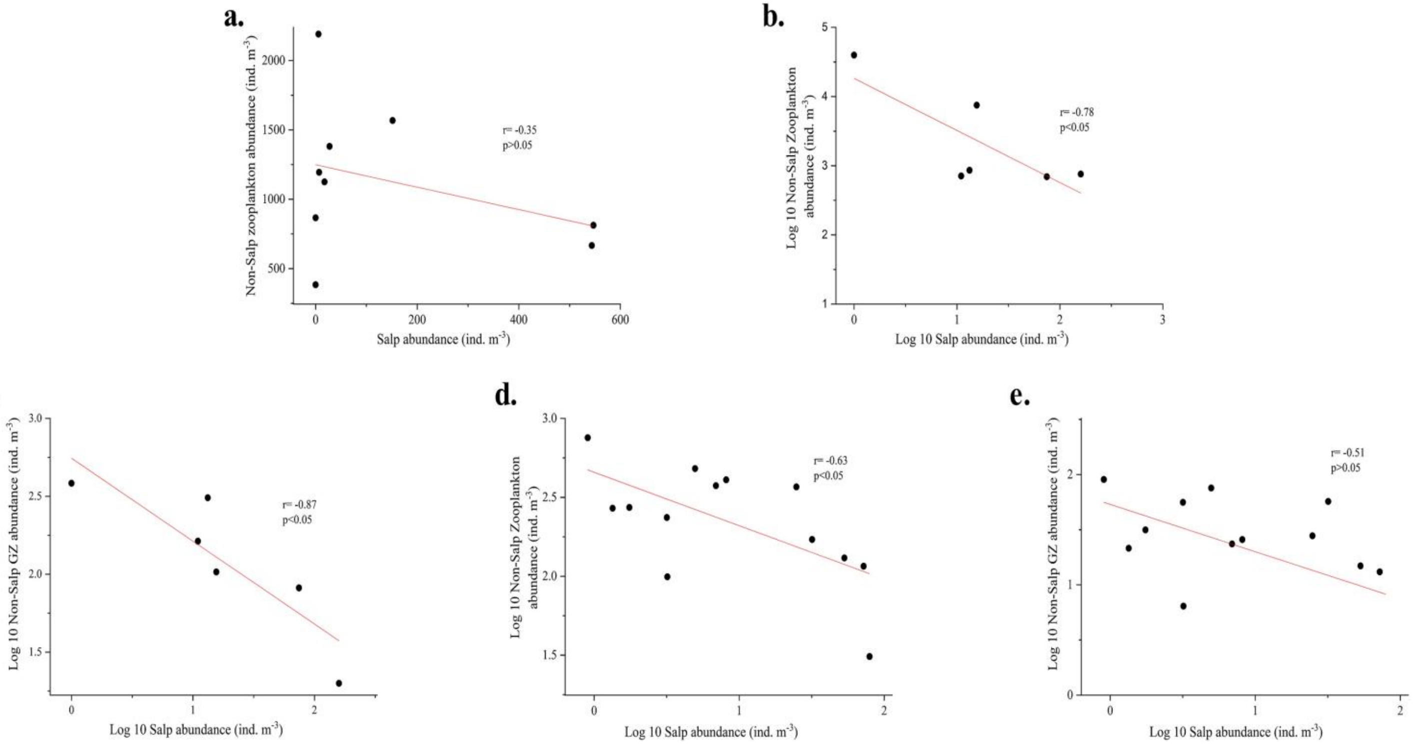


Fig. Relationships between the abundance of *Salpa fusiformis* with non-salp mesozooplankton, gelatinous zooplankton abundance in the East China Sea (a), East Sea (b, c) and South Sea (d, e).

- Elevated picoplankton biomass observed south of Jeju Island
- Salp hotspots co-occur with picoplankton-rich waters
- Suggests favorable feeding conditions for salps

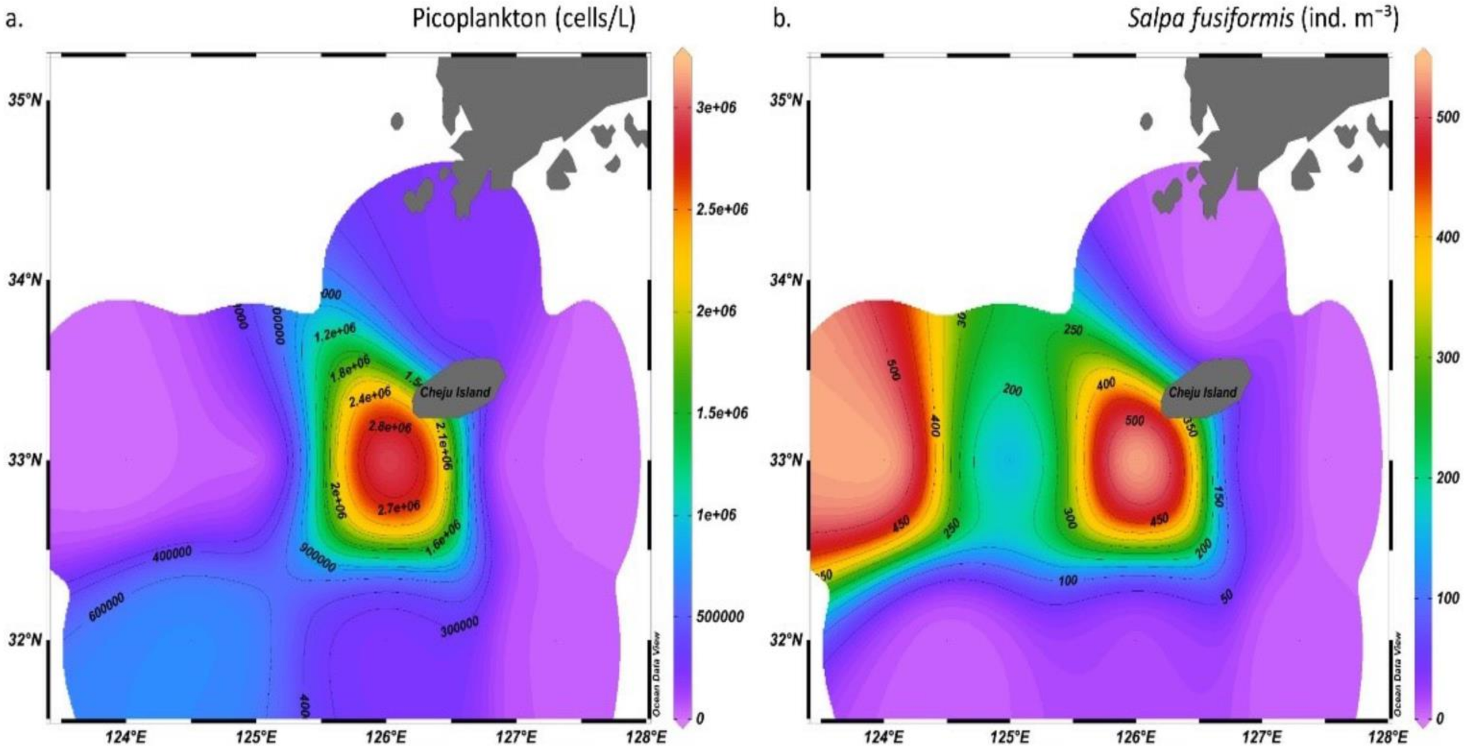


Fig. Abundance of picoplankton (a) and *Salpa fusiformis* (b) in the East China Sea.

- Mean salp size: ~22 mm.

Clearance rate estimation:

- Chl *a* depletion method: 0.7–2.1 L ind.$^{-1}$ h^{-1}
- Particle count method: 2.2–3.1 L ind.$^{-1}$ h^{-1}

Gut pigment content (fluorescence):

- 0.09 – 3.9 μg Chl *a* salp^{-1}.
- Strong positive relationship with salp size

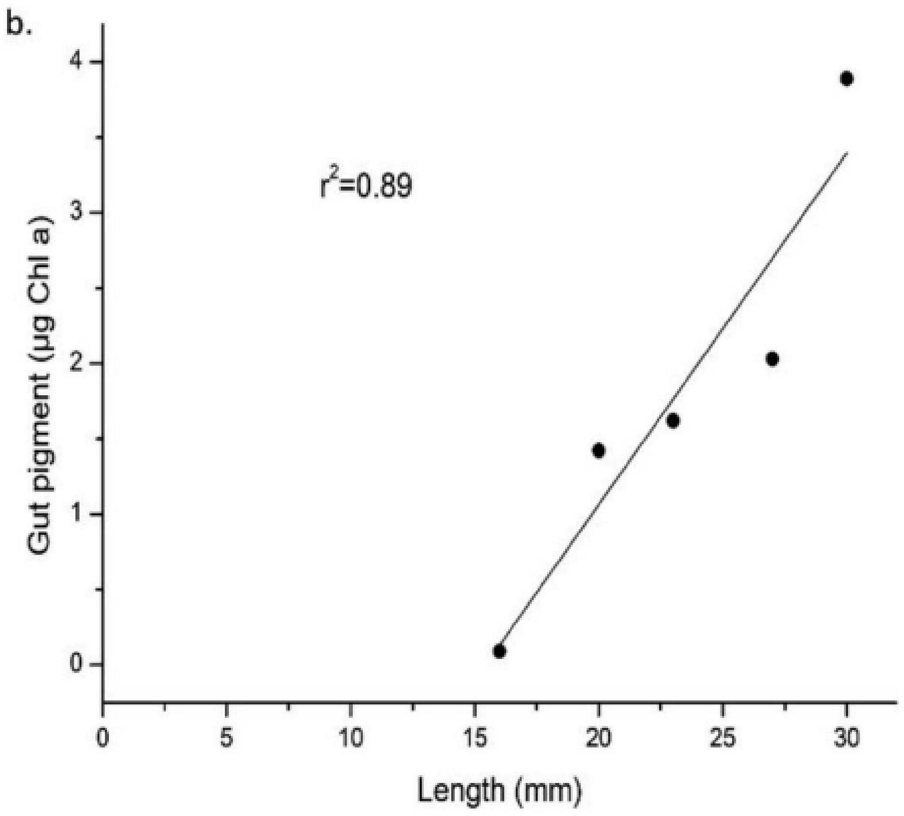


Fig. Relationship between salp body length and gut pigment content (μg Chl *a* salp^{-1})

Salp Ingestion Rates & Grazing Impact (GI)

Pigment ingestion:

- Mean: ~5.3 μg Chl *a* d^{-1} $salp^{-1}$
- Range: 1.3 – 12 μg Chl *a* d^{-1} $salp^{-1}$.
- Ingestion rate increases with salp size (volume & length).

Grazing Impact (GI)

- Individual grazing rate: ~15.7 μg Chl *a* h^{-1}
- GI on primary production: 0.06 – 69% d^{-1} (avg~ 33% PP d^{-1}).
- GI on Chl *a*: up to 76% Chl *a* d^{-1} (avg~ 20%).

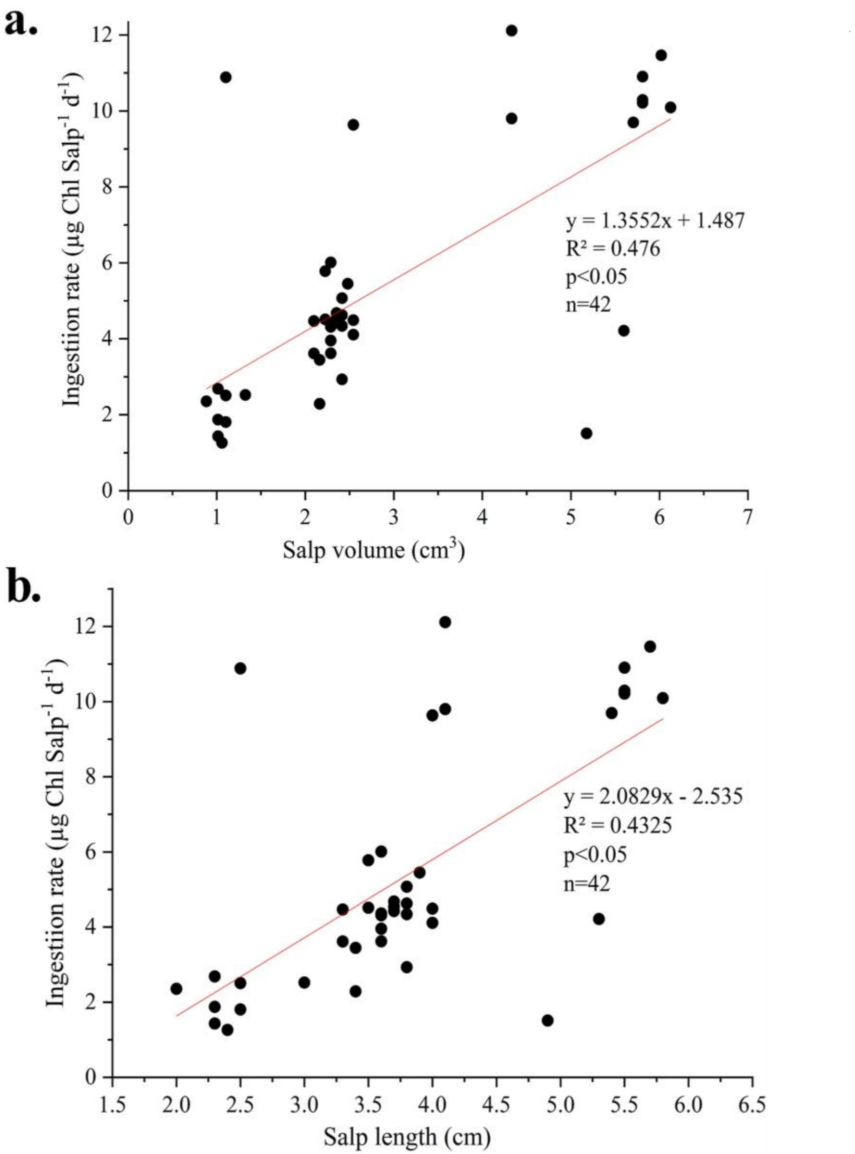


Fig. Relationship between Chl *a* ingestion rate with Salp volume (cm^3) (**a**) and Salp length (**b**).

4. Summary

Summary

Salp blooms associated with:

- Upwelling & warm currents
- Shallow thermocline, and
- Moderate phytoplankton biomass.

Salps vs mesozooplankton:

- Strong negative relationship
- Indicates grazing pressure & food competition

High filtration & ingestion rates:

- Efficient consumption of picoplankton
- Reduced phytoplankton biomass

Summary

Grazing impact:

- Up to ~69% of daily primary production
- Major influence on plankton dynamics
- Potential role in carbon export

Future directions:

- Assess the role of climate warming & current systems
- Long-term monitoring
- Further experimental studies.

Thank you!