

THE TORNABENE LAB AND SPECIATION IN THE PLEURONECTIDAE (FLATFISH)

CALDER
ATTA

University of
Washington

January 10, 2019

Workshop on Molecular
Systematics and
Evolution
The lab of Molecular
Systematics & Ecology
Shanghai Ocean
University
Shanghai



Hawaii



CANADA

WASHINGTON

MONTANA

NORTH DAKOTA

IDAHO

WYOMING



BOSTON UNIVERSITY

W

UNIVERSITY of WASHINGTON

NEVADA

UTAH

COLORADO

NEBRASKA

IOWA

ILLINOIS

INDIANA

OHIO

PENNSYLVANIA

KANSAS

MISSOURI

KENTUCKY

WEST VIRGINIA

VIRGINIA

OKLAHOMA

ARKANSAS

TENNESSEE

NORTH CAROLINA

ARIZONA

NEW MEXICO

TEXAS

LOUISIANA

MISSISSIPPI

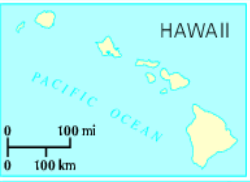
ALABAMA

~~WASHINGTON D.C.~~

FLORIDA

THE BAHAMAS

CUBA



FISH SYSTEMATICS AND BIODIVERSITY LAB

<https://www.fishsystematics.com>



**Dr. Luke
Tornabene**



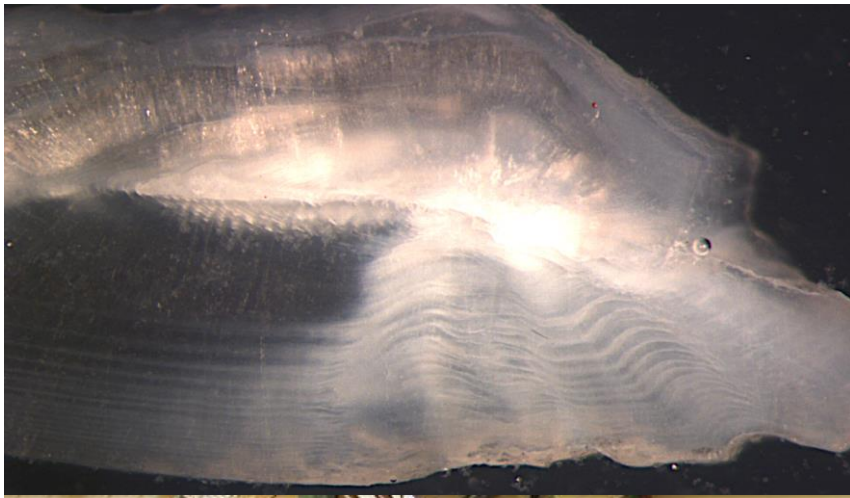
Burke
MUSEUM

Fish Collection

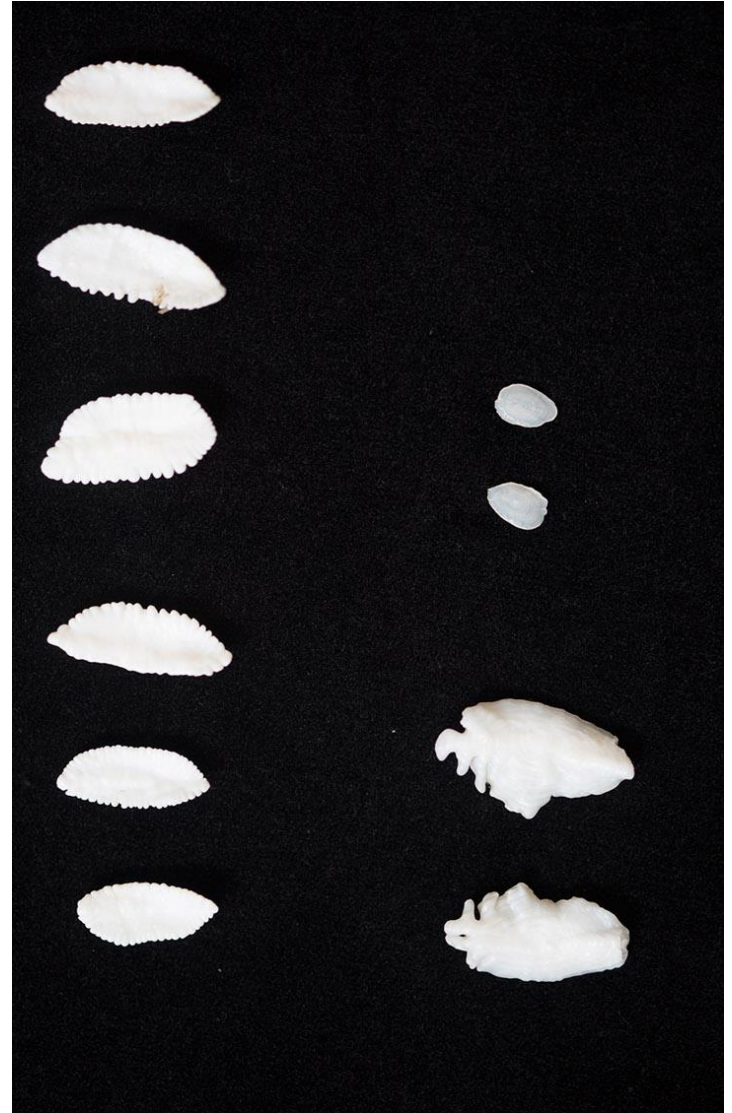


~ 9 million larvae and eggs





~ 2.5 million otolith pairs





Burke
MUSEUM

Fish Collection

- 12.7 million specimens total
 - ~9 million eggs and larvae • 4100 species
 - ~2.5 million otolith pairs • 300 families
 - 800,000 salmon scale samples • 10,000 tissue
 - 400,000 adults and juveniles samples
- Focus on Northeast Pacific fishes
- Can search for specimens at:
<http://www.burkemuseum.org/research-and-collections/ichthyology/collections/database/search.php>

Ichthyology Collections Database

BASIC SEARCH

ADVANCED SEARCH

SEARCH HELP

FIELD DESCRIPTIONS

You are accessing 187045 specimen records, updated last on September 7th, 2018

Field	Operator	Search Value
Family:	equals	<input type="text"/>
Genus (Show List):	<input type="text" value="equals"/>	<input type="text" value="atheresthes"/>
Species (Show List):	<input type="text" value="equals"/>	<input type="text" value="stomias"/>
Common Name (Show List):	<input type="text" value="contains"/>	<input type="text"/>
<input type="text" value="Catalog number"/>	<input type="text" value="contains"/>	<input type="text"/>
<input type="text" value="Field number"/>	<input type="text" value="contains"/>	<input type="text"/>
Region:	equals	<input type="text"/>
<input type="text" value="Country"/>	<input type="text" value="contains"/>	<input type="text"/>
<input type="text" value="Collector"/>	<input type="text" value="contains"/>	<input type="text"/>
Latitude:	<input type="text" value="is less than"/>	<input type="text"/>
Longitude:	<input type="text" value="is less than"/>	<input type="text"/>
Latitude:	<input type="text" value="is greater than"/>	<input type="text"/>
Longitude:	<input type="text" value="is greater than"/>	<input type="text"/>
Date Collected:	<input type="text" value=""/> (mm) <input type="text" value=""/> (yyyy)	

Search For: All Records Records with Tissue Samples

Collection to Search: Adult Larval (elh) Skeleton All

Return: List of All Records Map of All Records

Group Returned Records by: Sort by:

Records per Page: 10 20 50 100

Clear Form Submit

Can also search



<https://www.idigbio.org>

and...



<http://www.fishnet2.net>

↓

Criteria: All records where Genus equals 'atheresthes' and Species equals 'stomias'

Returned: 2175 Records on 44 Pages with Records Per Page

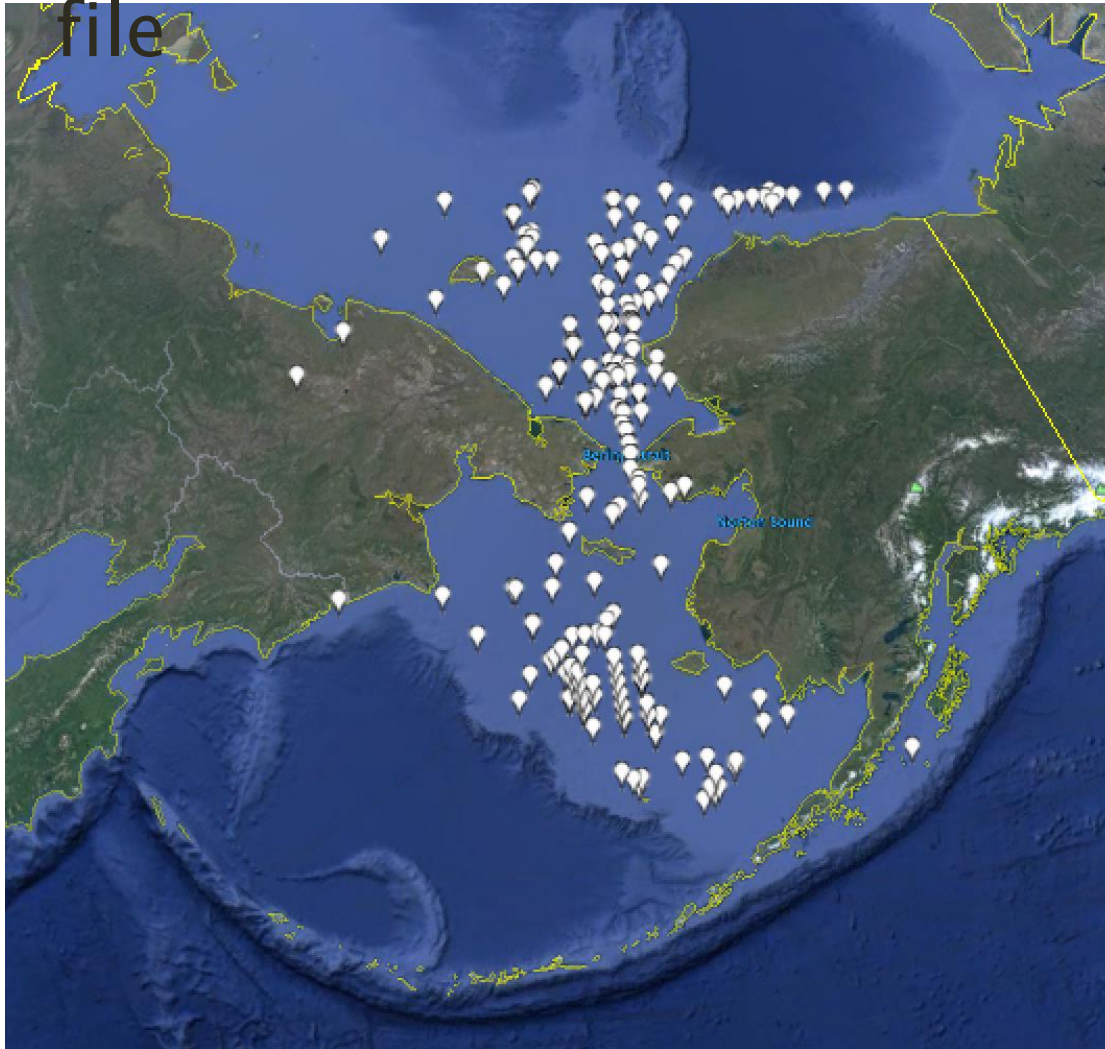
Sorted by [Scientific Name](#) ↑

« Prev [New Search](#) [Map Records](#) Next »

[1](#), [2](#), [3](#), [4](#), [5](#), [6](#), [7](#), [8](#), [9](#), [10](#), [20](#), [30](#), [40](#), [Last Page](#)

Catalog Number	Family	Genus	Species	Region	Date Collected
+ UW 109329	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/28/1998
+ UW 86328	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	7/30/1991
+ UW 168619	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/25/2006
+ UW 169383	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/25/2004
+ UW 128261	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/15/2001
+ UW 50073	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	3/7/1979
+ UW 52549	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	4/9/1990
+ UW 57174	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	3/25/1981
+ UW 61898	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	4/29/1989
+ UW 106312	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/10/1996
+ UW 106422	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/27/1996
+ UW 70052	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	4/13/1978
+ UW 109330	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/29/1998
+ UW 169384	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/25/2004
+ UW 35522	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	4/13/1987
+ UW 37758	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	4/3/1988
+ UW 36238	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/24/1983
+ UW 37266	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	4/14/1982
+ UW 37778	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	4/4/1988
+ UW 106313	PLEURONECTIDAE	ATHERESTHES	STOMIAS	EASTERN NORTH PACIFIC	5/10/1996

.kml
file



For loans contact:



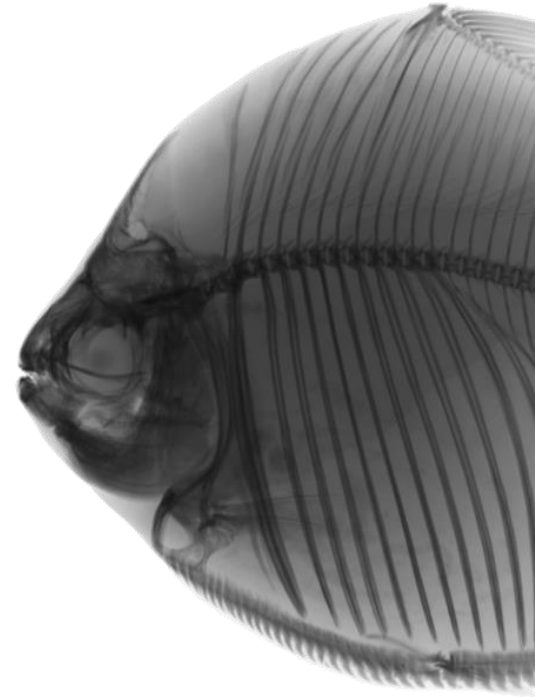
**Katherine Pearson
Maslenikov**
Collections Manager
pearsonk@uw.edu

BACKGROUND

--- Before Grad School ---

Biomechanics of fish jaws

- Functional morphology in tropical river fishes

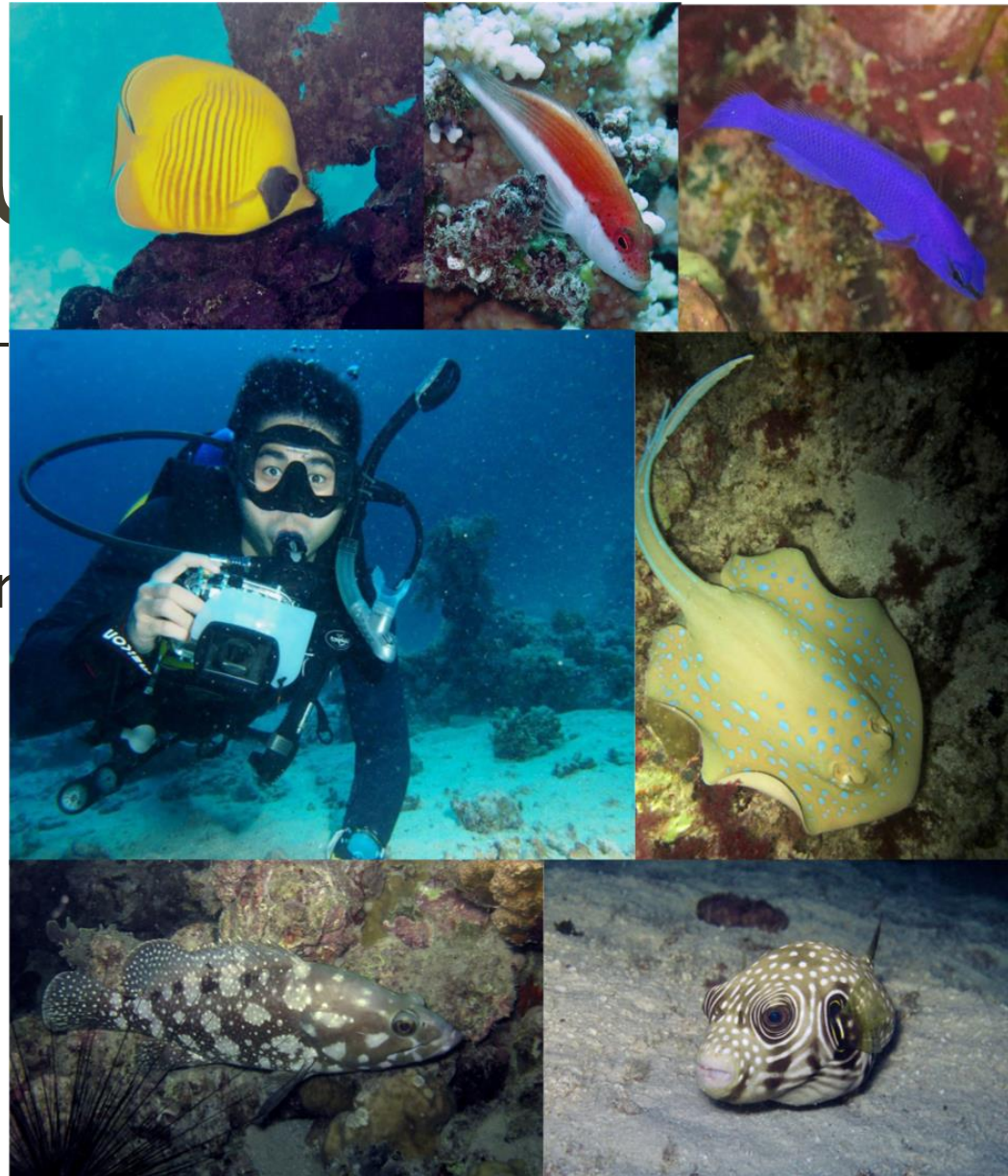


BACKGROUND

--- Before Grad School ---

Biomechanics of fish jaws
▪ Functional morphology in
tropical river fishes

Biodiversity of reef fishes
▪ Hawaii
▪ Red Sea



BACKGROUND

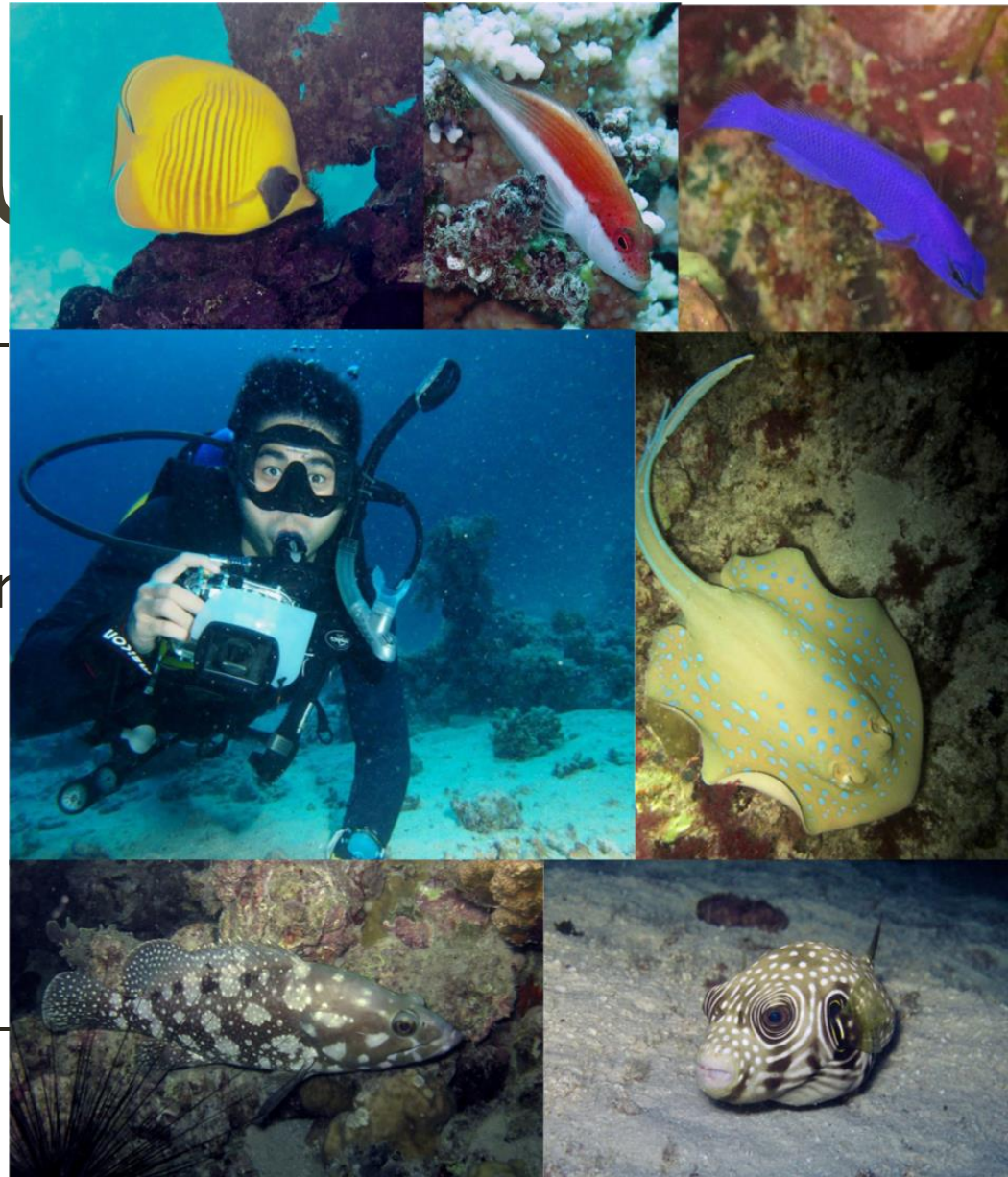
--- Before Grad School ---

Biomechanics of fish jaws
▪ Functional morphology in
tropical river fishes

Biodiversity of reef fishes
▪ Hawaii
▪ Red Sea

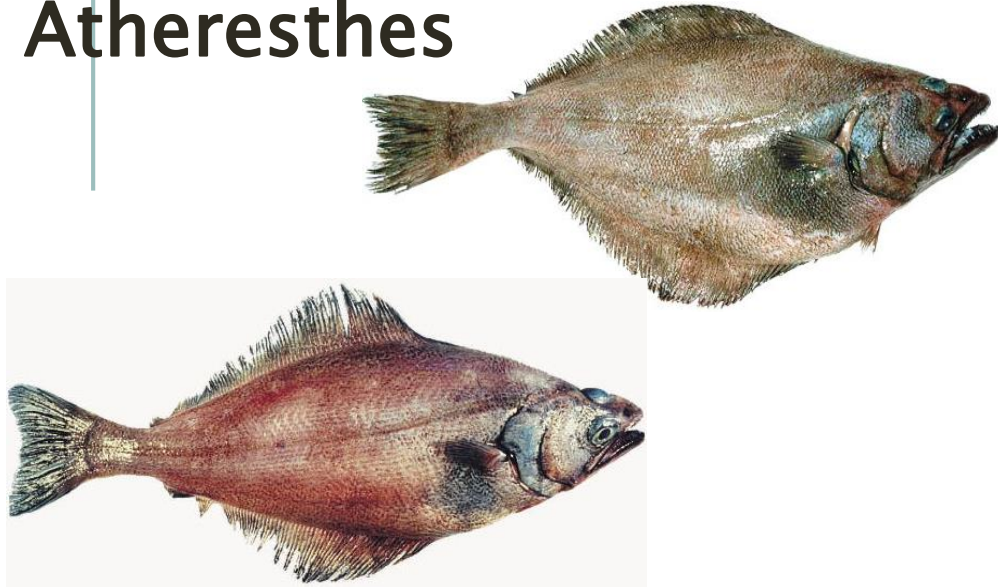
--- Grad School (Now) ---

Phylogenetics of flatfish
(Pleuronectidae)

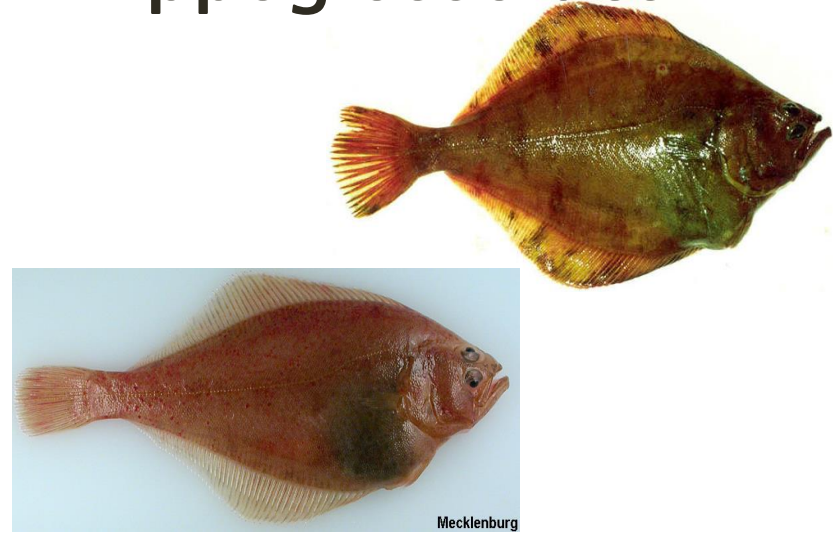


4 Sister Species Pairs

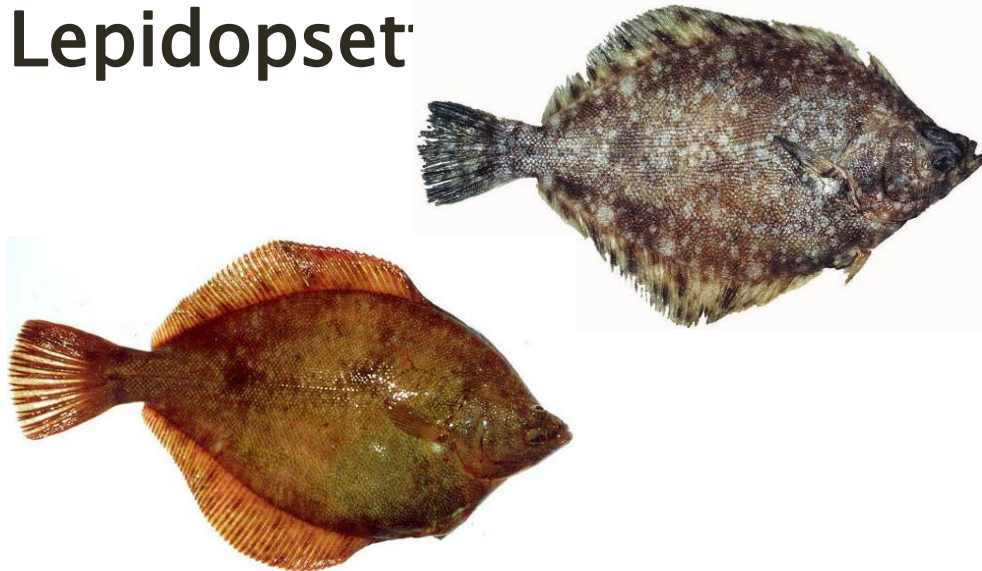
Atheresthes



Hippoglossoides



Lepidopset



Lin

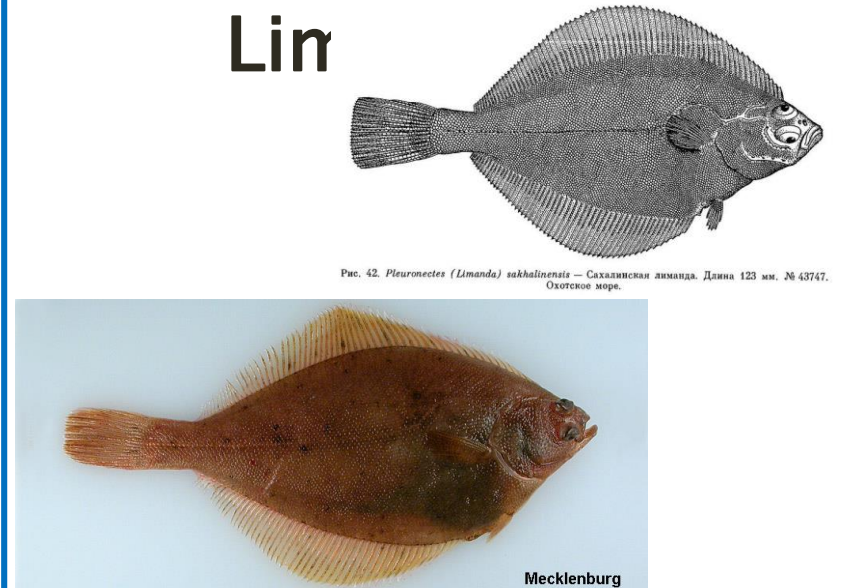


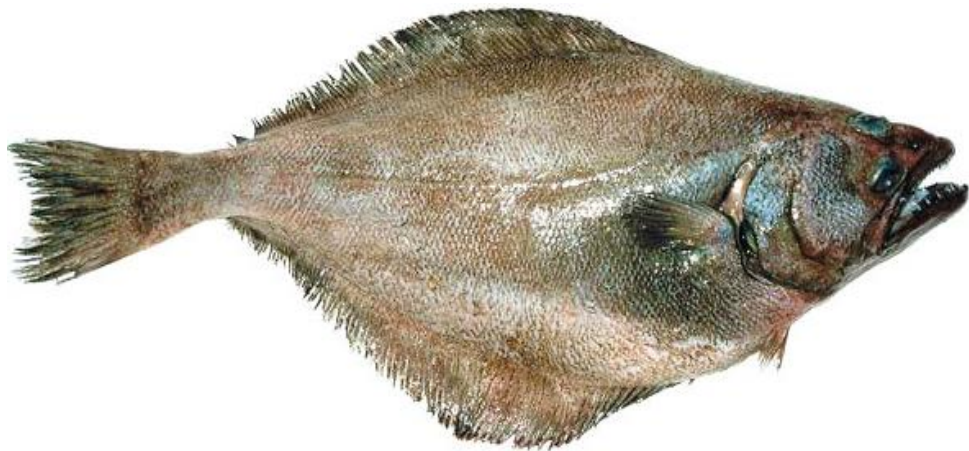
Рис. 42. *Pleuronectes (Limanda) sakhalinensis* — Сахалинская лиманда. Длина 123 мм, № 43747. Охотское море.

HOW DID SPECIATION OCCUR?

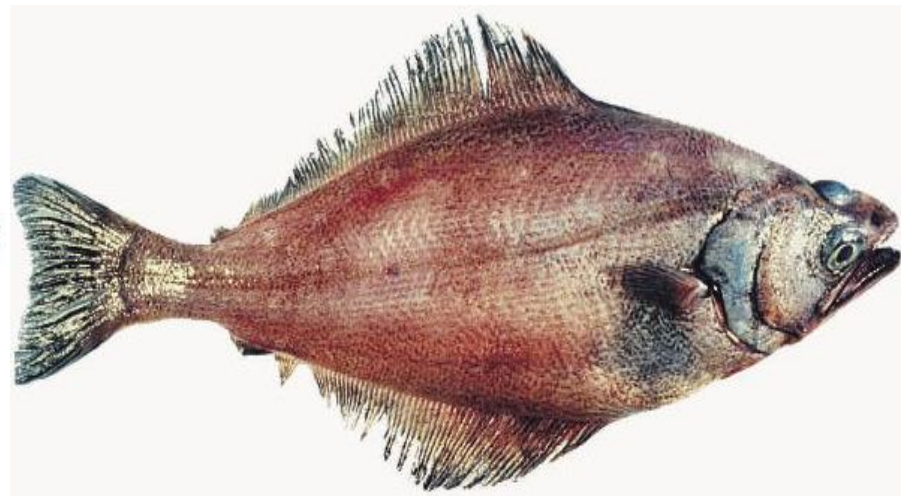
- Speciation is the result of genetic isolation and time.
- Allopatric speciation occurs from separation across a physical barrier.
- Flatfish are very mobile and live in the same homogenous habitat. There is no physical barrier? Did a barrier exist in the past?
- Other modes of speciation (sympatric/parapatric)?

SCENARIOS

1. Sympatric or Parapatric Speciation



Atheresthes evermanni
Arrow-tooth Flounder



Atheresthes stonoi
Kamchatka Flounder

Juvenile Diet



Larval Fish



Euphausiid (Krill)



Larval

SCENARIOS

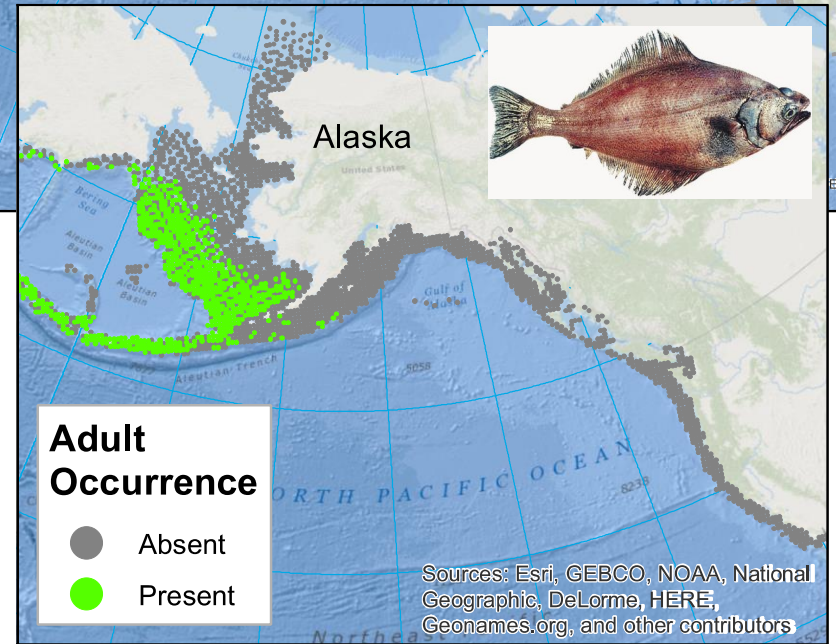
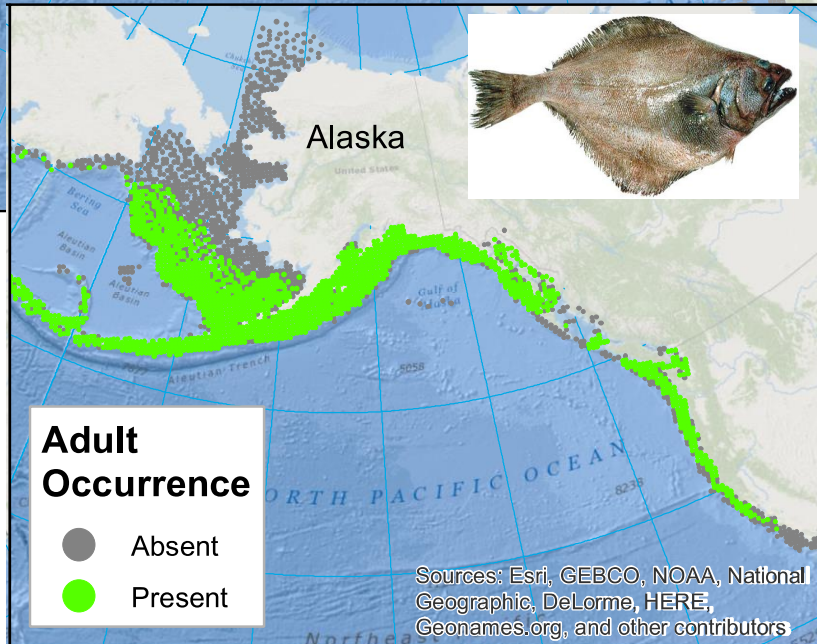
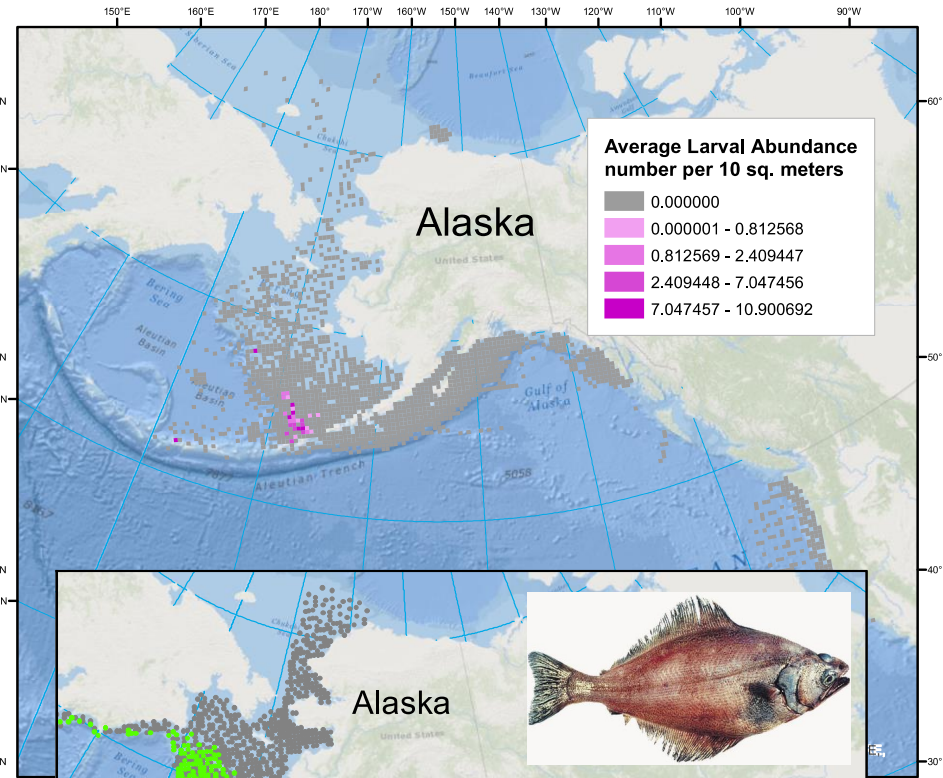
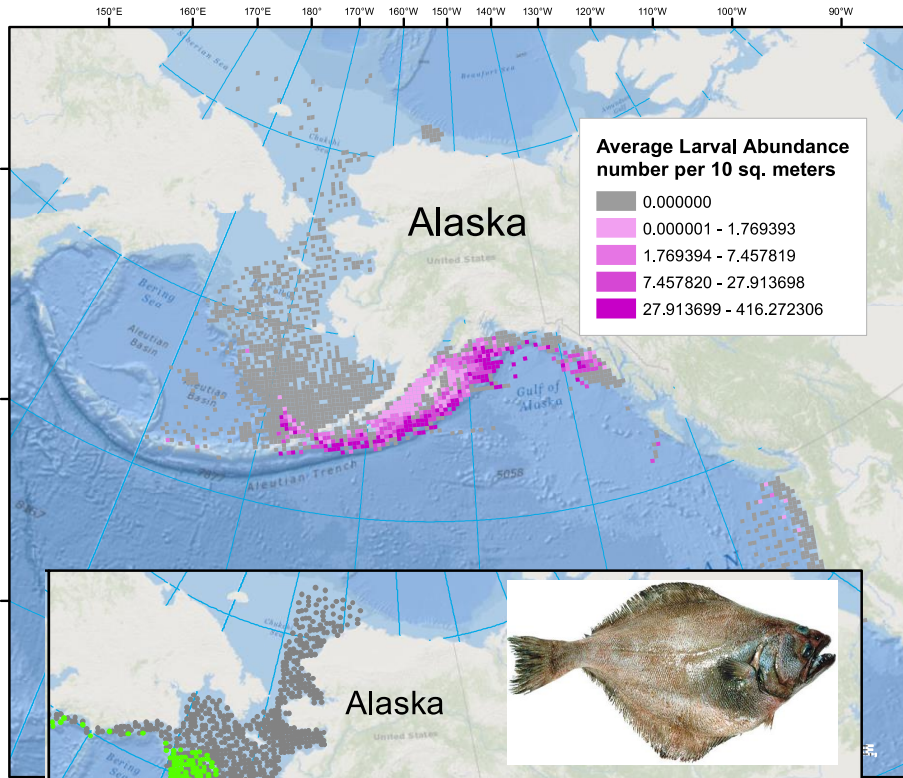
1. Sympatric or Parapatric Speciation
2. Geographic separation of breeding aggregations

Arrowtooth Flounder

Atheresthes stomias

Kamchatka Flounder

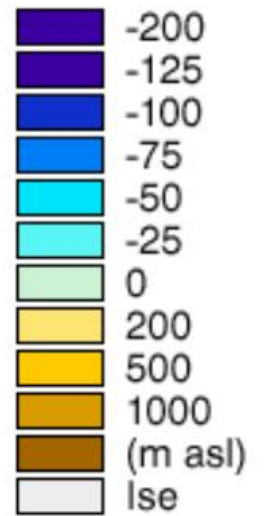
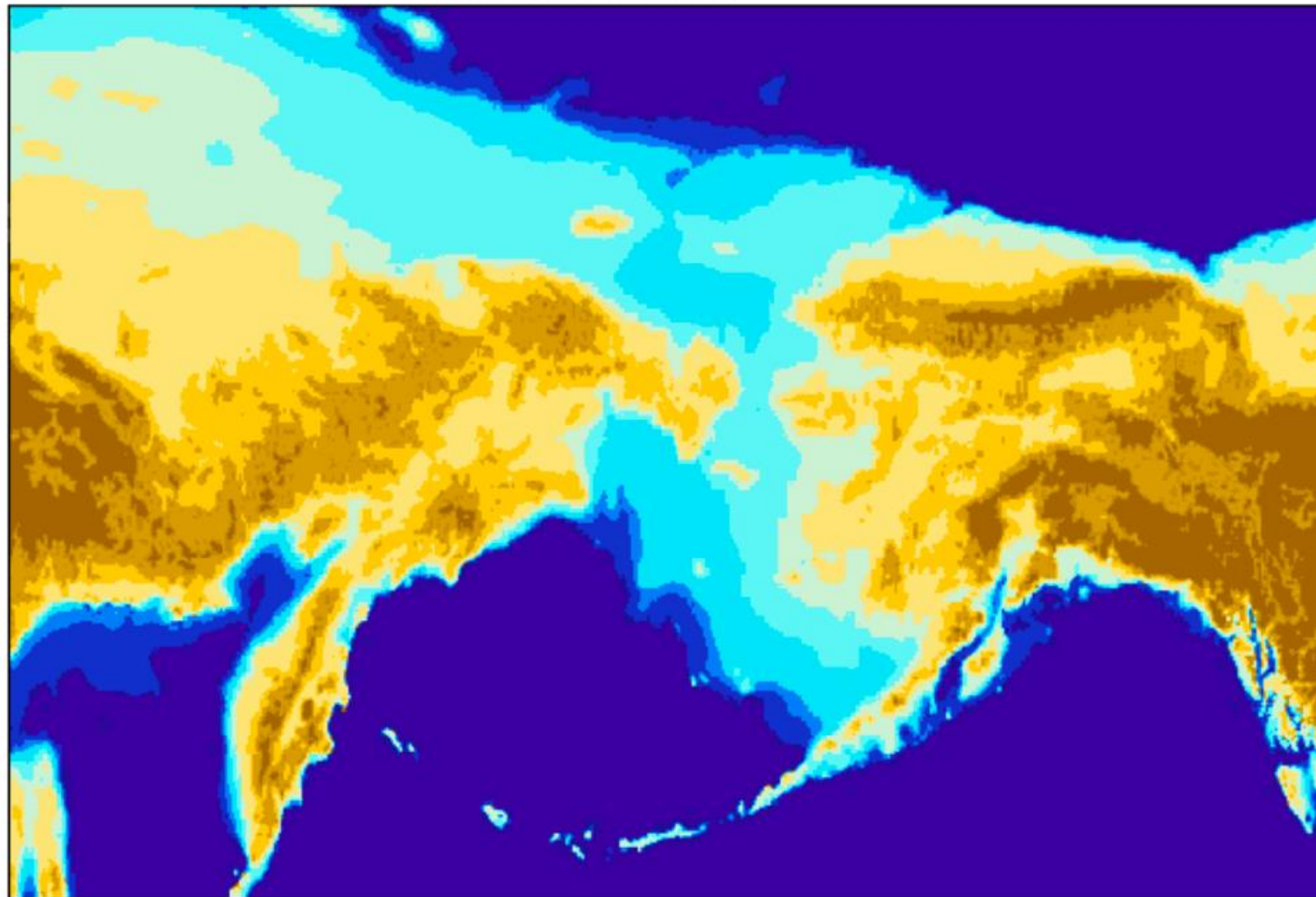
Atheresthes evermanni



SCENARIOS

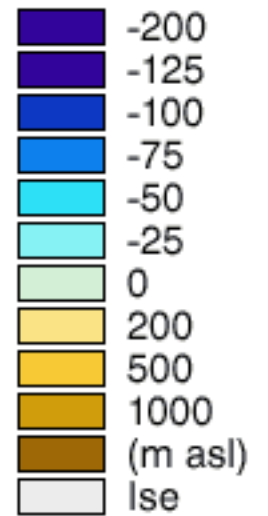
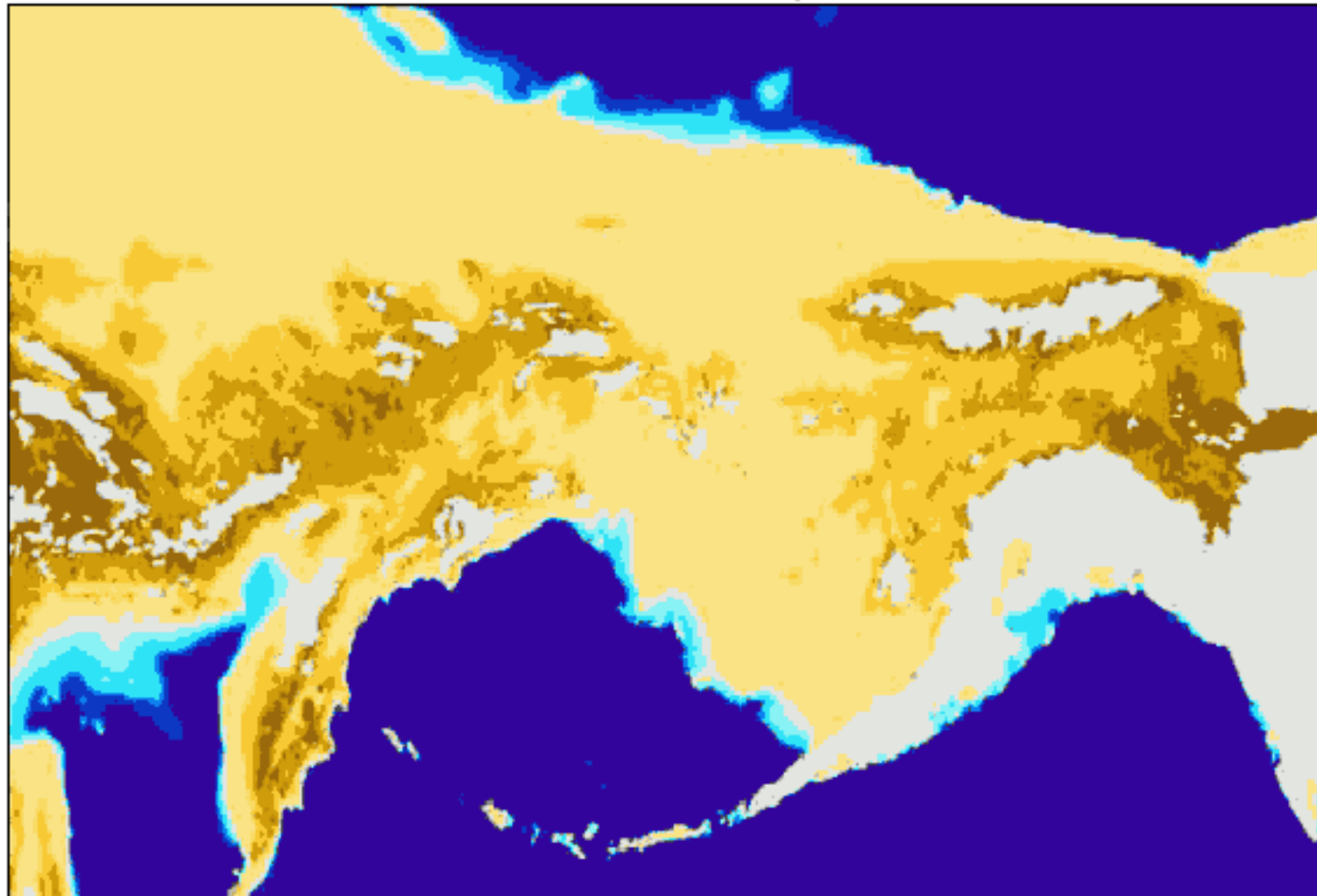
1. Sympatric or Parapatric Speciation
2. Geographic separation of breeding aggregations
3. **Bering Land Barrier**

PALE Paleoenvironmental Atlas of Beringia
Coastline Modern



PALE Paleoenvironmental Atlas of Beringia

Coastline 21,000 Cal years BP



SCENARIOS

1. Sympatric or Parapatric Speciation
2. Geographic separation of breeding aggregations
3. Bering Land Barrier
4. **Latitudinal Climate Shift**

Too Cold

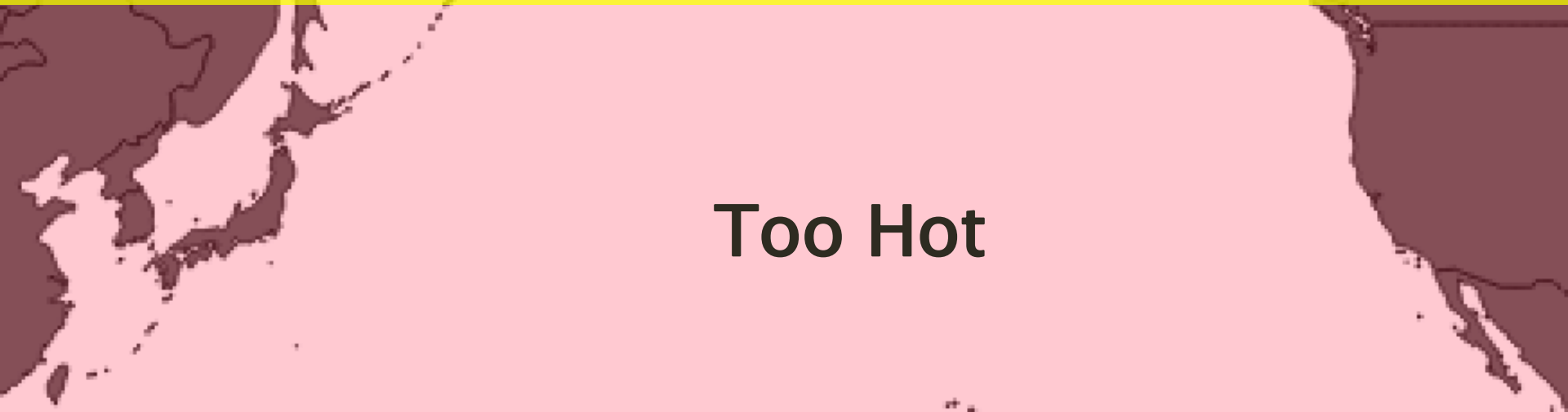


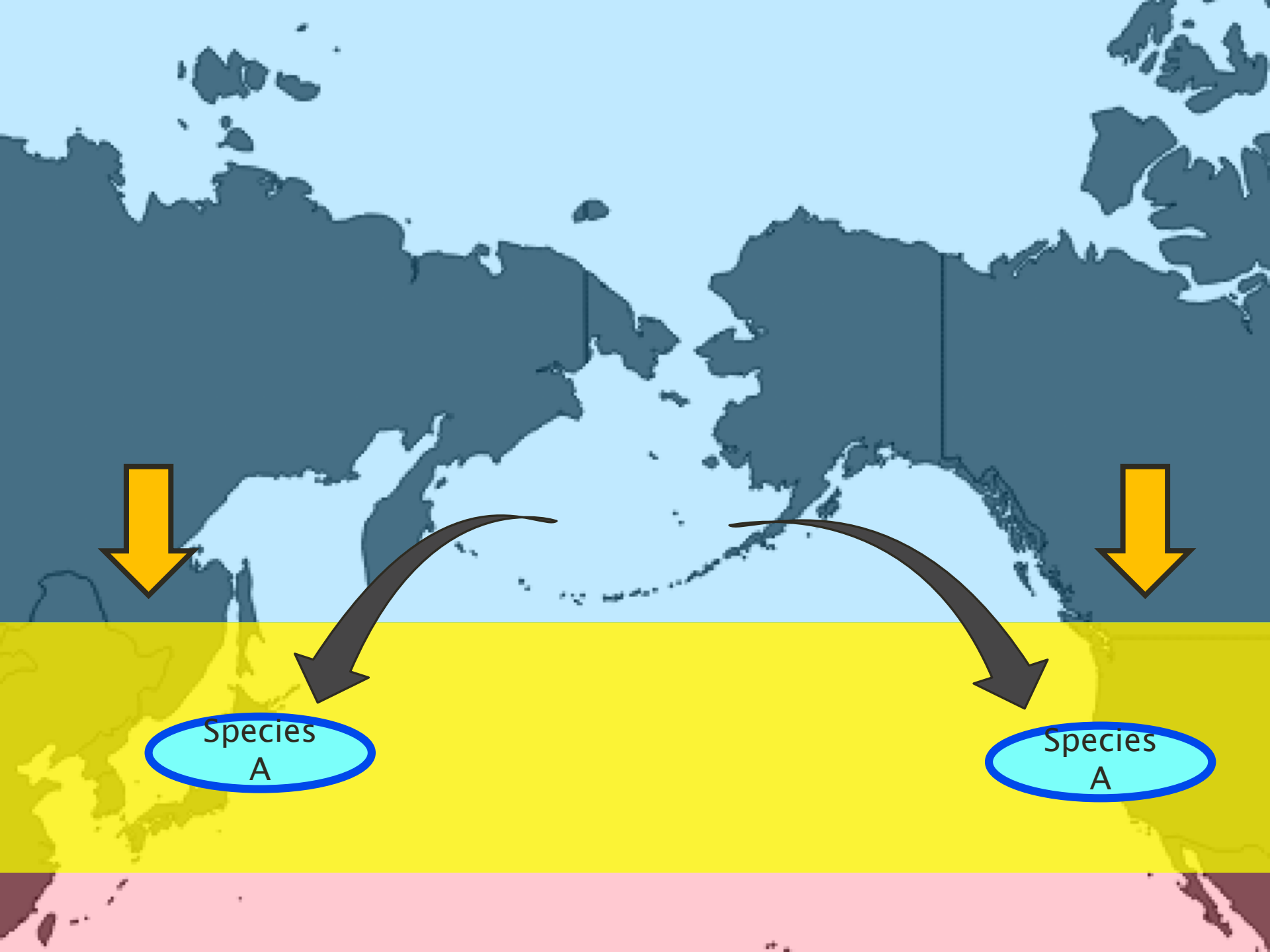
**Suitable
Climate**

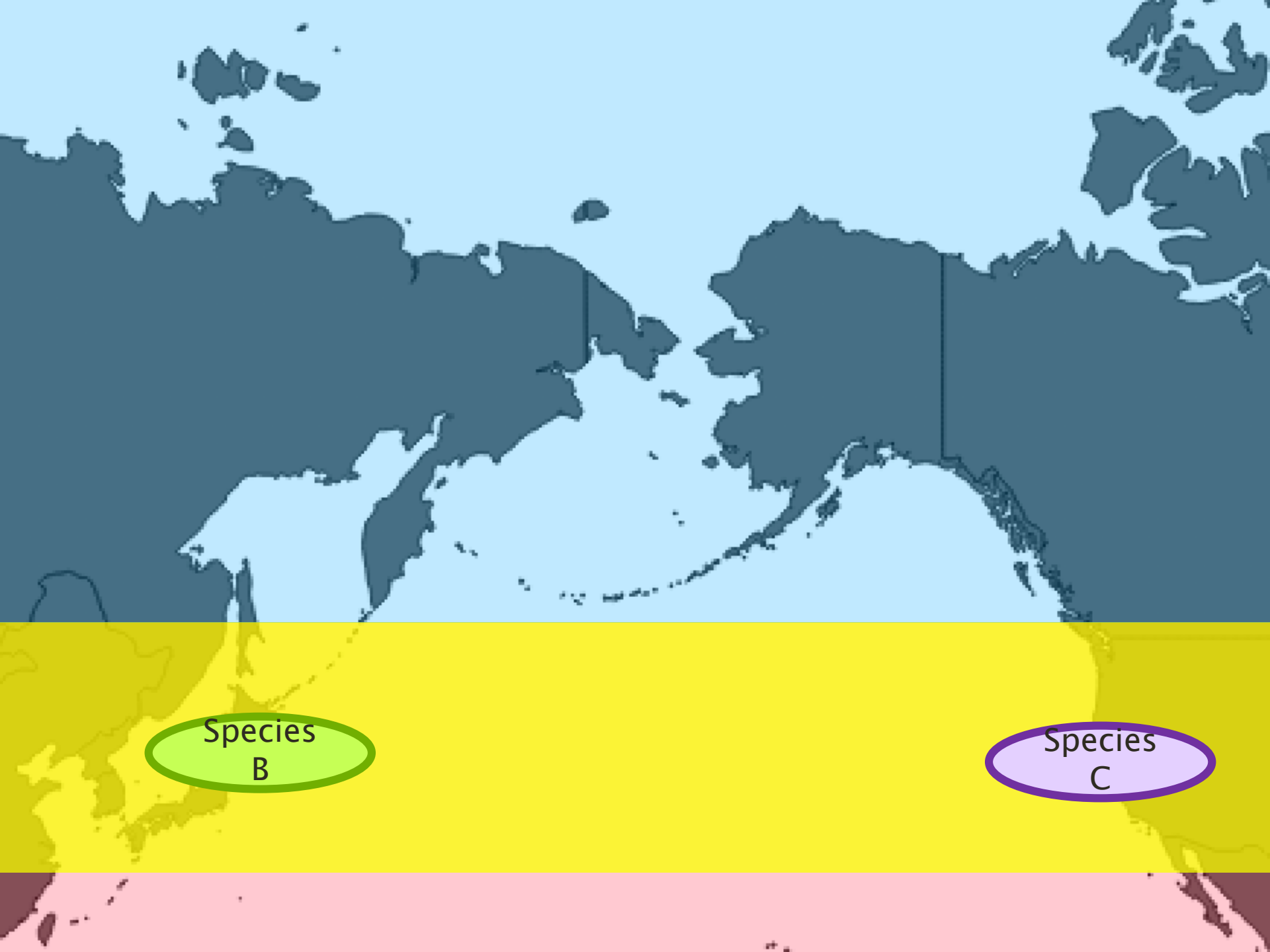


Species
A

Too Hot

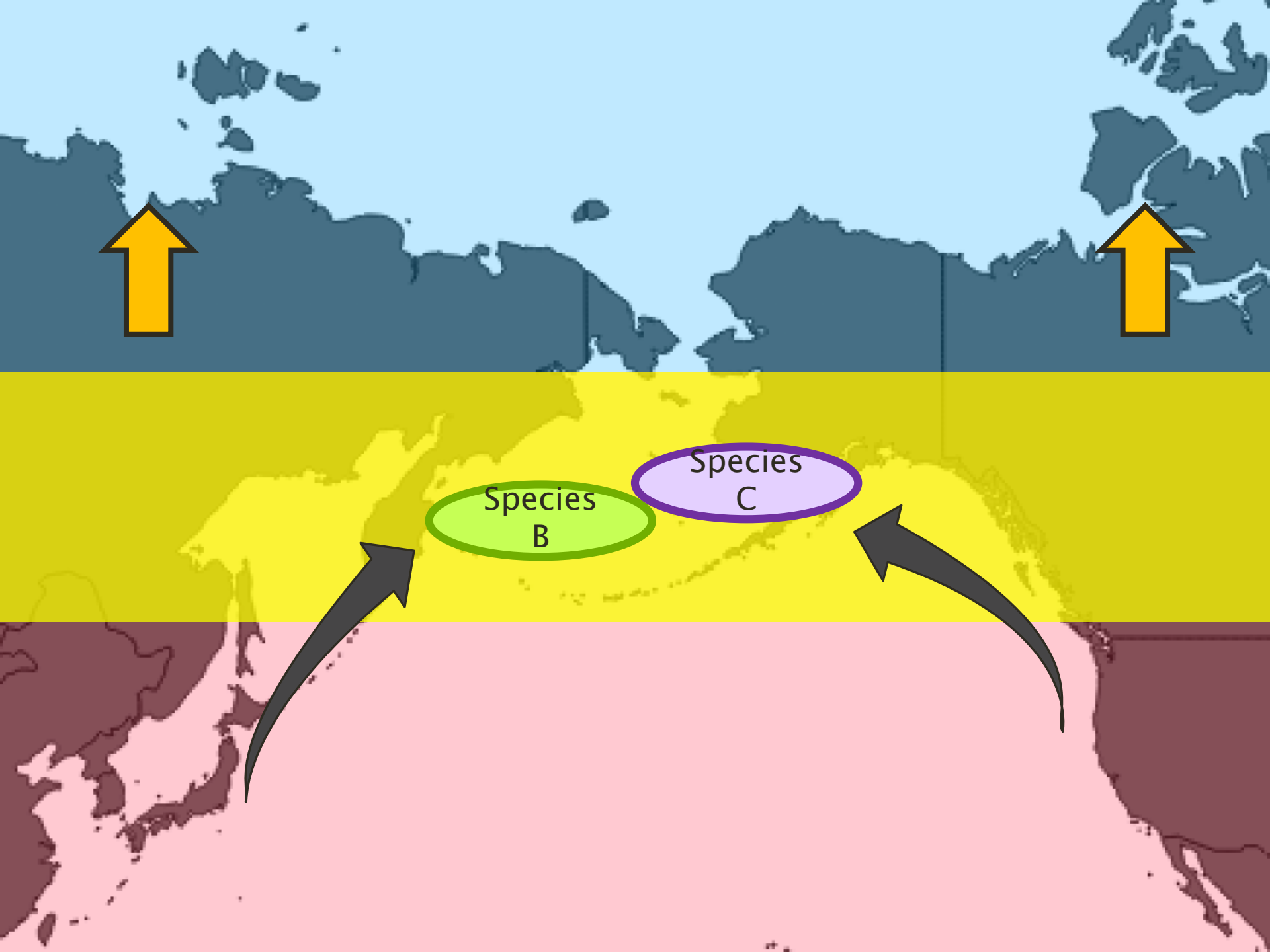






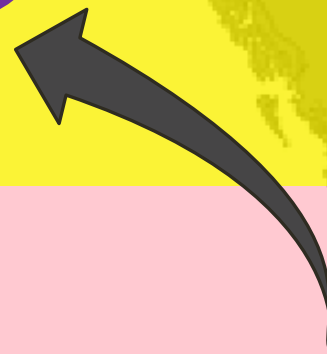
Species
B

Species
C



Species
B

Species
C



SCENARIOS

1. Sympatric or Parapatric Speciation
2. Geographic separation of breeding aggregations
3. Bering Land Barrier
4. Latitudinal Climate Shift
5. Taxonomy is not supported by sequence data



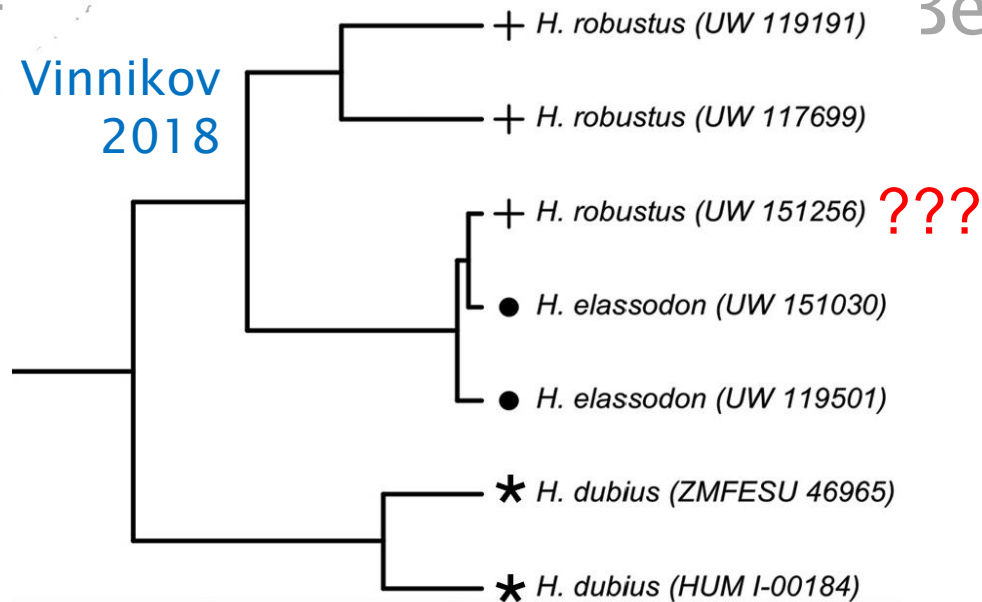
Hippoglossoides elassodon robustus

Hippoglossoides robustus

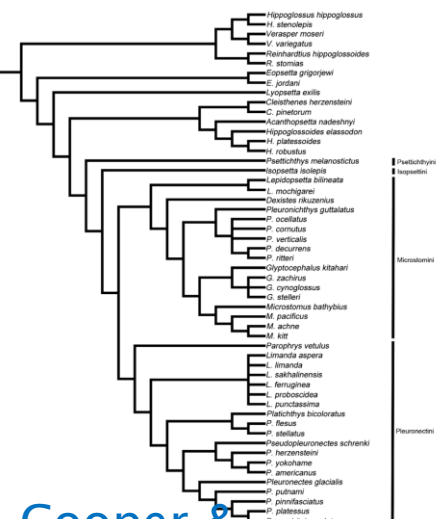
Flethead Sole

Bering Flounder

K. Vinnikov
2018

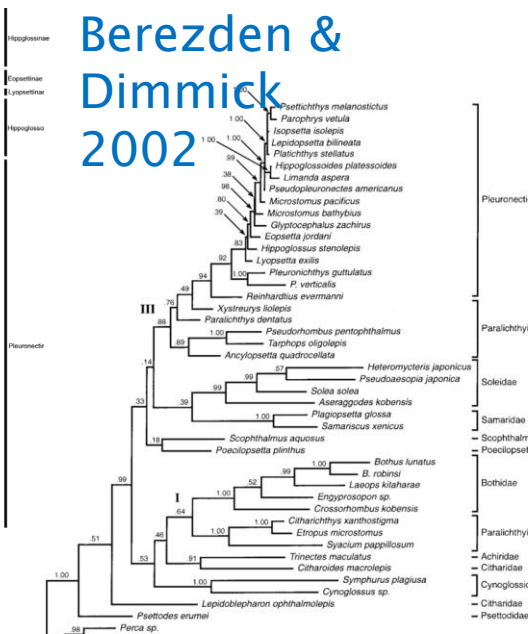


As larvae they are identified only based on geography!

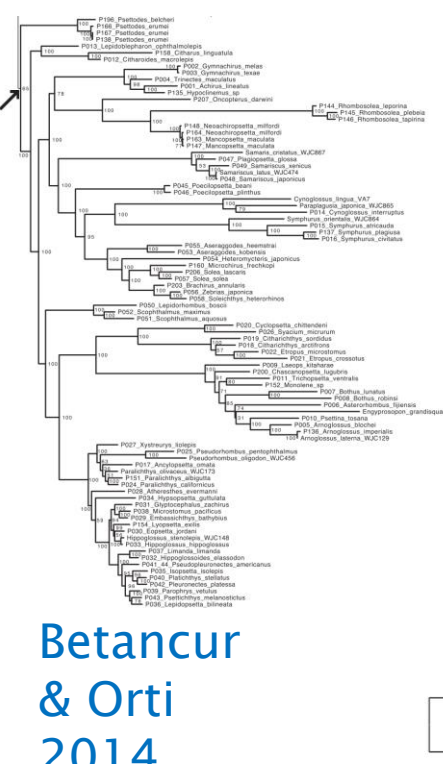


Berezden & Dimmick 2002

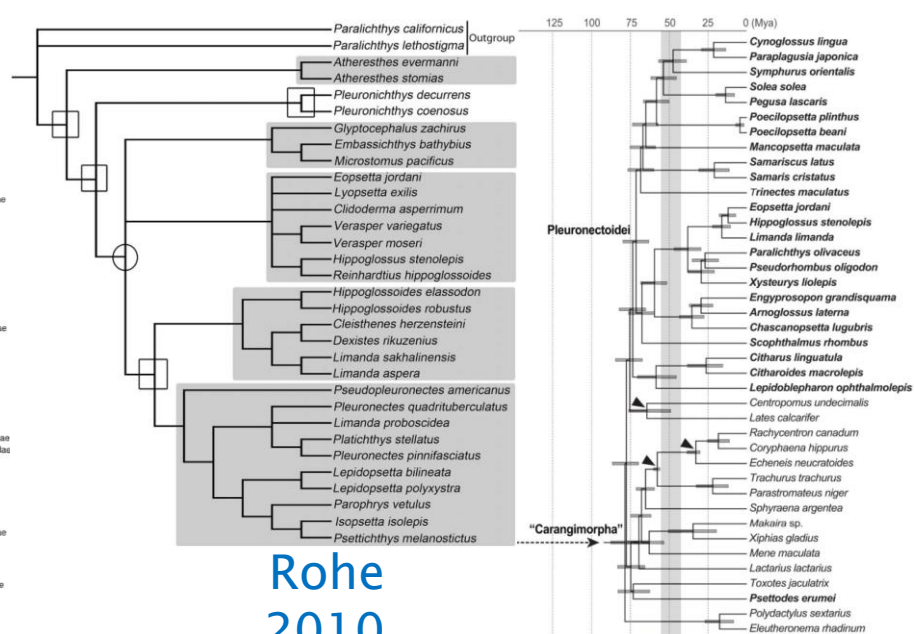
Cooper & Chapleau 1998



Ji et al. 2016

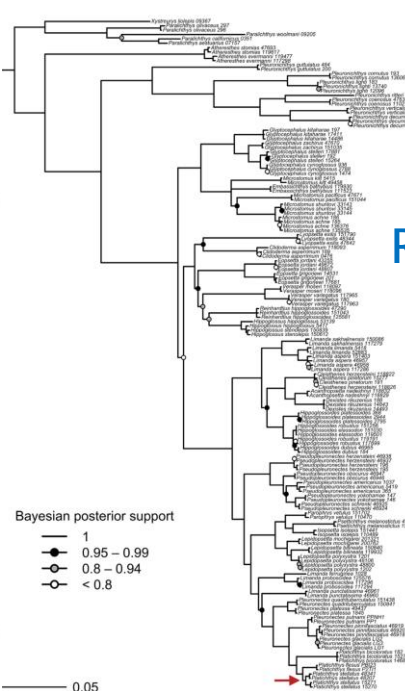


Betancur & Orti 2014

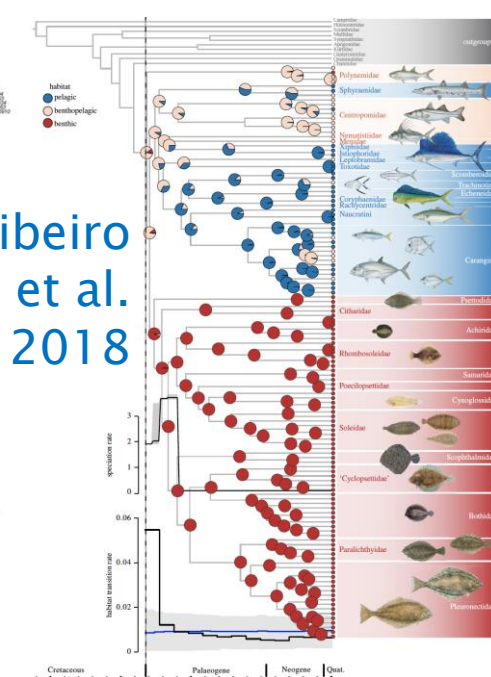


Rohe 2010

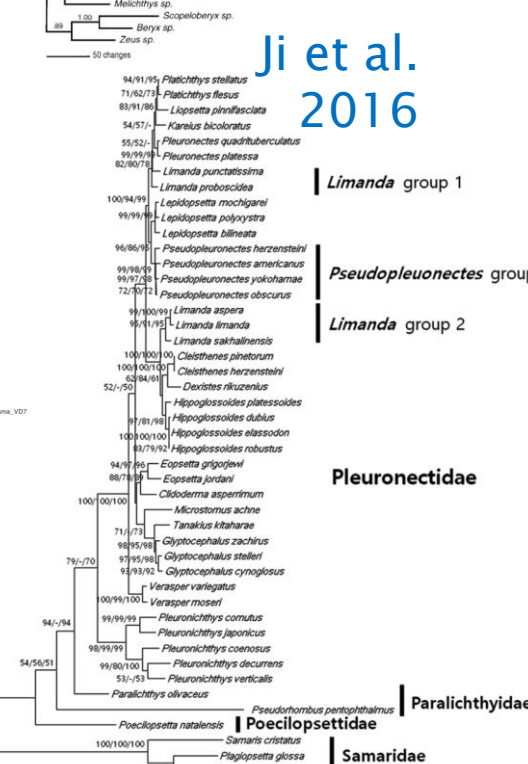
Vinnikov 2018



Campbell 2013



Ribeiro et al. 2018



Betancur & Orti 2014

OBJECTIVES

1. Identify potential causes of speciation in geological history.
2. Provide support or concern for current species designations (*Hippoglossoides*).
3. Use exon-capture as a new method for constructing Pleuronectid phylogeny, and compare to past phylogenies.

METHOD

Sampling:

- 31 species within Pleuronectidae
- 56 species within Pleuronectiformes
- 1 outgroup from Carangiformes
- 122 samples total

Exon-capture:

- 4434 markers
- (Jiang et al. 2017 for Actinopterygii)

Time-Calibration:

- 23 fossils

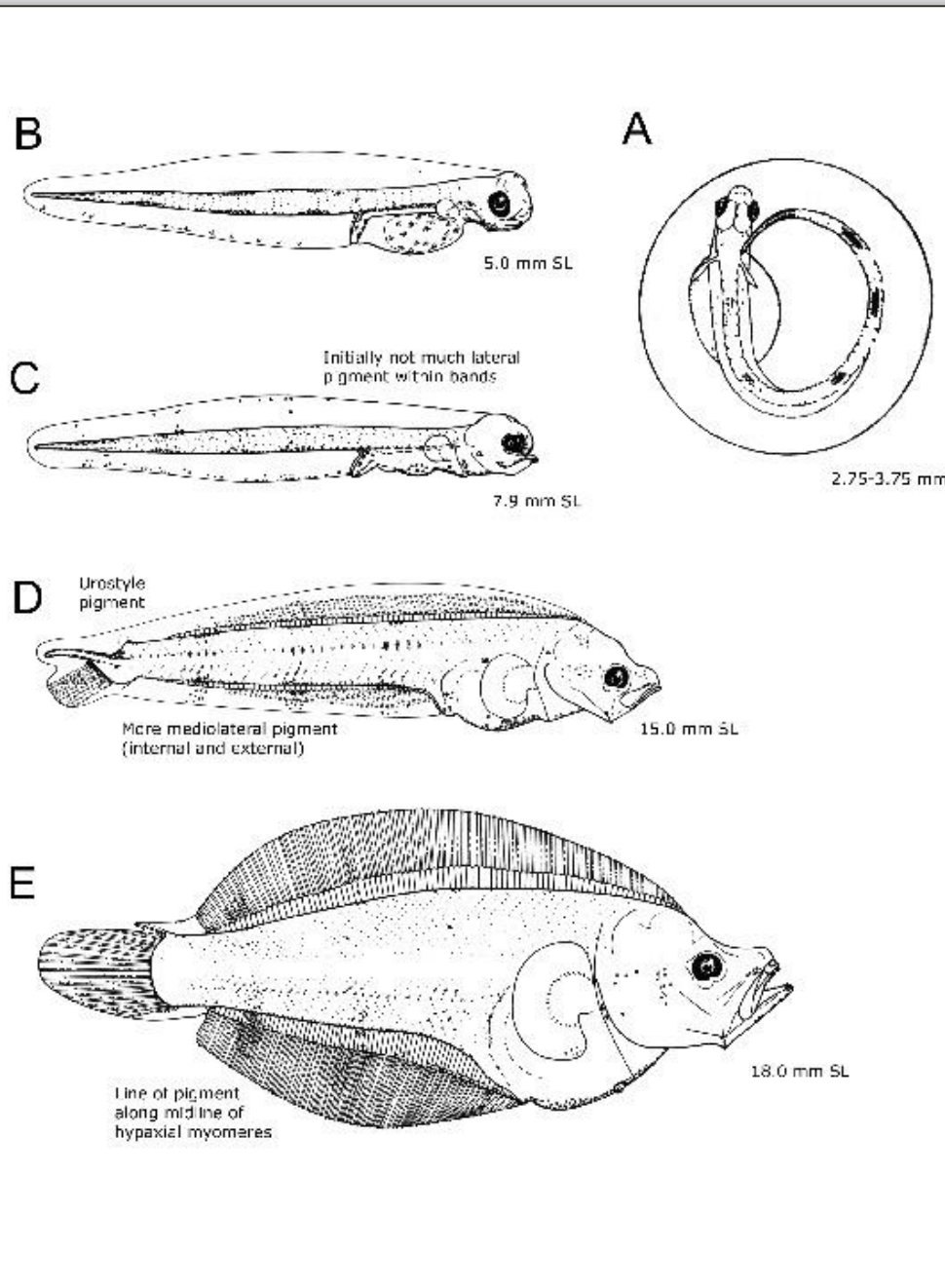
Species of interest	n
<i>Atheresthes evermanni</i>	7
<i>Atheresthes stomias</i>	6
<i>Hippoglossoides elassodon</i>	17
<i>Hippoglossoides robustus</i>	15
<i>Lepidopsetta bilineata</i>	8
<i>Lepidopsetta polyxystra</i>	7
<i>Limanda aspera</i>	6
<i>Limanda sakhalinensis</i>	6

Other projects in the lab...

LARVAE OF THE NORTH PACIFIC



Other p LARVA PACIF



Other projects in the lab...

PHYLOGENETICS OF DWARF GOBIES

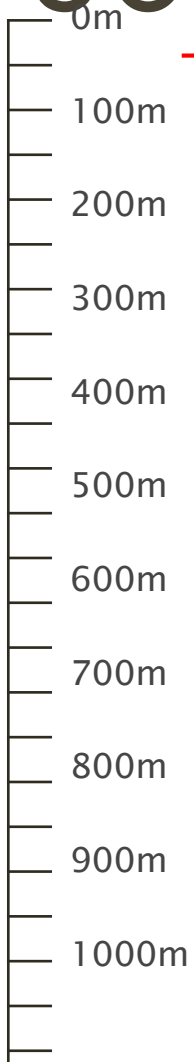


Photo by Mark V. Erdmann

Other projects in the lab...

DEEP REEF FISH COMMUNITIES

Depth



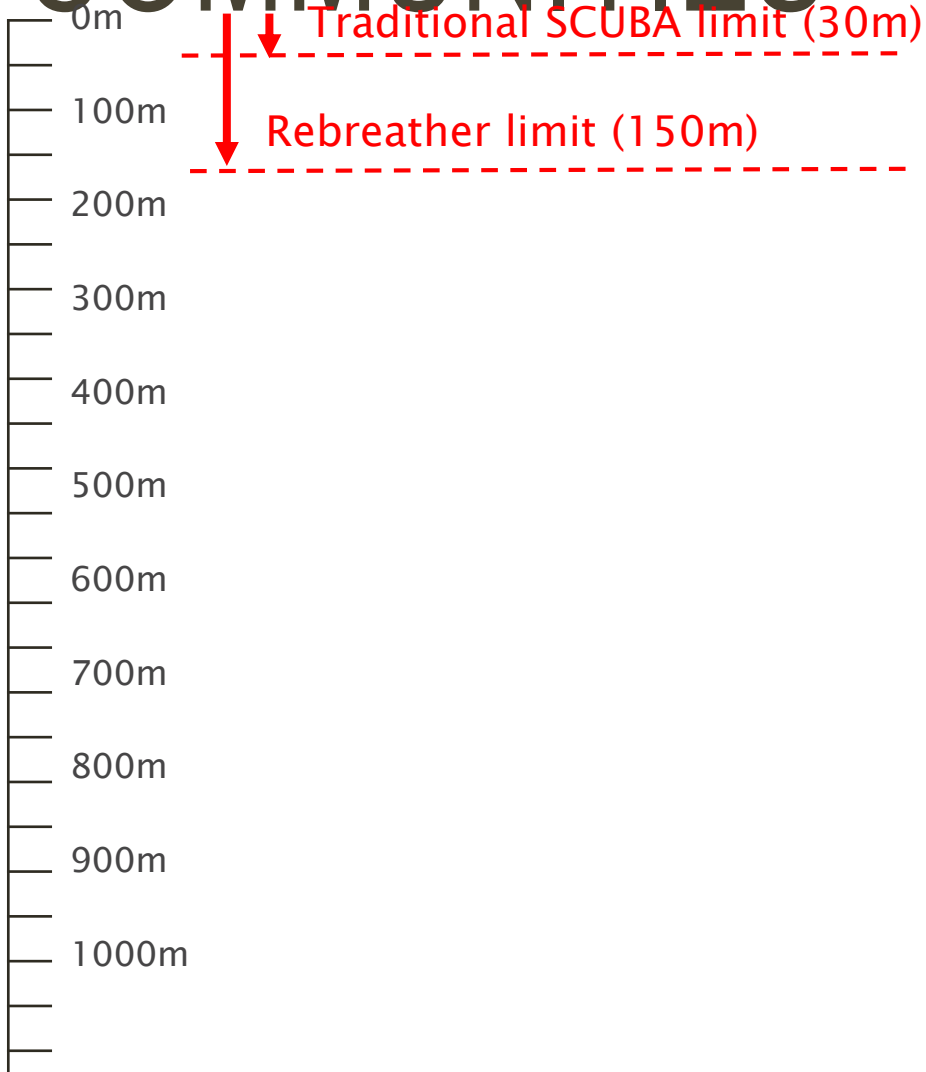
0m
Traditional SCUBA limit (30m)



Other projects in the lab...

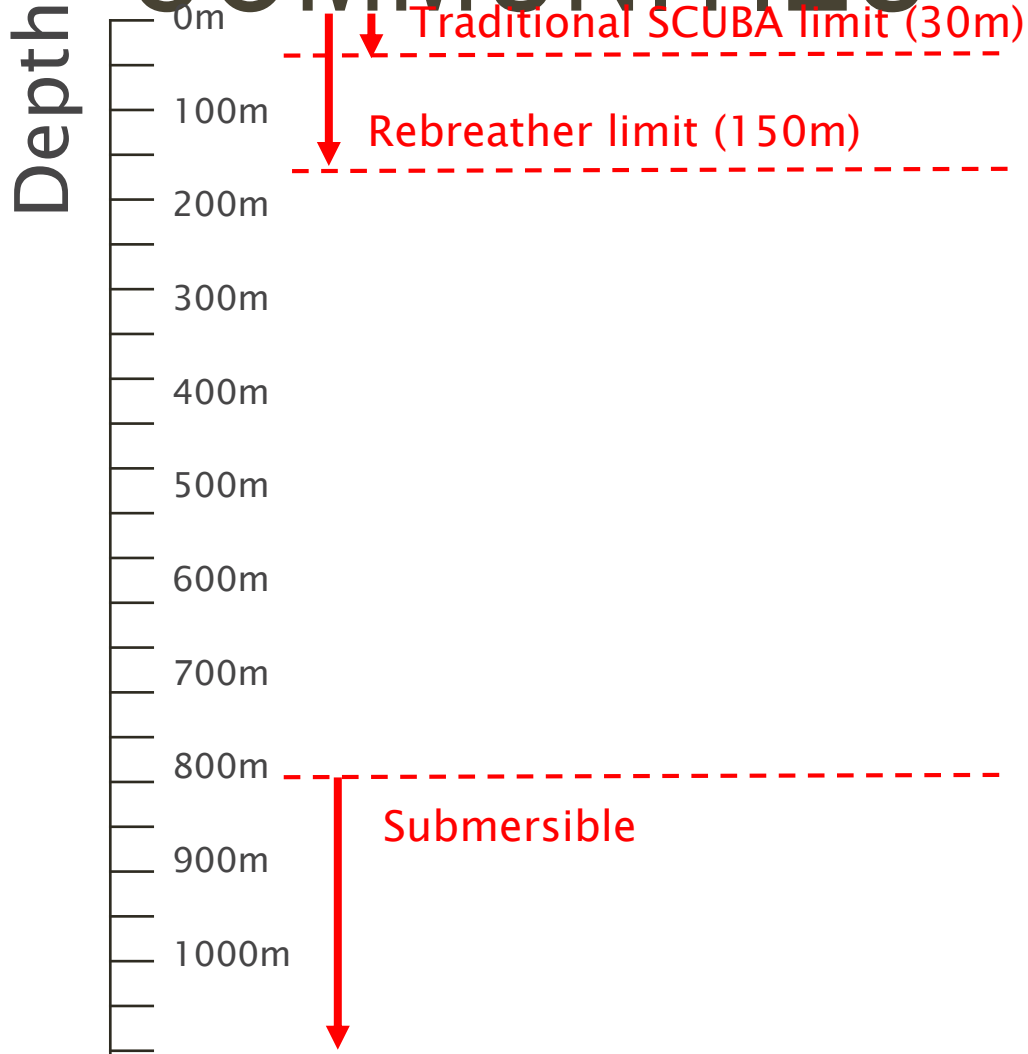
DEEP REEF FISH COMMUNITIES

Depth



Other projects in the lab...

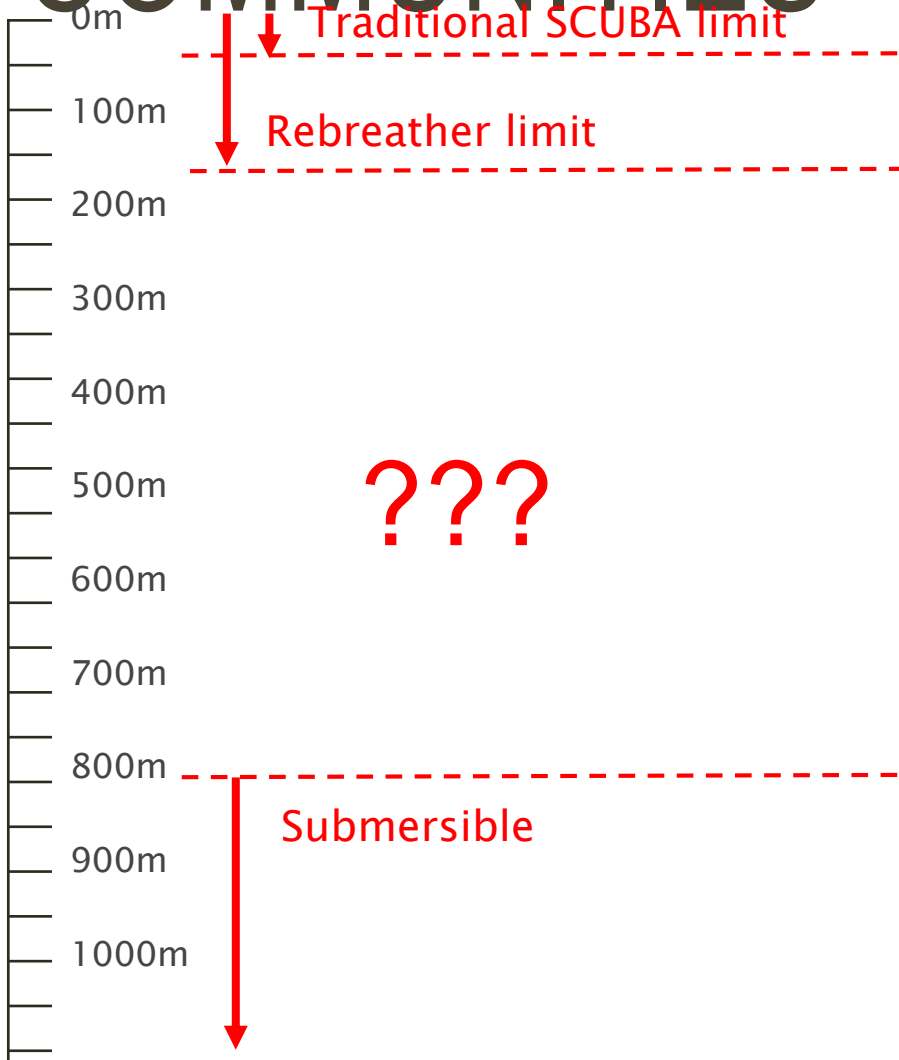
DEEP REEF FISH COMMUNITIES



Other projects in the lab...

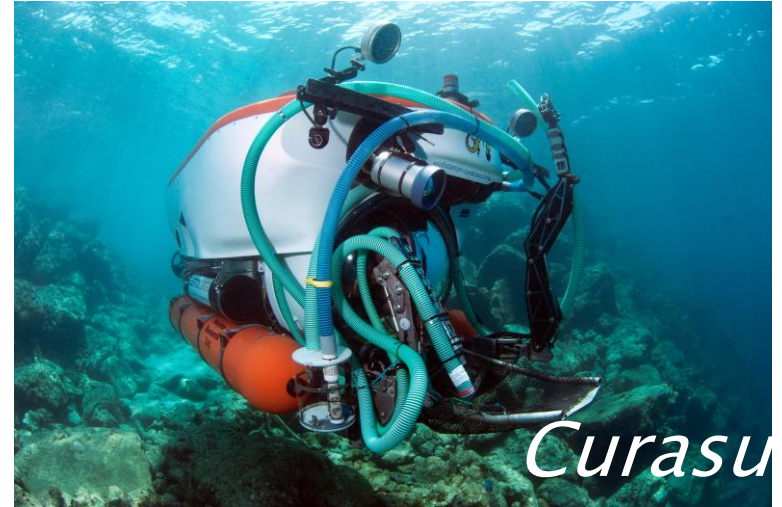
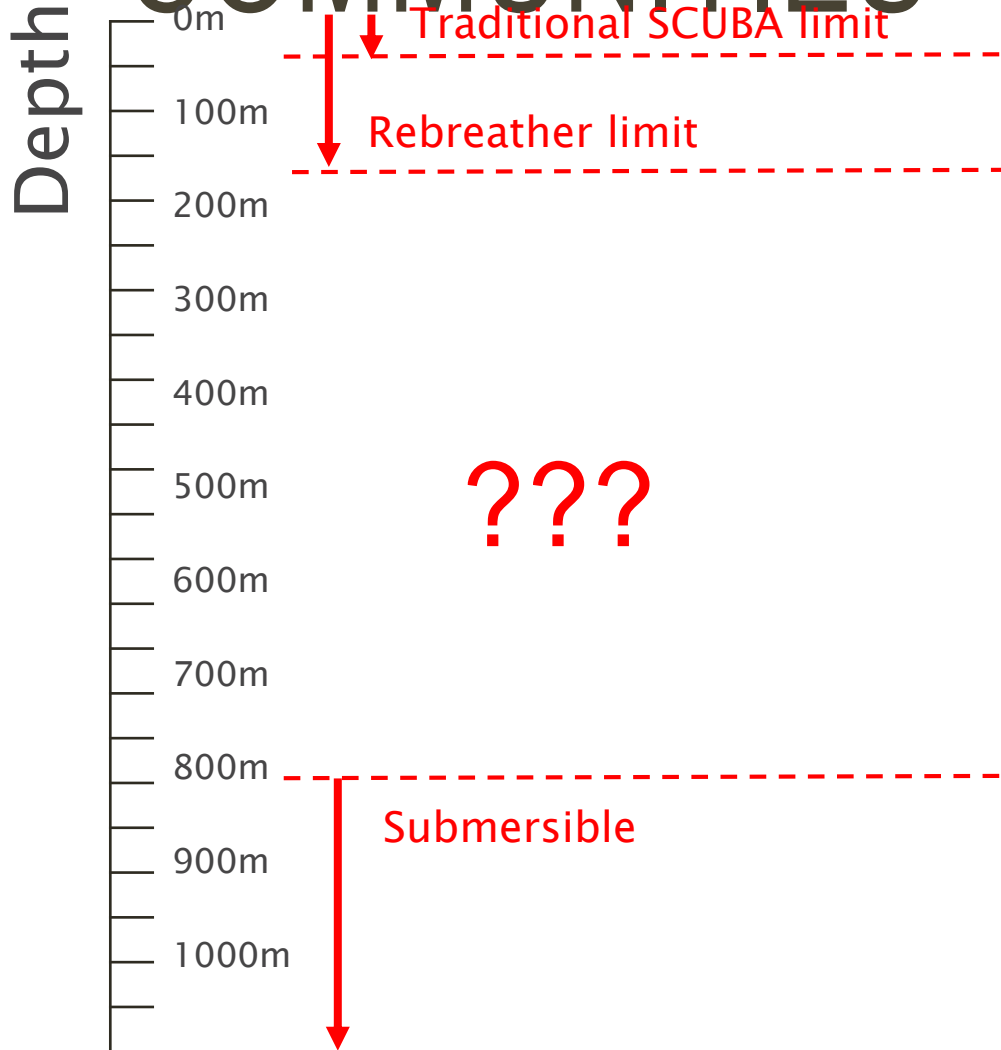
DEEP REEF FISH COMMUNITIES

Depth



Other projects in the lab...

DEEP REEF FISH COMMUNITIES



Other projects in the lab...

DEEP REEF FISH COMMUNITIES



Other projects in the lab...

DEEP REEF FISH COMMUNITIES

Symphysanodon octoactinus



Serranus notospilus



Serranus phoebe



Gephyroberyx daytoni



Pronotogrammus martinicensis



Symphysanodon berryi



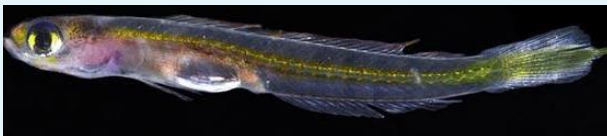
Chrionema squamentum



Osteichthys trachypoma



Palatogobius incendius



Palatogobius grandoculus



Liopropoma aberrans

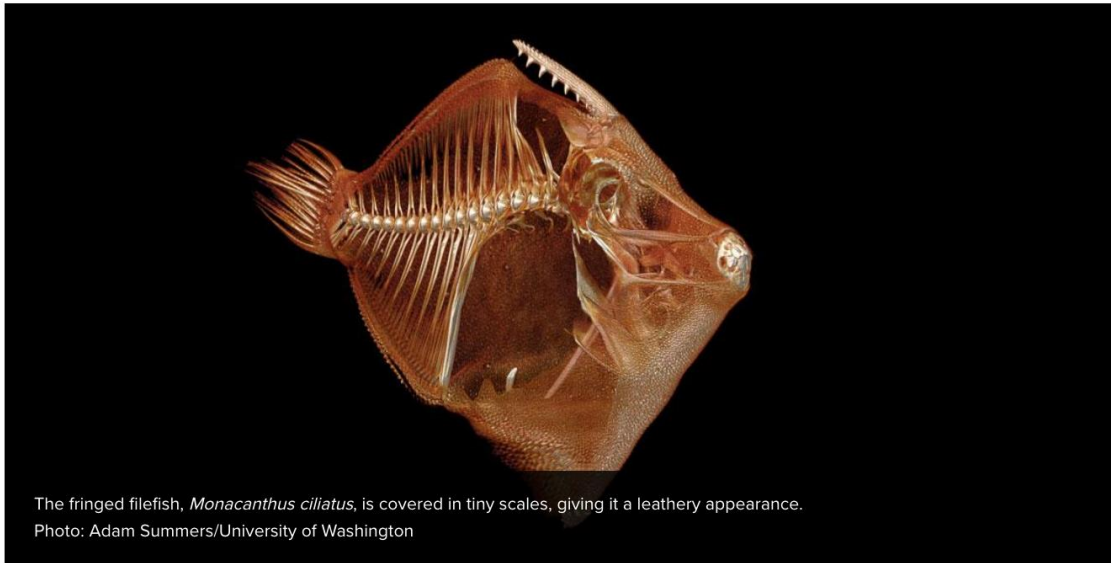


Other projects in the lab... SCAN ALL THE VERTEBRATES

Scientists to create digital encyclopedia of 3D vertebrate specimens

AUGUST 24, 2017
BURKE MUSEUM

ichthyology, mammalogy, fish, mammals, Burke research, 3D printing



The fringed filefish, *Monacanthus ciliatus*, is covered in tiny scales, giving it a leathery appearance.

Photo: Adam Summers/University of Washington

Written by Michelle Ma, *University of Washington News*

<http://www.burkemuseum.org/blog/scientists-create-digital-encyclopedia-3d-vertebrate-specimens>



THANK YOU!