Distribution and Ecology of Leptocephali in the western North Pacific Gyre Ecosystem

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Outline of Presentation

I. Eels and leptocephali
   - Biodiversity of eels
   - Reproductive ecology of eels
   - Unique leptocephalus larva
   - Ecology of leptocephali in epipelagic zone

II. Research on leptocephali
   - East China Sea
   - Kuroshio Extension
   - Western North Pacific
   - Connectivity of the WNP Gyre

III. Future Research
   - Clarify life histories of abundant species
   - Evaluate migration and recruitment
   - Develop identification techniques
   - Ecological significance of leptocephali
Marine eels use almost all habitats in the ocean and are often abundant in shallow water areas.
Reproductive ecology of most species is poorly known.

Spawning locations vary widely from no migration to long distance migrations.
Leptocephali Vary Widely in Size

Bigger Than Human Beings

4 mm

9 mm

250 mm
A Wide Variety of Body Shapes

Variation in body depth, gut morphology, pigmentation
A Wide Variety of Head Shapes
Ecology of Leptocephali

Feeding Biology is Poorly Known

- No zooplankton or large food items ever seen in their guts
- Appear to feed on marine snow or discarded larvacean houses
- Gain nutrition at bacterial level

Larvaceans filter small particles using gelatinous houses that they discard frequently when clogged

Mochioka and Iwamizu (1996)
Ecology of Leptocephali

Leptocephali can Swim both Forward and Backwards and are Completely Transparent

A Variety of Pigmentation Patterns likely Function as Disruptive Coloration to help Avoid Predation
Ecology of Leptocephali

Leptocephali are found in the upper Epipelagic Zone

Growth Rates may vary 0.3 - >1 mm/d

Some may vertically migrate deeper during the day
Leptocephali change during metamorphosis.

Triggers of this transformation are not yet known.

The large size of leptocephali results in large sizes of juveniles that recruit to many different habitats.
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Leptocephali are often Abundant but Special Gear is Needed to Collect Them Due to Net Avoidance
Techniques for Collecting Leptocephali

Criteria: Large mouth opening nets fished at night to reduce net avoidance

- Isaacs Kidd Midwater Trawl (IKMT) 8.7 m²
- Large ORI Ring Net 7.1 m²
- Large Mouth Rectangular Nets 6-10 m²
Stations sampled for Leptocephali

8 Cruises
Sampling in the Kuroshio Current and East China Sea

Tansei Maru
KT-00-16

2,376 Leptocephali
> 45 Species

1) East China Sea

NRL MODAS SST 30 Nov 2000

Higher Catch Over Shelf
Clouds
NOAA-14 SST
Kuroshio Current
Marine eels were Spawning
Congridae
Muraenidae
Nettastomatidae
Ophichthidae
Synaphobranchidae
Small Leptocephali
< 10 mm
> 9 species

24 Dec
2000
Taiwan
Distribution of size classes of *Gnathophis* spp. (Congridae) and *Dysomma* sp. (Synaphobranchidae) leptocephali

**Evidence of Recent Spawning**

**Evidence of Northward Transport**
A wide range of sizes Ophichthidae and Muraenidae leptocephali were collected primarily over the continental shelf. Ariosoma may spawn after short migration offshore. Spawning more over shelf than slope.
Marine eel Spawning in the East China Sea

Congridae
Muraenidae
Nettastomatidae
Ophichthidae
Synaphobranchidae

Ariosoma???

NOAA-14 SST

24 Dec 2000
Offshore Transport and Currents

Sea Surface Chlorophyll/Productivity

North Equatorial Current (NEC)

Kuroshio Extension

Complex Circulation

North Equatorial Countercurrent
3 April 2006

NOAA-14 SST

Korea

Japan

Complex hydrographic structure
2) Kuroshio Extension

KH-06-1 Hakuho Maru Cruise
12 Jan – 13 Mar 2006
36 stations w/ single MOHT tow in upper 100 m

1,368 Leptocephali
>39 species of 13 families
Leptocephali Collected in Kuroshio Extension and Recirculation Region

Mesopelagic eels (< 3-5 spp.?)
Nemichthyidae N = 105
Serrivomeridae N = 61

![Histogram of Serrivomer (N = 42)]

- Total length (mm)
- No. leptocephali

![Histogram of Nemichthys (N = 96)]

- Total length (mm)
- No. leptocephali
Leptocephali Collected in Kuroshio Extension and Recirculation Region

Shelf and Slope eels
Congridae (12 spp.) N = 1079
Chlopsidae (5 spp.) N = 15
Muraenidae (>7 spp.) N = 33
Ophichthidae (2 spp.) N = 3
Nettastomatidae (3 spp.) N = 40
Synaphobranchidae (2 spp.) N = 18

Congridae – 4 most abund. spp.
Gnathophis (>3 spp.) N = 615
Ariosoma major  N = 249
Ariosoma sp. 4  N = 88
Bathycongris sp.  N = 93

4 Abundant congrids

- Gnathophis
- Ariosoma major
- Ariosoma sp. 4
- Bathycongris
Proportional Abundance of Leptocephali in the Kuroshio Extension

Congridae was Dominant

Congrids

A. major

Gnathophis

Nemichthidae
Serrivomeridae
Gnathophis
Ariosoma major
Congridae
Ariosoma
Some Ariosoma etc.
recirculated south

KH-06-1

A. major
A. sp. 4
Dysomma
Gnathophis

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A. major
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Gnathophis
3) Western North Pacific

Japanese eel *Anguilla japonica* spawns in the NEC

Tropical Giant Mottled eel *Anguilla marmorata* also spawns in NEC
Ariosa major (Congridae) Leptocephali Consistently Collected in NEC Region at Large Sizes (~100 – 300 mm)

A variety of other species have been collected in NEC region
Ariosoma major may be abundant in East Asia

Their leptocephali are one of the most abundant species in parts of the W. North Pacific

Leptocephali Reach Very Large Sizes
Ariosoma major Leptocephali in the NEC Region

Sampling for Leptocephali 7 Cruises 1995 - 2006

1991 transects
Large Sized *Ariosoma major* Leptocephali in NEC Region May to September of 8 different Years

Total Length vs Date of Collection Plot

- **N = 455**
- Graph shows total length (mm) vs day of year (30 April to 7 October)
Ariosoma major Leptocephali are Smaller Elsewhere

- 70 – 110 mm
- 64 – 239 mm
- 40 – 56 mm
- 100 – 300 mm
Huang and Qiu (1994)
Ecology of Leptocephali in Kuroshio Gyre

Kobayashi et al. 2006  J. Geophys Res.

Variety of species get transported offshore into the Kuroshio Ext. etc.

Congrids appear to be the most abundant in Kuroshio recirc.

Seasurface Dynamic Height in North Pacific

- Two Countercurrents also Present -

Whole gyre is used by leptocephali but seasonal patterns unknown

Summary

How many species other than Anguilla recruit back???
3) Future Research

1) Life histories of eels and their leptocephali
   -distribution of leptocephali and otolith studies

2) Evaluate larval transport and recruitment mechanisms
   -how do leptocephali return to adult habitats
   -how many are lost due to offshore transport

3) Develop species level identification of leptocephali
   -both morphological and genetic techniques

4) Ecology or “functional biodiversity” of leptocephali
   -develop conceptual model for significance of
   leptocephali and eels in marine ecosystems
Much Awaits to be Learned About Leptocephali in the Epipelagic Layer of the Ocean