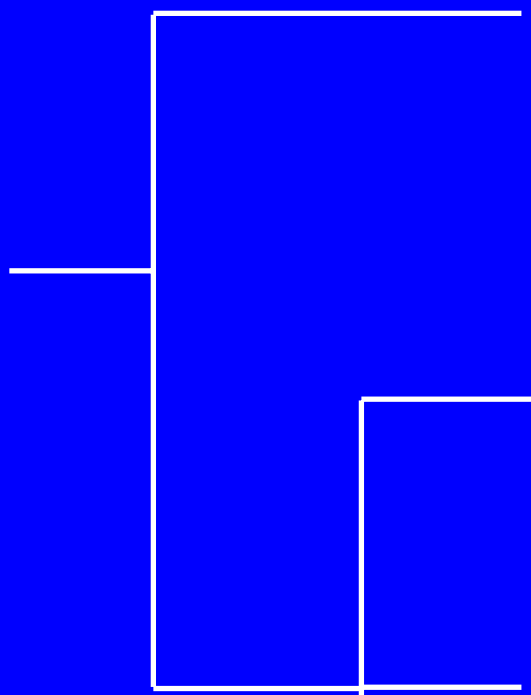
Paralarval distribution patterns of the gonatid squid *Berryteuthis anonychus* in the North Pacific

John Bower
Hokkaido University, Japan

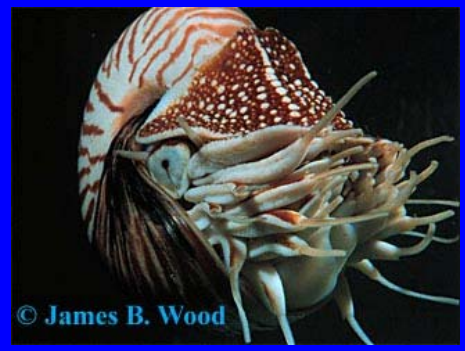
Cephalopods

Cephalopods

- appeared as a distinct class over 450 mya
- living forms originated less than 100 mya



Nautilus



Octopus

Cuttlefish

Squid

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


(Okutani, 2001)

"live fast and die young"

Cephalopod ecology:

(Okutani, 2001)

Cephalopod ecology:

- 650-700 described species

(Okutani, 2001)

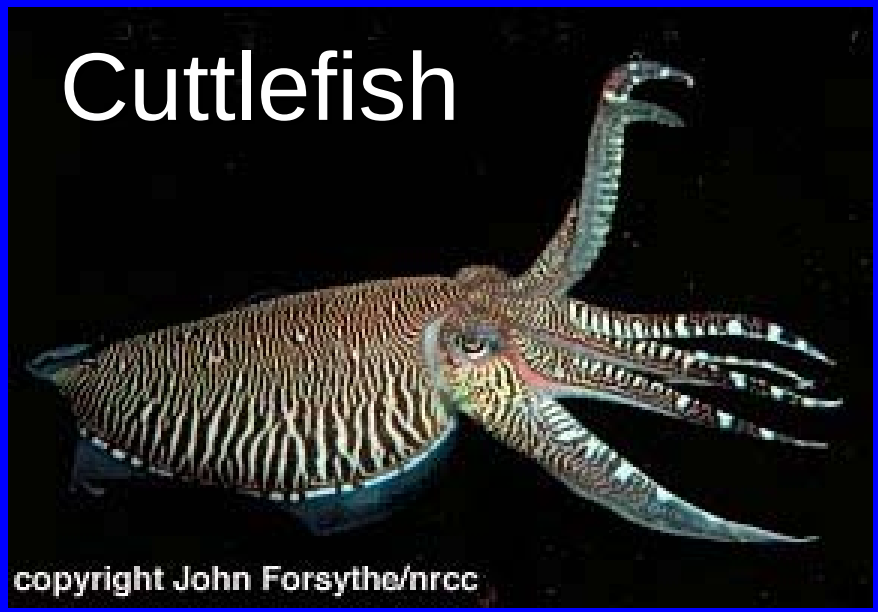
Cephalopod ecology:

- 650-700 described species

- can be roughly divided into inshore and offshore fauna


(Okutani, 2001)

Inshore fauna



Loliginid squids

Offshore fauna

Offshore fauna

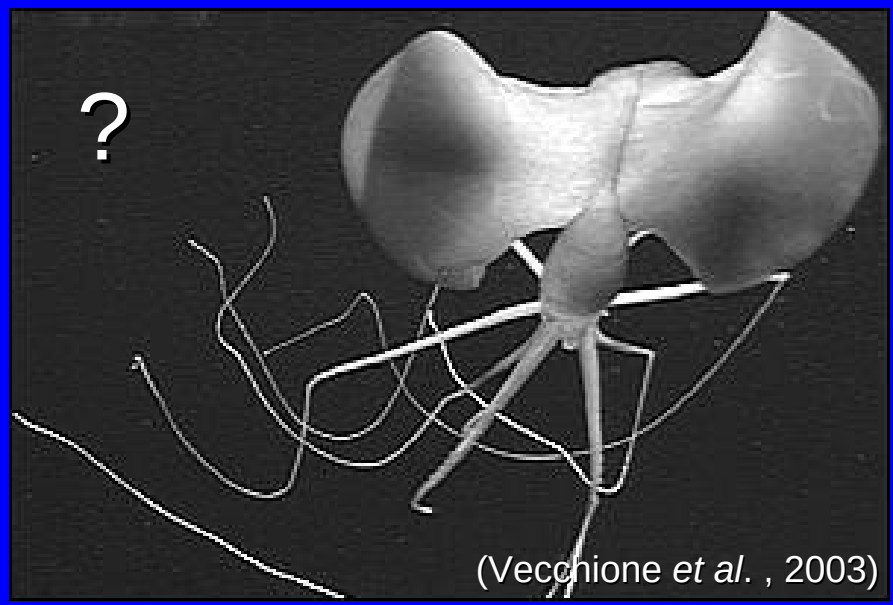
(Okutani, 2001)

Ommastrephid squids

Offshore fauna

(Okutani, 2001)

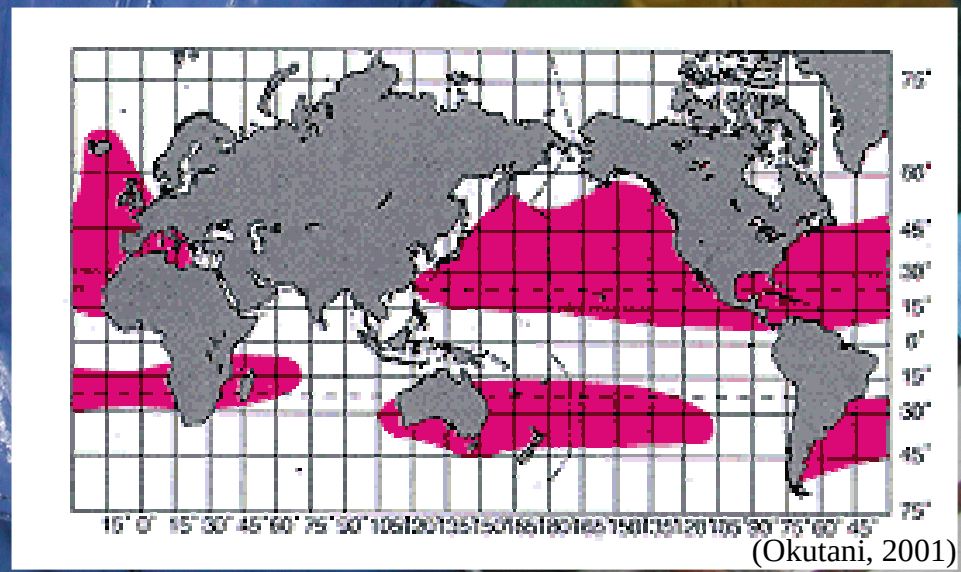
Ommastrephid squids



The giant squid!

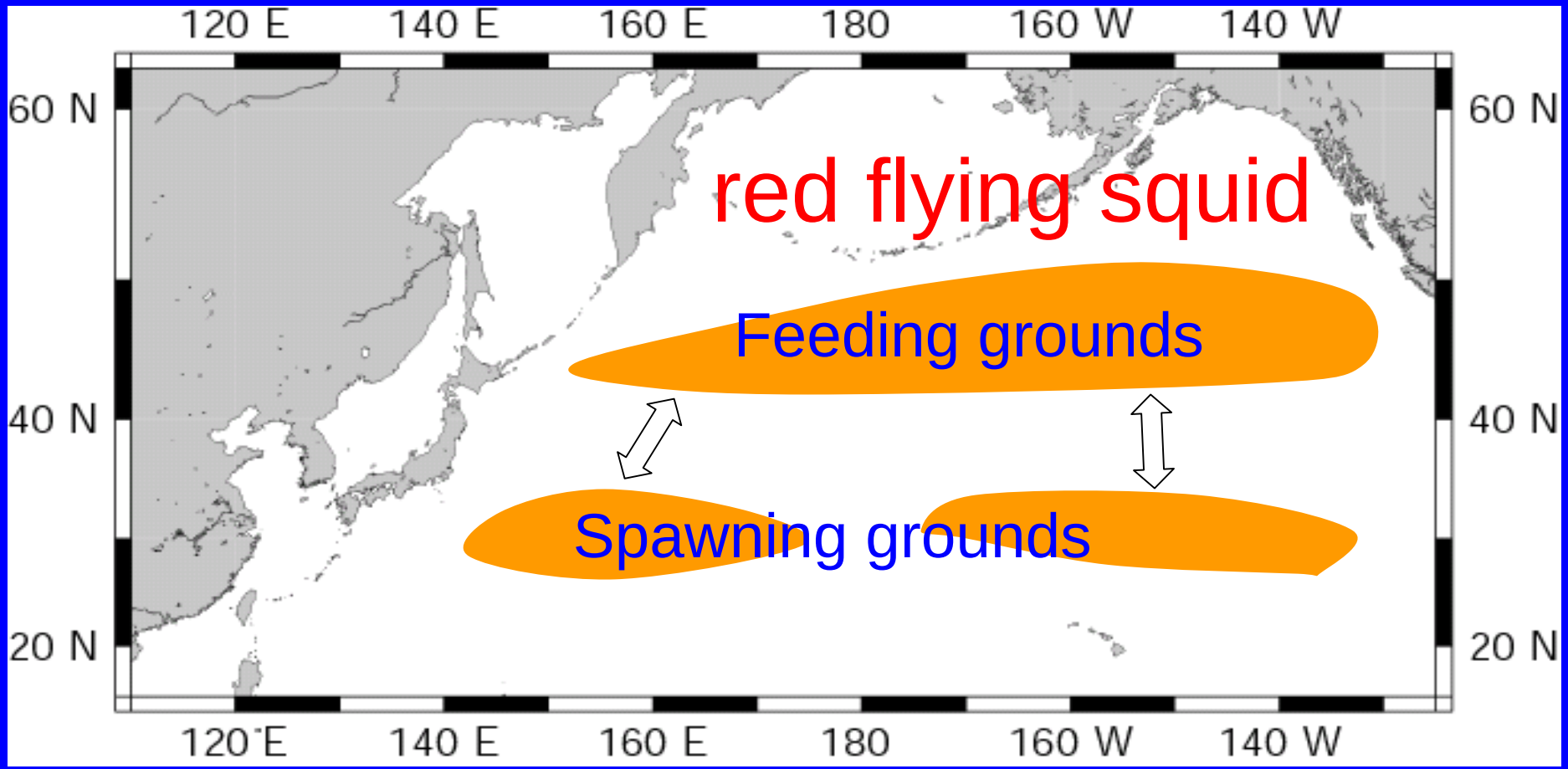

red (neon) flying squid

red (neon) flying squid

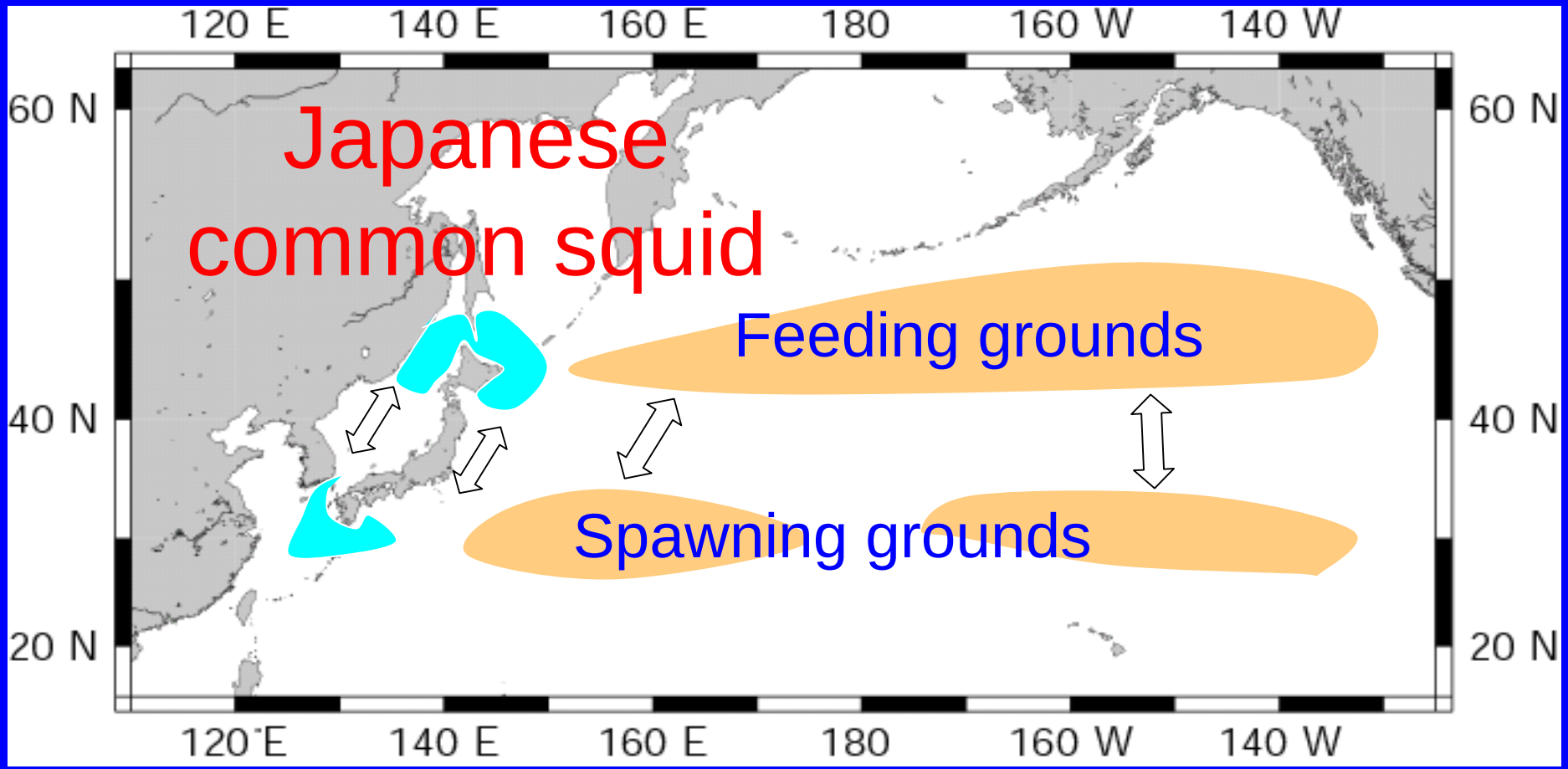


(Okutani, 2001)

Migration of squids in the North Pacific



Migration of squids in the North Pacific



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

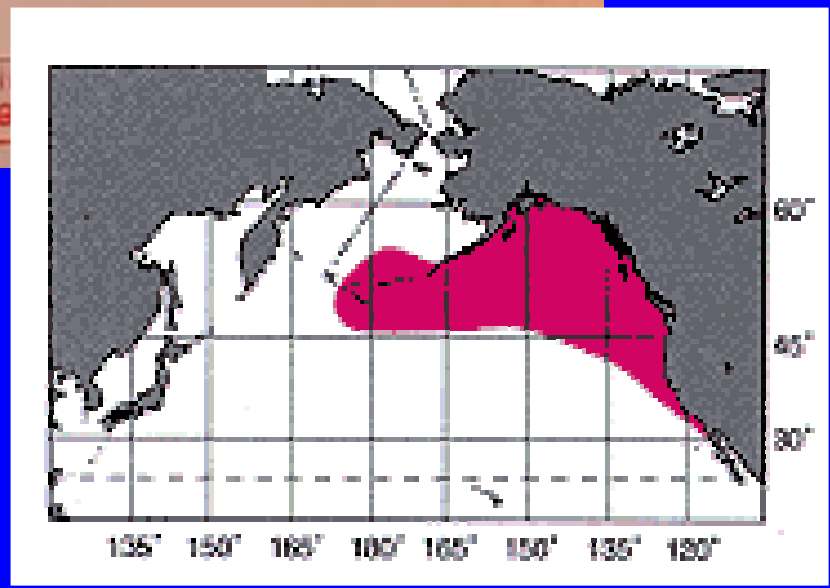
Gonatid squids

- 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*

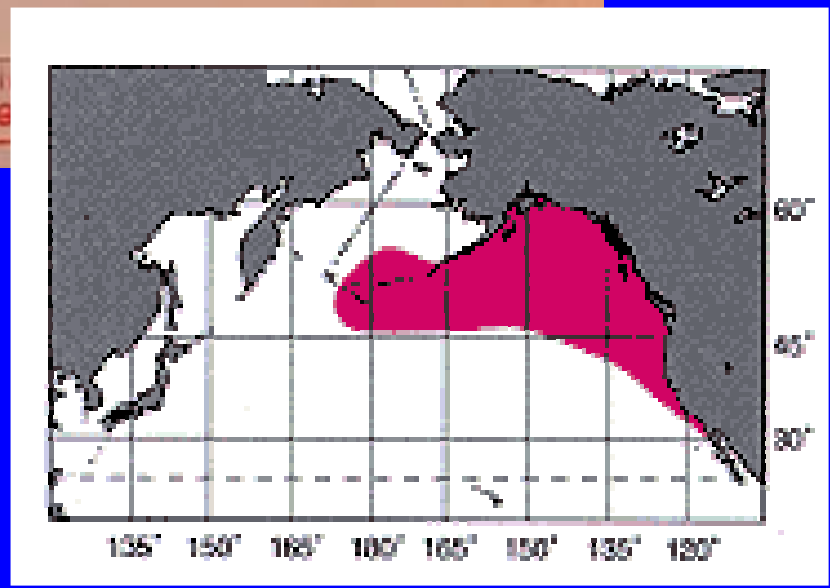
Berryteuthis anonychus
minimal armhook squid

(photo by Oleg Katugin)

Berryteuthis anonychus
minimal armhook squid



Berryteuthis anonychus
minimal armhook squid

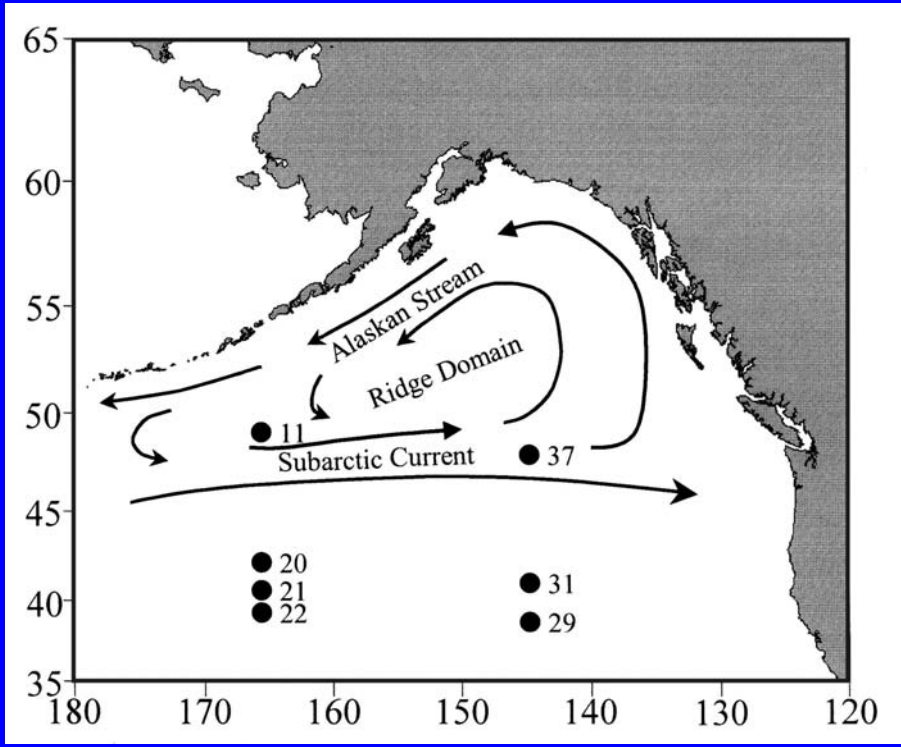


Major prey for:

- salmonids
- Pacific pomfret
- seabirds
- red flying squid

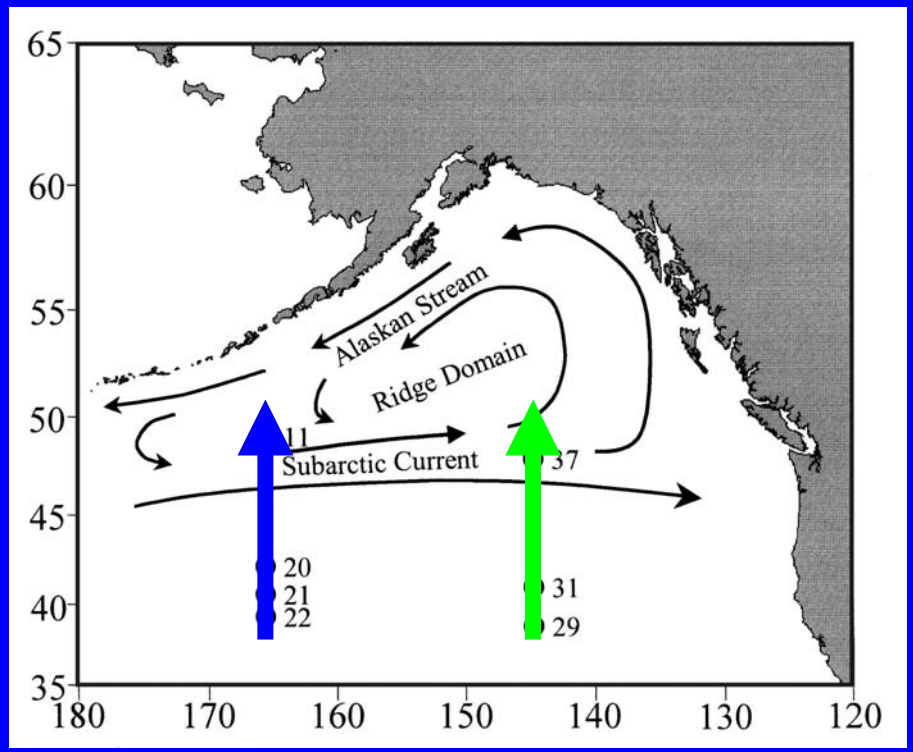
Size vs. Latitude

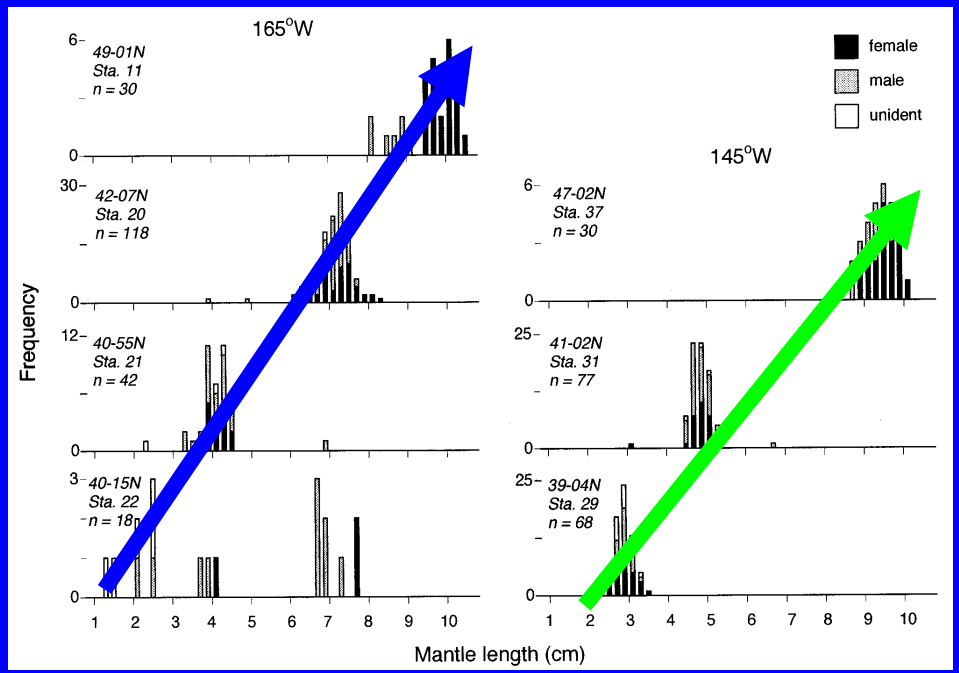
Size vs. Latitude



- NMFS trawl survey
- 7 stations
- May 1999

Size vs. Latitude

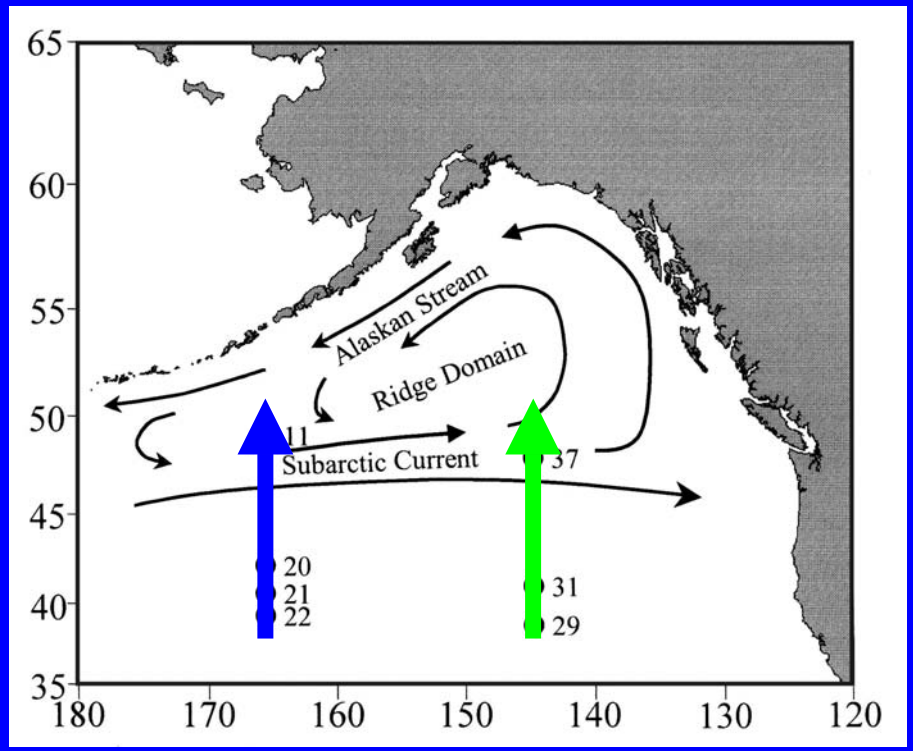


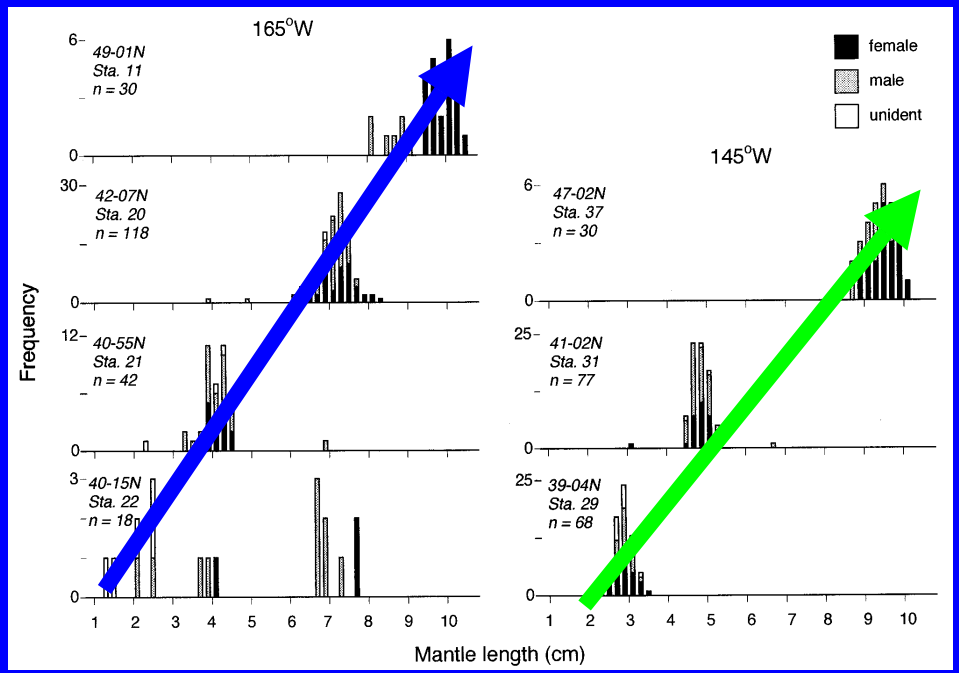


Bower *et al.* (2002)

- NMFS trawl survey
- 7 stations
- May 1999

Size vs. Latitude

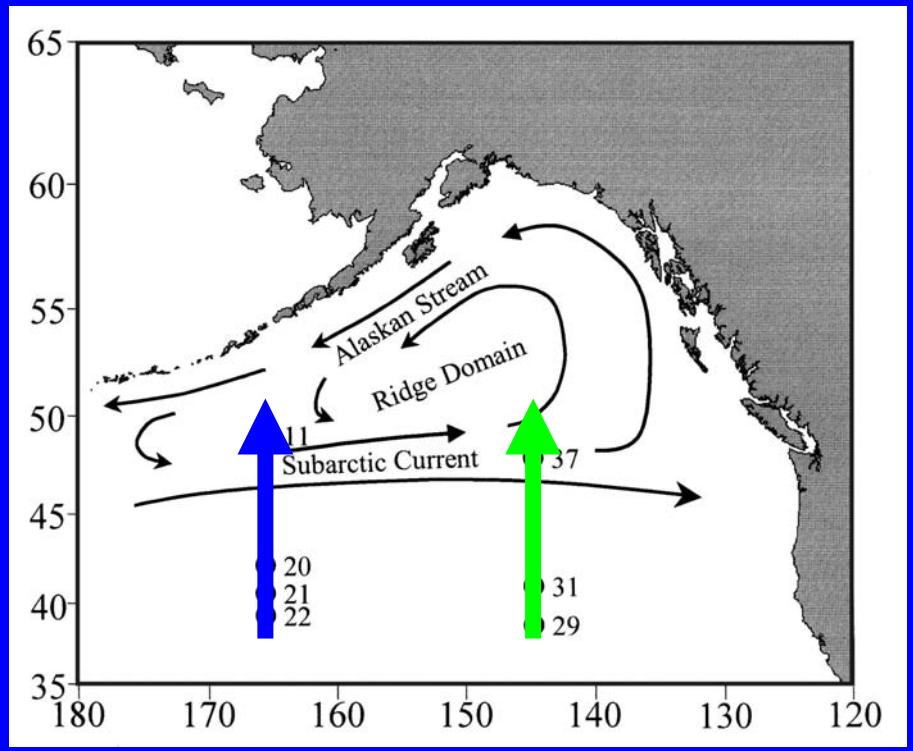


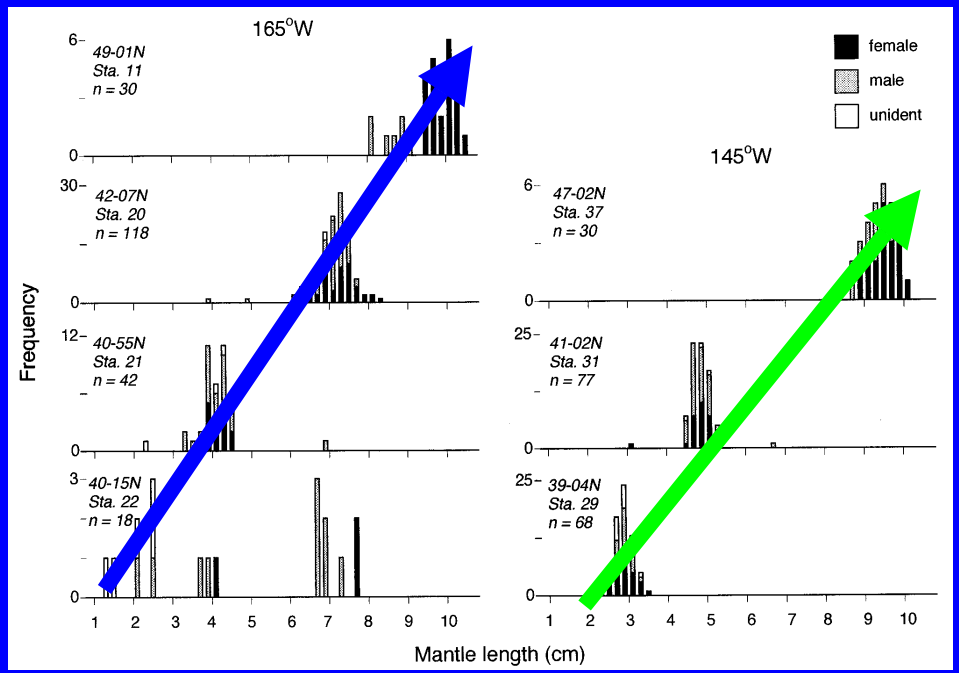


- NMFS trawl survey
- 7 stations
- May 1999

- 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:

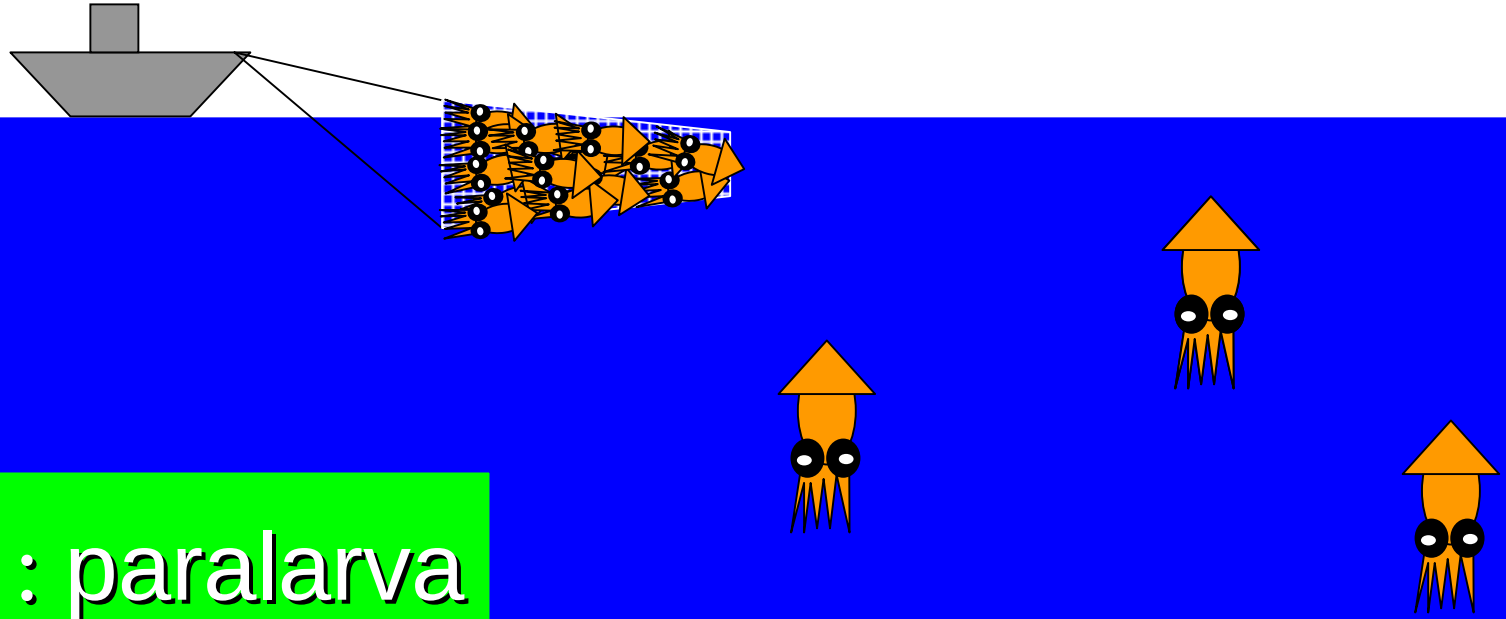
1) describe the paralarvae distribution patterns of *Berryteuthis anonychus*

Study objectives:

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

2) use this information to better understand its life cycle

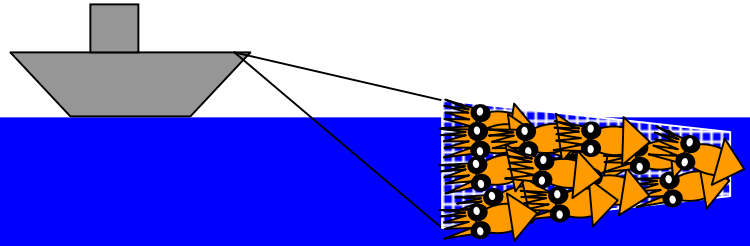
Why focus on the paralarvae?



: paralarva

: adult

Why focus on the paralarvae?



: paralarva

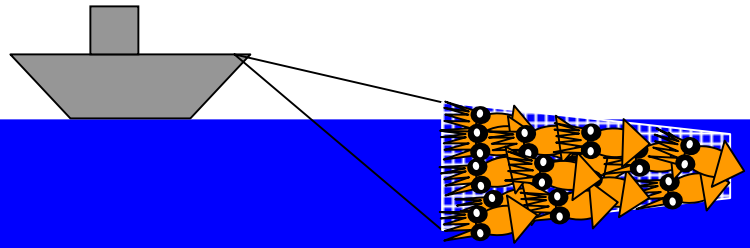
: adult

Paralarvae are:

1) more numerous

2) easier to catch

Why focus on the paralarvae?



: paralarva

: adult

Paralarvae are:

1) more numerous

2) easier to catch

BUT, difficult to identify!

Identification key available

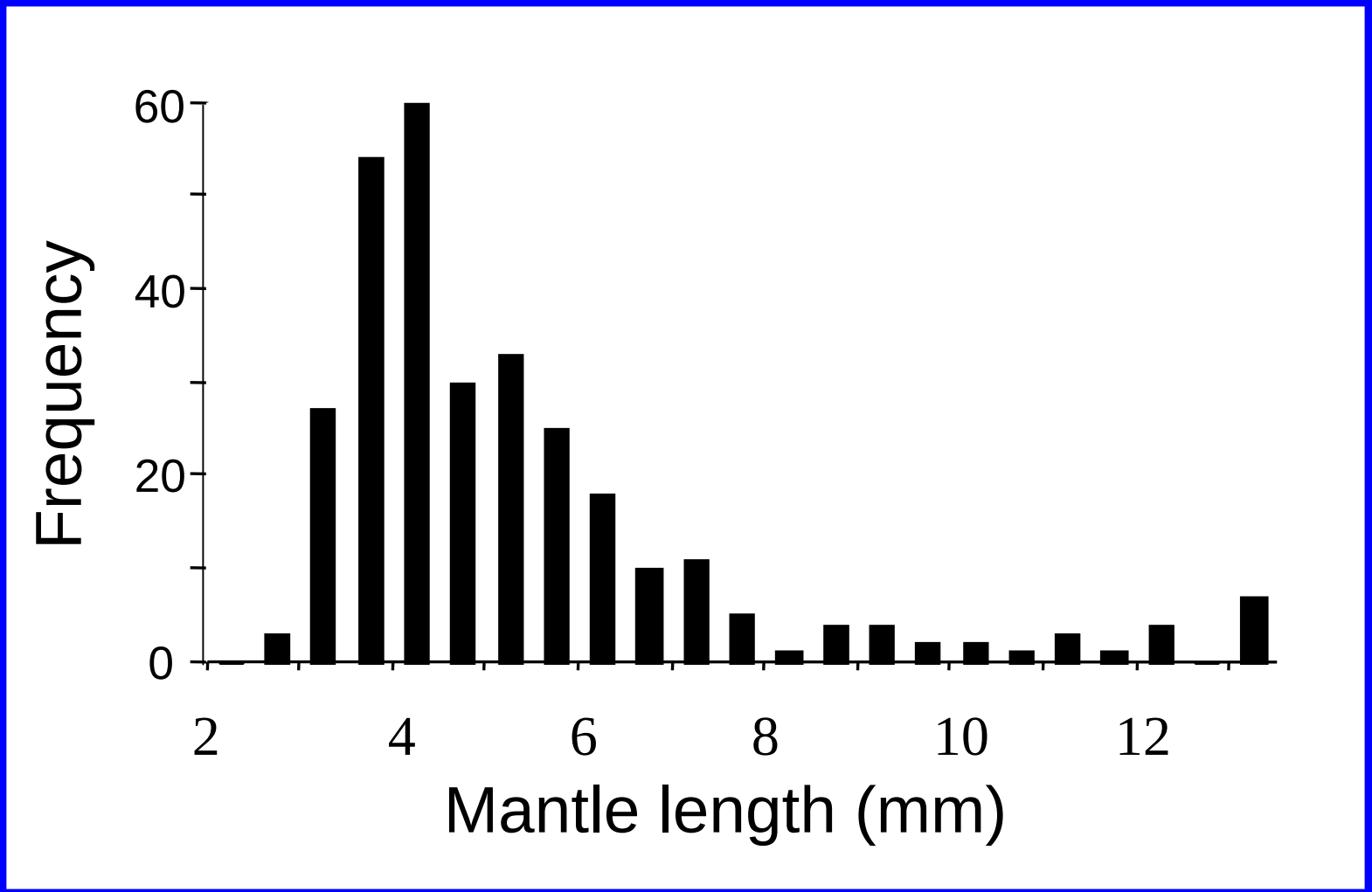
SIZE:	>30 mm	5-30 mm	<5 mm
Berryteuthis magister			
Berryteuthis anonychus			
Gonatopsis borealis			
Gonatopsis japonicus			
Gonatopsis octopedatus			
Gonatopsis okutanii			
Gonatus onyx			
Gonatus madokai			
Gonatus kamtchaticus			
Gonatus sp. type A			
Gonatus ursubrunae			
Gonatus oregonensis			
Gonatus californiensis			
Gonatus berryi			
Gonatus pyros			
Eogonatus tinro			

	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	✓		

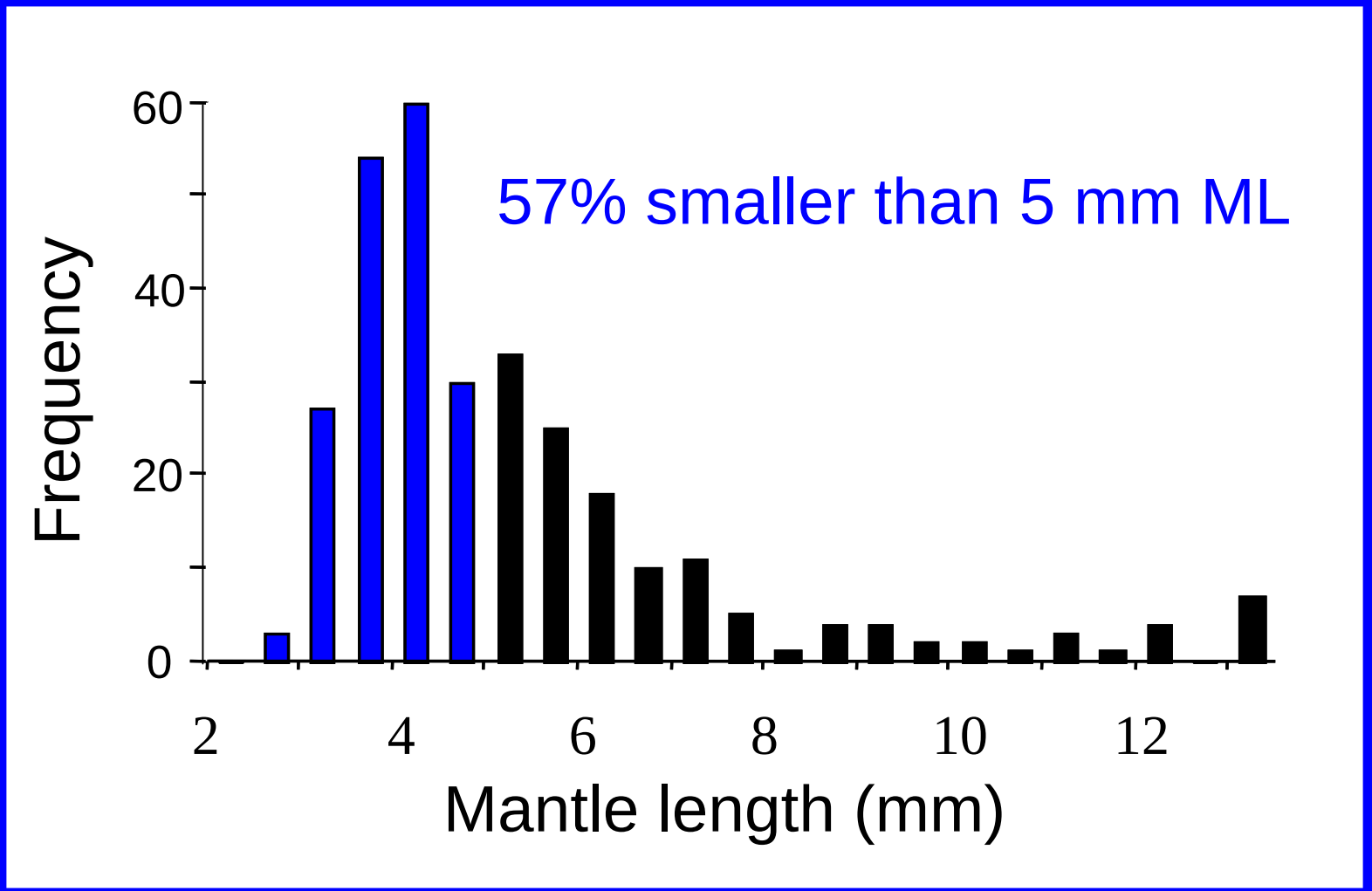
	Identification key available		
SIZE:	>30 mm	5-30 mm	<5 mm
Berryteuthis magister	✓	✓	
Berryteuthis anonychus	✓	✓	
Gonatopsis borealis	✓	✓	
Gonatopsis japonicus	✓		
Gonatopsis octopedatus	✓		
Gonatopsis okutanii	✓		
Gonatus onyx	✓	✓	
Gonatus madokai	✓	✓	
Gonatus kamtchaticus	✓	✓	
Gonatus sp. type A		✓	
Gonatus ursubrunae	✓		
Gonatus oregonensis	✓		
Gonatus californiensis	✓		
Gonatus berryi	✓	✓	
Gonatus pyros	✓	✓	
Eogonatus tinro	✓		

	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	✓		

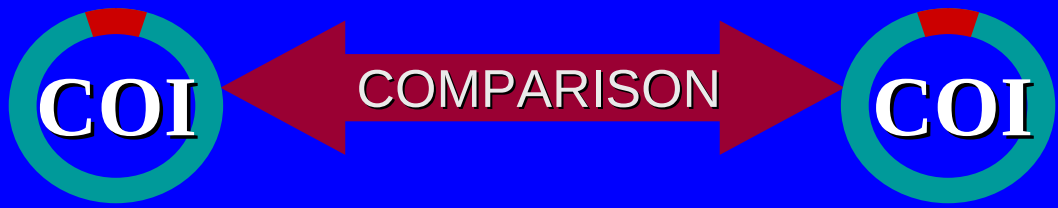
Size frequency of all cephalopods (1999-2001)

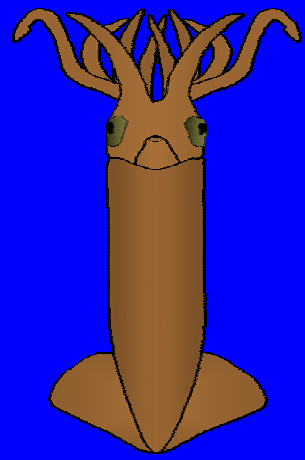


Size frequency of all cephalopods (1999-2001)



In-progress DNA analysis by Shimura

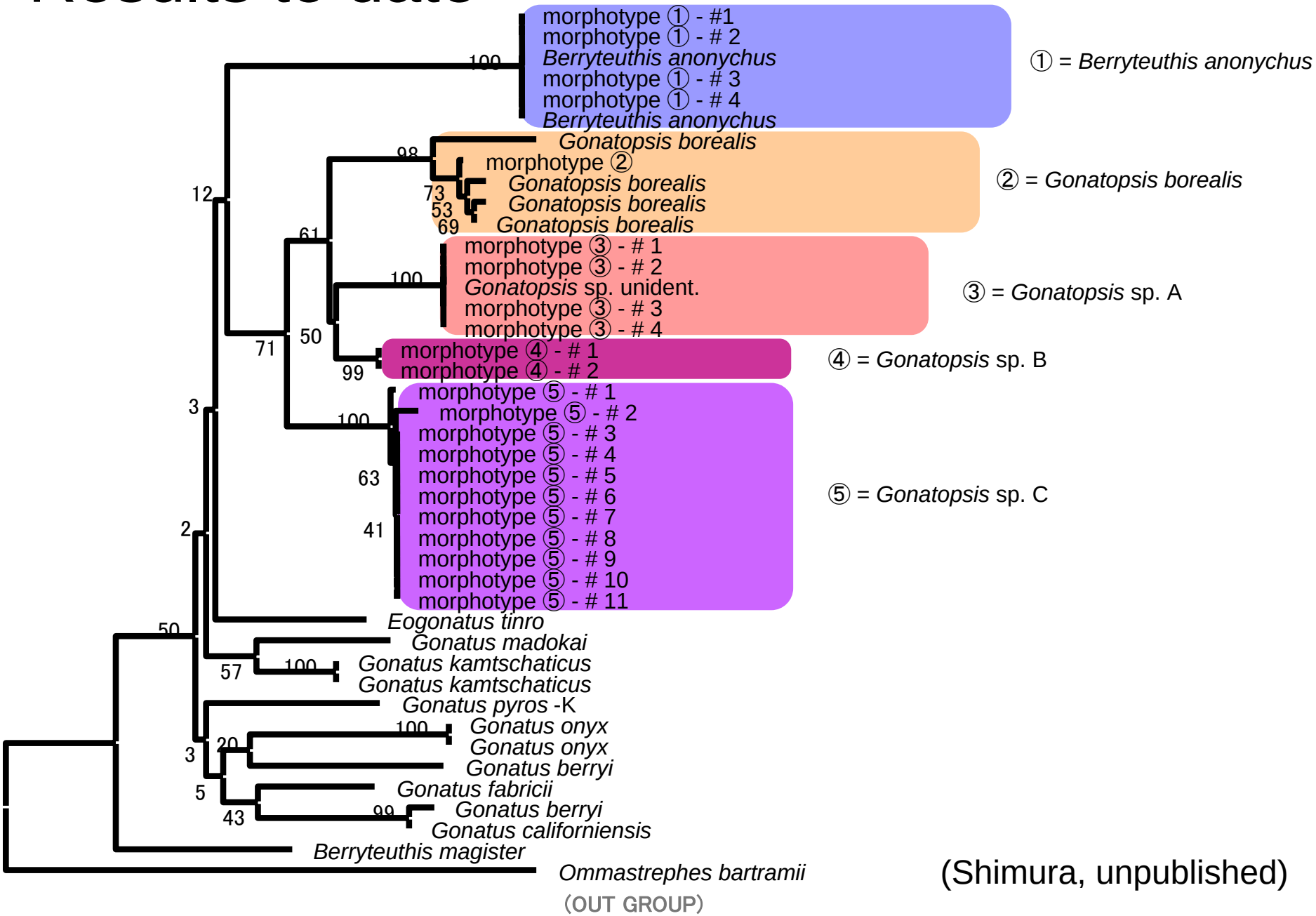




paralarvae

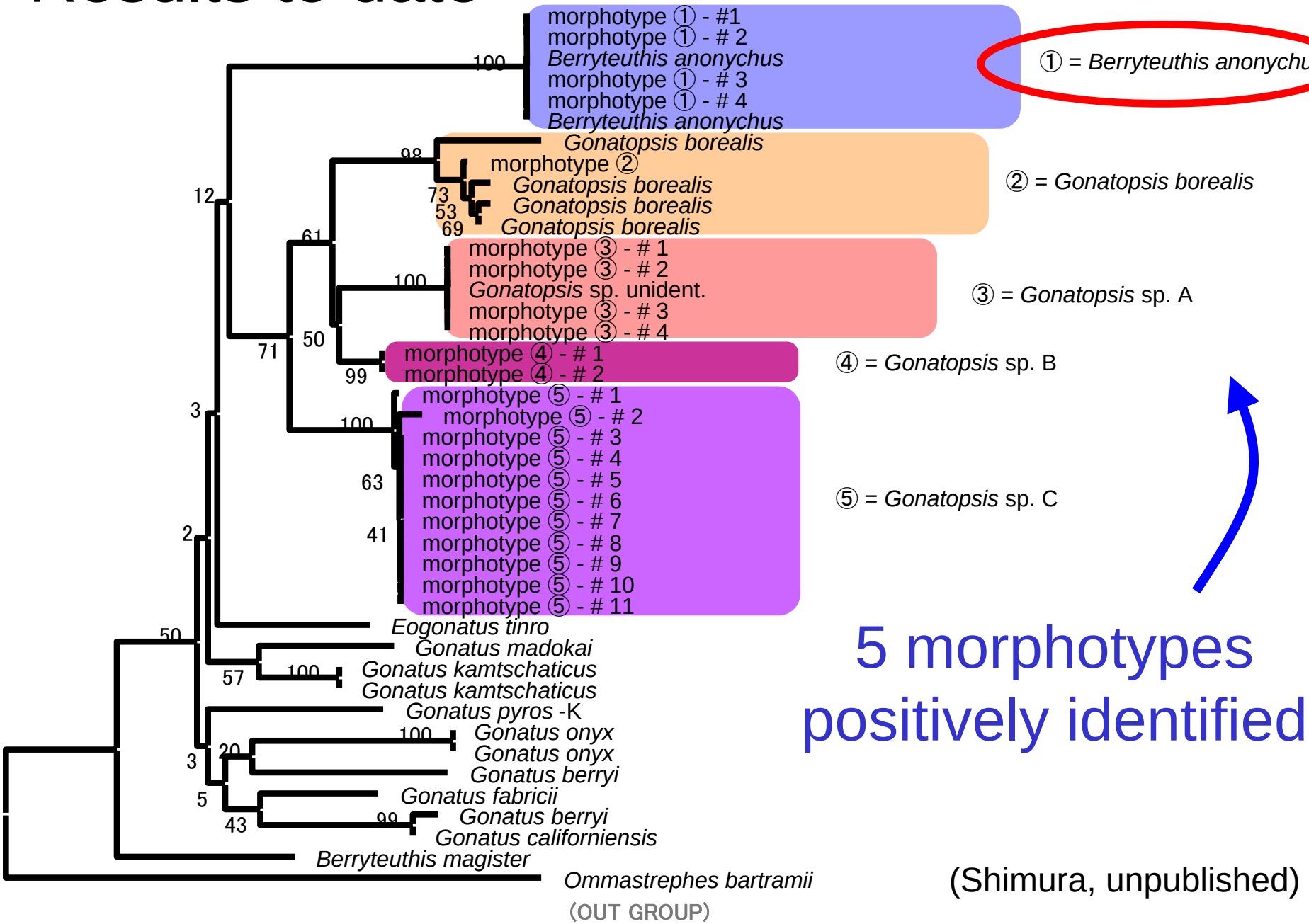
adults

Results to date



(Shimura, unpublished)

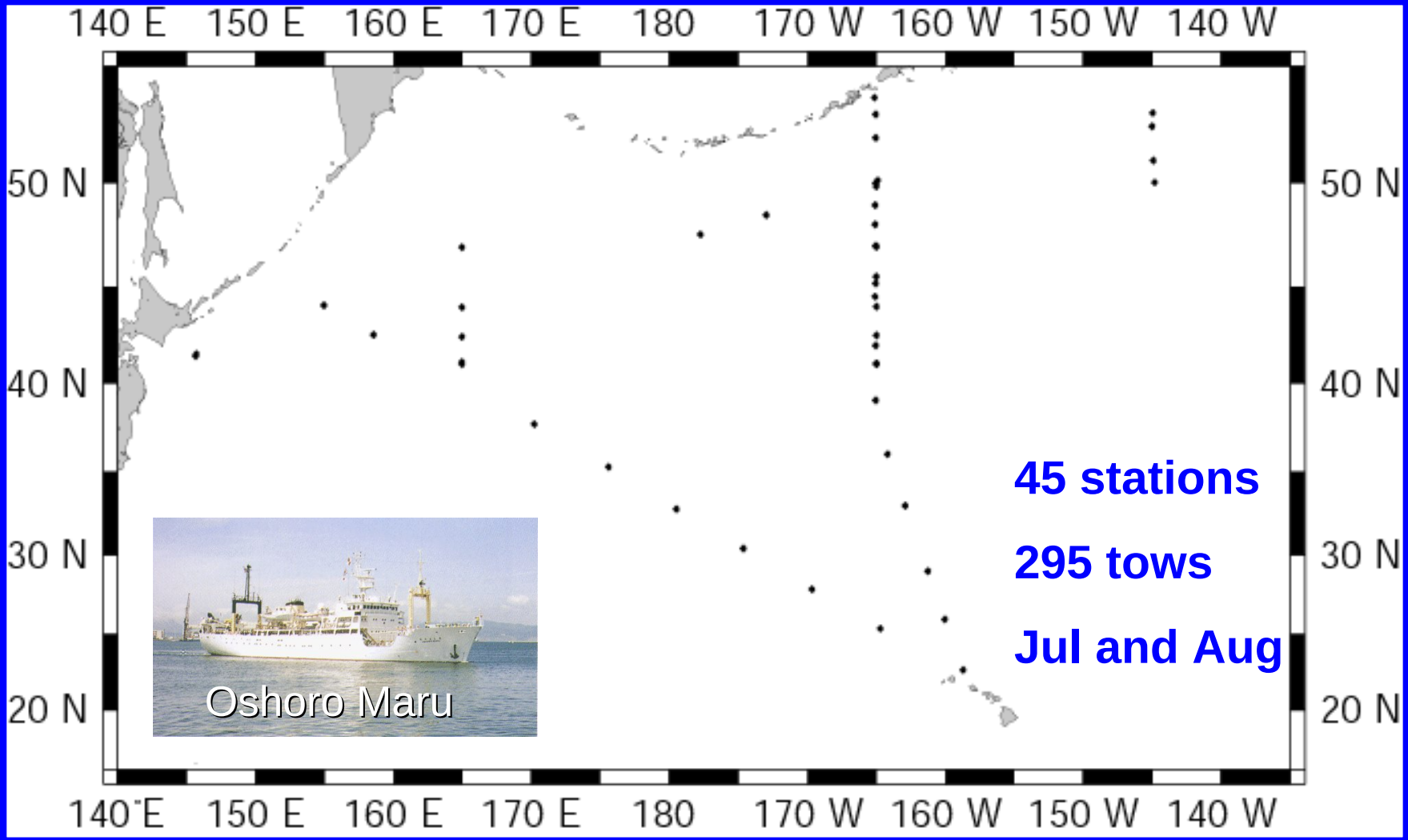
Results to date



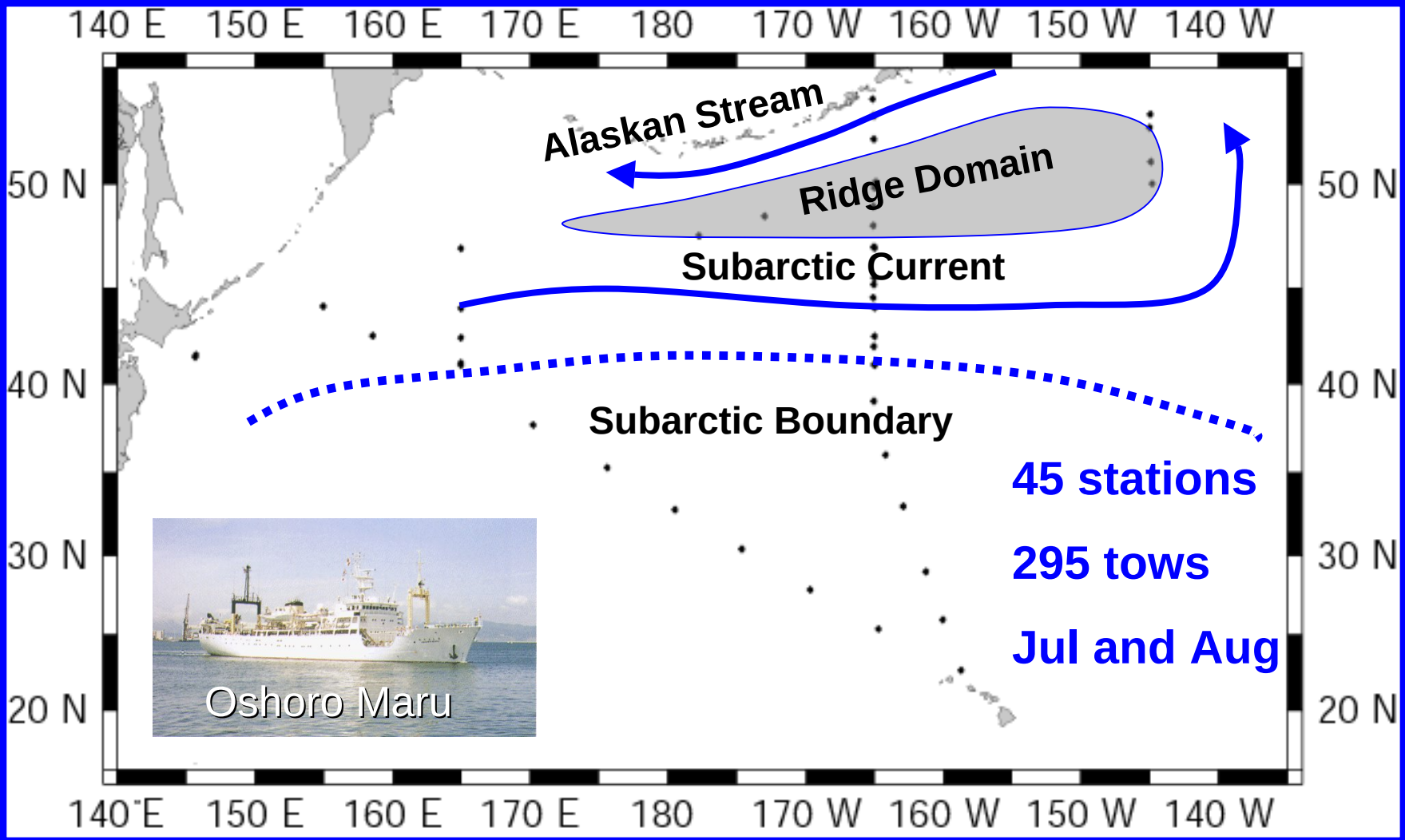
5 morphotypes positively identified

(Shimura, unpublished)

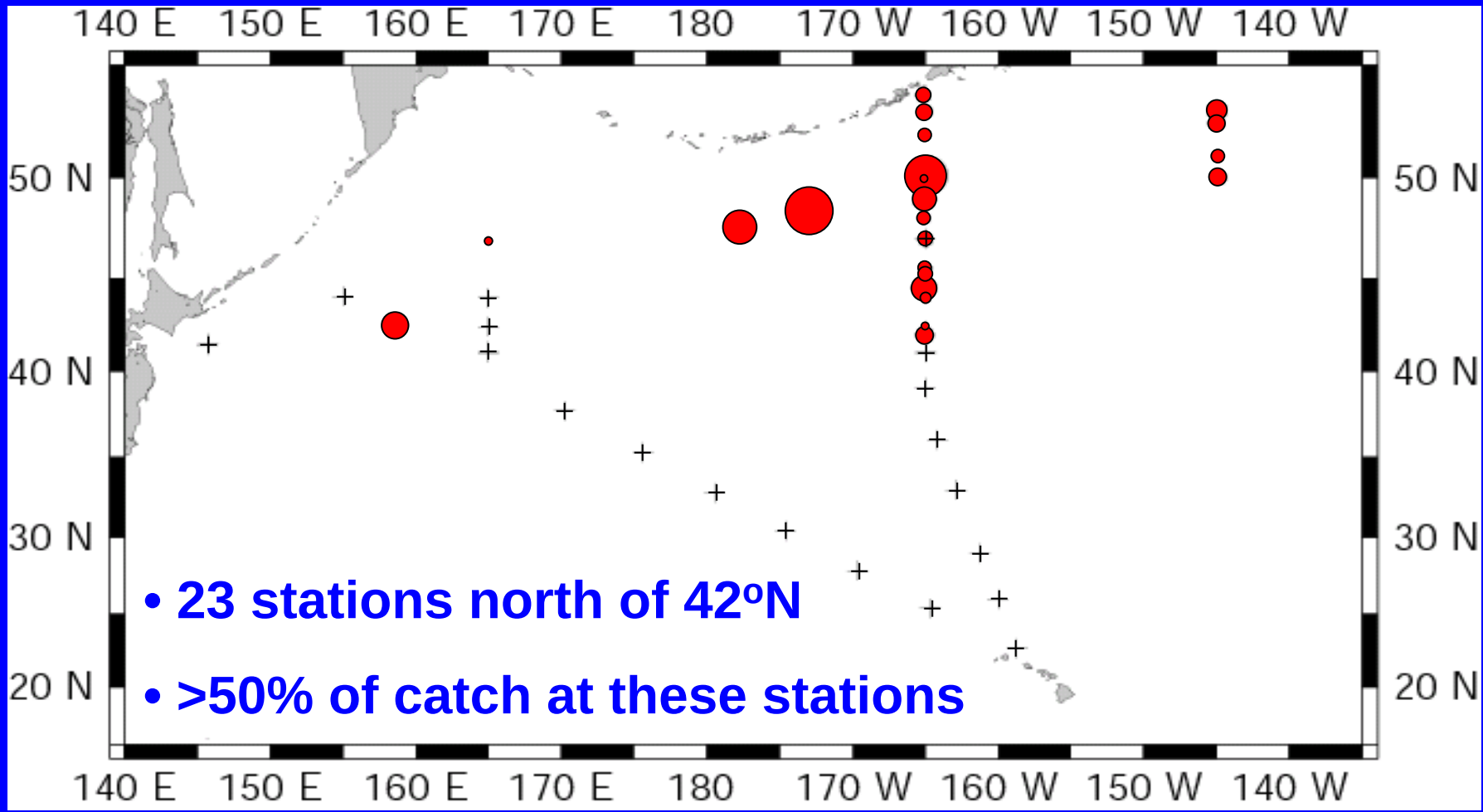
Sampling stations (2002-04)



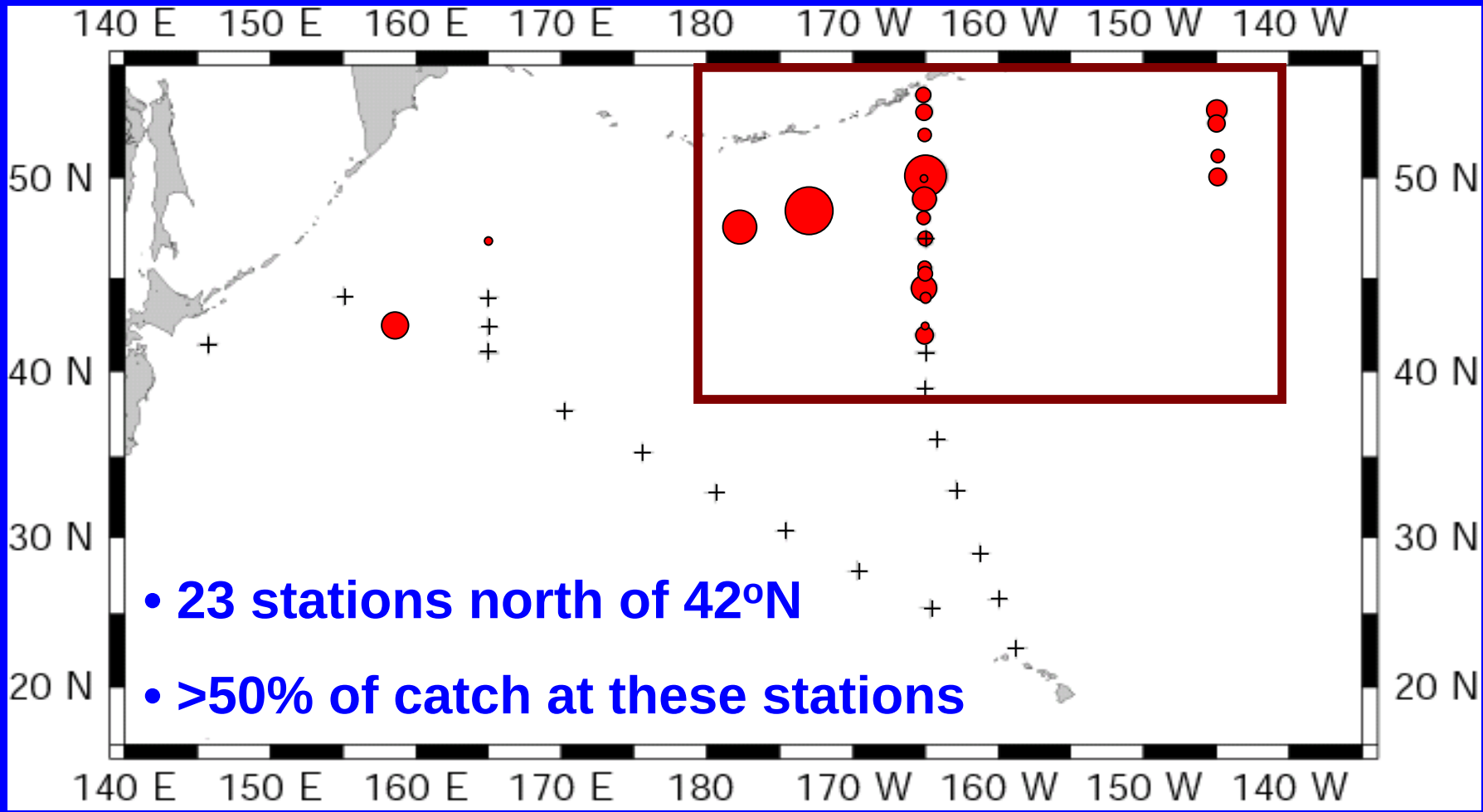
Sampling stations (2002-04)



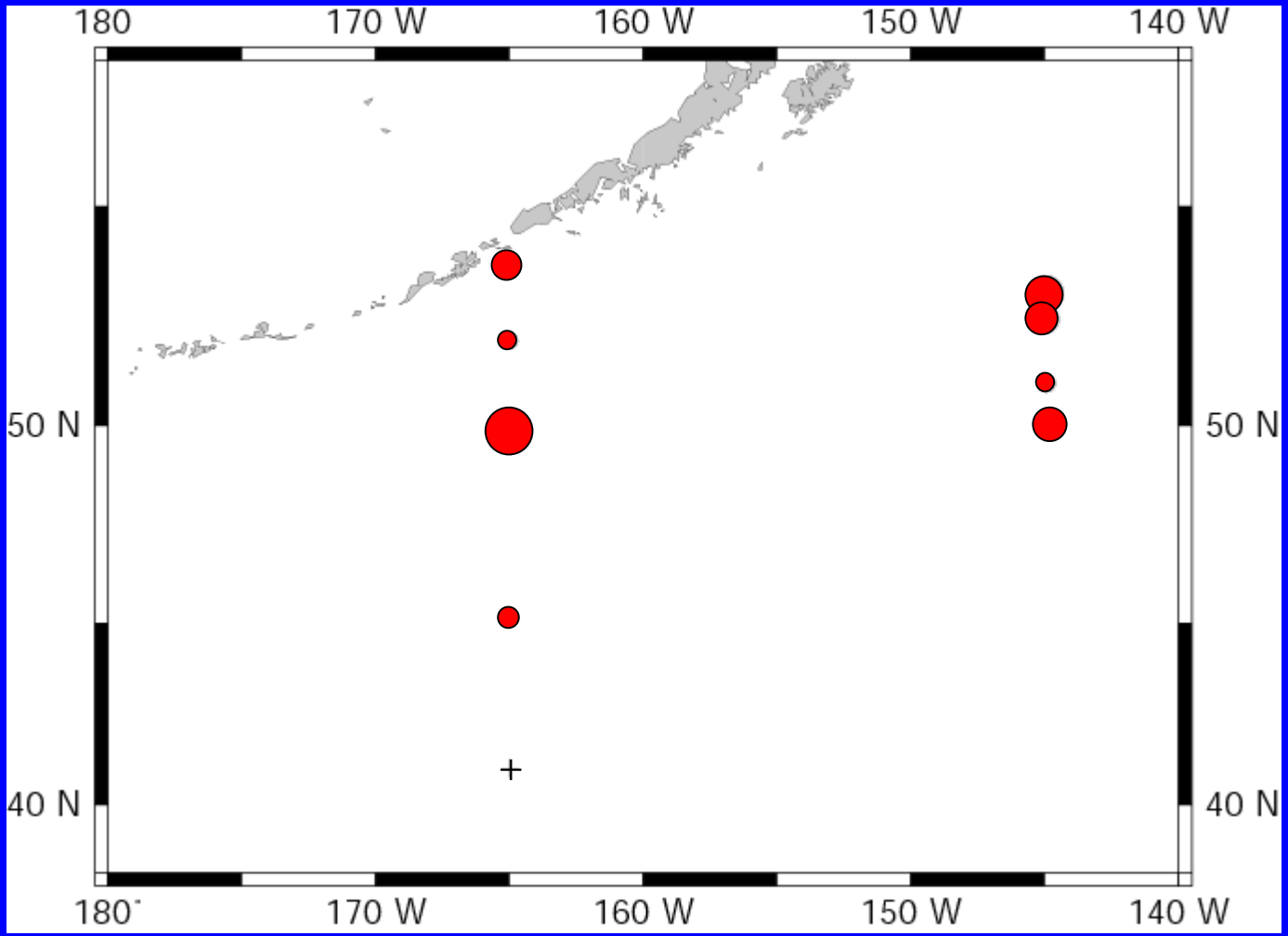
Distribution of *Berryteuthis anonychus* paralarvae (2002-04)



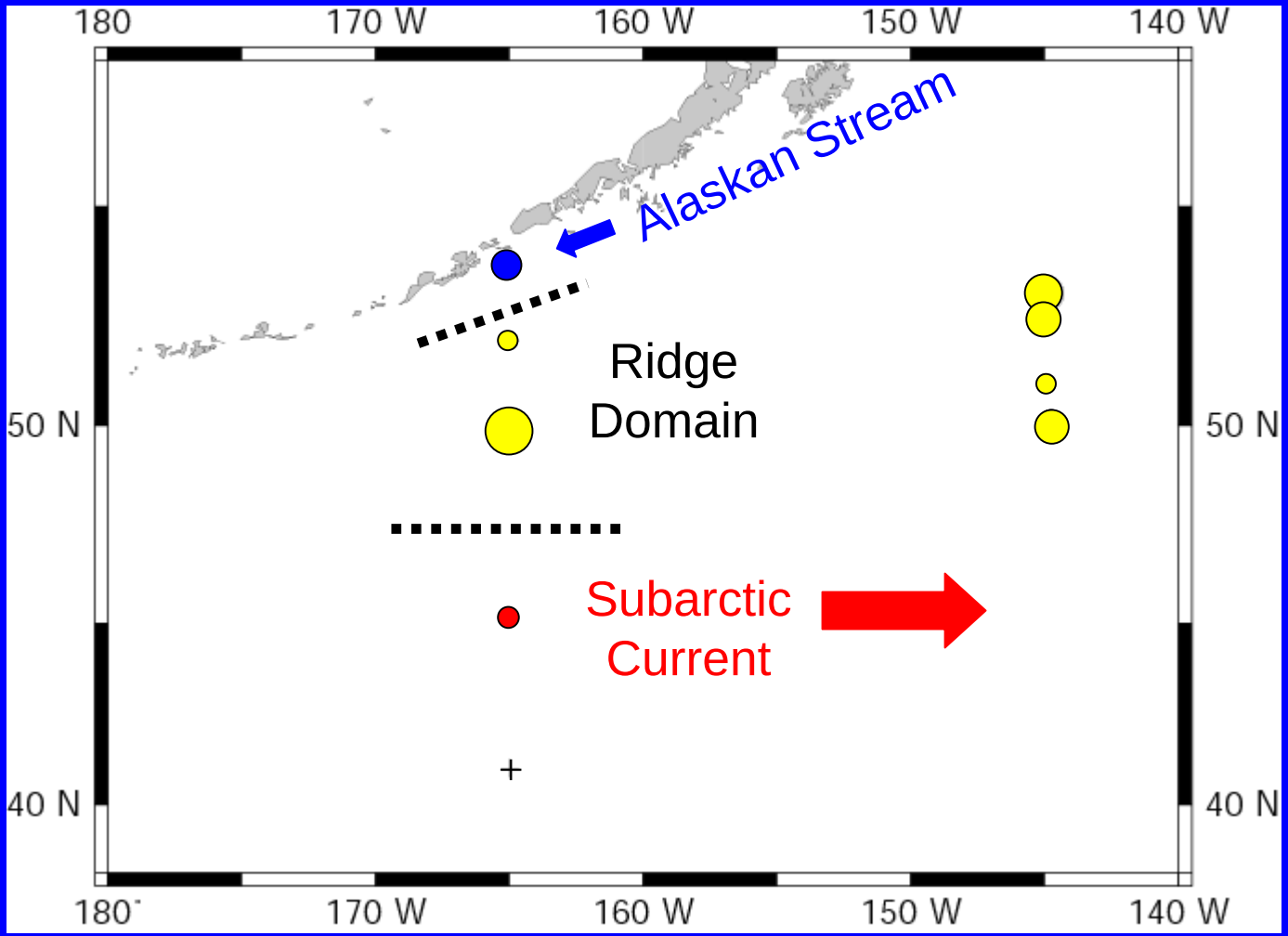
Distribution of *Berryteuthis anonychus* paralarvae (2002-04)



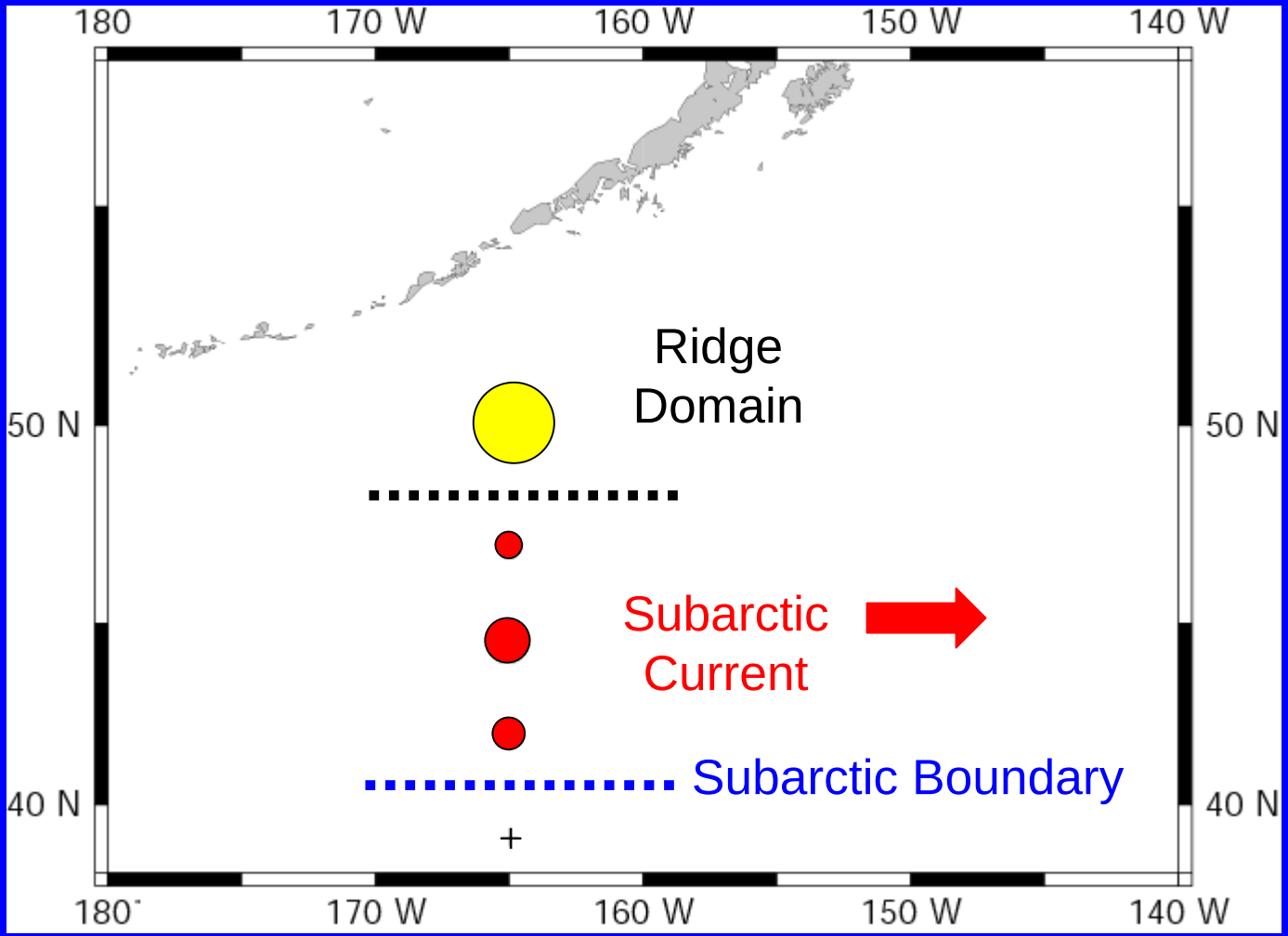
Distribution of *Berryteuthis anonychus* paralarvae - 2002



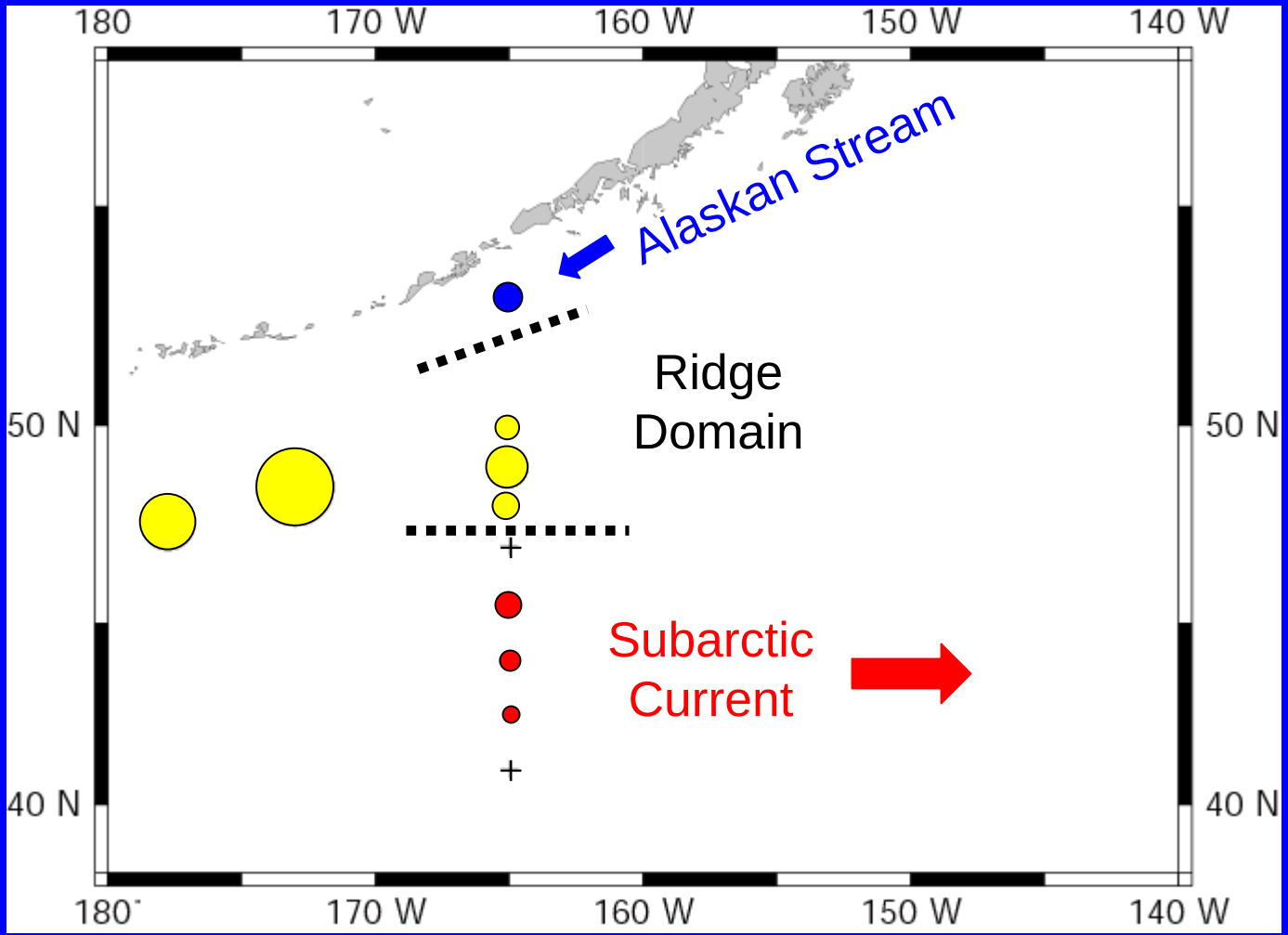
Distribution of *Berryteuthis anonychus* paralarvae - 2002



Distribution of *Berryteuthis anonychus* paralarvae - 2003



Distribution of *Berryteuthis anonychus* paralarvae - 2004



Key results of paralarval surveys

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^{o}N)

Key results of paralarval surveys

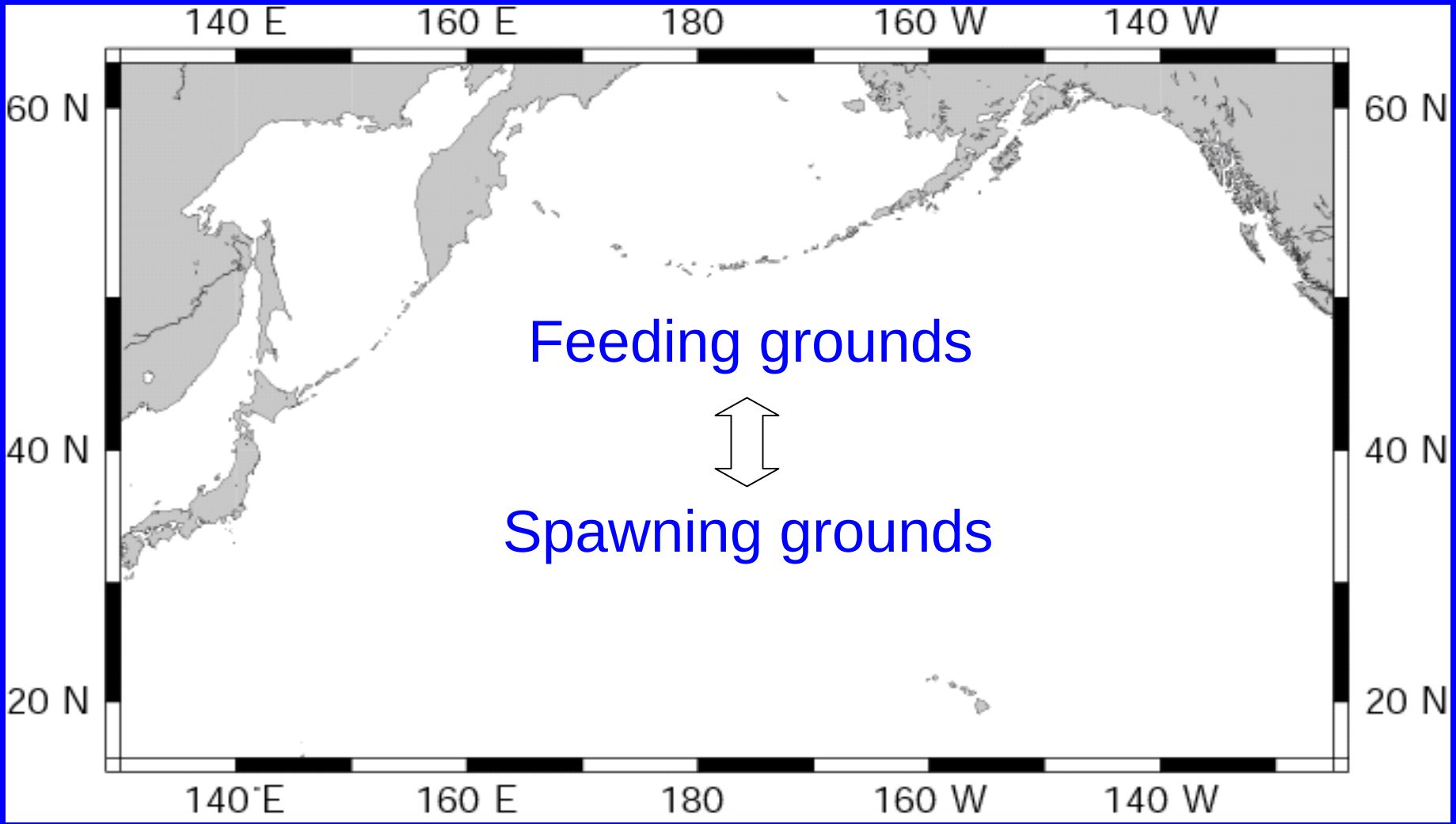
Berryteuthis anonychus paralarvae:

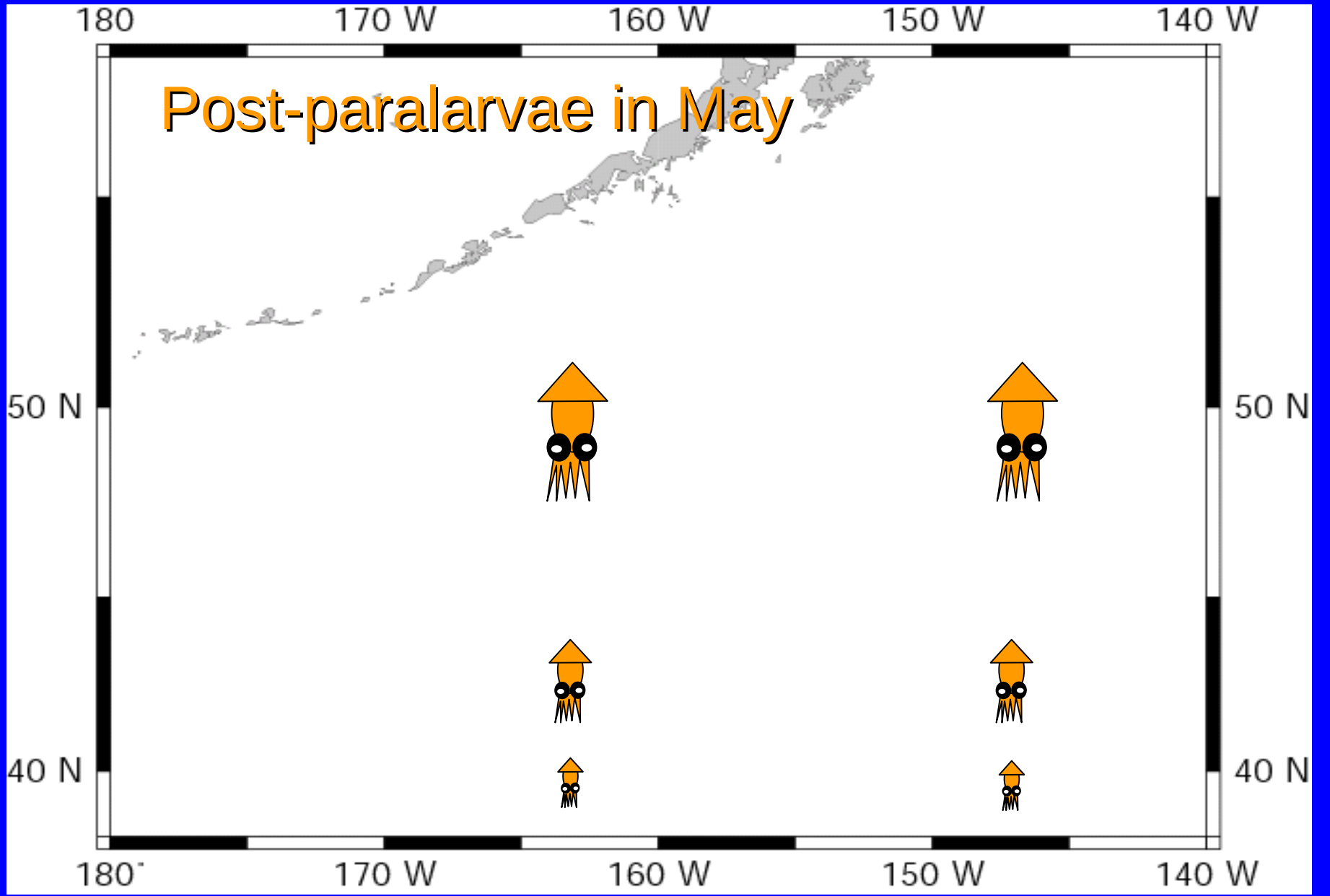
1) are abundant in the Northeast Pacific

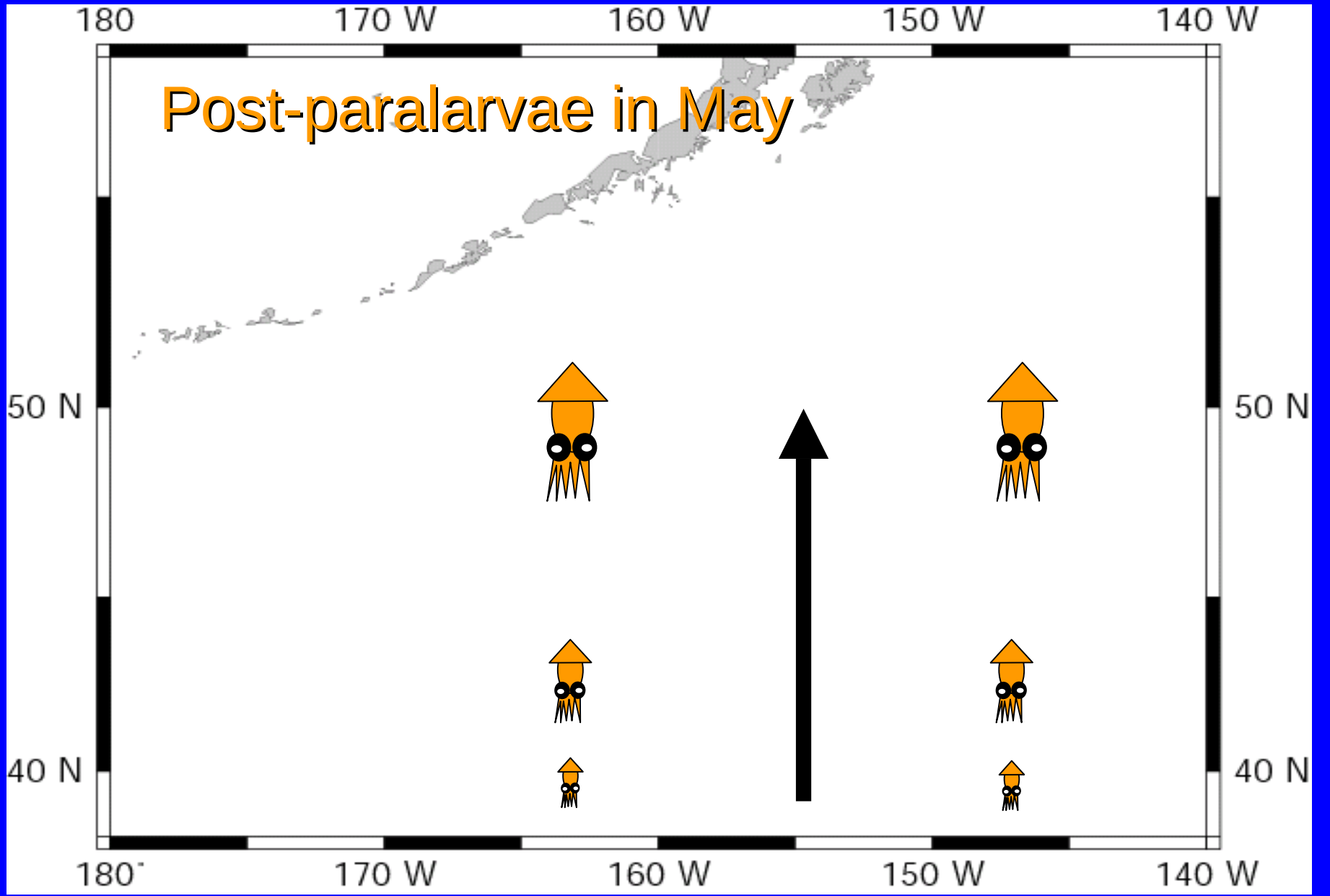
2) have a wide latitudinal distribution (42-54^{o}N)

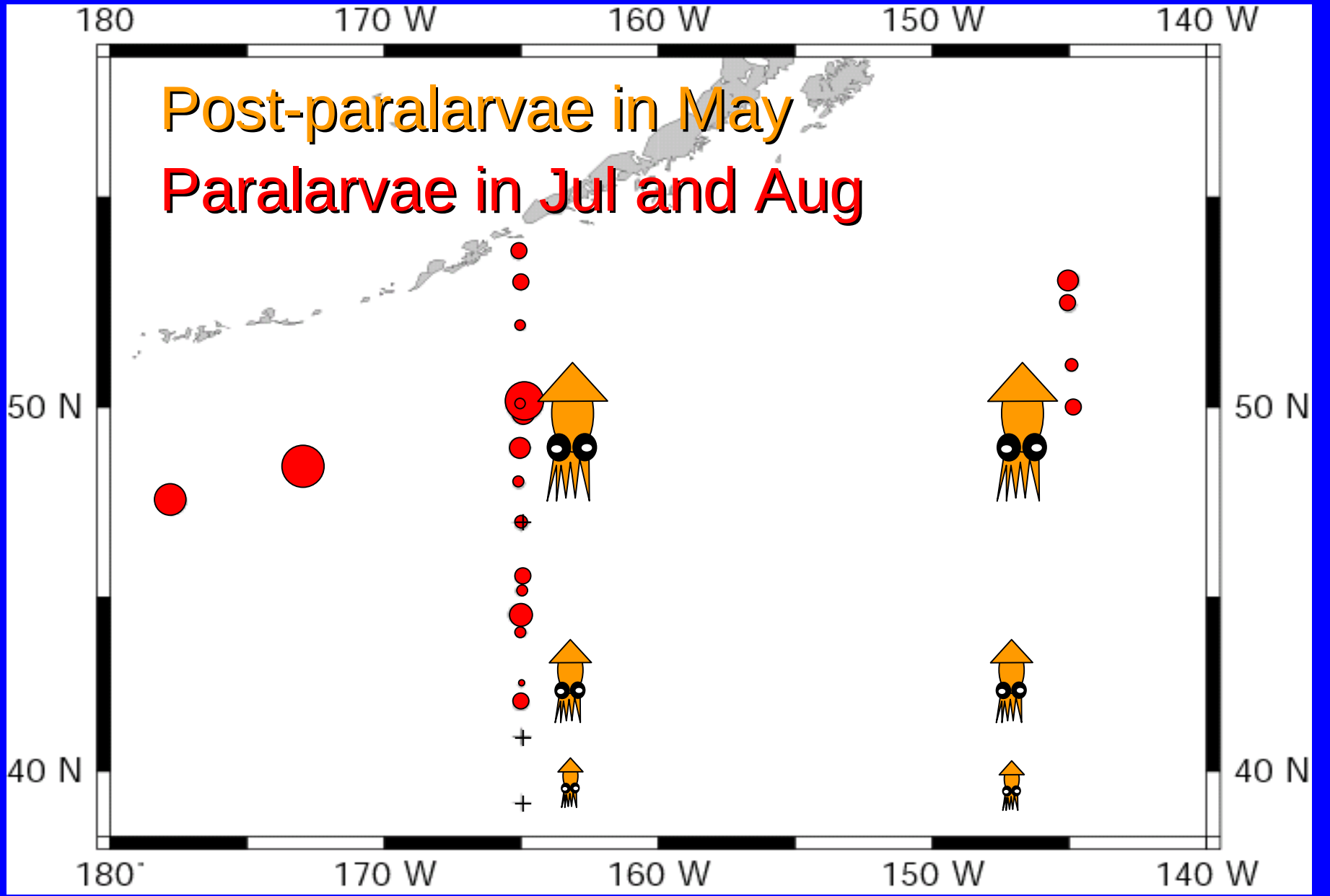
3) occur north of the Subarctic Boundary

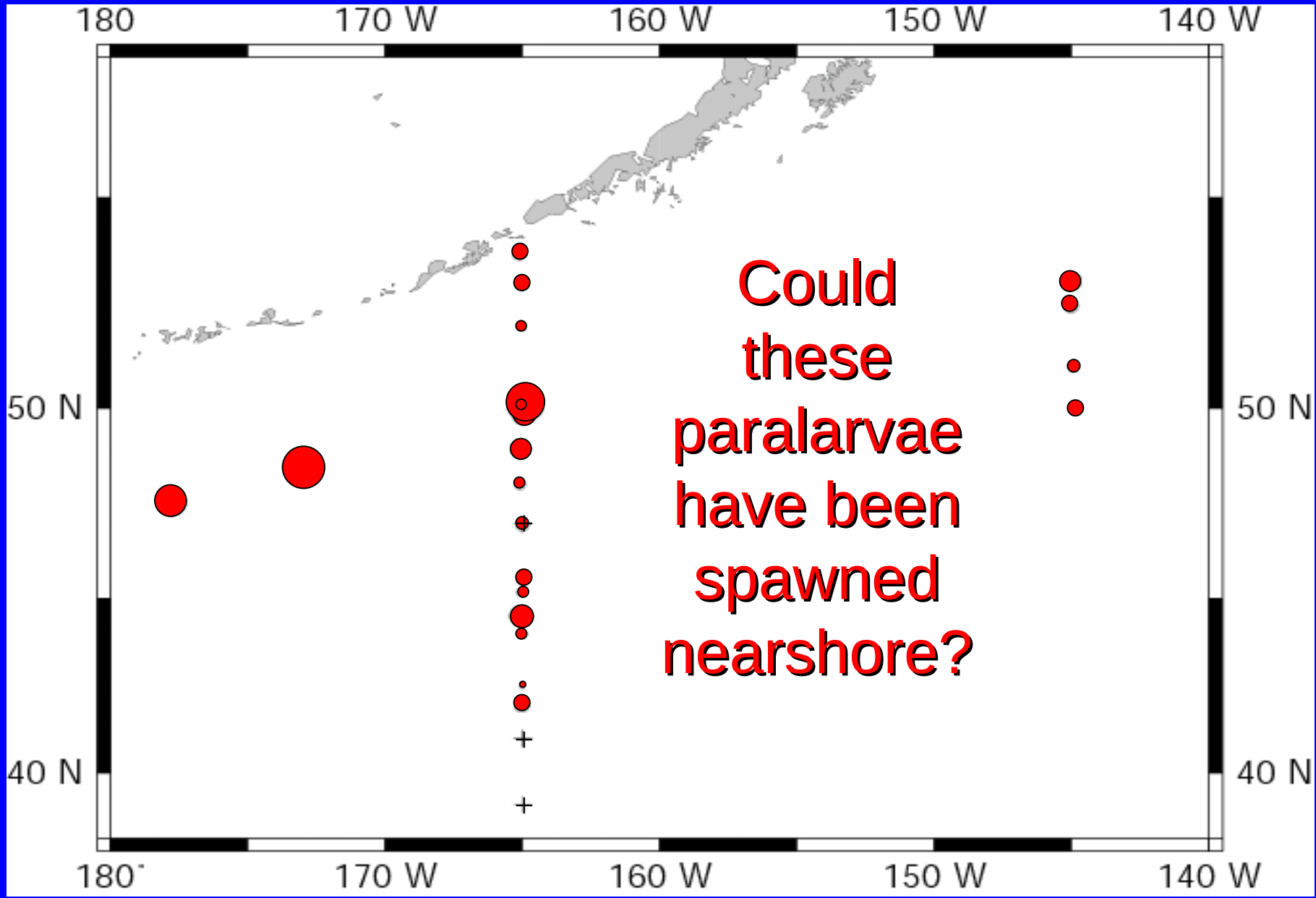
Common migration pattern of squid in the North Pacific




Post-paralarvae in May
180
170 W
160 W
150 W
140 W
50 N
40 N


Post-paralarvae in May
180
170 W
160 W
150 W
140 W
50 N
40 N
180
170 W
160 W
150 W
140 W


Post-paralarvae in May
Paralarvae in Jul and Aug
180
170 W
160 W
150 W
140 W
50 N
40 N


180
170 W
160 W
150 W
140 W
50 N
40 N
Could these paralarvae have been spawned nearshore?

Giant Pacific Octopus
(Enteroctopus dofleini)

Giant Pacific Octopus
(Enteroctopus dofleini)

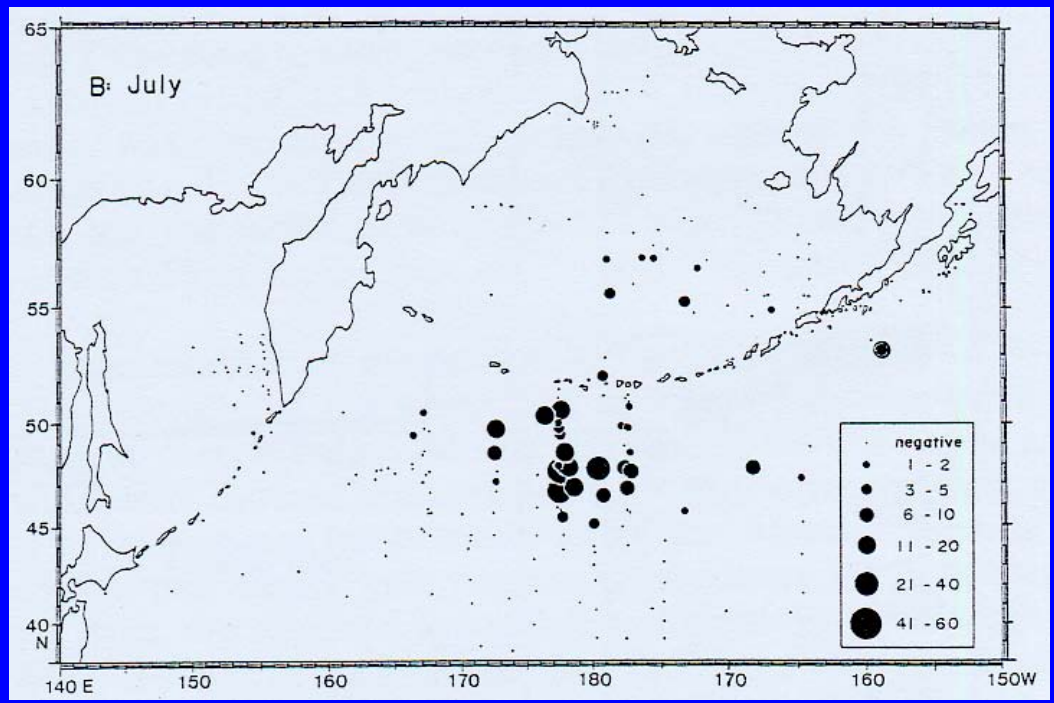

(photo by David Scheel)


a benthic spawner in coastal waters

(photo by Paul Hughes)

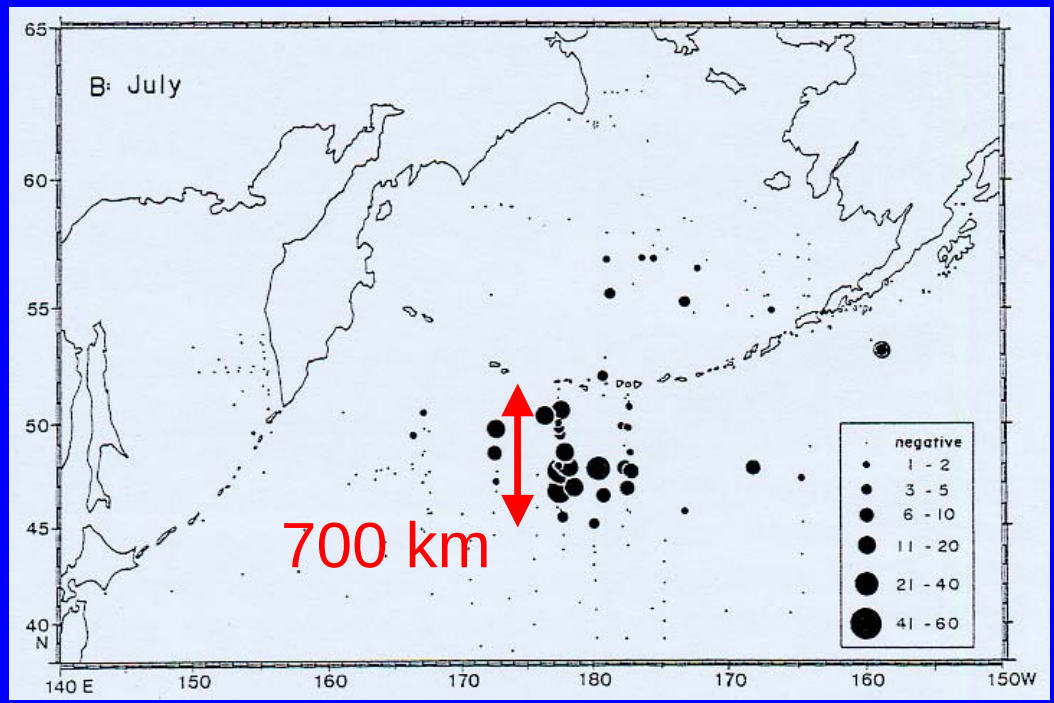
Giant Pacific Octopus *(Enteroctopus dofleini)*

Distribution of Giant Pacific Octopus paralarvae (Kubodera, 1991)



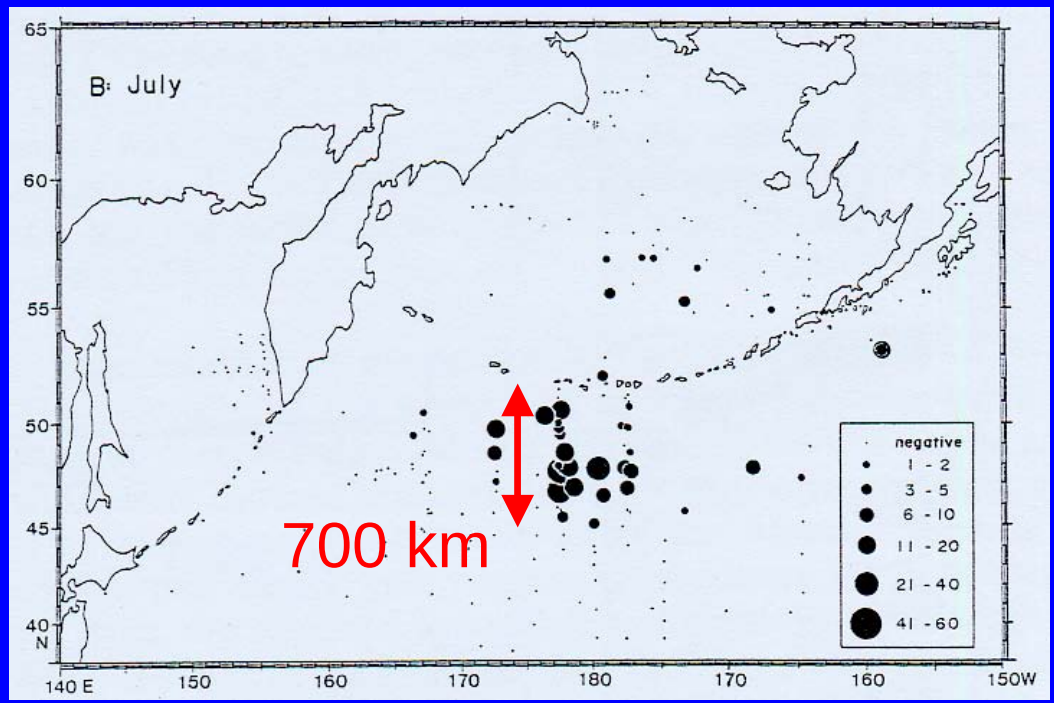
Giant Pacific Octopus *(Enteroctopus dofleini)*

Distribution of Giant Pacific Octopus paralarvae (Kubodera, 1991)

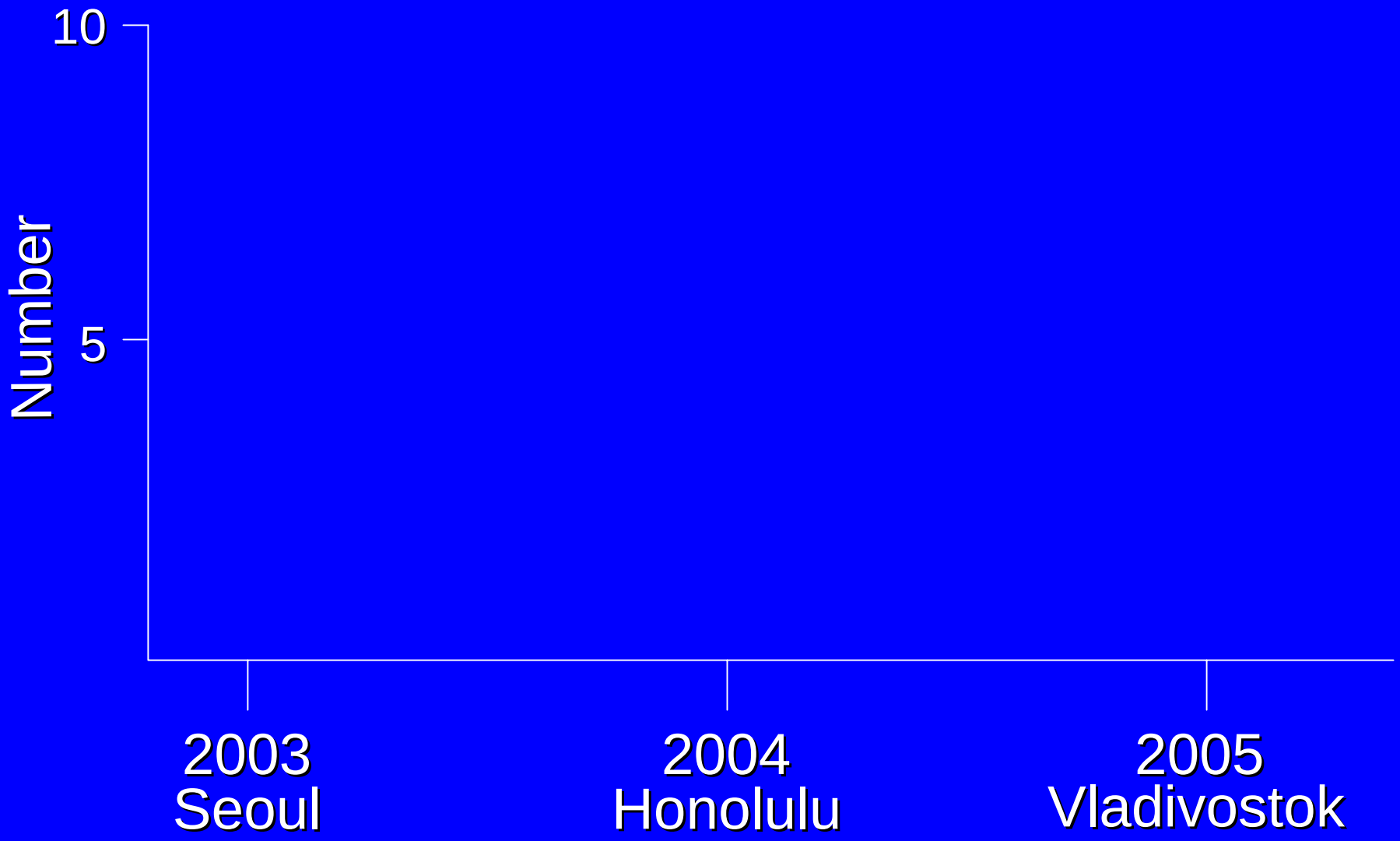


Giant Pacific Octopus *(Enteroctopus dofleini)*

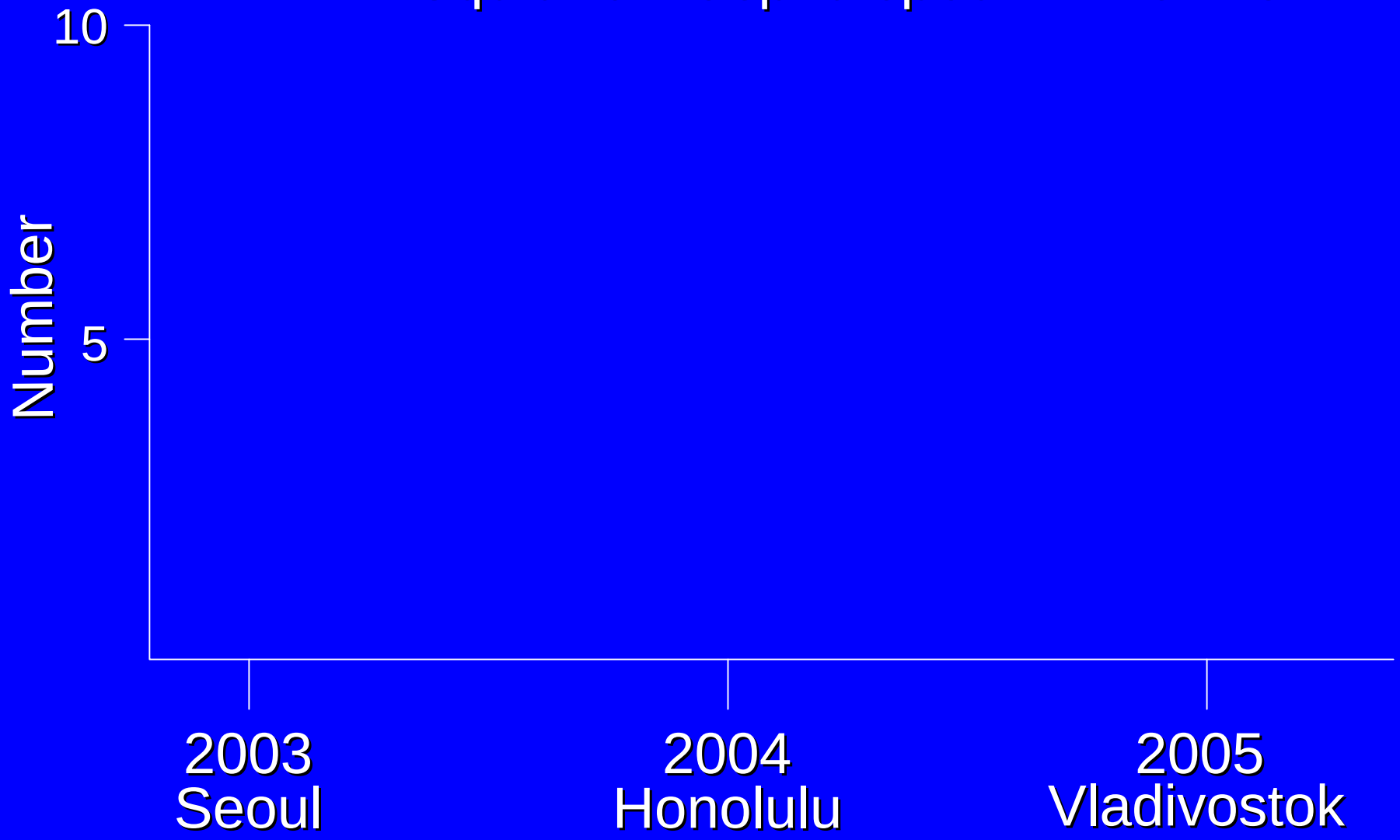
Distribution of Giant Pacific Octopus paralarvae (Kubodera, 1991)



More study is needed


10
5
Number
2003
Seoul
2004
Honolulu
2005
Vladivostok

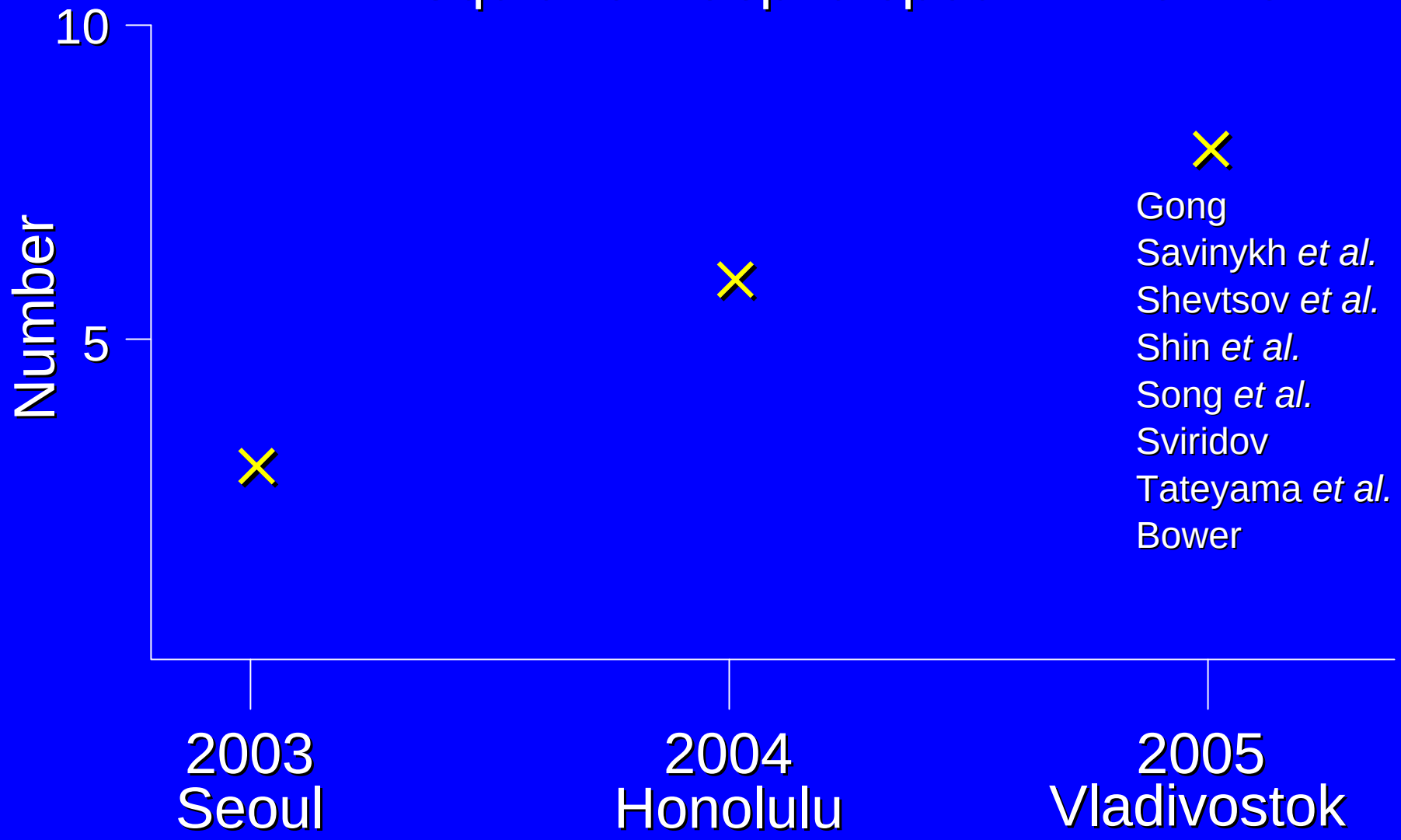
Presentations at the PICES annual meeting with “Squid” or “Cephalopod” in the title



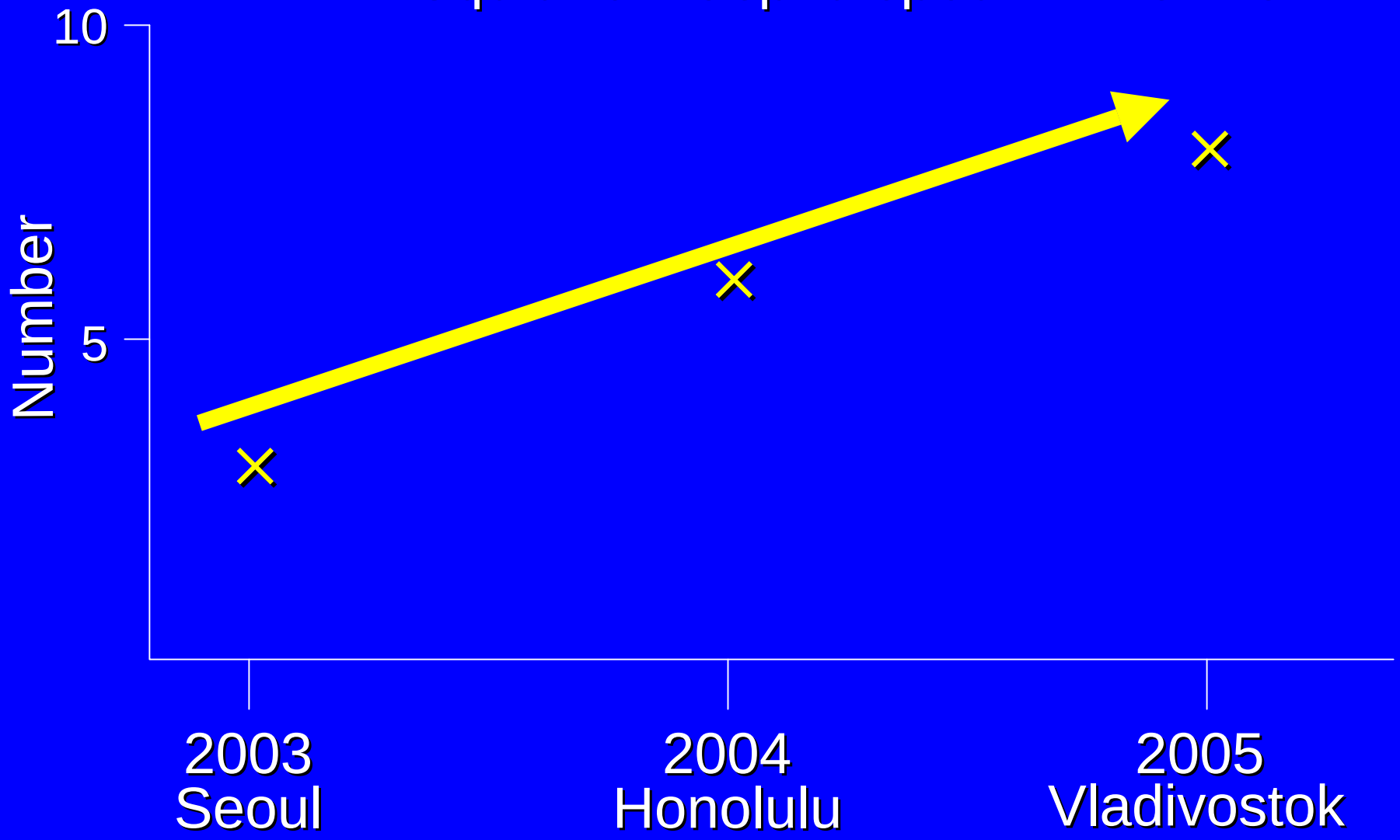
Presentations at the PICES annual meeting with “Squid” or “Cephalopod” in the title

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

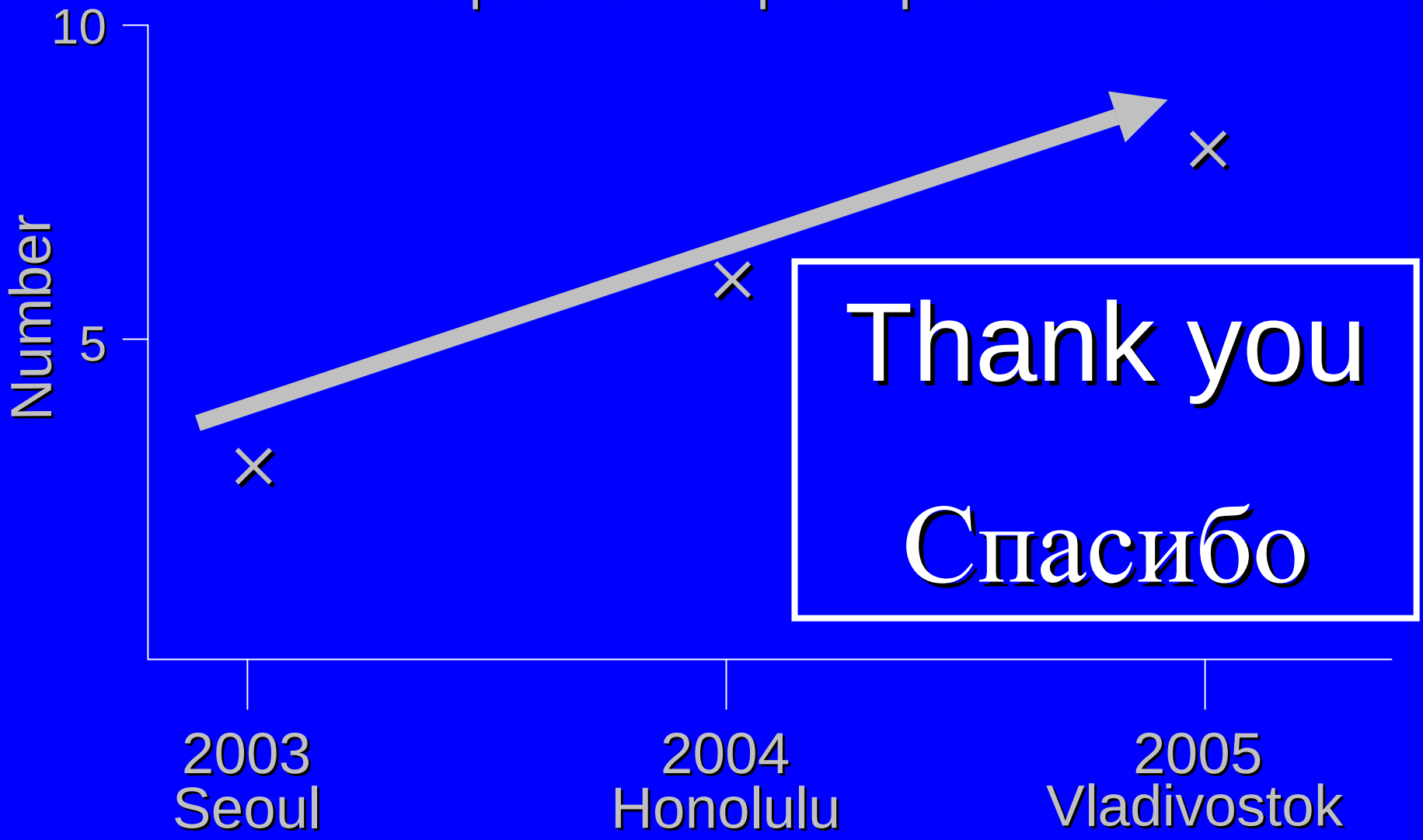
Presentations at the PICES annual meeting with “Squid” or “Cephalopod” in the title



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



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



Thank you

Спасибо