Distribution and life cycle patterns of the squids *Gonatopsis octopedatus* and *Gonatopsis japonicus* (Cephalopoda: Gonatidae) in the northwestern Pacific Ocean.

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Squids of the family Gonatidae inhabiting the northwestern Pacific Ocean and its marginal seas

**Gonatidae (12)**

**Berryteuthis (2)**
- B. magister
- B. anonychus

**Gonatopsis (4)**
- G. borealis
- **G. octopedatus**
- **G. japonicus**
- Gonatopsis sp. cf. makko

**Gonatus (6)**
- G. madokai
- G. kamtschaticus
- G. berryi
- G. onyx
- G. pyros
- G. tinro

*7 teeth in a radula*

*5 teeth in a radula*
External characters of the squids

*Gonatopsis japonicus* и *Gonatopsis octopedatus*

- **Gonatopsis japonicus**
  - Mantle length 40-60 cm
  - Fin sagittate, with long posterior “tail”
  - Tetraserial armature along the entire length of the arms

- **Gonatopsis octopedatus**
  - Mantle length 12-16 см
  - Fin round, without long posterior “tail”
  - Arm tips with numerous tiny suckers
Major Goal
To reveal specific traits in distribution, biology and life cycle patterns of two gonatid squids *Gonatopsis octopedatus* and *G.japonicus* in the Okhotsk Sea and adjacent Pacific Ocean in order to evaluate the position of these species in pelagic ecosystems

Objectives:
1) to analyze database collected in TINRO-Centre research cruises;
2) to look at the spatial distribution of squids (by months, depths and ontogenetic stages);
3) to reveal the size structure of squid catches (by months);
4) to look at biological characters of squids (maturity, feeding);
5) to suggest hypothetical schemes of squid life cycles
<table>
<thead>
<tr>
<th>Species</th>
<th>Cruises</th>
<th>Stations</th>
<th>Catch (N)</th>
<th>Analysis (N)</th>
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<tbody>
<tr>
<td><em>G. octopedatus</em></td>
<td>25</td>
<td>264</td>
<td>4749</td>
<td>1086</td>
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<tr>
<td><em>G. japonicus</em></td>
<td>29</td>
<td>264</td>
<td>1790</td>
<td>697</td>
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<td><strong>Total</strong></td>
<td><strong>37</strong></td>
<td><strong>549</strong></td>
<td><strong>6539</strong></td>
<td><strong>1783</strong></td>
</tr>
</tbody>
</table>
Gonatopsis octopedatus

Distribution in all seasons and depths (individuals per square km)

Deep-water part
(> 500 м)

1-10
11-100
> 100
**Gonatopsis octopedatus**

Distribution of juveniles and adults

- **Juveniles (DML<70 mm)**: More or less evenly over deep-water areas
- **Adults (DML>70 mm)**: Patchily over deep-water areas
**Gonatopsis octopedatus**

*Epipelagic zone*

**Juveniles (DML<70 mm)**
0-200 m

- Very abundant; in the south

**Adults (DML>70 mm)**
0-200 m

- Rare
Gonatopsis octopedatus

Upper mesopelagic zone

Juveniles (DML<70 mm)
200-500 m
In the center

Adults (DML>70 mm)
200-500 m
More common; on the slope and in the south
Gonatopsis octopedatus
Lower meso- and bathypelagic zones

Juveniles (DML<70 mm)
>500 m
Rare; in the south

Adults (DML>70 mm)
>500 m
More frequent; on the slope and in the south
Gonatopsis octopedatus
Seasonal Vertical distribution

(1) **Spring** rare and even across depth range 0-500 m
(2) **Summer** two peaks (at 0-200 m and 500-1000 m)
(3) **Autumn** descend from epi- to meso- and bathypelagic zones
(4) **Winter** mainly in the upper mesopelagic zone
1) Three size groups in both areas; 2) Females mature at larger size
Gonatopsis octopedatus

Monthly changes in size structure in the Okhotsk Sea

1) Mature animals occur in the late summer-autumn and winter
2) Early juveniles occur in the same seasons
3) Two generations could be traced from succession of modal classes

No time for embryonic development, or long-term embryonic development !!!
**Gonatopsis octopedatus**

Hypothetical scheme of the species life cycle in the Okhotsk Sea

1) Juveniles occur through summer, suggesting that paralarvae appear during spring-summer.
2) They grow and start ontogenetic descend at about 70 mm DML in autumn.
3) Squid mature in deep layers (on the slope and over great depths), where they mate in winter-spring.

After mating male dies, while female begins brooding fertilized eggs in an egg-mass between her arms;
Large eggs suggest long-term embryonic development at low temperatures in deep water, during approximately 1 year-long period
Life cycle: embryonic (1 year), postembryonic (1 year), brooding by females (1 year)
Gonatopsis japonicus
All depths and seasons

Deep-water part >500 m
Gonatopsis japonicus

Juveniles and adults are distributed mainly over deep-sea areas. Similar patterns; adults are more abundant and occur over larger area.
Gonatopsis japonicus

Epipelagic zone

Distribution patterns of juveniles and adults are similar
Gonatopsis japonicus

Upper mesopelagic zone

Distribution patterns of juveniles and adults are similar, though adults occur over somewhat wider area.
Gonatopsis japonicus
Lower meso- and bathypelagic zones

No juveniles at great depths

Adults in the south

Adults (DML>80 mm) >500 m
**Gonatopsis japonicus**

Seasonal vertical distribution

1. **Summer**
   - Two peaks
   - Strong at 0-200 m, weaker at >500 m

2. **Autumn**
   - More or less evenly across depths
   - (due to the descend?)

3. **Winter**
   - Rare and within depths 0-500 m

Mainly in the upper layers
Gonatopsis japonicus

Size structure

Peaks that correspond to ontogenetic stages are hardly discernible
**Gonatopsis japonicus**

Monthly changes in size structure in the Okhotsk Sea

1) Two generations
2) Hard to distinguish between size classes (hence, hard to trace them in time)
3) No spawning squid have ever been found
4) Difficult to come up to life-cycle scenario for this species
Major conclusions

- *G.octopedatus* and *G.japonicus* are widely distributed beyond the shelf zone in the Okhotsk Sea and in the Pacific Ocean off the Kuril Islands.

- Early ontogenetic stages and juveniles of *G.octopedatus* and *G.japonicus* are found mainly in the epipelagic layers.

- Immature *G.octopedatus* start living in the bathypelagic zone, while *G.japonicus* continue vertical migrations to the surface layers, most likely, till maturation.

- Adult *G.octopedatus* and *G.japonicus* are deep-water dwellers, and spawn presumably in the bathyal zone.

- Seasonal groupings of *G.octopedatus* and *G.japonicus* indicate different spawning events during a year.