Paralarval distribution patterns of the gonatid squid *Berryteuthis anonychus* in the North Pacific

(Photo by Oleg Katugin)

John Bower
Hokkaido University, Japan
Cephalopods
Cephalopods

• appeared as a distinct class over 450 mya
• living forms originated less than 100 mya
Cephalopod themes:

(Okutani, 2001)
Cephalopod themes:

- high growth rates
- early attainment of adult size and maturity
- death after breeding

(Okutani, 2001)
Cephalopod themes:

- high growth rates
- early attainment of adult size and maturity
- death after breeding

“live fast and die young”

(Okutani, 2001)
Cephalopod ecology:

(Okutani, 2001)
Cephalopod ecology:

- 650-700 described species

(Okutani, 2001)
Cephalopod ecology:

- 650-700 described species

- can be roughly divided into *inshore* and *offshore* fauna

(Okutani, 2001)
Inshore fauna

Octopus

Cuttlefish

Loliginid squids

(Okutani, 2001)

(photo by Richard Young)

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(Okutani, 2001)
Offshore fauna
Offshore fauna

Ommastrephid squids

(Okutani, 2001)
Offshore fauna

Ommastrephid squids

Vampire squid
(photo by Brad Siebel)

? (Vecchione et al., 2003)

(Okutani, 2001)
The giant squid!

(Kubodera and Mori, 2005)
red (neon) flying squid
red (neon) flying squid
Migration of squids in the North Pacific

- Feeding grounds
- Spawning grounds

red flying squid
Migration of squids in the North Pacific

Japanese common squid

Spawning grounds

Feeding grounds
Gonatid squids
Gonatid squids

- Muscular squids of moderate size
Gonatid squids

- Muscular squids of moderate size
- Arms have 4 rows of suckers/hooks, rather than 2
Gonatid squids

- Muscular squids of moderate size
- Arms have 4 rows of suckers/hooks, rather than 2
- 19 species worldwide - 16 in the North Pacific
Gonatid squids

- Muscular squids of moderate size
- Arms have 4 rows of suckers/hooks, rather than 2
- 19 species worldwide - 16 in the North Pacific
- 4 genera: 
  - Gonatus
  - Gonatopsis
  - Eogonatus
  - Berryteuthis
    - Berryteuthis magister
    - Berryteuthis anonychus
*Berryteuthis anonychus*

minimal armhook squid

(photo by Oleg Katugin)
Berryteuthis anonychus
minimal armhook squid
*Berryteuthis anonychus*

Minimal armhook squid

Major prey for:
- salmonids
- Pacific pomfret
- seabirds
- red flying squid
Size vs. Latitude
Size vs. Latitude

- NMFS trawl survey
- 7 stations
- May 1999
Size vs. Latitude

- NMFS trawl survey
- 7 stations
- May 1999

Bower et al. (2002)
Size vs. Latitude

- NMFS trawl survey
- 7 stations
- May 1999

suggest a northward migration in spring
Size vs. Latitude

- NMFS trawl survey
- 7 stations
- May 1999

- suggest a northward migration in spring
- spawning ground remains unknown
Study objectives:
Study objectives:

1) describe the paralarvae distribution patterns of *Berryteuthis anonychus*
Study objectives:

1) describe the paralarvae distribution patterns of *Berryteuthis anonychus*

2) use this information to better understand its life cycle
Why focus on the paralarvae?
Why focus on the paralarvae?

Paralarvae are:

1) more numerous
2) easier to catch
Why focus on the paralarvae?

Paralarvae are:
1) more numerous
2) easier to catch

BUT, difficult to identify!
Identification key available

**SIZE:**
- >30 mm
- 5-30 mm
- <5 mm

Berryteuthis magister
Berryteuthis anonychus
Gonatopsis borealis
Gonatopsis japonicus
Gonatopsis octopedatus
Gonatopsis okutanii
Gonatus onyx
Gonatus madokai
Gonatus kamtchaticus
Gonatus sp. type A
Gonatus ursubrunae
Gonatus oregonensis
Gonatus californiensis
Gonatus berryi
Gonatus pyros
Eogonatus tinro
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Size frequency of all cephalopods (1999-2001)
Size frequency of all cephalopods (1999-2001)

57% smaller than 5 mm ML
In-progress DNA analysis by Shimura

paralarvae

paralarvae

adults

COI

COMPARISON

COI

adults
Results to date

1 = Berryteuthis anonychus
2 = Gonatopsis borealis
3 = Gonatopsis sp. A
4 = Gonatopsis sp. B
5 = Gonatopsis sp. C

(Shimura, unpublished)
Results to date

5 morphotypes positively identified

(Shimura, unpublished)
Sampling stations (2002-04)

- 45 stations
- 295 tows
- Jul and Aug

Oshoro Maru
Sampling stations (2002-04)

- Alaskan Stream
- Ridge Domain
- Subarctic Current
- Subarctic Boundary

45 stations
295 tows
Jul and Aug

Oshoro Maru
Distribution of *Berryteuthis anonychus* paralarvae (2002-04)

- 23 stations north of 42°N
- >50% of catch at these stations
Distribution of *Berryteuthis anonychus* paralarvae (2002-04)

- 23 stations north of 42°N
- >50% of catch at these stations
Distribution of *Berryteuthis anonychus* paralarvae - 2002
Distribution of *Berryteuthis anonychus* paralarvae - 2002

![Map showing the distribution of *Berryteuthis anonychus* paralarvae in 2002 with labeled areas such as Ridge Domain, Subarctic Current, and Alaskan Stream.](image-url)
Distribution of *Berryteuthis anonychus* paralarvae - 2003
Distribution of *Berryteuthis anonychus* paralarvae - 2004
Key results of paralarval surveys

Alaskan Stream
Key results of paralarval surveys

*Berryteuthis anonychus* paralarvae:

1) are abundant in the Northeast Pacific
Key results of paralarval surveys

*Berryteuthis anonychus* paralarvae:

1) are abundant in the Northeast Pacific

2) have a wide latitudinal distribution (42-54°N)
Key results of paralarval surveys

*Berryteuthis anonychus* paralarvae:

1) are abundant in the Northeast Pacific

2) have a wide latitudinal distribution (42-54°N)

3) occur north of the Subarctic Boundary
Common migration pattern of squid in the North Pacific

Feeding grounds

Spawning grounds
Post-paralarvae in May
Post-paralarvae in May
Post-paralarvae in May

Paralarvae in Jul and Aug
Could these paralarvae have been spawned nearshore?
Giant Pacific Octopus
(*)Enteroctopus dofleini*)

(photo by David Scheel)
Giant Pacific Octopus

(Enteroctopus dofleini)

a benthic spawner in coastal waters

(photo by David Scheel)

(photo by Paul Hughes)
Giant Pacific Octopus
(*Enteroctopus dofleini*)

Distribution of Giant Pacific Octopus
paralarvae (Kubodera, 1991)

- A benthic spawner in coastal waters

(photo by David Scheel)

(photo by Paul Hughes)
Giant Pacific Octopus
*(Enteroctopus dofleini)*

Distribution of Giant Pacific Octopus paralarvae (Kubodera, 1991)

- 700 km

A benthic spawner in coastal waters

*photo by David Scheel*

*photo by Paul Hughes*
Giant Pacific Octopus
*(Enteroctopus dofleini)*

Distribution of Giant Pacific Octopus paralarvae (Kubodera, 1991)

700 km

More study is needed
Presentations at the PICES annual meeting with “Squid” or “Cephalopod” in the title

Number

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Presentations at the PICES annual meeting with "Squid" or "Cephalopod" in the title

Number

Fujino et al.
Kiyofuji et al.
Bower and Takagi

2003 Seoul
2004 Honolulu
2005 Vladivostok
Presentations at the PICES annual meeting with “Squid” or “Cephalopod” in the title

- Katugin and Shevtsov
- Sakurai et al.
- Shimura et al.
- Yamamoto et al.
- Bower and Miyahara
- Bower and Ichii

Locations:
- 2003 Seoul
- 2004 Honolulu
- 2005 Vladivostok
Presentations at the PICES annual meeting
with “Squid” or “Cephalopod” in the title

- 2003 Seoul
- 2004 Honolulu
- 2005 Vladivostok

Gong
Savinykh et al.
Shevtsov et al.
Shin et al.
Song et al.
Sviridov
Tateyama et al.
Bower
Presentations at the PICES annual meeting with “Squid” or “Cephalopod” in the title

Number

10

5

2003 Seoul

2004 Honolulu

2005 Vladivostok

Seoul

Honolulu

Vladivostok
Presentations at the PICES annual meeting with “Squid” or “Cephalopod” in the title

Thank you

Спасибо