Life cycle characteristics of the neon flying squid associated with oceanographic regime in the North Pacific

T. Ichii, K. Mahapatra, M. Sakai & D. Inagake
Migration of neon flying squid (Yatsu et al. 1998)

1. Why the autumn cohort is rare in the western North Pacific?

2. Why growth pattern is different between the two cohorts?

3. Where are males of the autumn cohort gone?

Mysteries

Migration of neon flying squid (Yatsu et al. 1998)
Materials

Research driftnet data
Murata & Hayase (1993)
Ichii et al. (2004)

Paralarvae survey data
Ichii et al. (2004)

Oceanographic data
Chl-a: SeaWiFS data, SST: AVHRR Pathfinder data
Climatological temperature, salinity and current data: (e.g. http://podaac.jpl.nasa.gov )

Growth of the neon flying squid
Chen & Chiu (2003), Murata & Hayase (1993)
Migration of neon flying squid (Yatsu et al. 1998)

Winter–spring cohort

Autumn cohort

Winter-spring cohort

Feeding ground

Spawning ground

Study area

Migration of neon flying squid  (Yatsu et al. 1998)
Oceanographic environment in winter

- Unfavorable cold SST (<10°C)
- Optimum spawning SST (21-25°C)
- Transitional Domain (7-10°C at 100m)
- Subtropical Frontal Zone (salinity 34.6-35.2 at 0m)
Monthly change in oceanographic environment

- **Unfavorable cold SST (<10°C)**
- **Optimum spawning SST (21-25°C)**
- **Transitional Domain (7-10°C at 100m)**
- **Subtropical Frontal Zone (salinity 34.6-35.2 at 0m)**
In Autumn the optimum spawning SST coincides with Subtropical Frontal Zone in central and eastern NP.
Monthly location of Transition Zone Chlorophyll Front
Monthly location of optimum spawning SST in relation to current

Unfavorable cold SST (<10°C)
Optimum spawning SST (21-25 °C)
In Autumn the optimum spawning SST coincides with the Kuroshio current in western North Pacific. Why the autumn cohort is rare in western North Pacific?

→ Because of Kuroshio current

Unfavorable spawning environment

Unfavorable cold SST (<10°C )
Optimum spawning SST (21-25 °C)

In Autumn the optimum spawning SST coincides with the Kuroshio current in western North Pacific.
Oceanographic summary

North Pacific Oceanographic scheme

Unfavorable cold SST

Optimum spawning SST

Kuroshio current

Subtropical Frontal Zone

Autumn spawning ground

Subtropical Domain

Winter-spring spawning ground

Transitional Domain

TZCF (chl-a front)
Seasonal meridional movements of oceanographic features averaged over the region bounded by 170°E - 150°W
Female migration in relation to oceanographic environment

Autumn cohort
Female migration in relation to oceanographic environment

Autumn cohort
Female migration in relation to oceanographic environment

Autumn cohort
Female migration in relation to oceanographic environment

**Autumn cohort**

**Winter-spring cohort**
Female migration in relation to oceanographic environment

**Autumn cohort**

**Winter-spring cohort**
2. Why growth pattern is different between the two cohorts?

- The autumn cohort utilizes food rich area in spawning ground and northward migration whereas the winter-spring cohort does so in southward migration.
3. Where are males of the autumn cohort gone?
Male migration in relation to oceanographic environment

Winter-spring cohort
### Male migration in relation to oceanographic environment

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**Optimum spawning SST**

**High chl-a area**

**Unfavorable cold SST**

**Transitional Domain**

**Subtropical Frontal Zone**

**Winter-spring cohort (L)**

**Winter-spring cohort (SS)**

**Autumn cohort (LL)**

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**Spawning Observation data**

- **25cm ML**
- **Observation data**

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**Month**

- **Latitude (°N)**
- **Optimum spawning SST**
- **Unfavorable cold SST**
- **Transitional Domain**
- **Subtropical Frontal Zone**
- **Winter-spring cohort (L)**
- **Winter-spring cohort (SS)**
3. Where are males of the autumn cohort gone?

They grow faster to size at maturity, leading to a very short migration.
Summary

North Pacific Oceanographic scheme

- Rare occurrence of autumn cohort in western NP
- Difference in growth pattern between the two cohorts
- Short migration of males of the autumn cohort
- Optimum spawning SST
- SST (sea surface temperature)
- Subtropical Frontal Zone
  - Autumn spawning ground
  - Winter-spring spawning ground
- Kuroshio current
- TZCF (chlorophyll-a front)

Transitional Domain
Lower stock level of the autumn cohort during 1999-2002 (Ichii et al. 2006)

Reduced primary production in STFZ during 1999 – 2002 (Bograd et al. 2004)
Interannual variations in stock level (research driftnet CPUE) of the autumn cohort
Comparisons in high chl-a area and SST between two regimes
Comparisons in high chl-a area and SST between two regimes

**Productive STFZ regime (pre-1999)**

- Unfavorable cold SST
- High chl-a area
- Optimum spawning SST
- Subtropical Frontal Zone
- Transition Domain

**Less productive STFZ regime (1999-2002)**

- Extent of autumn spawning ground
Comparisons in high chl-a area and SST between two regimes

Productive STFZ regime (pre-1999)

Less productive STFZ regime (1999-2002)
Comparisons in high chl-a area and SST between two regimes:

**Productive STFZ regime (pre-1999)**

**Less productive STFZ regime (1999-2002)**

- **Extensive autumn spawning ground**
- **Extent of productive autumn spawning ground**
Comparisons in high chl-a area and SST between two regimes
Comparisons in high chl-a area and SST between two regimes

Productive STFZ regime (pre-1999)

- Favorable cold SST
- High chl-a area
- Optimum spawning SST
- Subtropical Frontal Zone
- Transition Domain

Less productive STFZ regime (1999-2002)

- Favorable cold SST
- High chl-a area
- Optimum spawning SST
- Subtropical Frontal Zone
- Transition Domain

→ Lower stock level of the autumn cohort

Extent of productive autumn spawning ground
Interannual variations in TZCF position could have important implications for stock level of the autumn cohort.