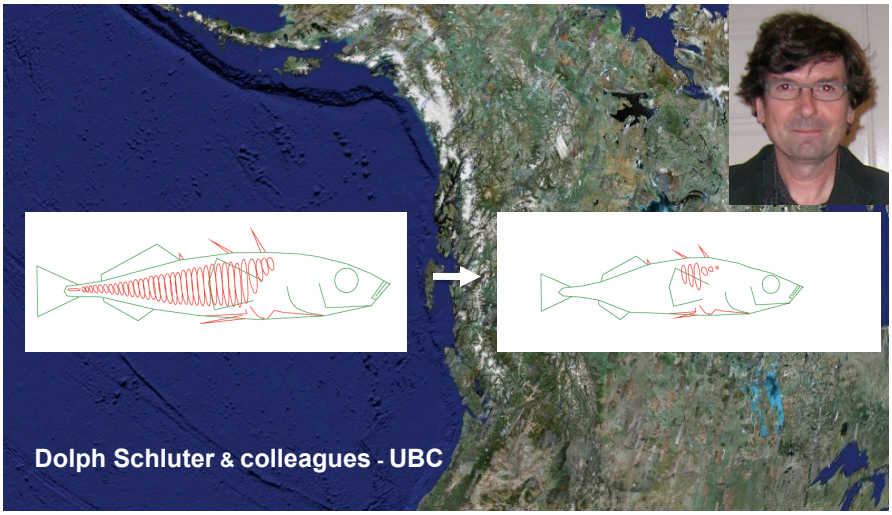
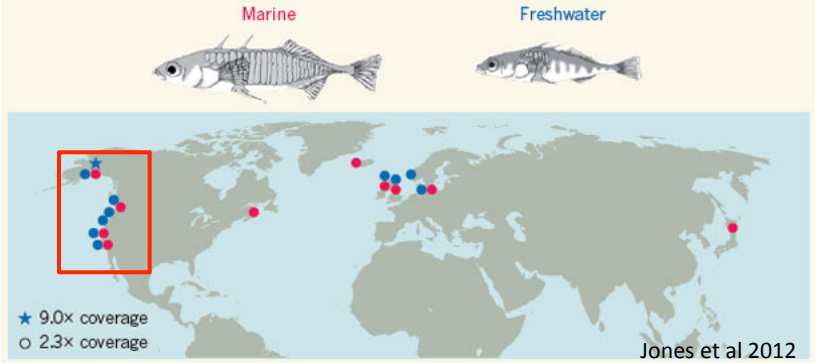
Evolution in three-spined sticklebacks

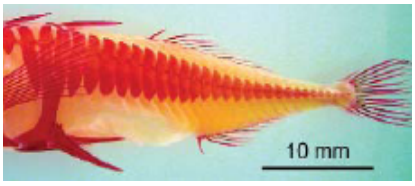




- this area was covered in ice until about 12000 years ago
- lakes formed as land comes up as weight of ice reduced
- over time these lakes lose saltiness and become freshwater
- lakes were shortly thereafter colonized by marine sticklebacks

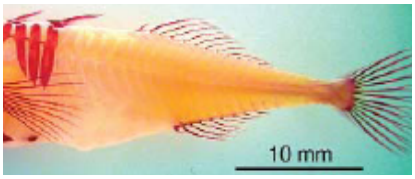
Lateral plates

Marine



complete set of 32-36 bony plates

Freshwater



0-9 plates

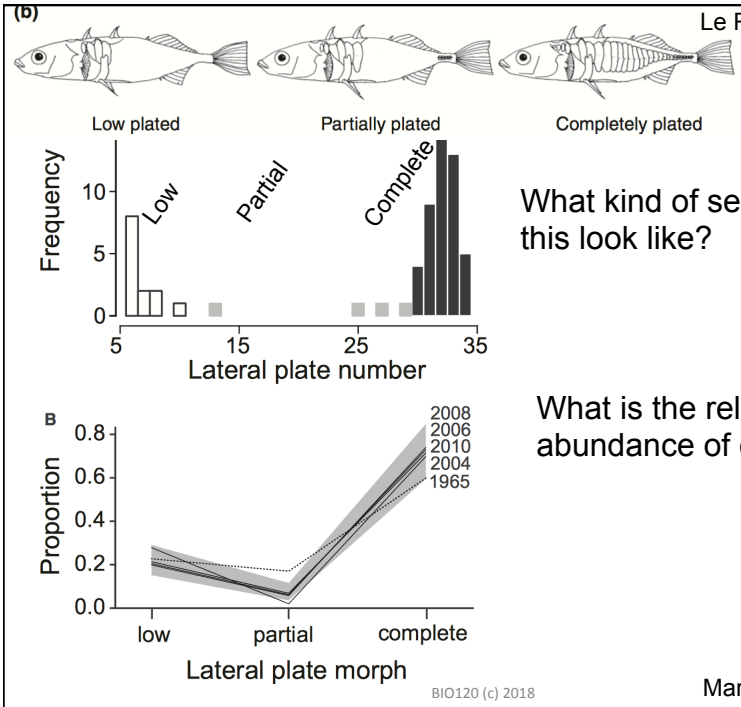
Colosimo et al. *Science* (2005)

Why are there differences in the number of lateral plates in marine vs freshwater fish?

Eda affects lateral plate number

"Ectodysplasin (*Eda*) is a member of the tumor necrosis family of secreted signaling molecules and, in mammals, is required for proper development of a number of ectodermal derivatives (e.g., teeth, hair, and sweat glands) and dermal bones."

Colosimo et al. 2005: 1928



Le Rouzic et al 2011

What kind of selection does this look like?

What is the relative abundance of each morph?

Marchinko et al 2014

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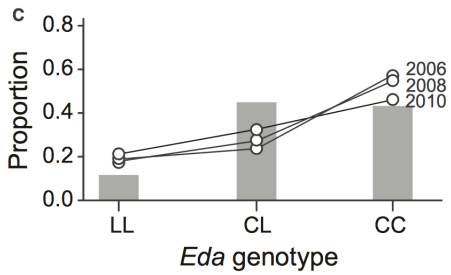
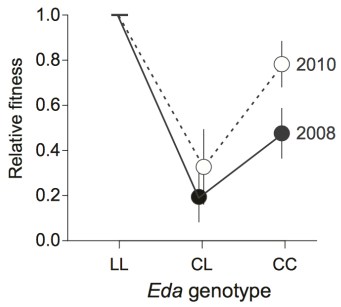


What is the relative abundance of each *Eda* genotype?

The C allele is dominant to the L allele. Heterozygotes have complete morphs



What is the relative fitness of each *Eda* genotype?

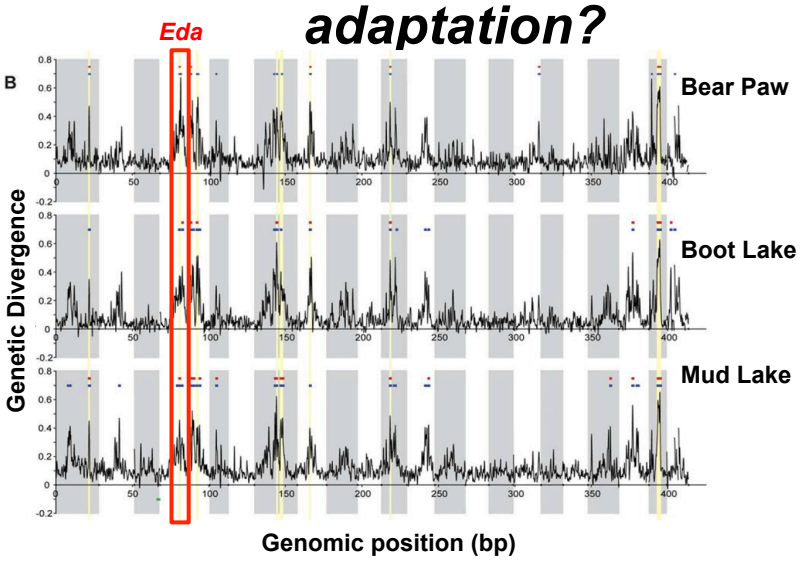
Marchinko et al 2014

What do these results show us?

- There is disruptive selection for lateral plates – intermediates are rare
- Complete morphs are most abundant
- Heterozygotes (CL) at *Eda* have complete morphs; L is recessive allele
- Individuals with low morphs due to a LL genotype have the highest relative fitness
- **What explains this relationship between low relative abundance and high relative fitness in LL individuals?**

Marchinko et al 2014

Can we find evidence for local adaptation?

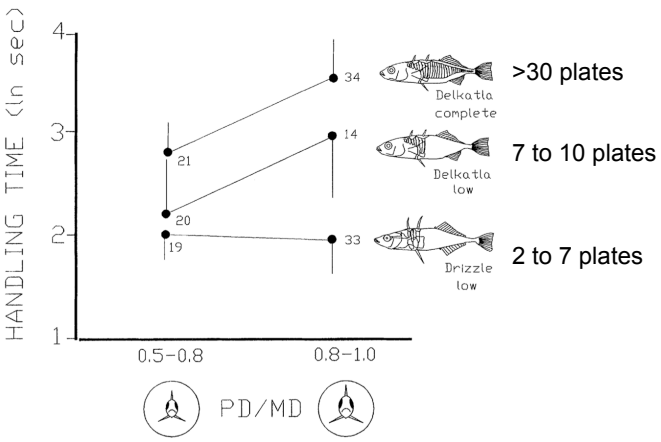


Hohenlohe et al 2010

Local adaptation?

- This study looked at the amount of genetic differentiation between oceanic population and 3 freshwater populations
- In all 3 comparisons, one of the strongest areas of differentiation is in the region on chromosome 4 that carries *Eda* locus

Is there a selective advantage to lateral plate number in these environments?

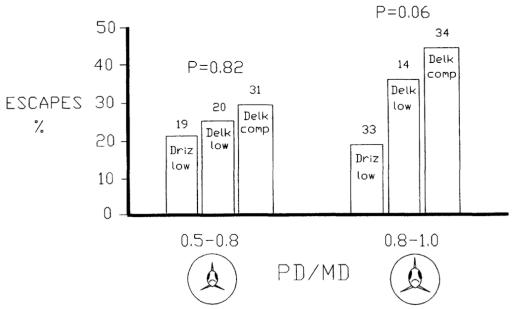


>30 plates

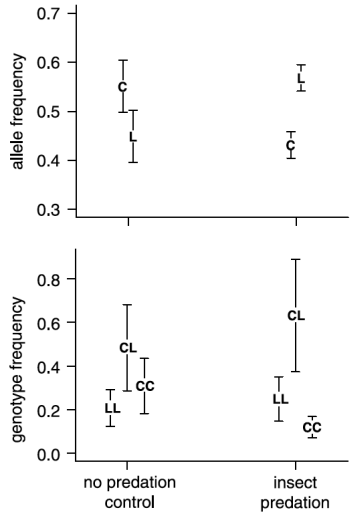
7 to 10 plates

2 to 7 plates

Is there a selective advantage to lateral plate number in these environments?



Is there a selective advantage to lateral plate number in these environments?



predation = 2 common aquatic insect predators of juvenile sticklebacks

no predation = no predators

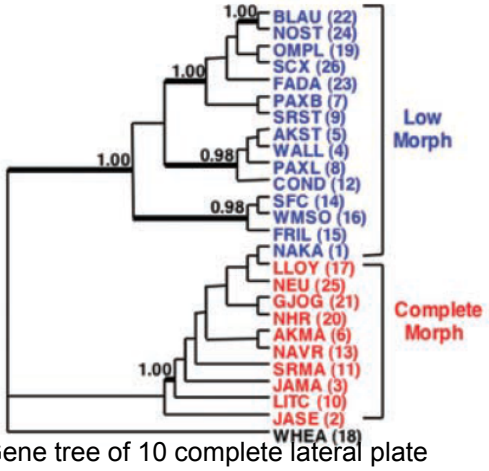
- ran trials until 50% of individuals remained
- genotyped survivors for *Eda* locus

Marchinko 2008

What do these results show us?

- In marine environments, high plate number is associated with lower handling time and greater chance of escape
- In freshwater environments, low plate number is associated with lower predation by insects and higher growth rate

What is evolutionary history of this trait?



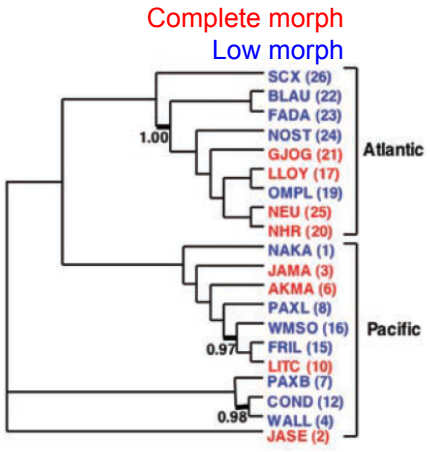
Gene tree of 10 complete lateral plate morph populations and 15 low lateral plate morph populations based on *Eda* sequence

Colosimo et al 2005

Does this mean that all low-plated populations have a single origin?

They sequenced 25 random nuclear loci of these 25 populations and built a phylogeny based on genetic differences between 193 SNPs

What would the phylogeny look like if there was a single origin of all low-plated populations?



Colosimo et al 2005

What do these results tell us?

- *Eda* alleles of almost all low-plated populations share a common ancestor
- Populations form monophyletic group based on geography
- Low allele is found at low frequencies in completely-plated marine populations

Are these different species?

Why are there differences in the number of lateral plates in marine vs freshwater fish?

- There is a single major gene (*Eda*) that affects the number of lateral plates
- This genetic polymorphism is maintained by frequency-dependent selection favouring the recessive (low-plate) allele There is evidence of local adaptation at the *Eda* locus
- There are different selective agents that select for different plate numbers in the marine and freshwater environment
- There was rapid, parallel evolution of low-plated morphs in numerous freshwater locations