

# Ring Species and the Museum

Mike Seward

OEB 275br

May 7<sup>th</sup>, 2013

# Biological Species Concept (BSC)

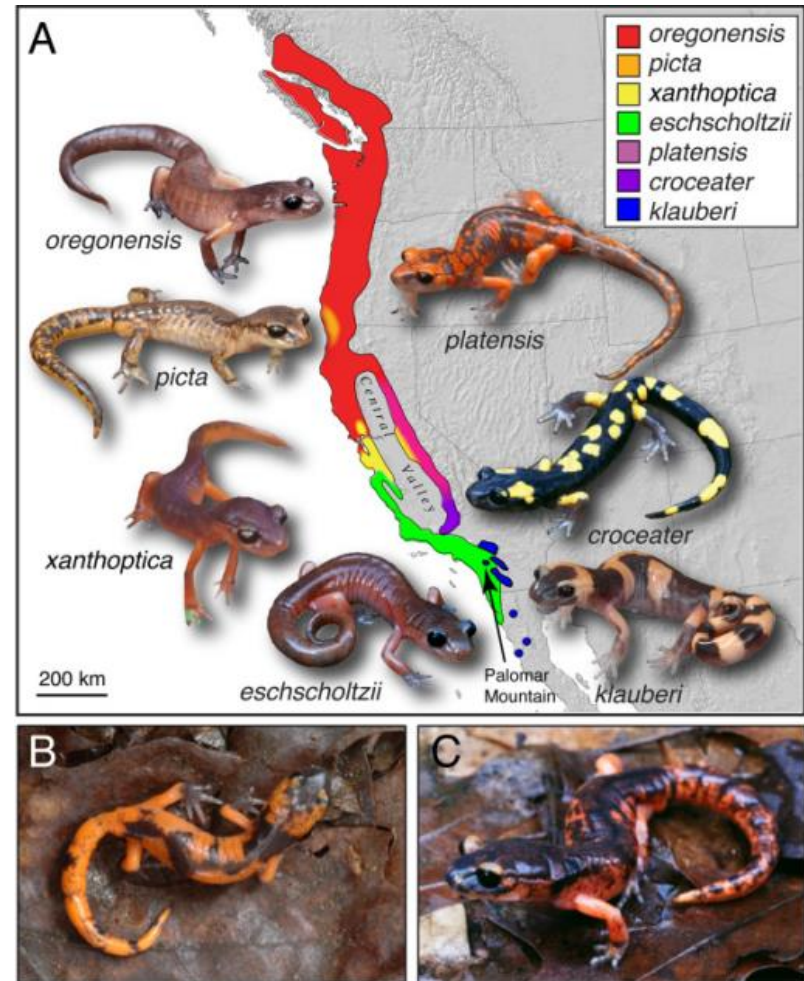
- Definition: a species is a group of interbreeding natural populations that are reproductively isolated from other such groups.

Separate species?



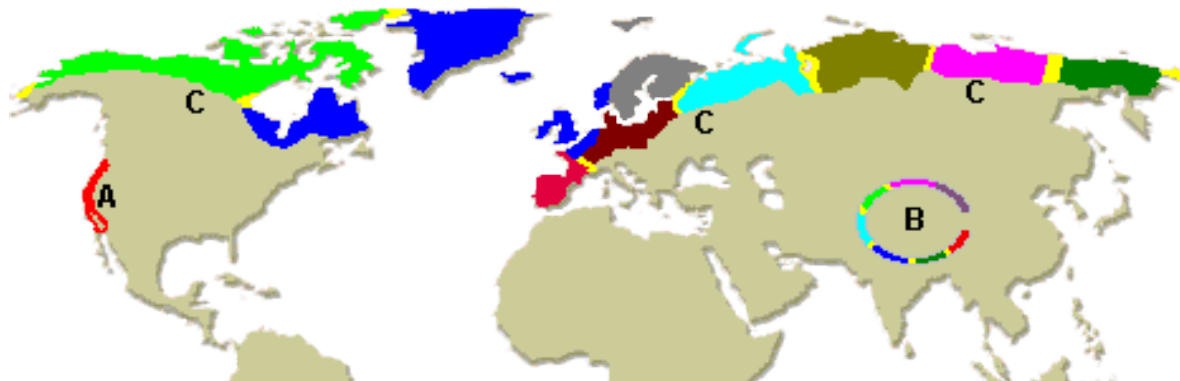
# Ring Species

- Ring species are a connected series of neighboring populations, each of which can interbreed with adjacent populations, but where at least two “end” populations are too distantly related to interbreed.
- Challenges the BSC because there can be gene flow through the ring to these “end” populations despite being reproductively isolated.

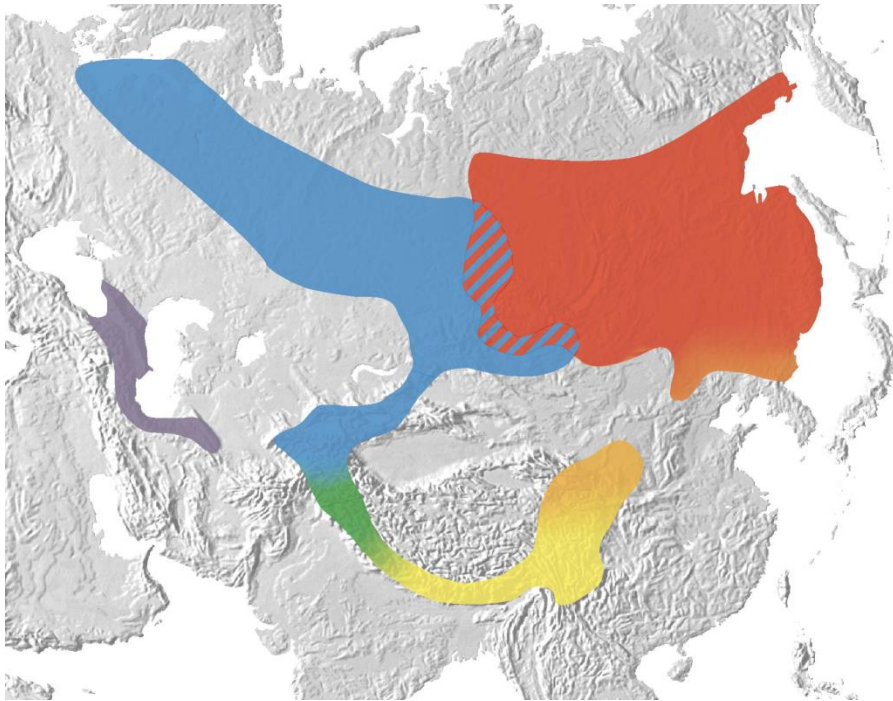


# Examples of Ring Species

- There are only a few confirmed ring species including the:
  - *Ensatina eschscholtzii* salamander in California (a)
  - *Phylloscopus trochiloides* greenish warbler in Asia (b)
  - *Larus* gull in the Arctic circle (c)
  - *Euphorbia tithymaloides* plant in Central America.

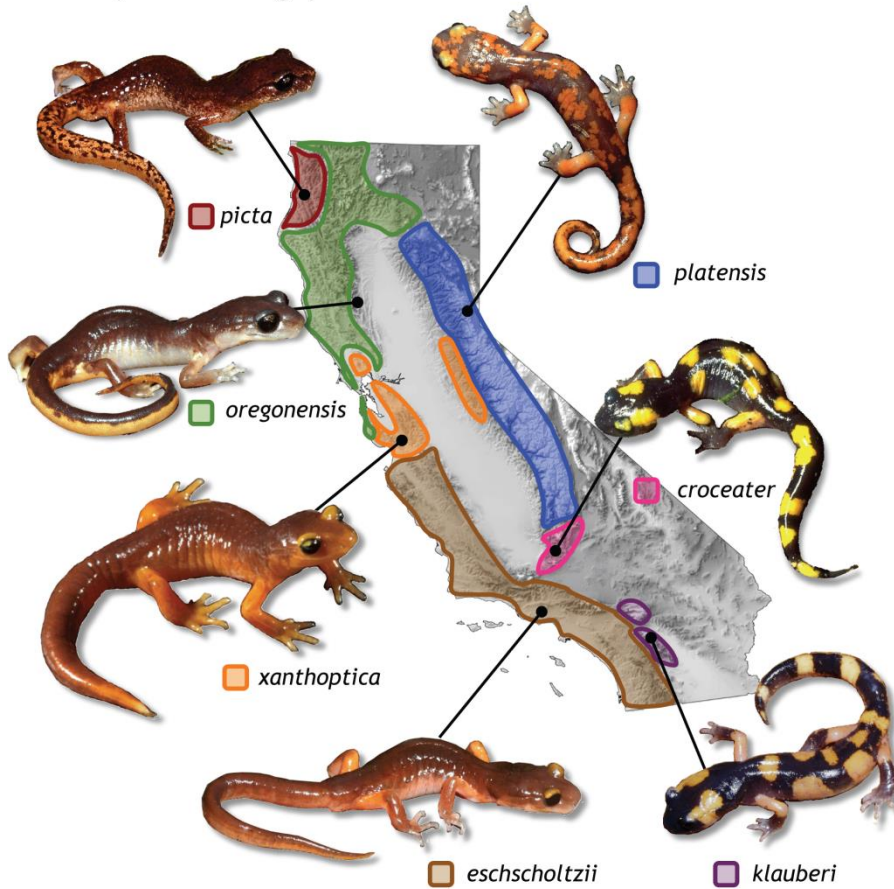


# *Phylloscopus trochiloides* greenish warbler

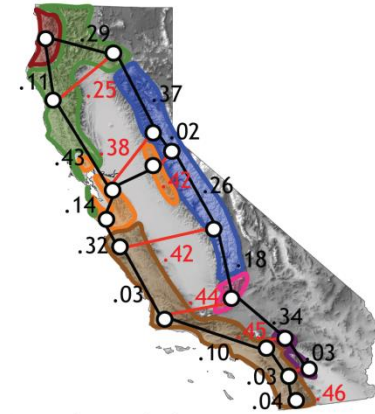


# *Ensatina eschscholtzii* salamander

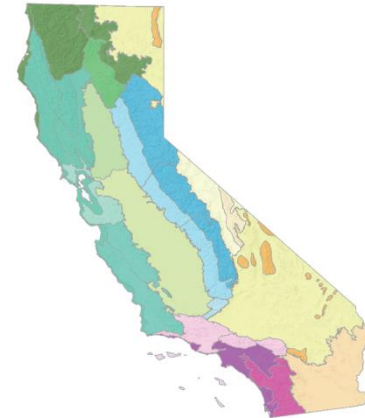
a) *Ensatina* ring species



b) Genetic divergence



c) Ecological divergence



# Online Genetic Databases

- GenBank will provide genomic information that we can then examine using software programs.



RESEARCH ARTICLE

Open Access

Predictors for reproductive isolation in a ring species complex following genetic and ecological divergence

Ricardo J Pereira<sup>1,2,3\*</sup>, William B Monahan<sup>4</sup> and David B Wake<sup>1</sup>

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## Speciation in a ring

**Darren E. Irwin<sup>\*</sup>, Staffan Bensch<sup>\*</sup> & Trevor D. Price**

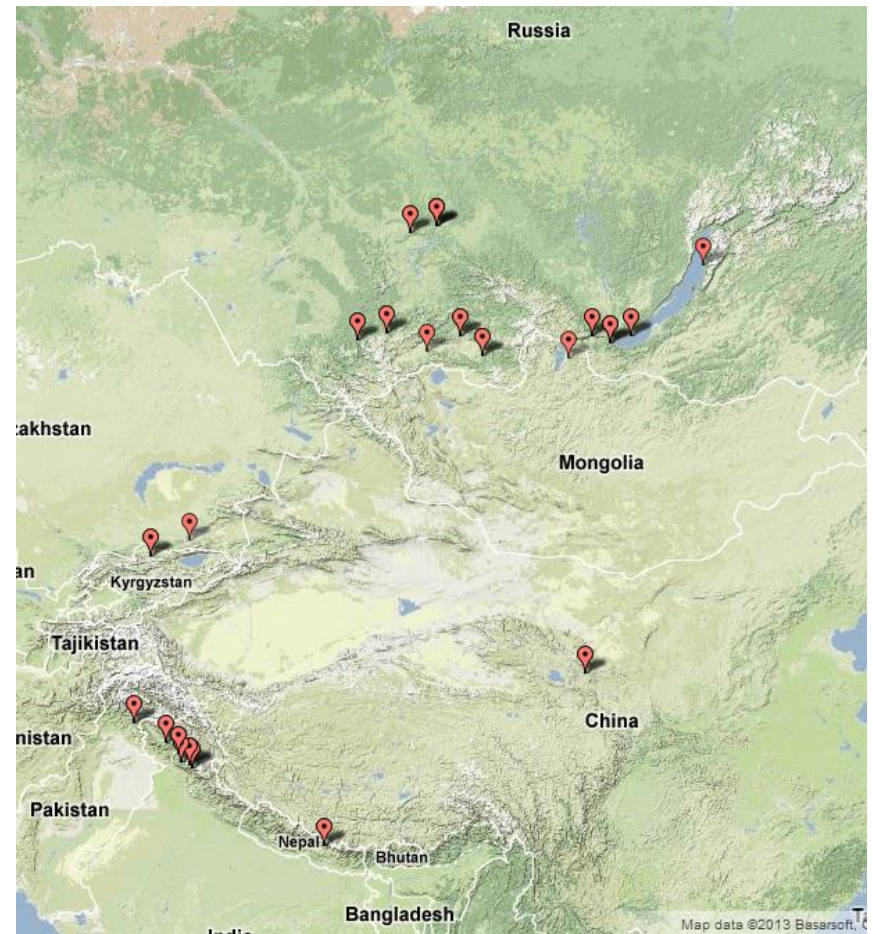
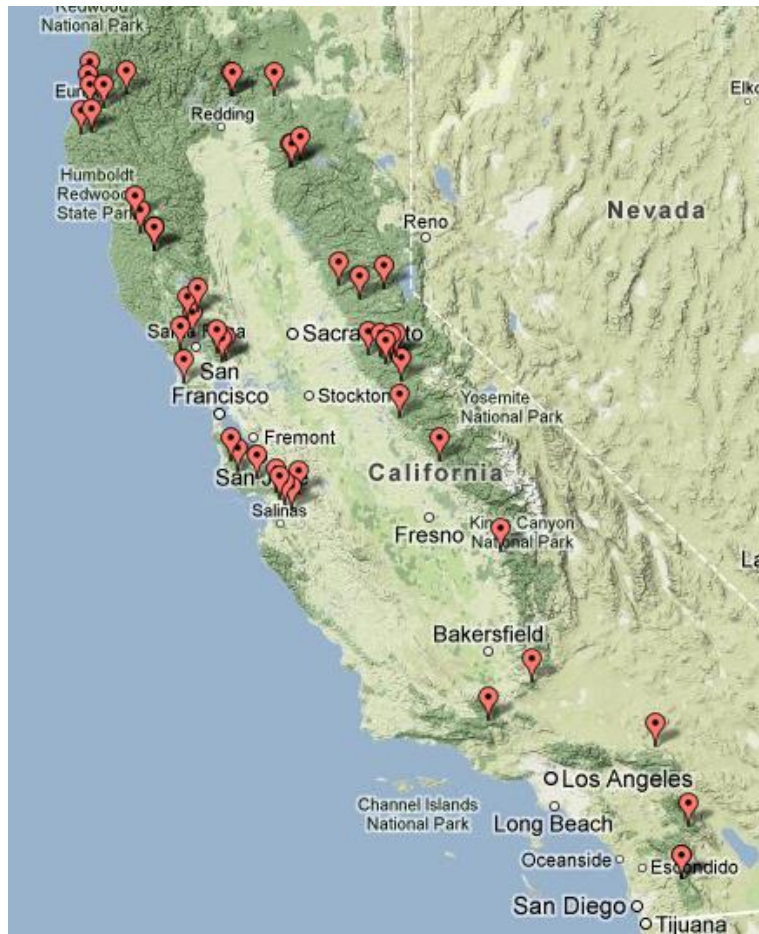
*Department of Biology 0116, University of California, San Diego,  
9500 Gilman Drive, La Jolla, California 92093, USA*

# GenBank IDs

Sample ID	Population	Lat	Long	GenBank
202330	croc	35.04722	-118.48598	L75796
195607	croc	34.65289	-119.02541	L75797
172480	plat c	39.037	-120.9075	JN022615
225030	plat c	39.01371	-120.33931	JN022616
172459	oreg b	38.9064	-120.6445	L75813
CM165	oreg b	40.90261	-123.58649	JN022617
CM166	oreg b	40.90261	-123.58649	JN022618
CM167	oreg b	40.90261	-123.58649	JN022619
CM168	oreg b	40.90261	-123.58649	JN022620
CM171	oreg b	40.90261	-123.58649	JN022621



# BatchGeo to select samples

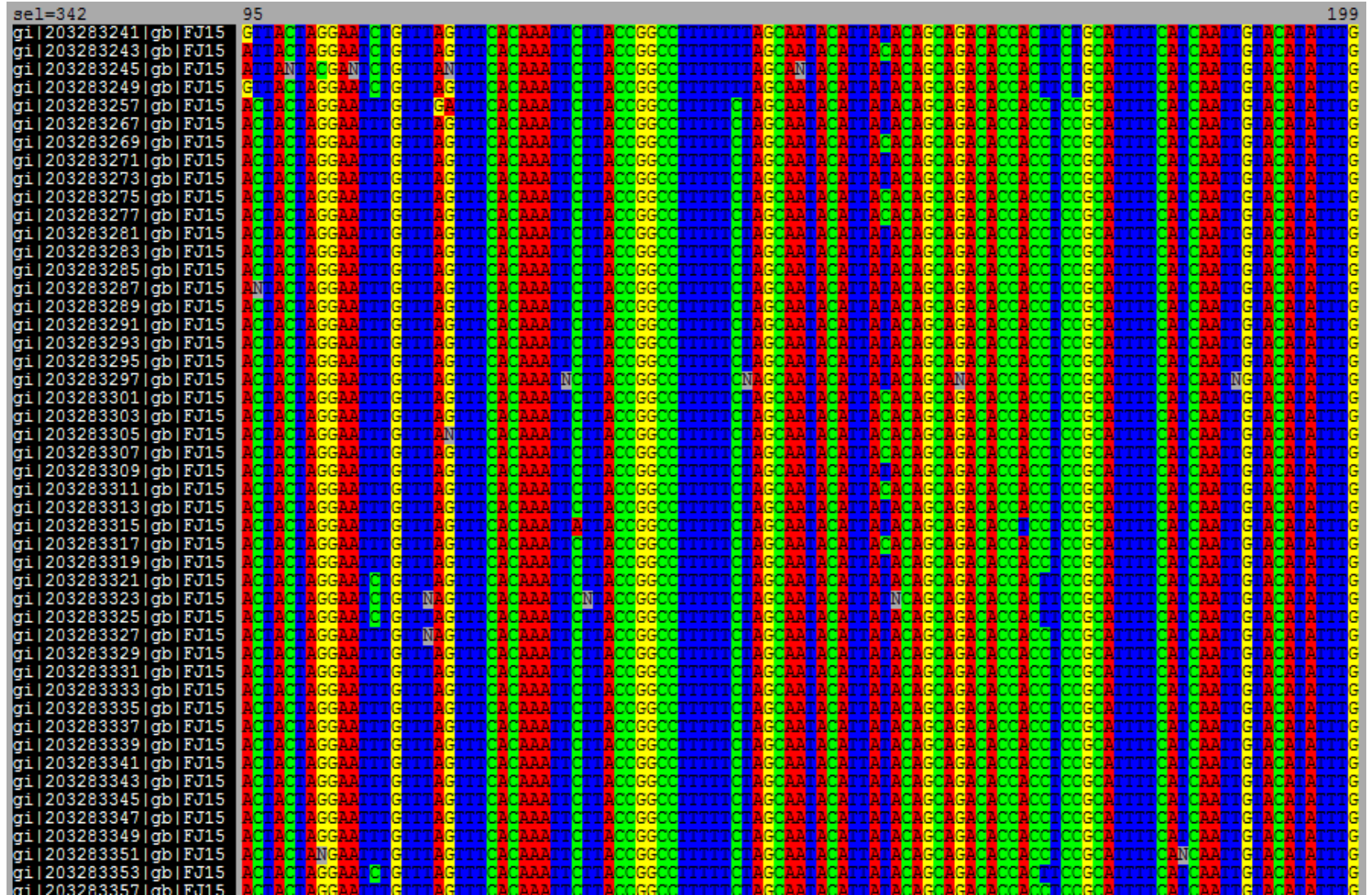


# FASTA format with BatchEntrez

>GenBankID: L75811, gene=cytb

```
AAAATTCACCCTTTATTA AAAAATCATT AATAACTCCTTCATTGATTTA  
CCC ACTCCATCAAATTTATCTTATTTATGAAACTTTGGATCACTACT  
AGGAATCTGTTTAGTTTCACAAATTCTTACTGGCCTTTTTCTAGCA  
ATACATTATACAGCAGATACCACCTCTGCATTCTCATCAGTTGTACA  
TATTTGCCGCGATGTGAATTACGGGTGAGTTTTACGAAATATTCAT  
GCCAACGGAGCCTCATTTTTTTTTTATCTGTATTTATTTACATATTGG  
ACGAGGTATATATTATGGATCCTATATATTTAAAGAACTTGAAATAT  
TGGAGTAATATTATTATTTTTTTGTAATAGCAACAGCATTGTAGGTTA  
TGTTCTTCCATGAGGACAAATATCATTCTGAGGCGCCACAGTTATC  
ACAAACCTCTTGTCAGCAATCCCATATATAGGAGATACACTAGTTCA  
ATGAATTTGGGGAGGCTTTTCAGTAGATAAAGCAACCCTTACCCGA  
TTTTTTGCTTTTTCATTTTATTCTACCATTTATTGTAATGGGAGTTAG  
CATTATTCACTTATTATTTCTGCATGAAACCGGCTCCAATAATCCAA  
CAGGACTTTATTCTAATACAGATAAAATTTATTCCACCCATACTTC  
TCATATAAAGACTTATTTGGATTT
```

# SeaView Alignment



# SeaView Alignment Statistics

52 species

519 selected sites

including 518 complete (no gaps, no N)

including 137 variable (26.4% of complete)

including 49 informative (9.5% of complete)

## BASE COMPOSITION :

All sites : 36.9% A 38.4% C 12.2% G 12.4% T

Complete sites only :

	Minimum	Maximum:
A : 37.0 %	36.5% (AF316189)	40.3% (DQ453513)
C : 38.3 %	37.8% (AF316171)	39.2% (DQ453513)
G : 12.3 %	8.9% (DQ453513)	12.7% (AF316189)
T : 12.4 %	11.6% (DQ453513)	13.1% (AF316171)

## OBSERVED CHANGES (complete sites)

Transition/transversion ratio : 6.837 (mean over all sequence pairs)

Minimum : 0.000 (AF316220 - AF316234, 0 transitions, 1 transversions)

Maximum : 25.000 (AF316208 - AF316284, 25 transitions, 1 transversions)

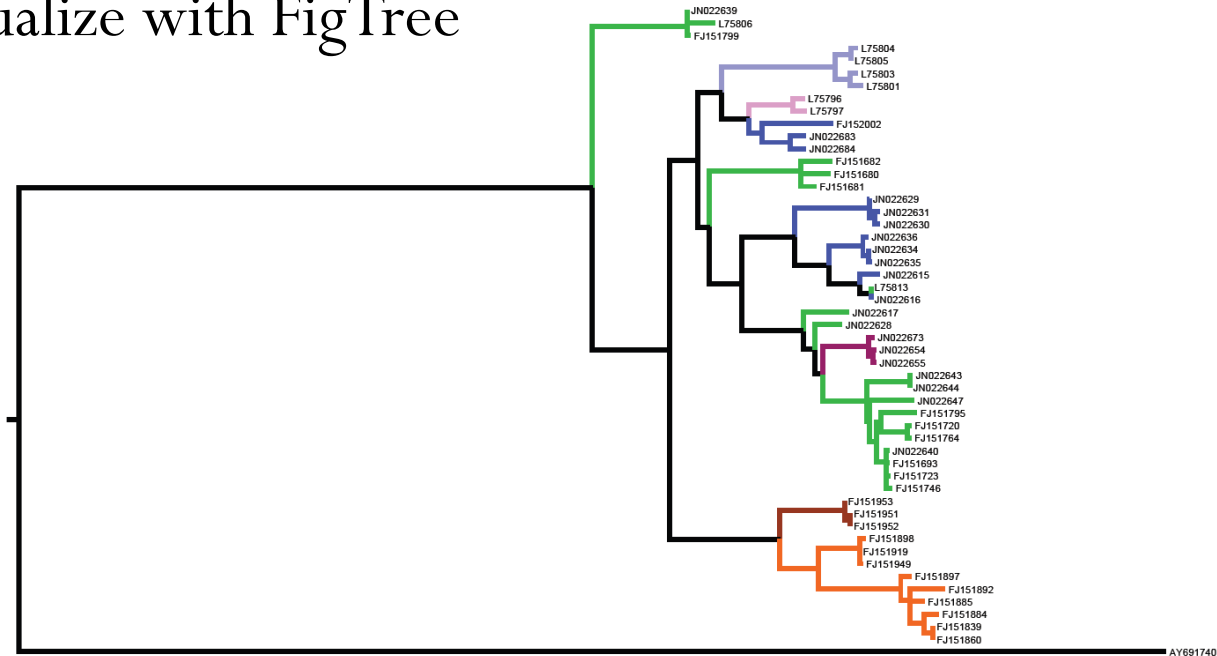
# Making the Trees

- PhyML



PhyML 3.0: new algorithms, methods and utilities

- Visualize with FigTree

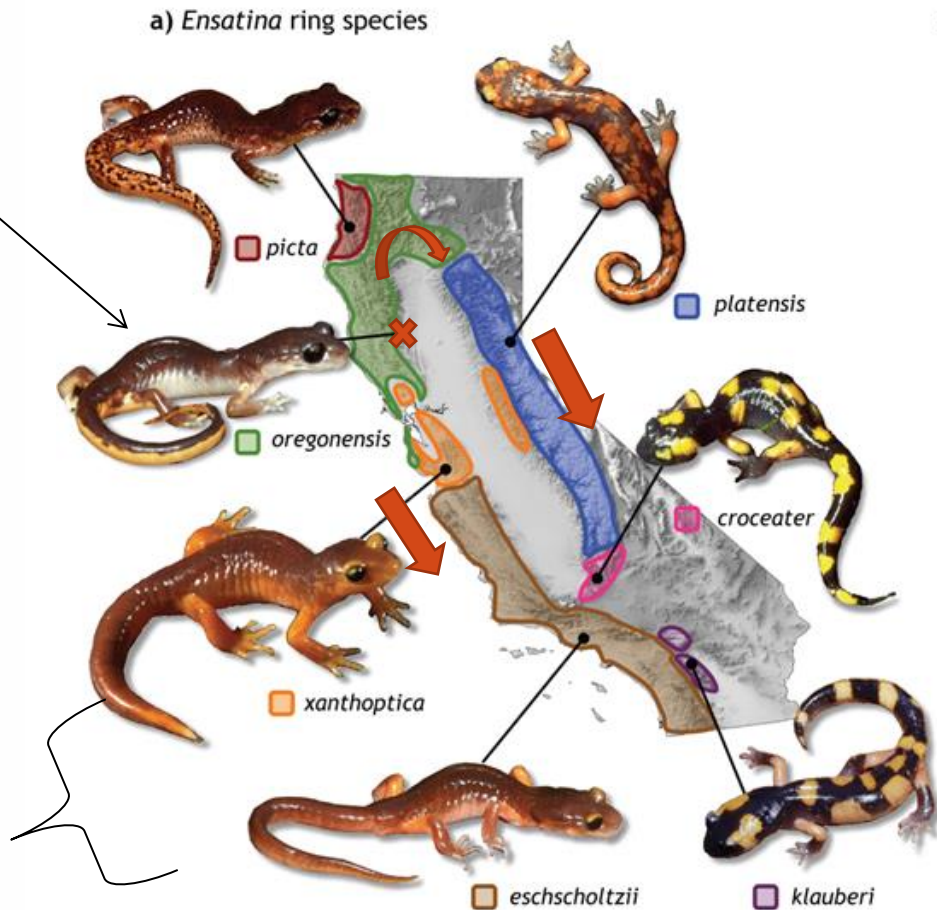
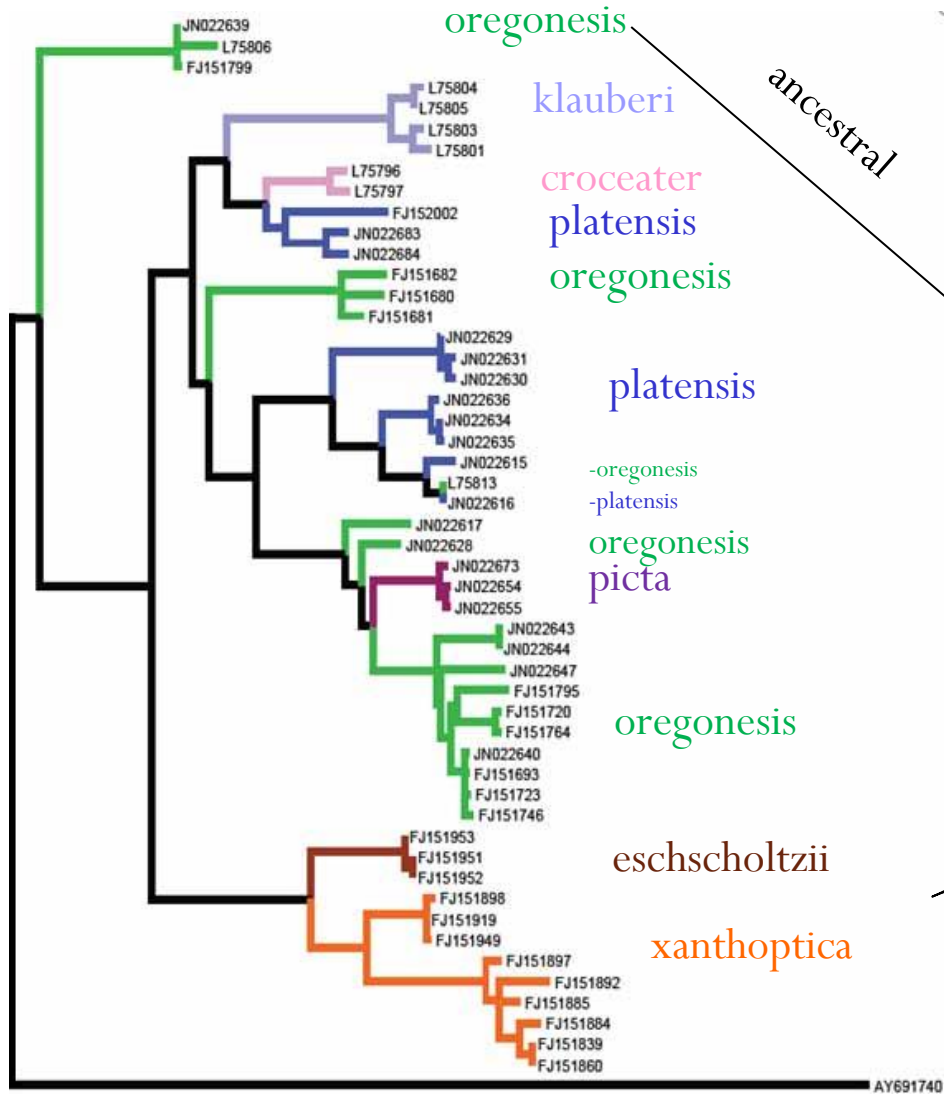


# Rooting the Trees

- Use the NCBI Blast tool to find similar sequences
  - list >500 to get out of species
- Warbler
  - Zebra finch ND6
- Salamander
  - Pigmy salamander cytb



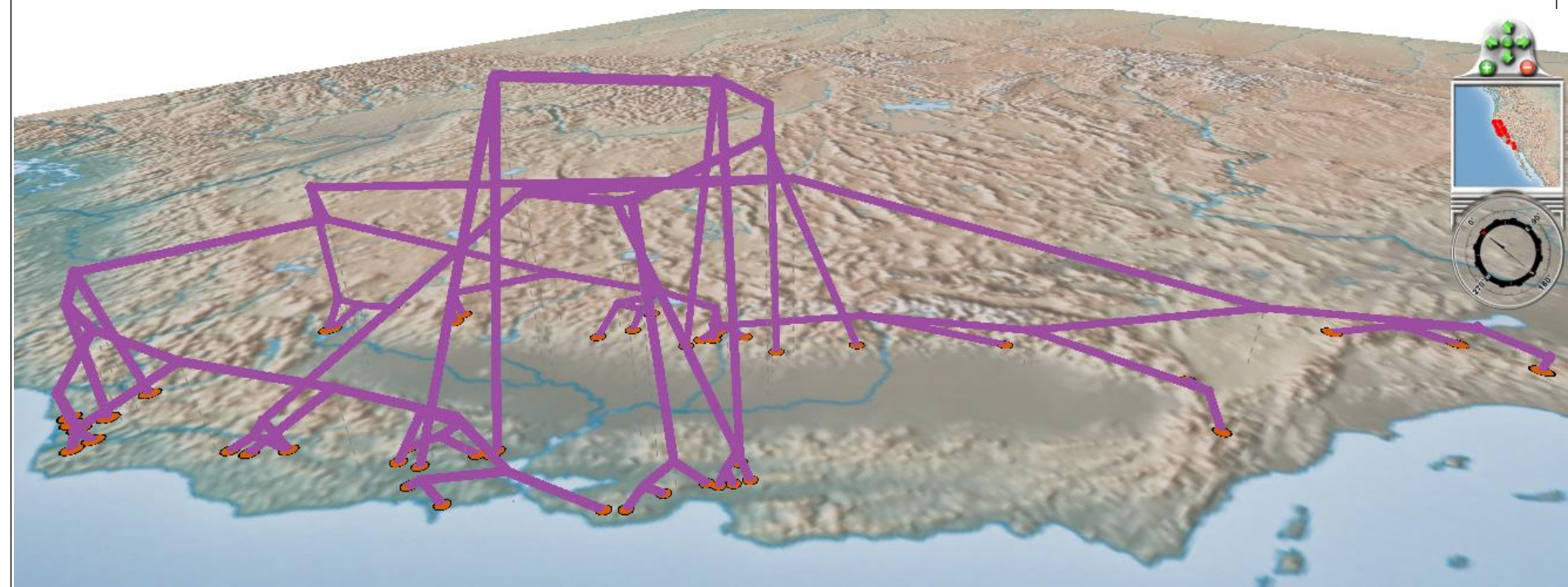
# Salamander



Pigmy salamander

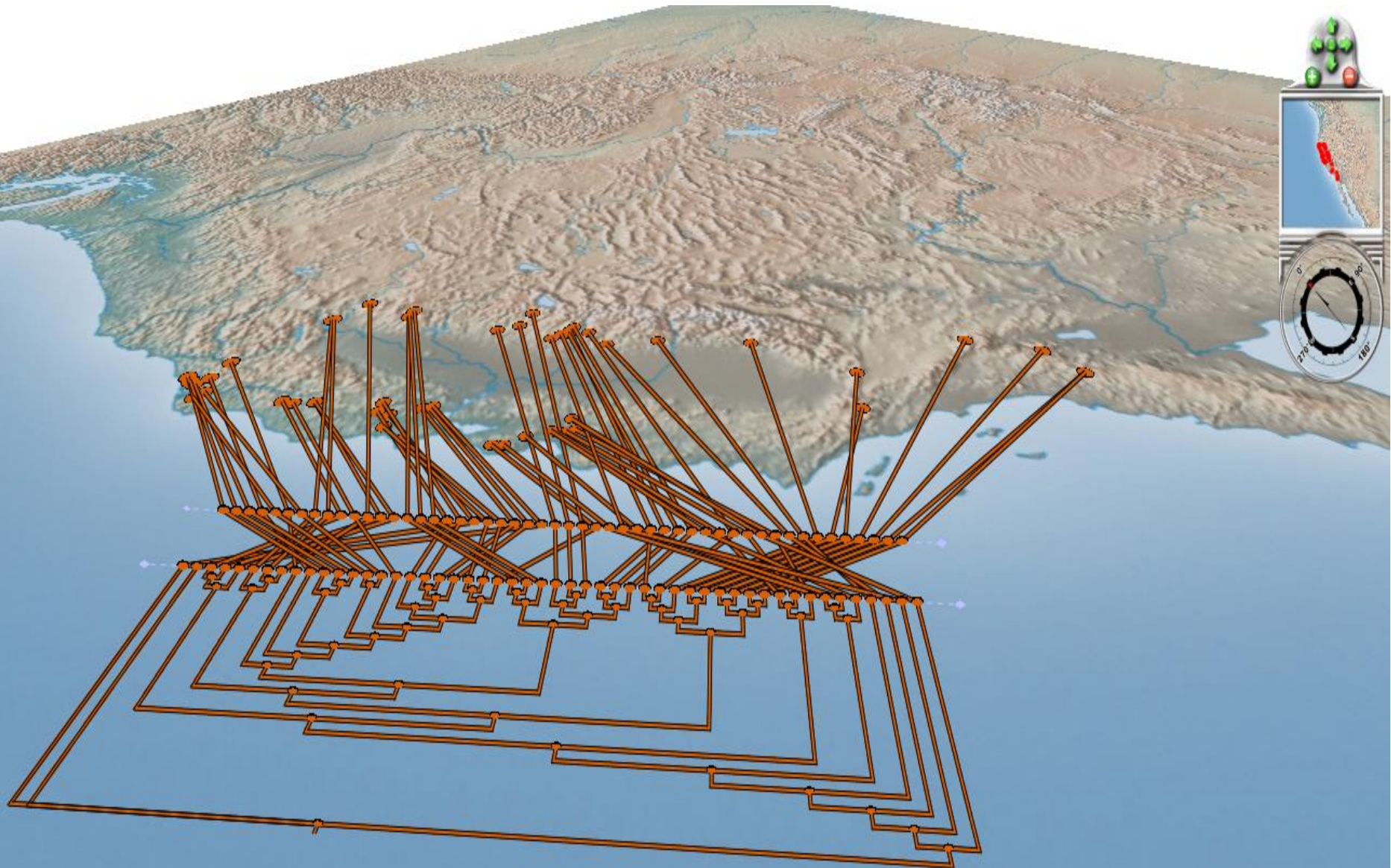
# GenGIS-salamander

- Combining digital map data with phylogenetic trees



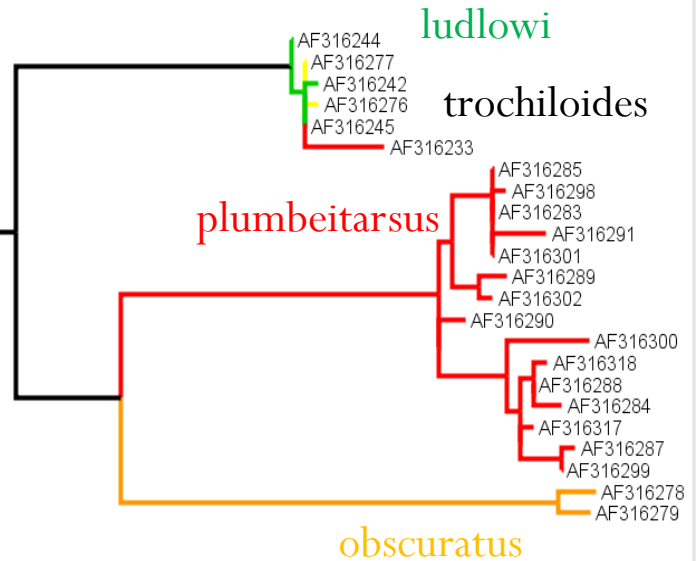
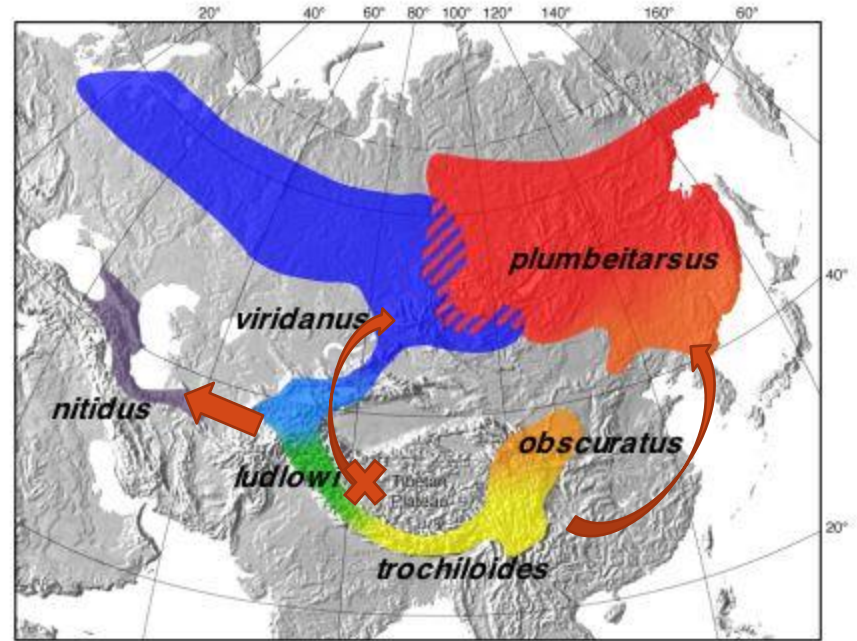
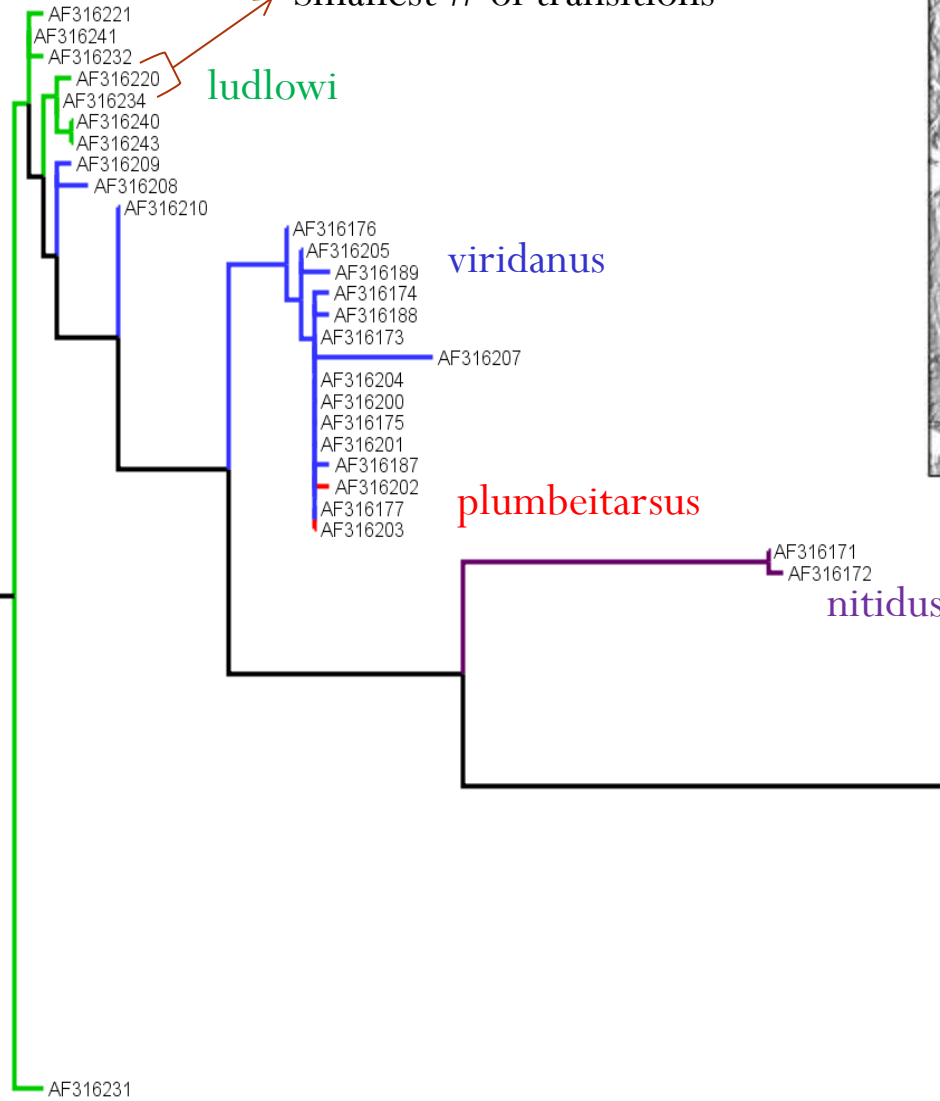


# 2D cladogram




# Warbler

Smallest # of transitions



# MCZBase at Harvard

- Fortunately, we have 89 warblers at Harvard (Yes!!)



**MCZBASE: The Database of the Zoological Collections**  
Museum of Comparative Zoology - Harvard University

Search   My Stuff   Help

0 of these 89 records have coordinates . [Problems viewing this page? Click for HTML version](#)   [Report Bad Data](#)

Records... Order by... ...then order by  
1 - 20   collection   collection   Settings...   [Customize Form](#)   [Download](#)   [Save Search](#)

Cat Num	Identification	Specific Locality	Verbatim Date	Dec. Lat.	Dec. Lo
<a href="#">Ornithology 98440</a>	<a href="#">Phylloscopus trochiloides</a>	Kara-Kitat	3/8/1904		
<a href="#">Ornithology 57852</a>	<a href="#">Phylloscopus trochiloides</a>	Tchegan-Burazi Pass	6/7/1912		
<a href="#">Ornithology 62910</a>	<a href="#">Phylloscopus trochiloides</a>	Mengtsz	1/5/1911		
<a href="#">Ornithology 52525</a>	<a href="#">Phylloscopus trochiloides</a>	Lu lu ping	13/5/1908		
<a href="#">Ornithology 185696</a>	<a href="#">Phylloscopus trochiloides</a>	Sandakphu	21/7/1958		

- Some are over 100 years old!

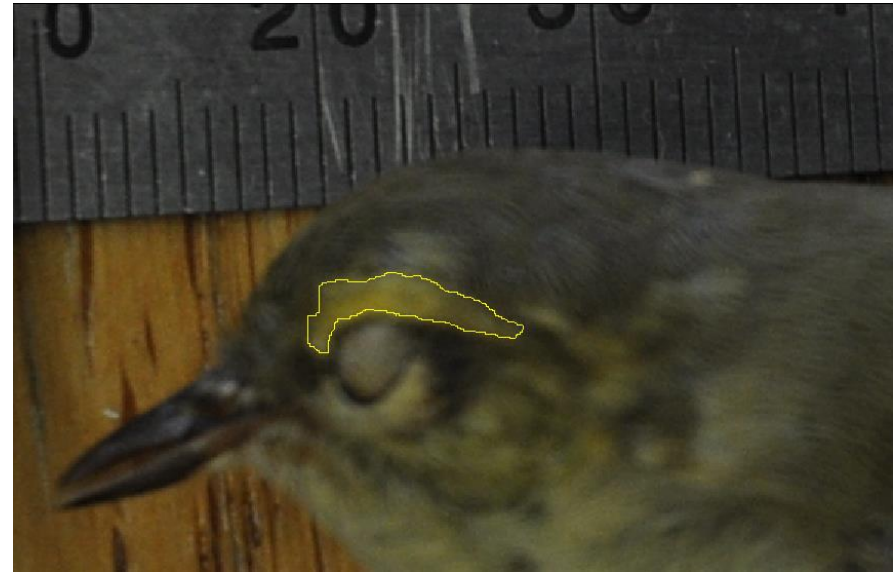
# Morphology

- Wing length
- Beak length
- Body length



# ImageJ- How to Quantify an Image

- Use ImageJ to measure the eyebrow area, a highly variable warbler trait.

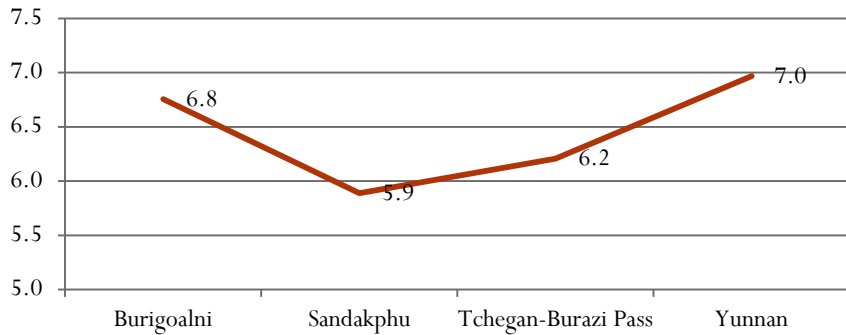


# Batch Geo: Warbler Skins

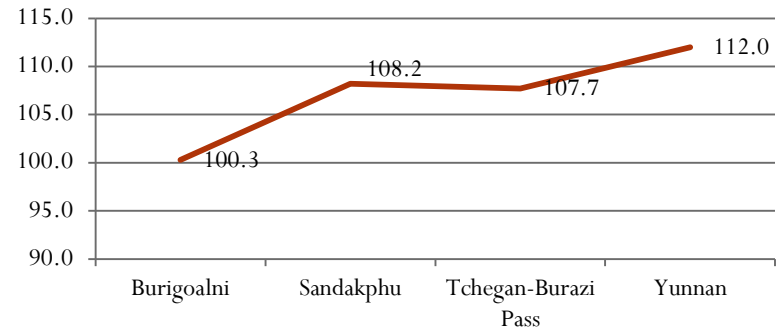


# Morphology Averages: 5 per location

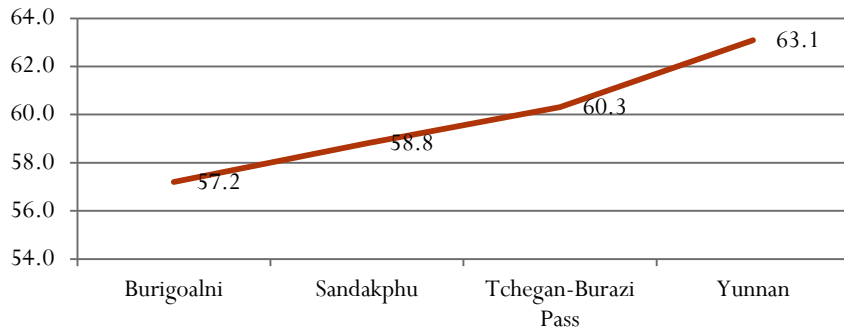
## Bill length



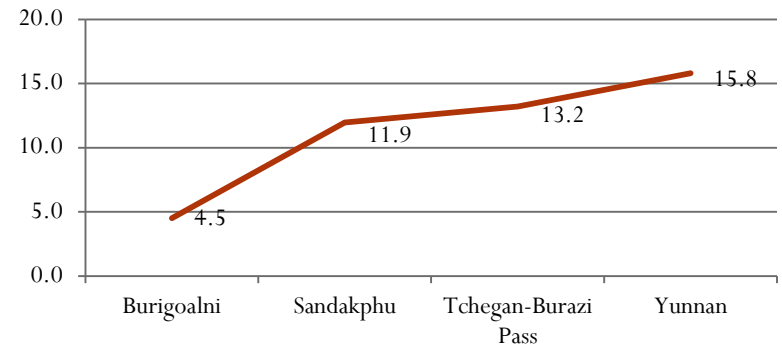
## Body Length



## Wing Length



## Eyebrow Area



<b>Burigoalni :</b>	Bangladesh	<b>Tchehan-Burazi Pass :</b>	Russia
<b>Sandakphu :</b>	India	<b>Yunnan :</b>	China

# ANOVA: Analysis of Variance

- Body length and wing length are not statistically significant
- Bill length and eyebrow are statistically significant

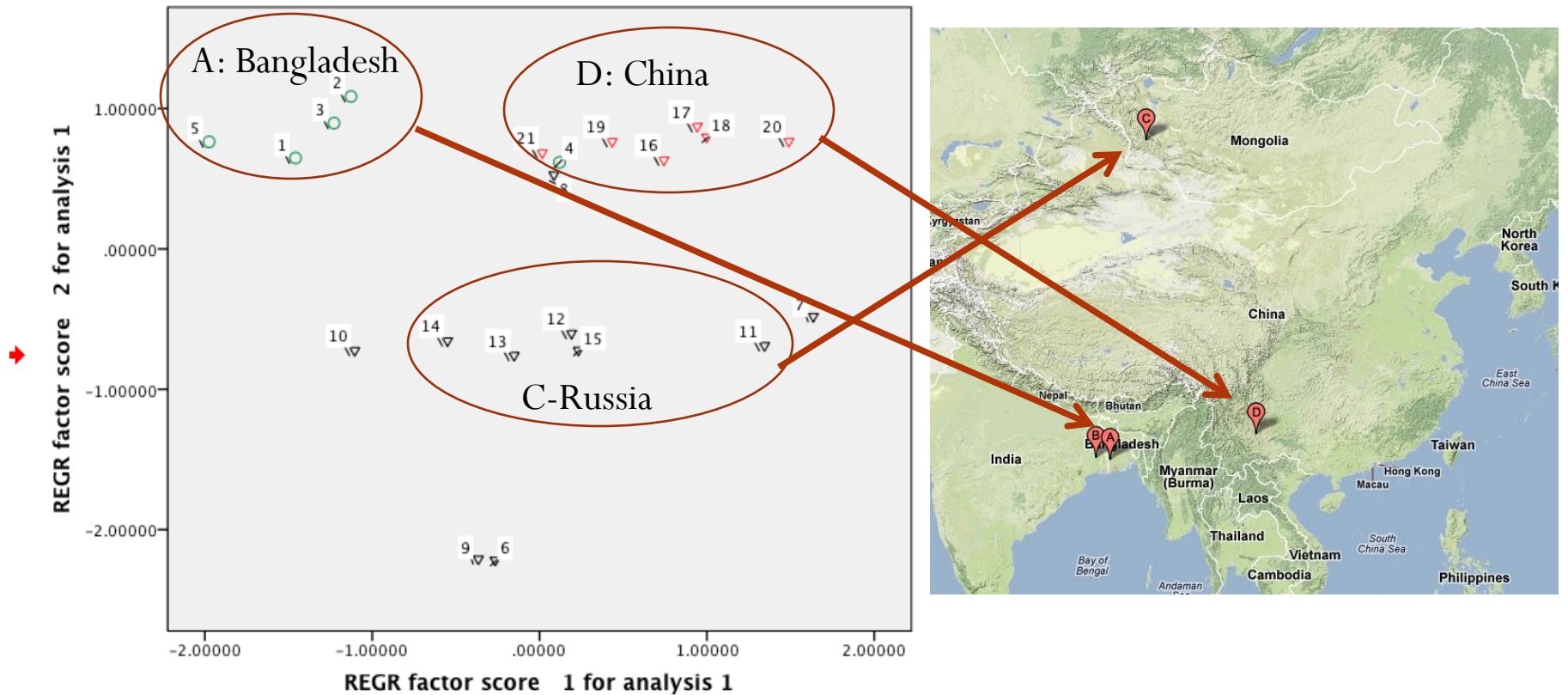
Variable	P-Value
Bill length	.000
Wing Length	.196
Body Length	.101
Eyebrow Area	.001



# ANOVA morphological results

- Graph**
- Conclude that Bangladesh is more similar to China than to Russia. This makes sense on the map

[DataSet1]



Note: We cannot distinguish the group from India.

# Closing the ring between the museum and genomic studies

Thank you!!

