

# The genomics of organismal diversification



Walter Salzburger

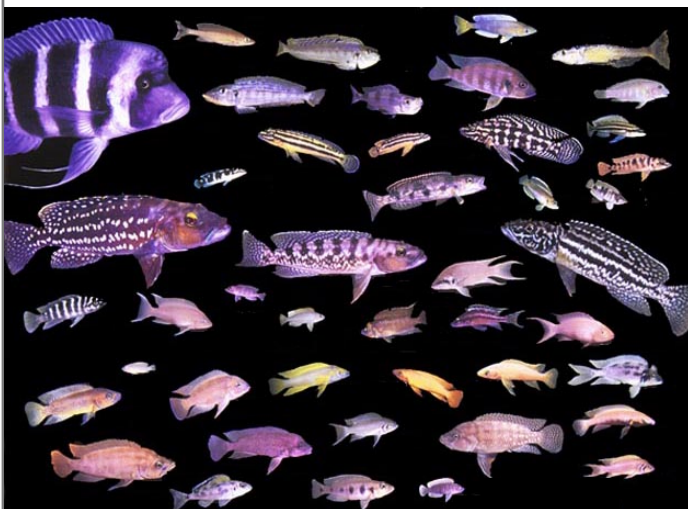
Zoological Institute  
University of Basel, Switzerland



## preface

adaptive radiation

genomic era

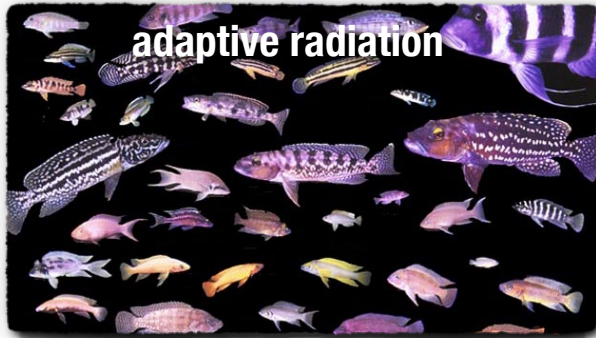


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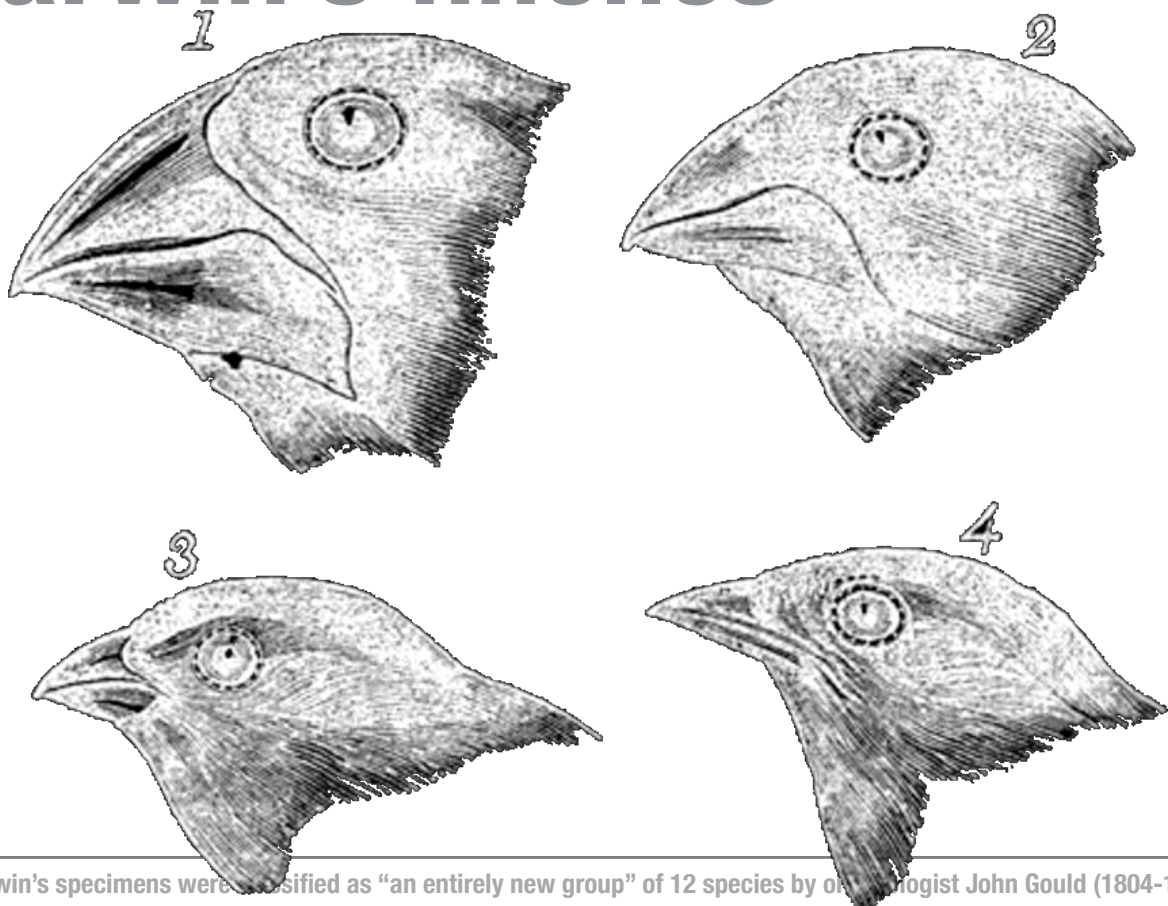


... D Berner & W Salzburger (2015) Trends in Genetics

# preface



# darwin's finches



① Darwin's specimens were classified as "an entirely new group" of 12 species by ornithologist John Gould (1804-1881)



# darwin's finches

1

2

3

4

ANCESTOR FINCH  
from South America  
mainland.

**Seed eaters**  
Bills of seed eaters are adapted  
for harvesting and crushing seeds.

Large ground finch  
(*Geospiza magnirostris*)

Medium ground finch  
(*G. fortis*)

Small ground finch  
(*G. fuliginosa*)

Sharp-billed ground  
finch (*G. difficilis*)

Large cactus finch  
(*G. conirostris*)

Cactus finch  
(*G. scandens*)

Large-billed  
finches can crush  
large, hard seeds.

Small-billed finches cannot  
crush large seeds as well,  
but are more adept at  
handling small seeds.

Cactus finches are  
adapted to opening  
cactus fruits and  
extracting the seeds.

**Bud eater**  
The bud eater's heavy bill is adapted for  
grasping and wrenching buds from branches

Vegetarian finch  
(*Platyspiza crassirostris*)

**Insect eaters**  
The bills of insect eaters vary because they eat  
different types and sizes of insects and they  
capture them in different ways

Small tree finch  
(*Camarhynchus parvulus*)

Large tree finch  
(*C. psittacula*)

Medium tree  
finch (*C. pauper*)

Mangrove finch  
(*C. heliobates*)

Woodpecker finch  
(*C. pallidus*)

Warbler finch  
(*Certhidea olivacea*)

The large tree finch uses  
its heavy bill to twist apart  
wood to reach larvae inside.

The small and medium  
tree finches and mangrove  
finches pick insects from  
leaves and branches and  
explore crevices for hidden  
prey.

The woodpecker finch uses its long  
beak to probe into dead wood,  
crevices, and bark for insects.

The warbler finch uses  
quick motions to capture  
insects on plant surfaces.

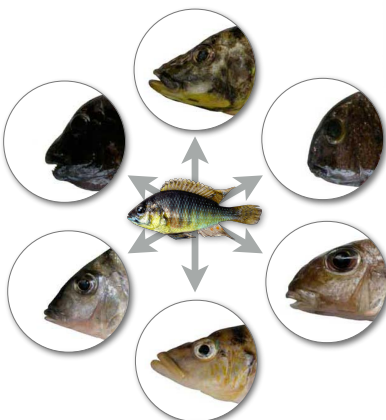
(*Certhidea olivacea*)  
Warbler finch

insects on plant surfaces  
quick motions to capture  
The warbler finch uses

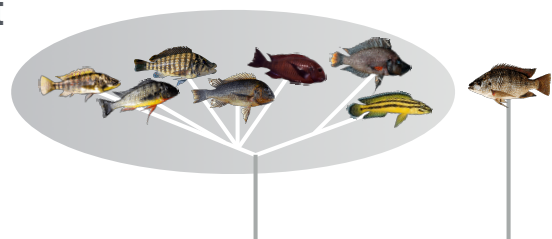
# adaptive radiation



phenotype-  
environment  
correlation



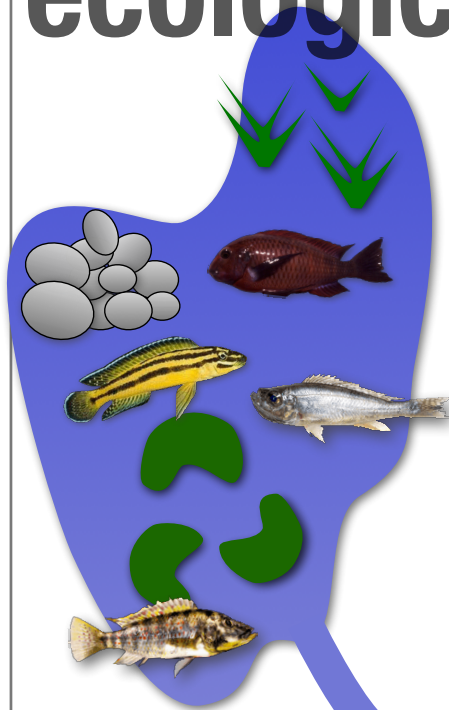
common ancestry



rapid speciation

anoles images: Rich Glor

# ecological opportunity



colonization



extinction

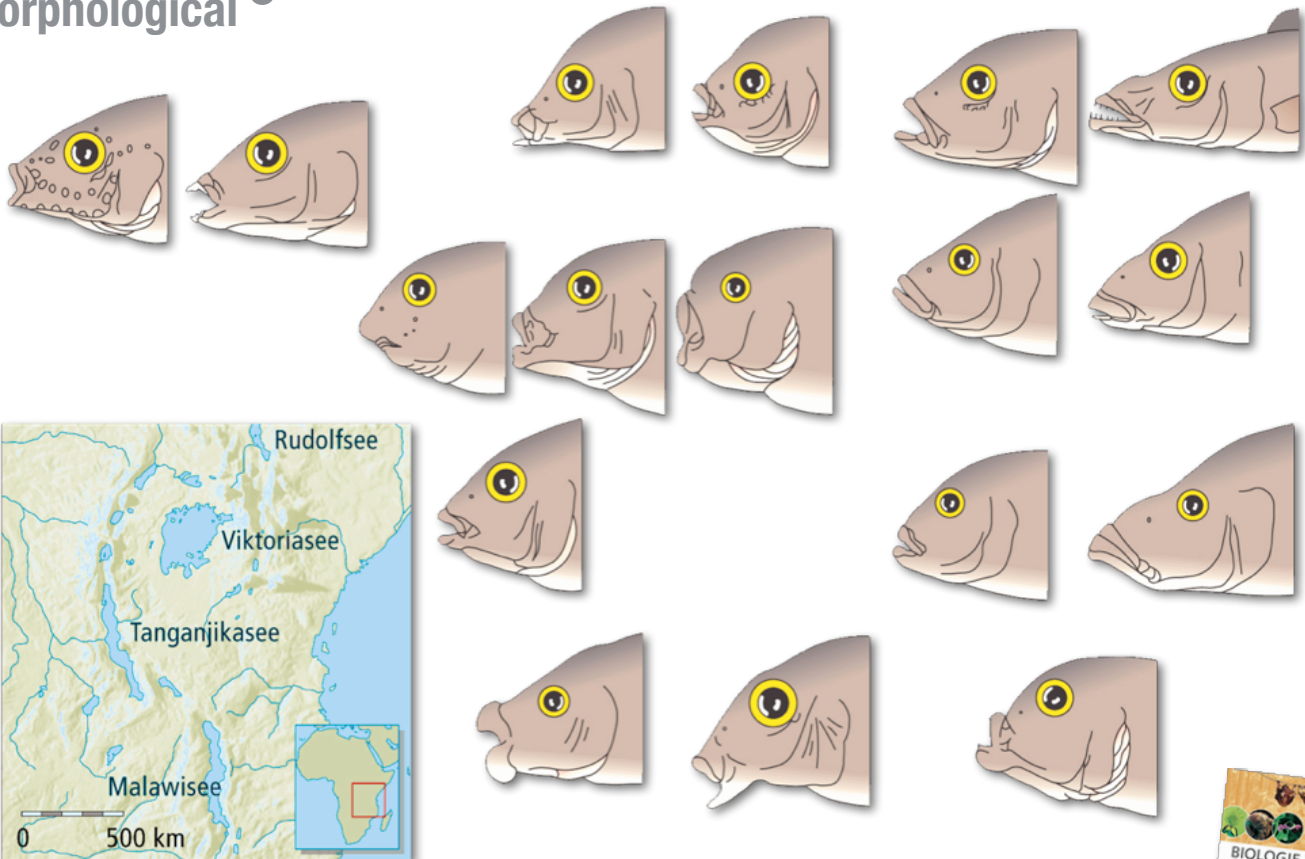


innovation

① for more information, check Dolph Schluter's book "Ecology of Adaptive Radiation" (2000)

www.worldpress.com

ecological  
morphological



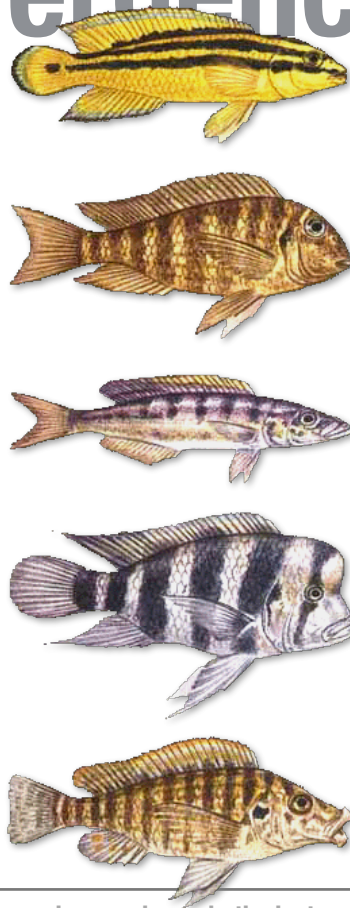
... H Hofer & W Salzburger (2008) Biologie III



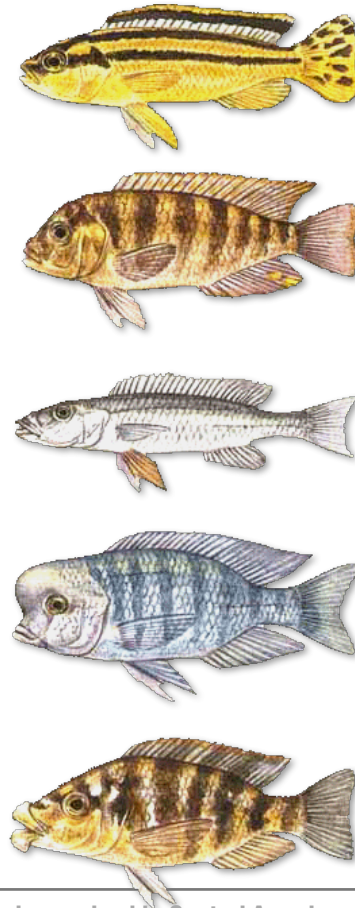


# convergence

Lake Tanganyika



Lake Malawi



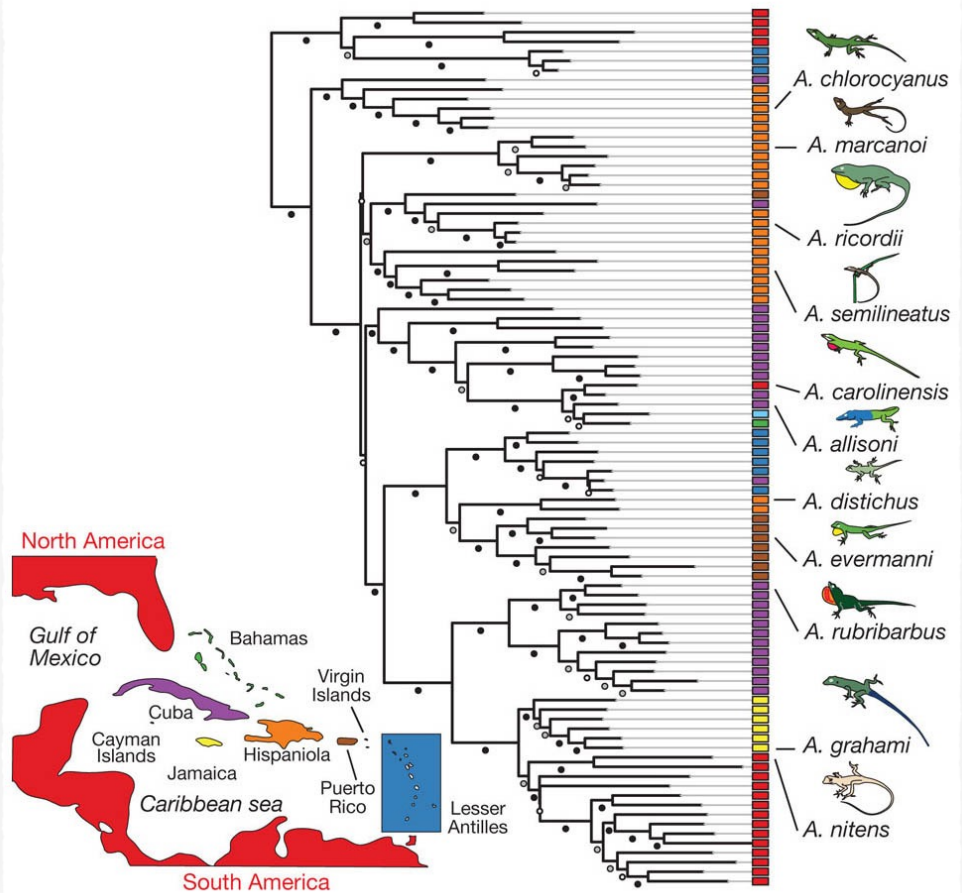
① Thick-lipped cichlid species, as shown in the last row, have also evolved in Central American species flocks

image: M Stiasny & A Meyer (1999) Sci Am

# Radiating Genomes

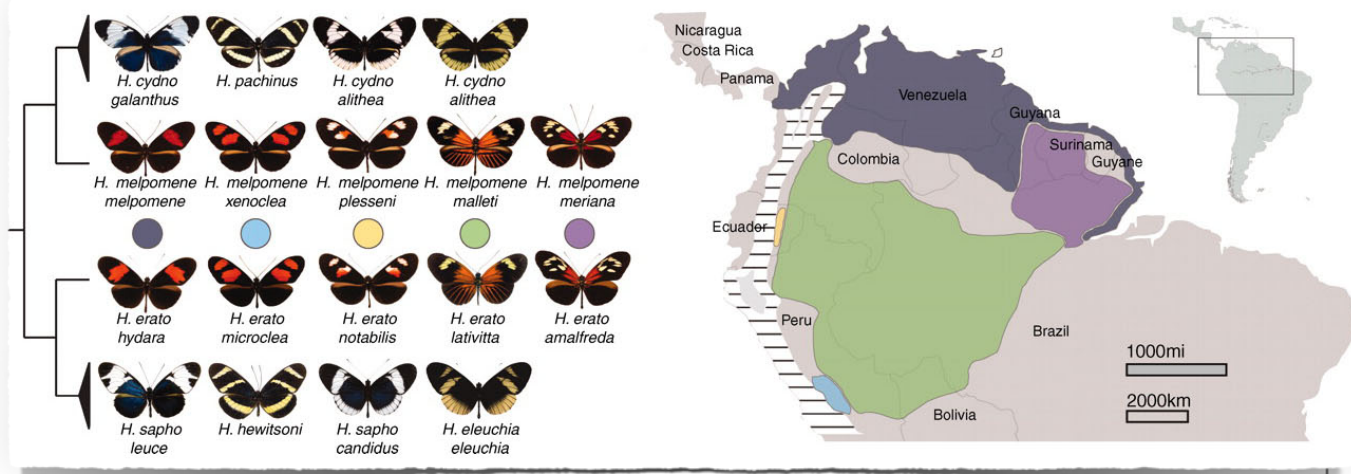


# Anolis



... J Alföldi et al. (2011) Nature

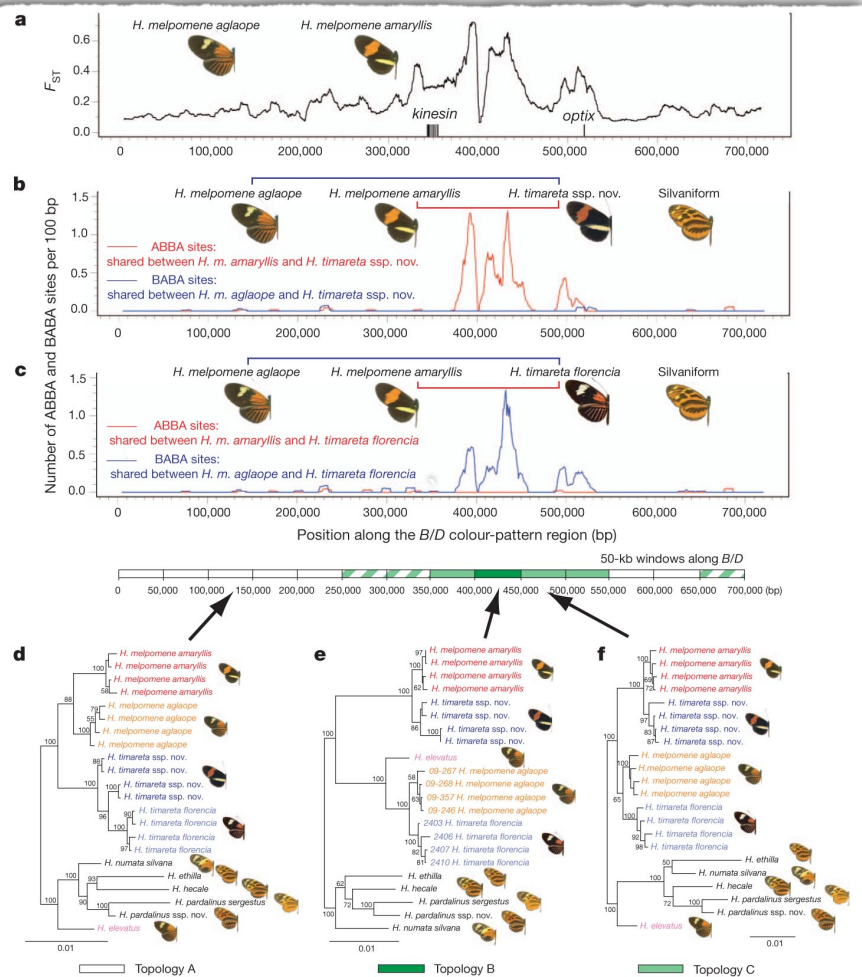
# Heliconius



... R Reed et al. (2011) Science

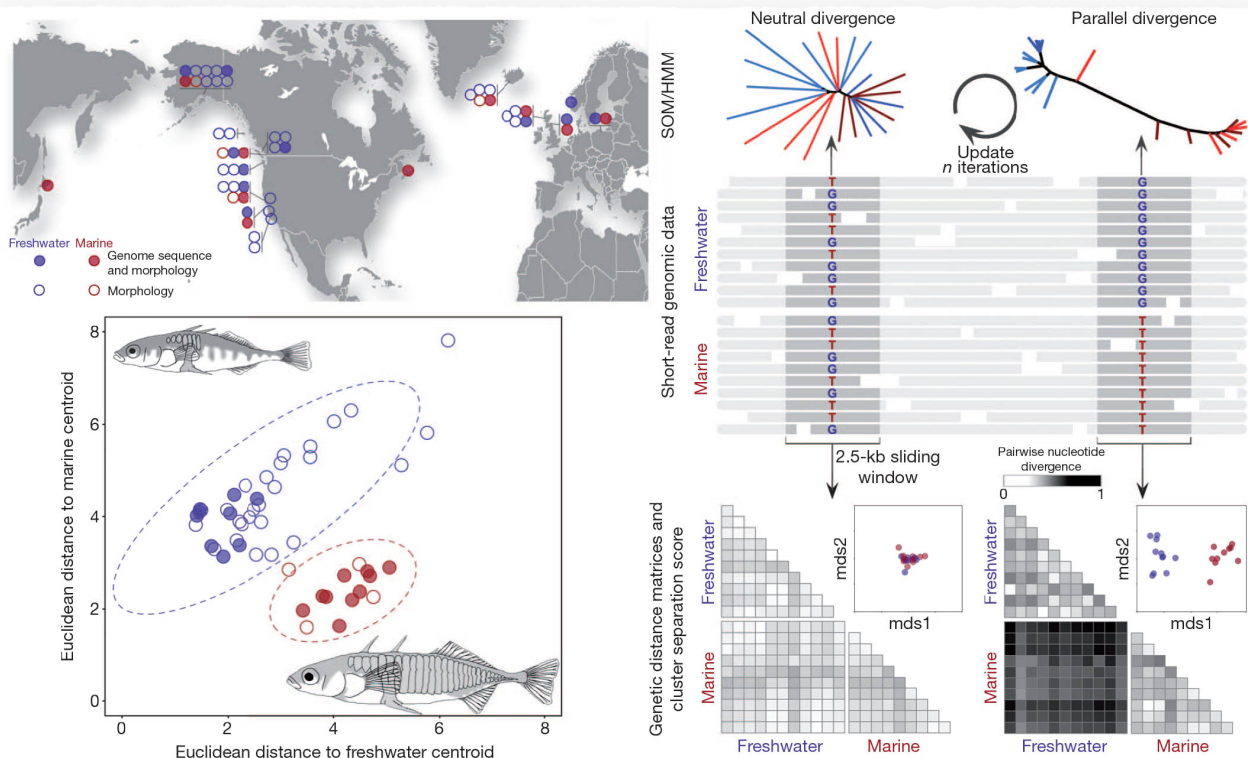


# Helio



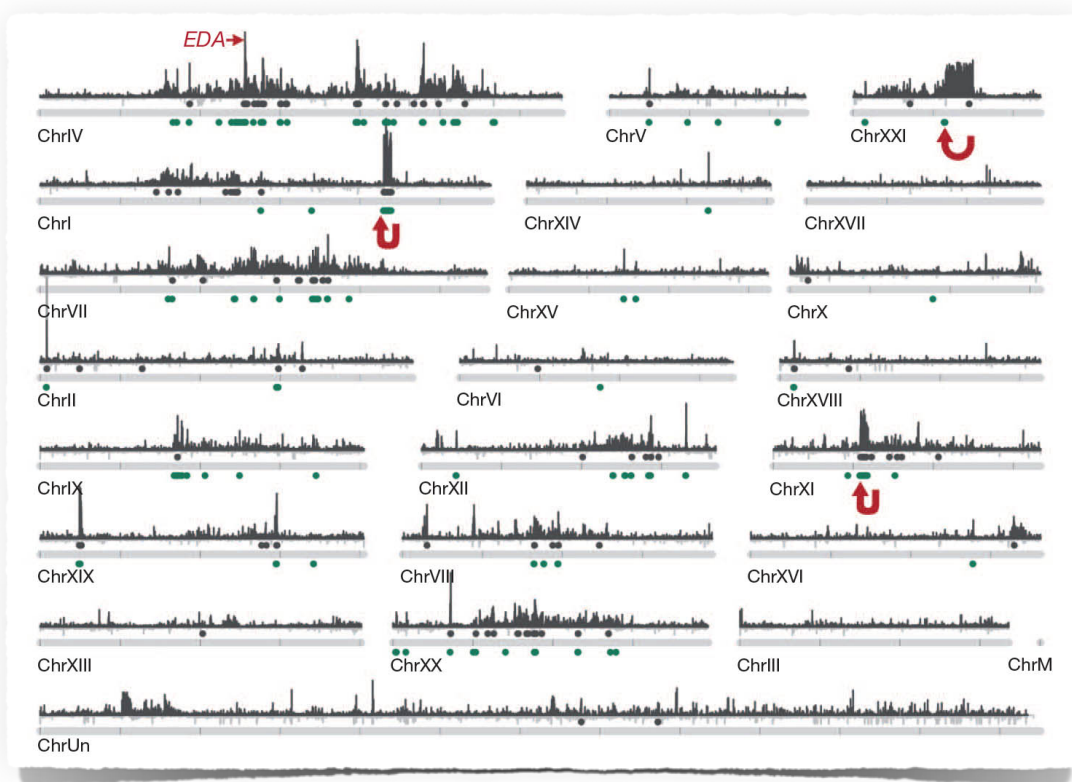
••• The Heliconius Genome Consortium (2012) Nature

# sticklebacks



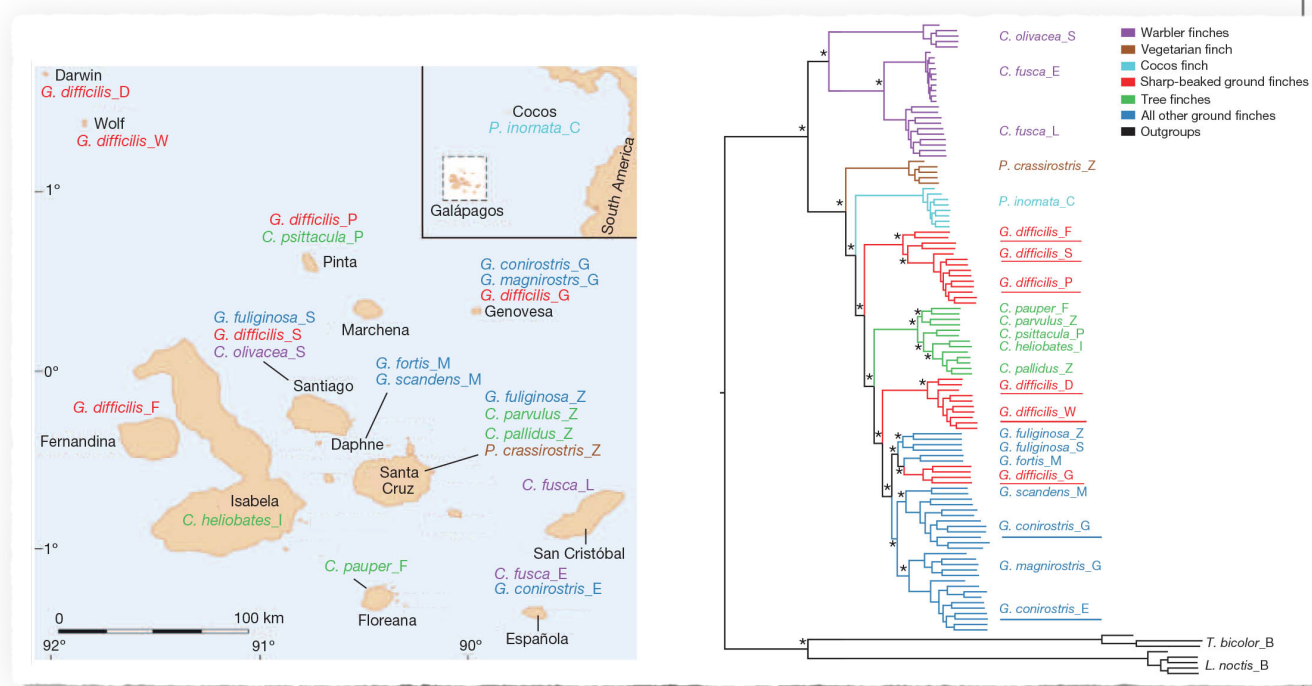
••• FC Jones et al. (2012) Nature

# sticklebacks



••• FC Jones et al. (2012) Nature

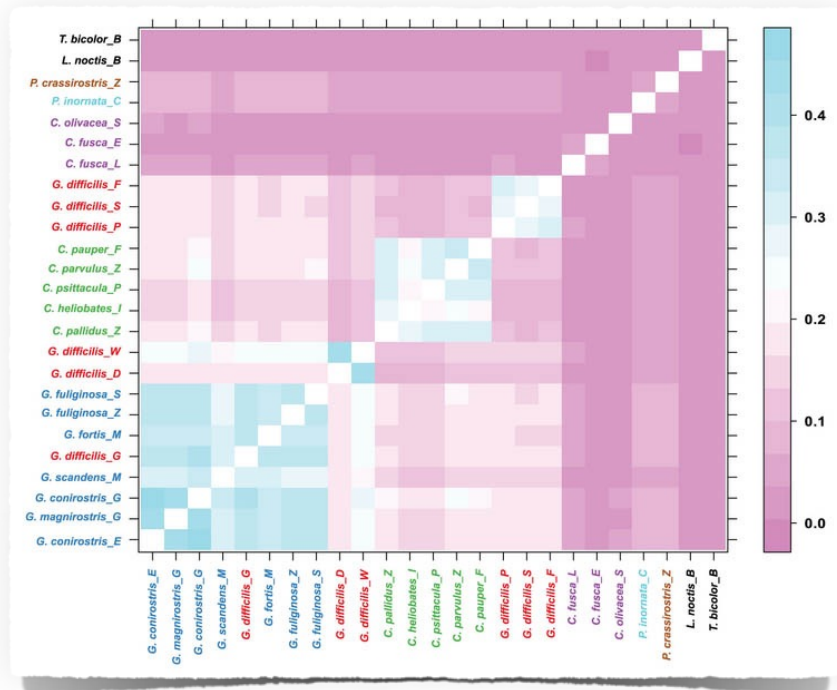
# darwin's finches



••• S Lamichhane et al. (2015) Nature

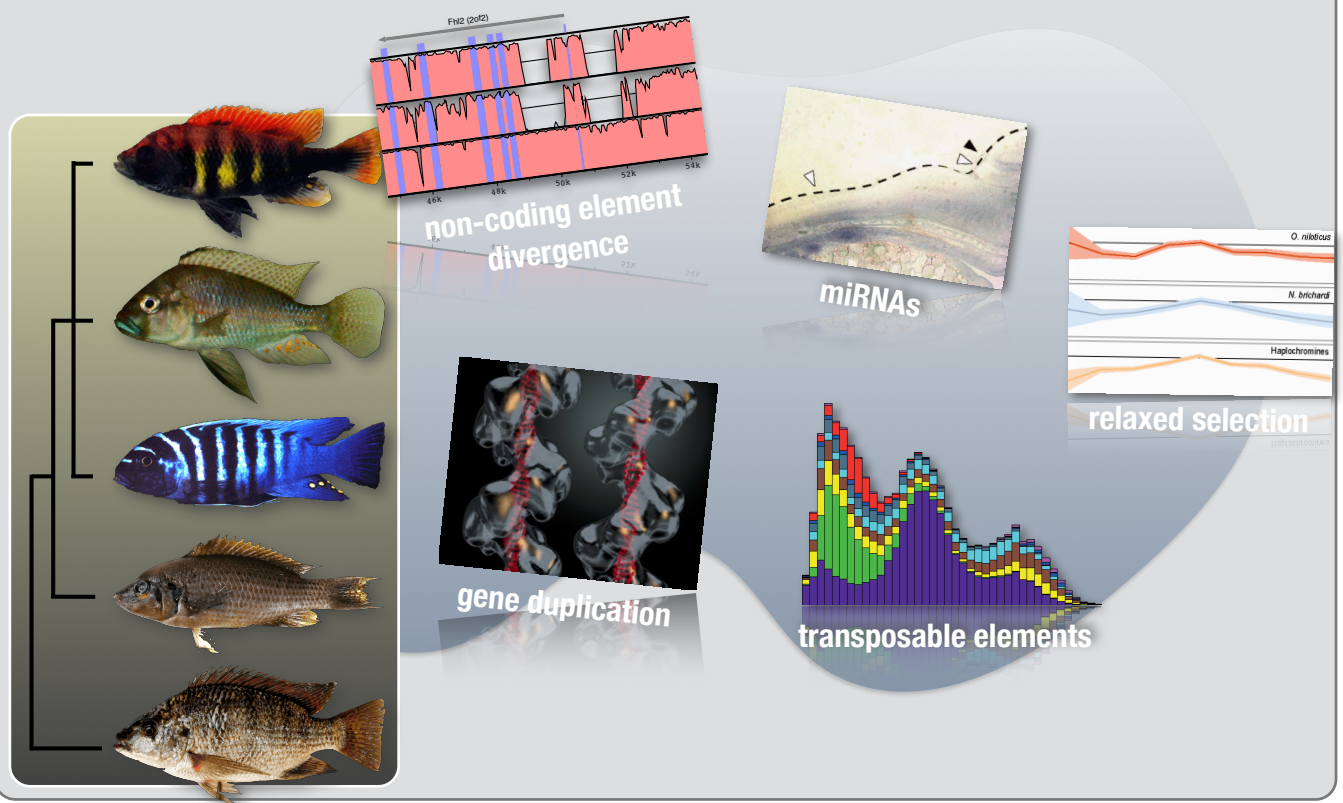


# darwin's finches



... S Lamichhaney et al. (2015) Nature

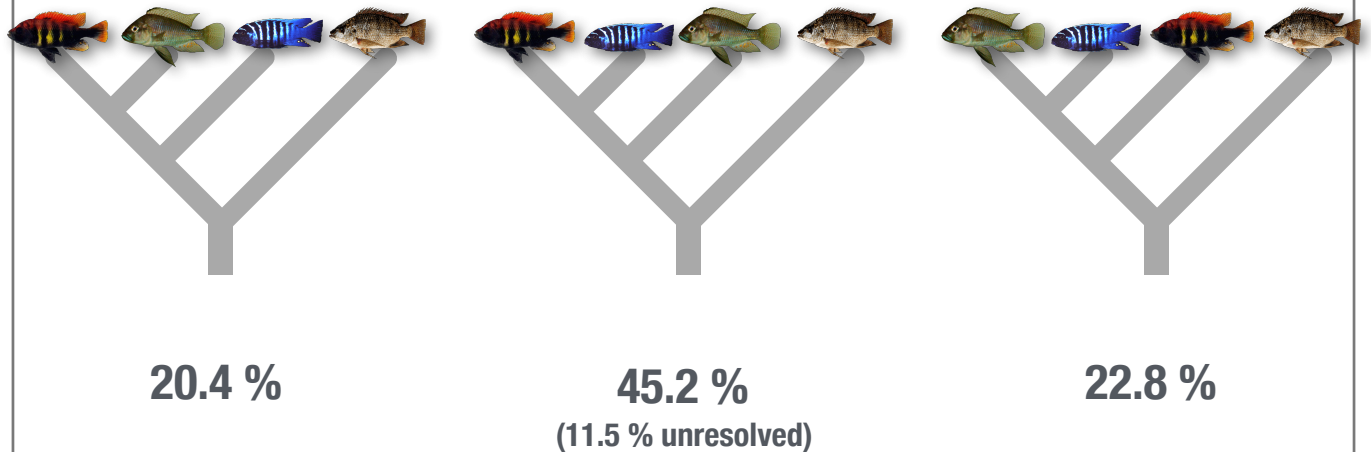
# natural variation



... D Brawand et al. (2014) Nature

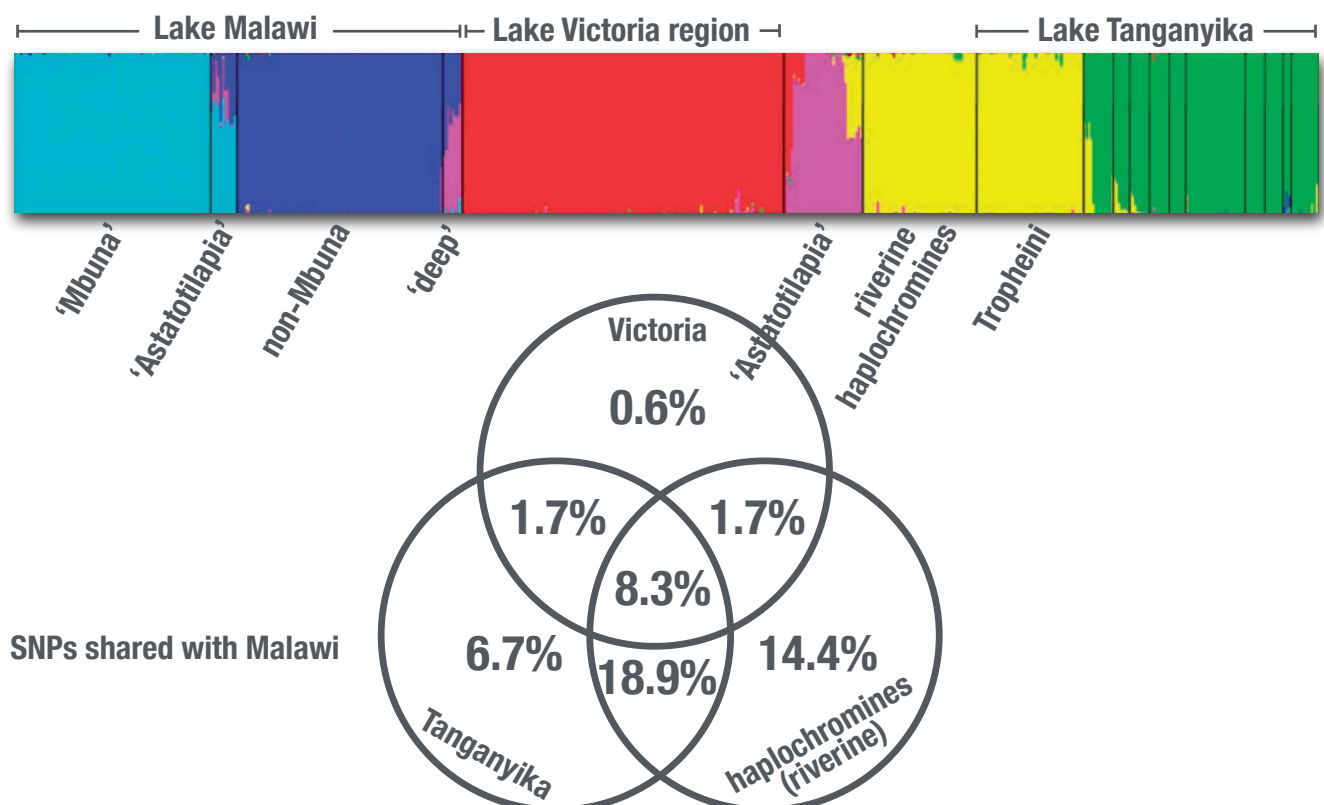
# cichlids

## SNP phylogenies



... D Brawand et al. (2014) Nature

# cichlid



... YHE Loh et al. (2013) Molecular Biology and Evolution



# radiating genomes

|                                                                                    | genomes     | gene duplications | mobile elements | regulatory changes | accelerated coding evolution | miRNAs | inversions | hybridization introgression ILS |
|------------------------------------------------------------------------------------|-------------|-------------------|-----------------|--------------------|------------------------------|--------|------------|---------------------------------|
|   | 1           | n/r               | YES             | maybe              | n/r                          | n/r    | n/r        | n/a                             |
|   | 5<br>(>100) | YES               | YES             | YES                | YES                          | YES    | n/r        | YES                             |
|   | 1<br>(>100) | n/r               | n/r             | n/r                | n/r                          | n/r    | n/r        | YES                             |
|   | 1<br>(>100) | n/r               | YES             | maybe              | n/r                          | YES    | n/r        | YES                             |
|  | 1<br>(>100) | n/r               | n/r             | YES                | n/r                          | n/r    | YES        | YES                             |

... D Berner & W Salzburger (2015) Trends in Genetics