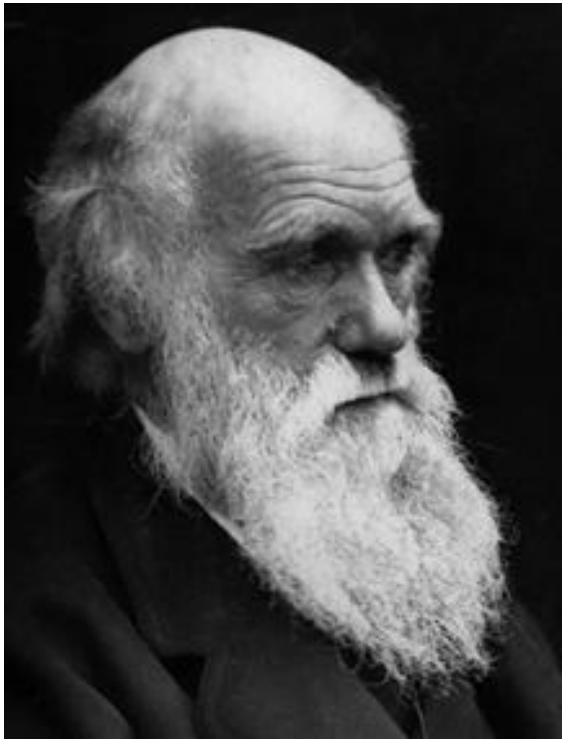
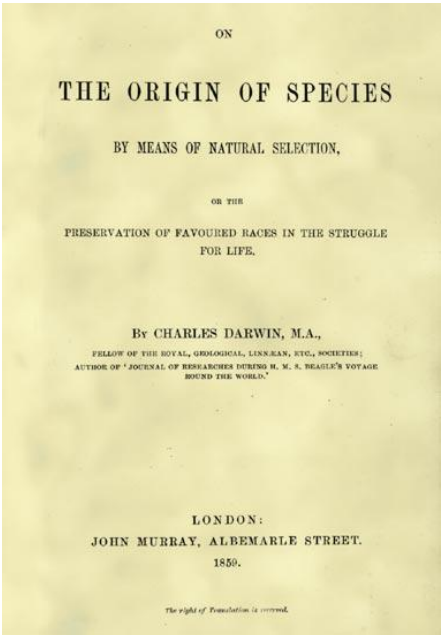
Biodiversity implications of rapid evolution

Andrew Hendry, McGill University

Ever since Darwin





ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

The right of Translation is reserved.

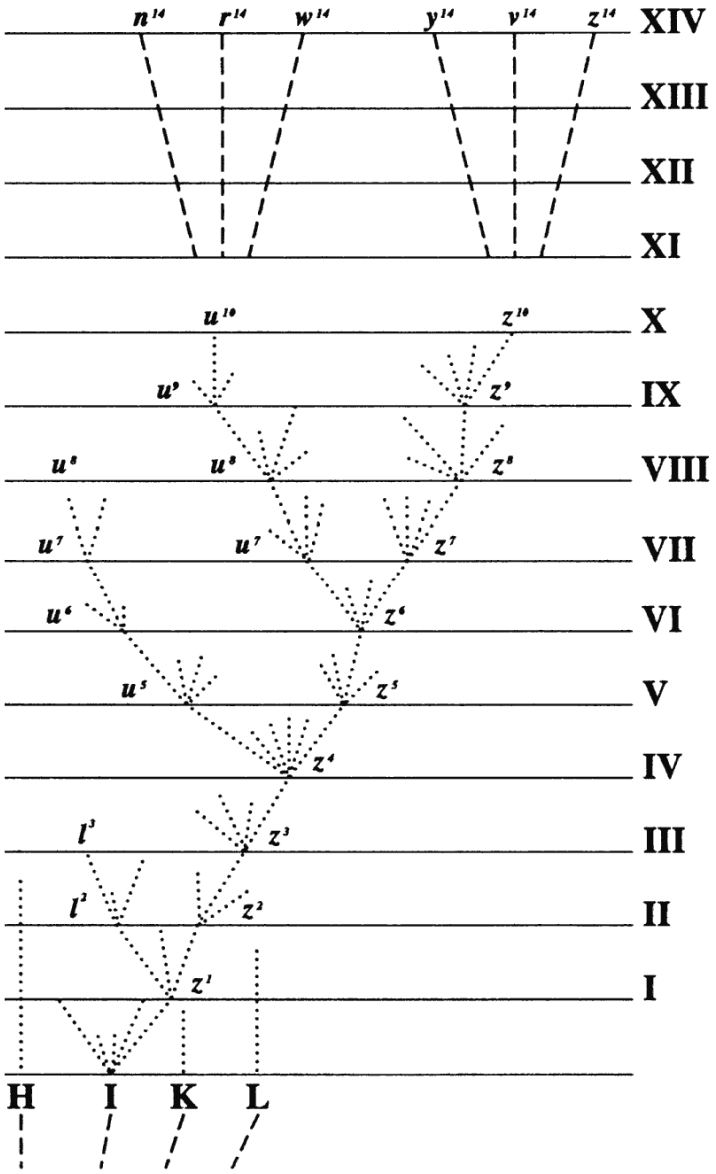
"We see nothing of these slow changes in progress, until the hand of time has marked the long lapse of ages…" (Darwin 1859)

"she can never take a leap, but must advance by the shortest and slowest steps" (Darwin 1859)

But is that really what he meant?

"After fourteen thousand generations, six new species, marked by the letters n^{14} to z^{14}, are supposed to have been produced." (Darwin 1859)

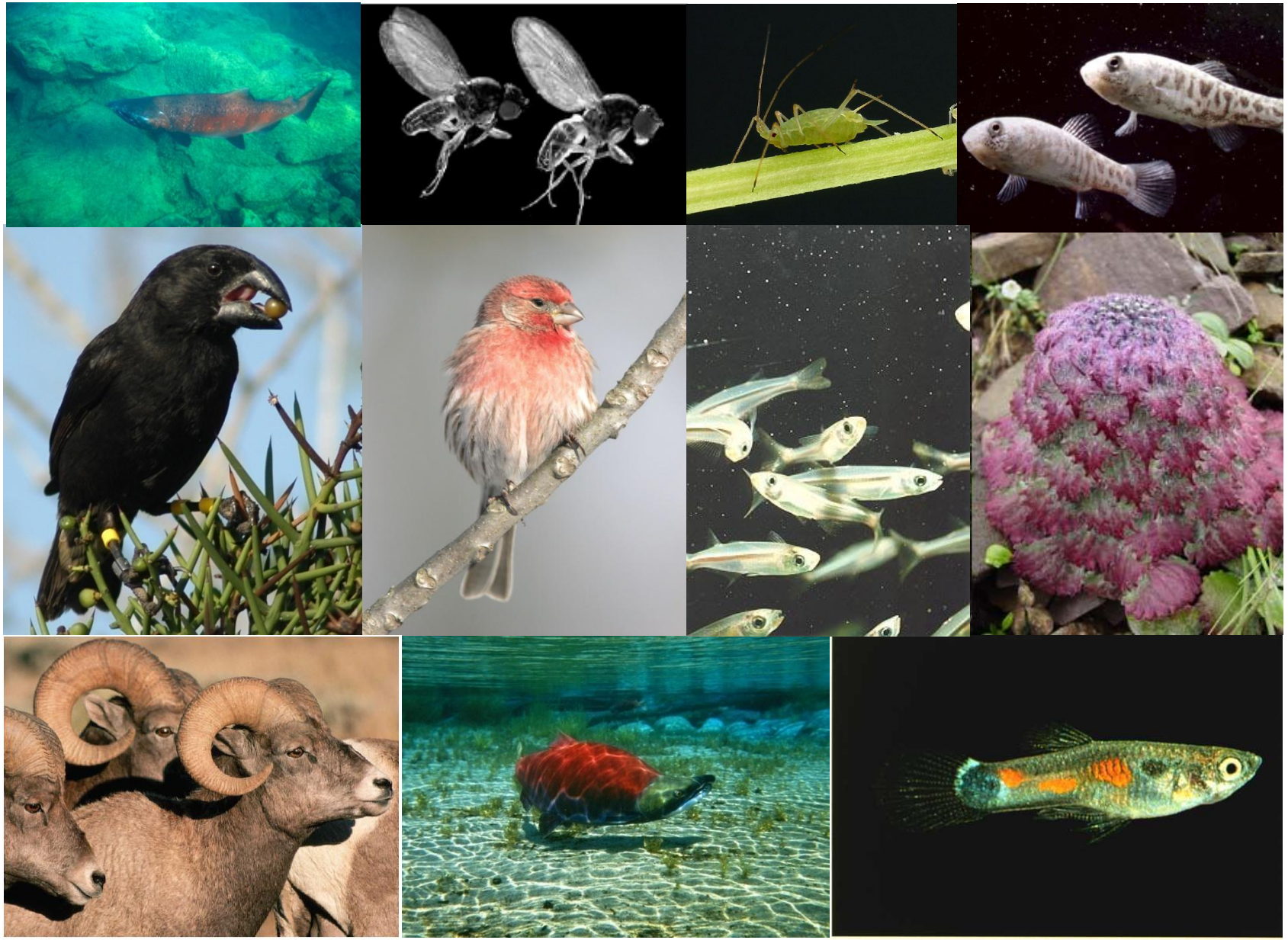
"… there seems no difficulty in an amount of change, quite equivalent to that which usually distinguishes allied species, sometimes taking place in less than a century.. ." (Wallace 1889)



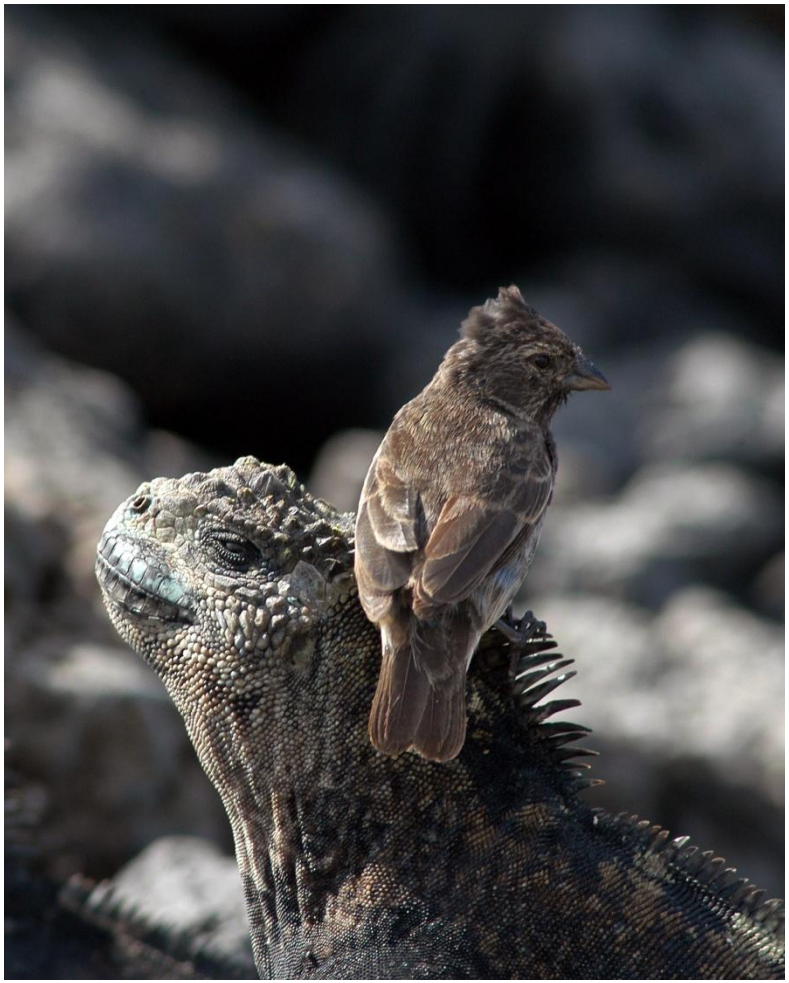
Rapid evolution and human welfare.

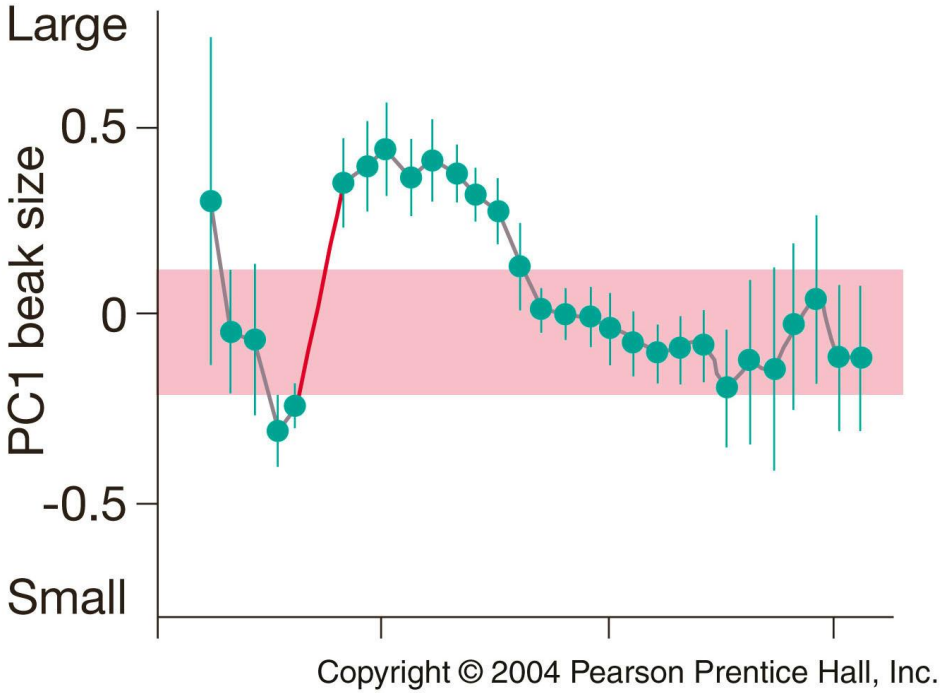
1. HIV drug resistance.
2. Antibiotic resistance.
3. Pesticide resistance.
4. Herbicide resistance.

Rapid evolution and biodiversity in the “wild”



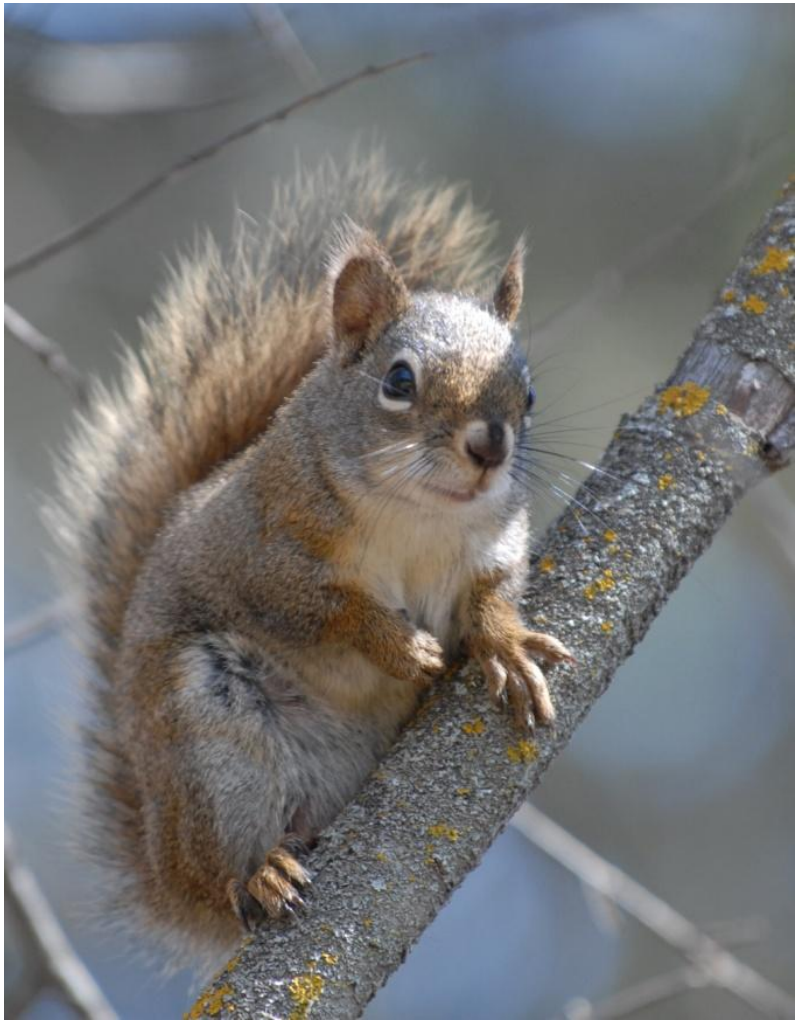
Natural variation

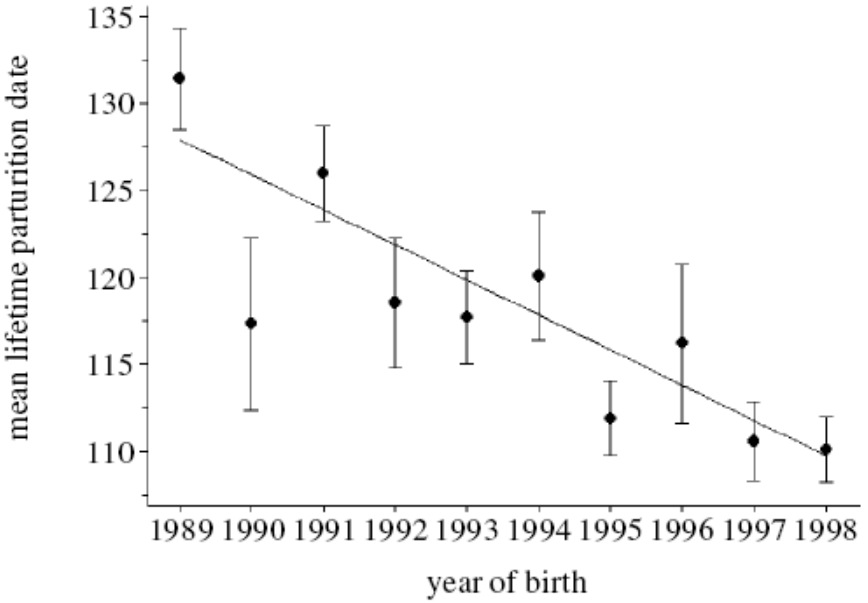


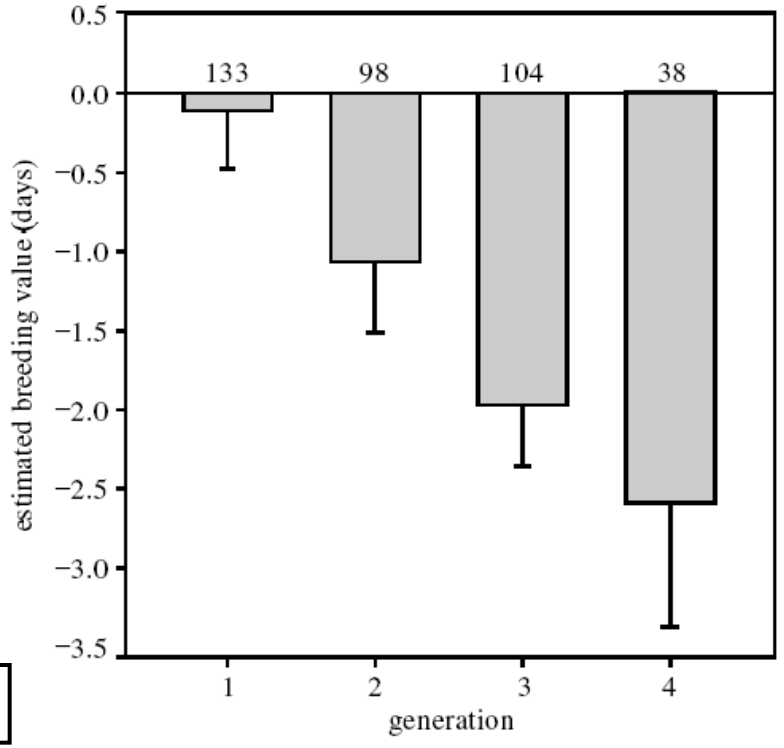


Grant and Grant (2002 – Science)

Global warming

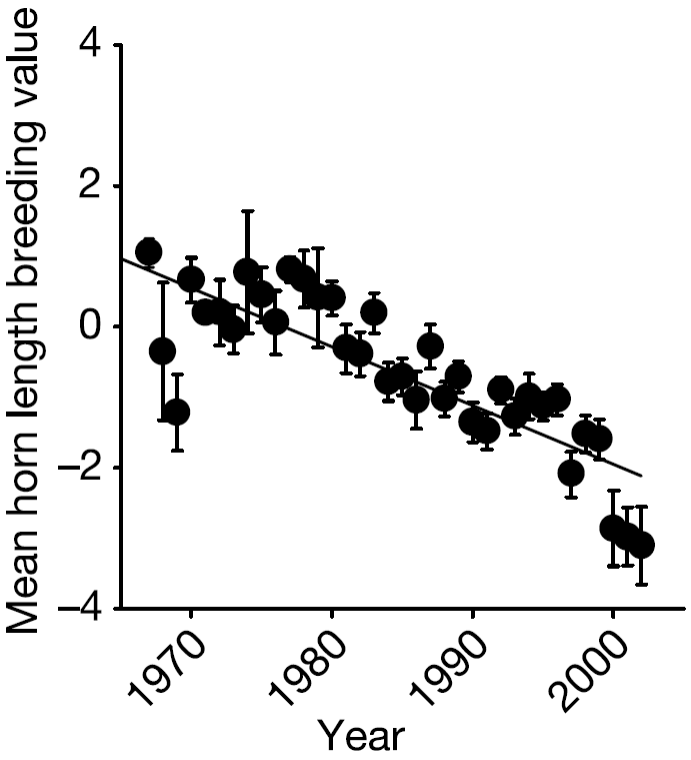


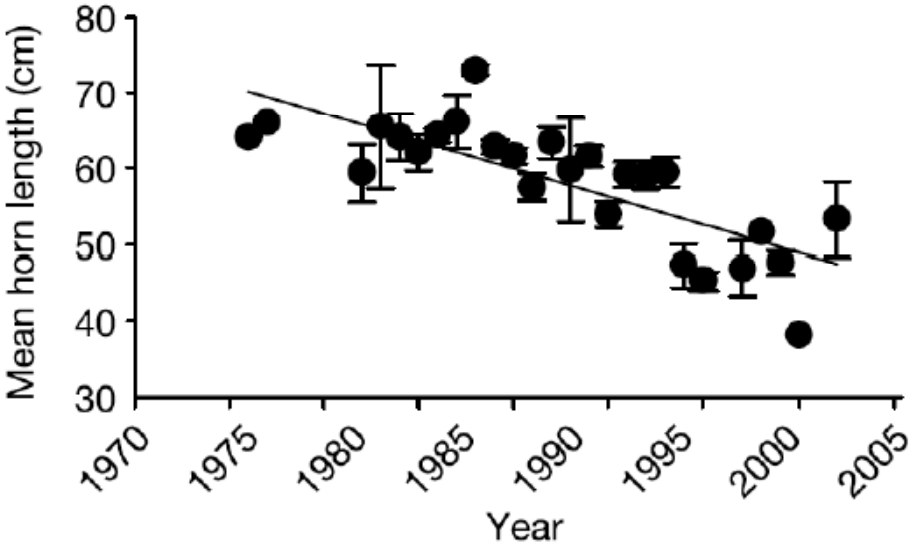




Reale et al. (2003 – Proc. Roy. Soc. Lond. B)

Human harvesting





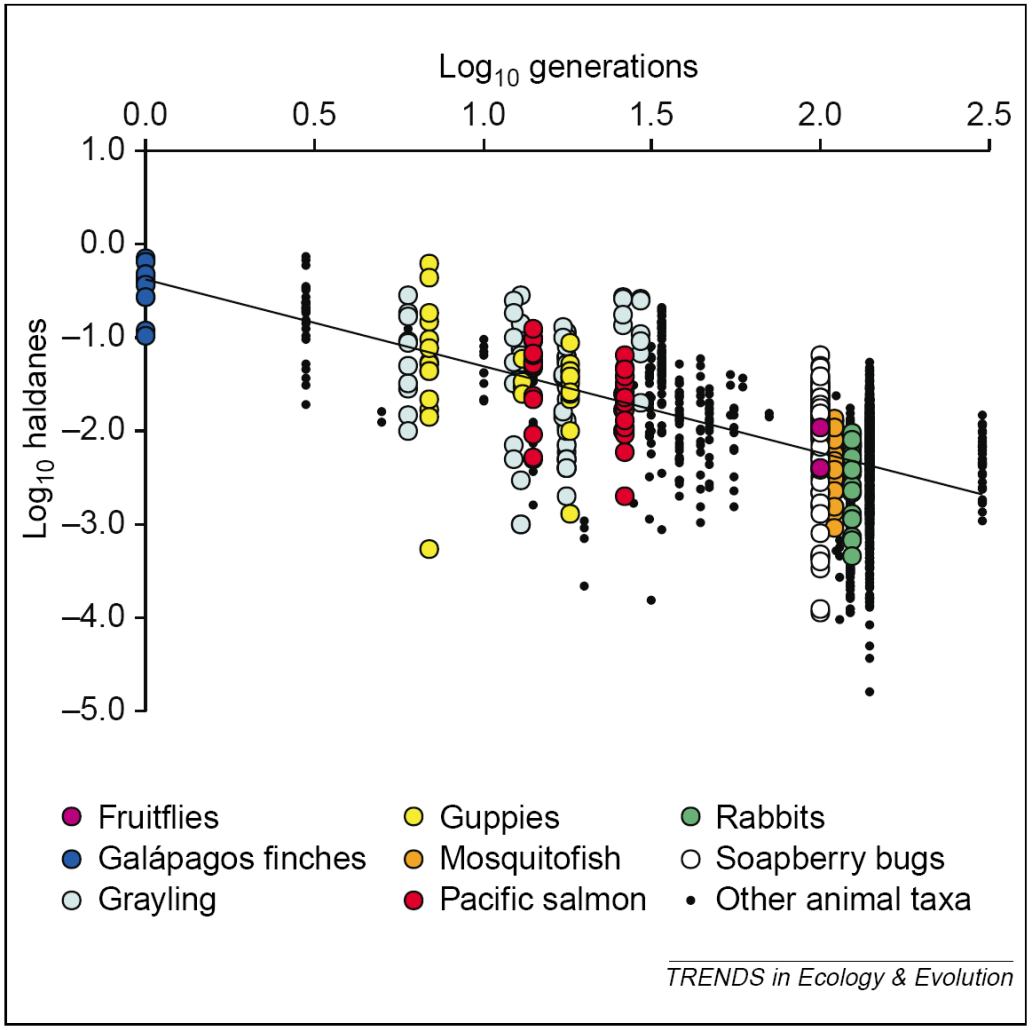
Coltman et al. (2004 – Nature)

But how general is it?

the “haldane”

(standard deviations per generation)

$$h = \frac{\left[\frac{X_2 - X_1}{S_p}\right]}{generations}$$



Hendry and Kinnison (1999 - Evolution)
Kinnison and Hendry (2001 - Genetica)

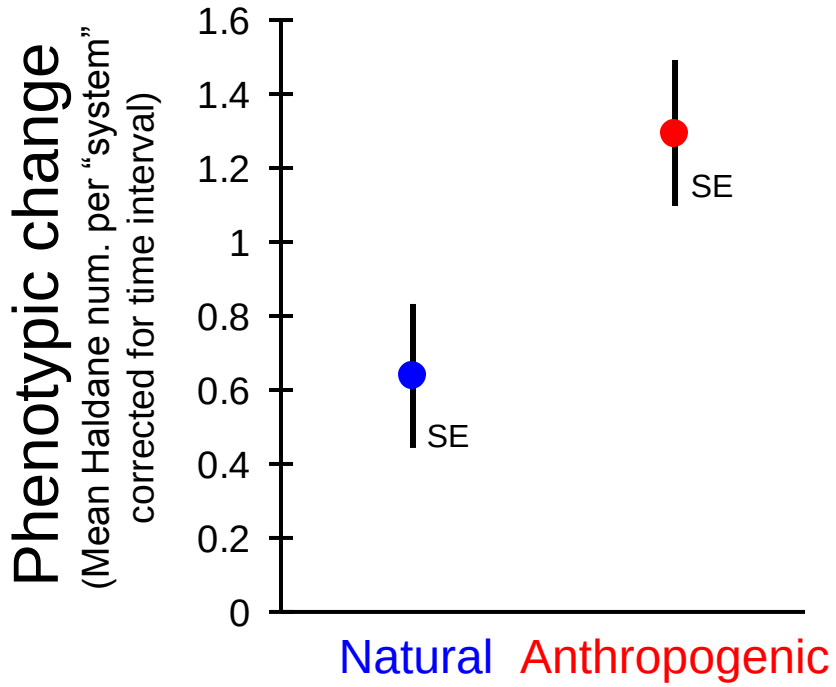
Stockwell et al. (2003 - Trends Ecol Evol)

Currently-analyzed database (animals only)

(< 200 generations)

	Total	Studies	Species	Anthro.	Natural
Haldanes	2414	65	45	33	18

Many types of anthropogenic change: climate, pollution, introduction, harvesting, etc.



Conclusion: Human disturbances are associated with phenotypic changes that rise above "natural" variation.

Hendry et al. (2008 – Mol Ecol)

Will evolution aid population persistence in the face of environmental change?

An illustrative model.

A quantitative-genetic model of a single trait that includes realistic population growth (Hendry 2004 – Evol Ecol Res).

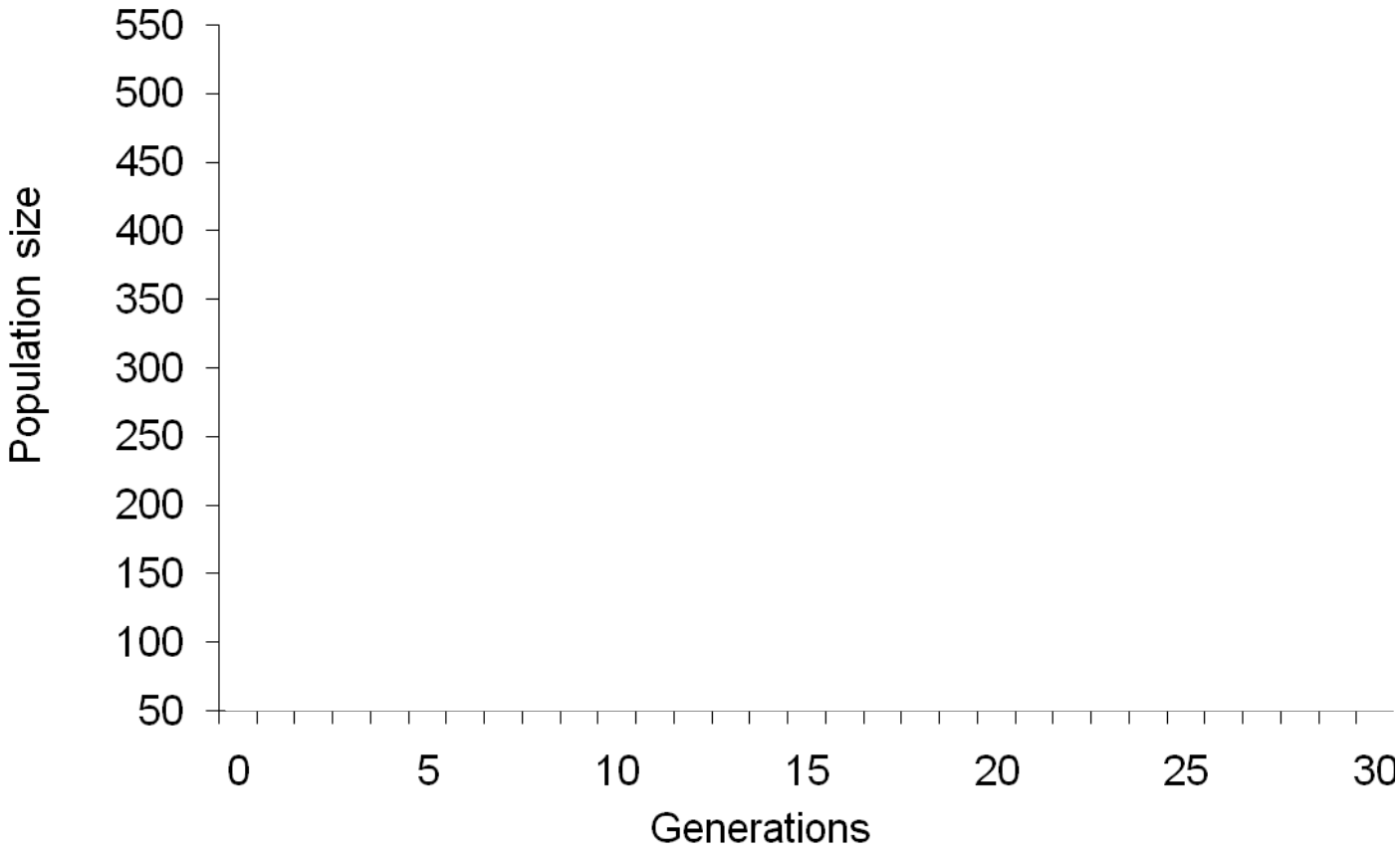
Start with a well-adapted population of 500 individuals.

Perturb the environment

– single/abrupt or continuous/gradual

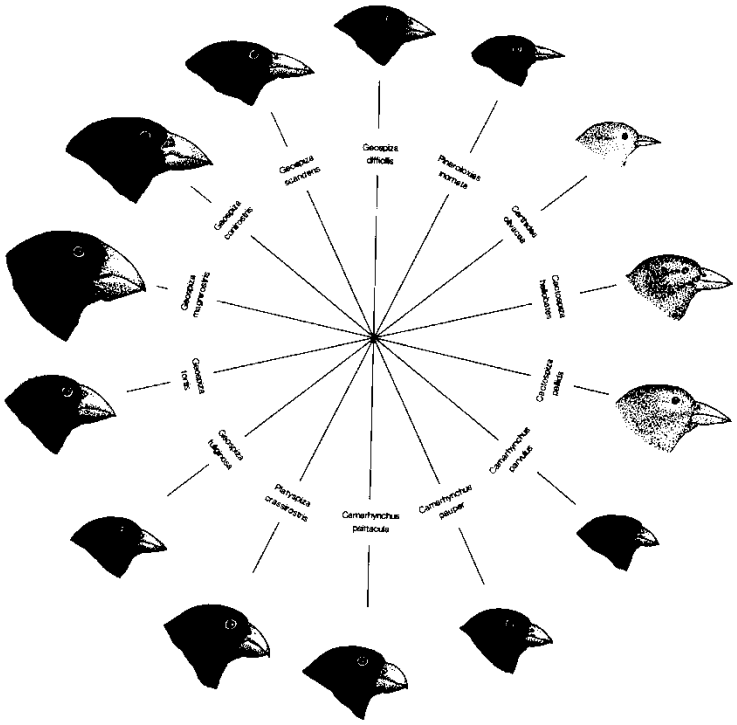
No plasticity allowed.

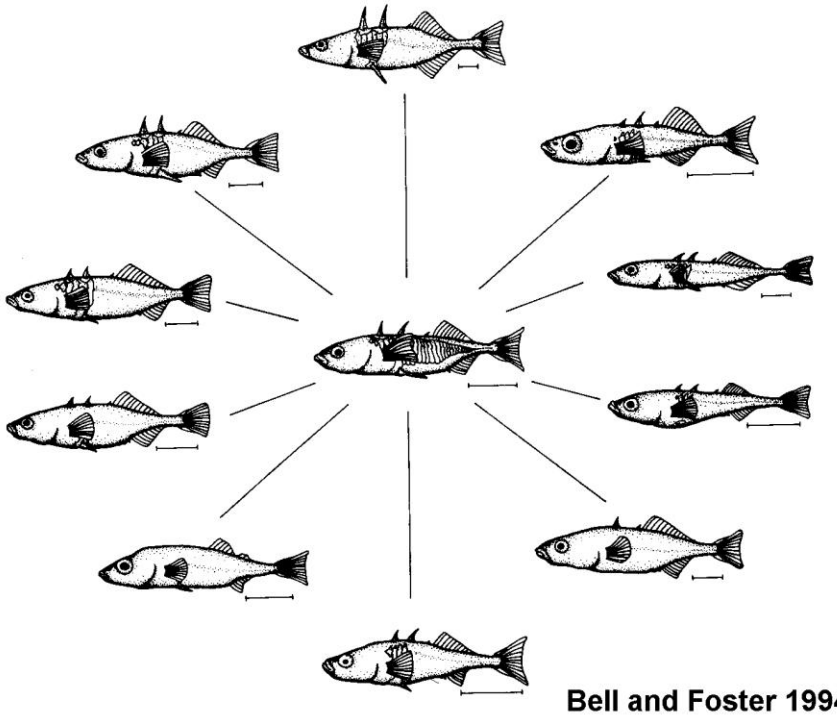
Single/abrupt shift in the environment.



Increasing genetic variation aids persistence.

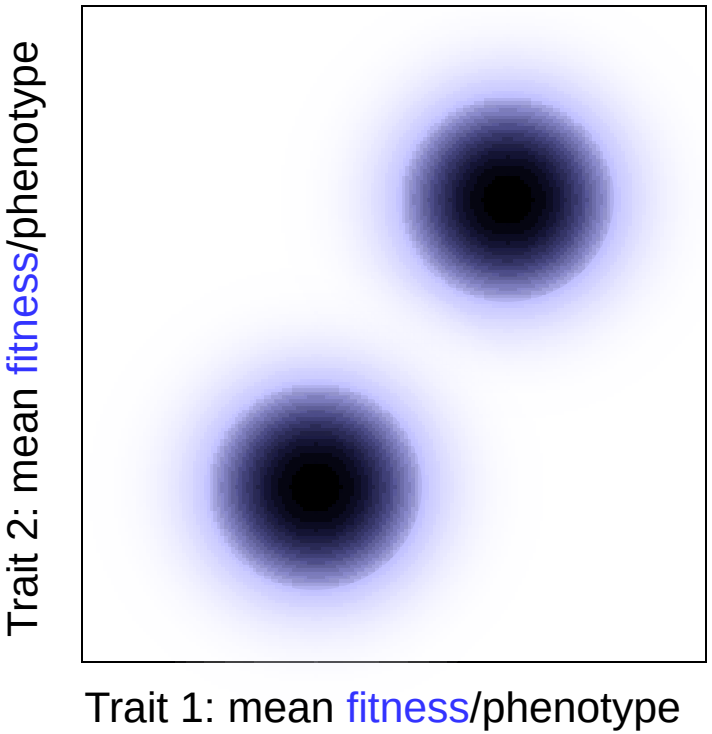
Human influences on adaptive radiation.





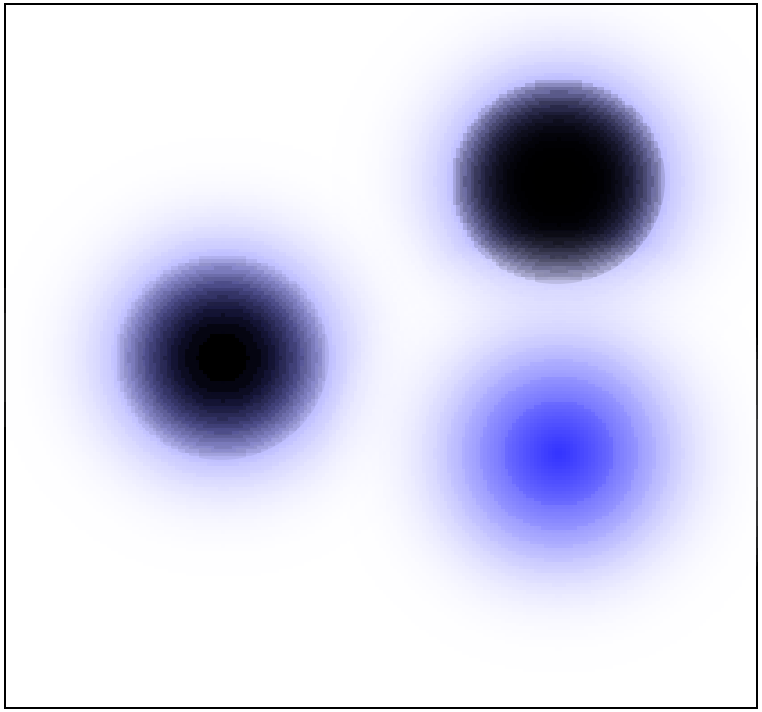
Bell and Foster 1994

Evolution on adaptive landscapes



A new peak that does not change the distinction of old peaks

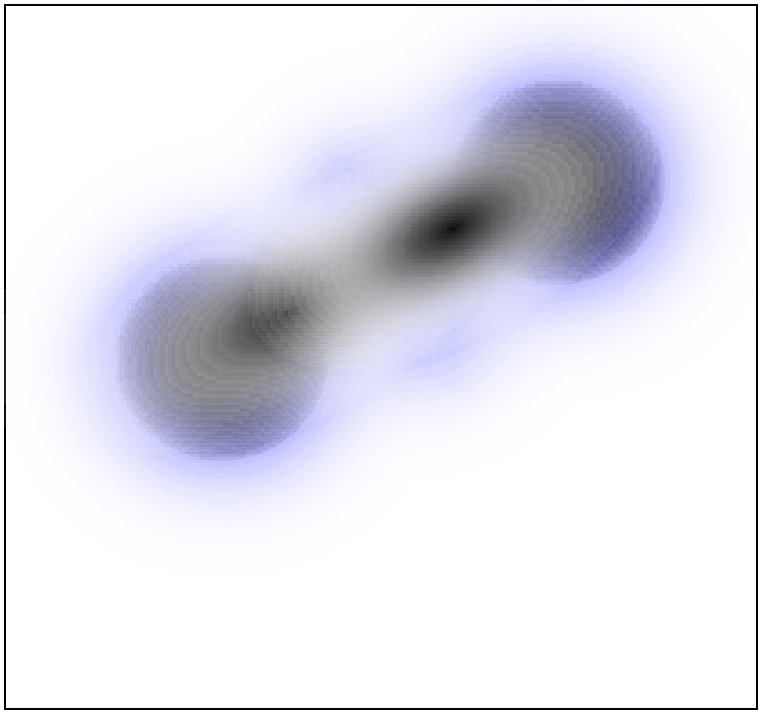
Example: Insect host races on introduced plants

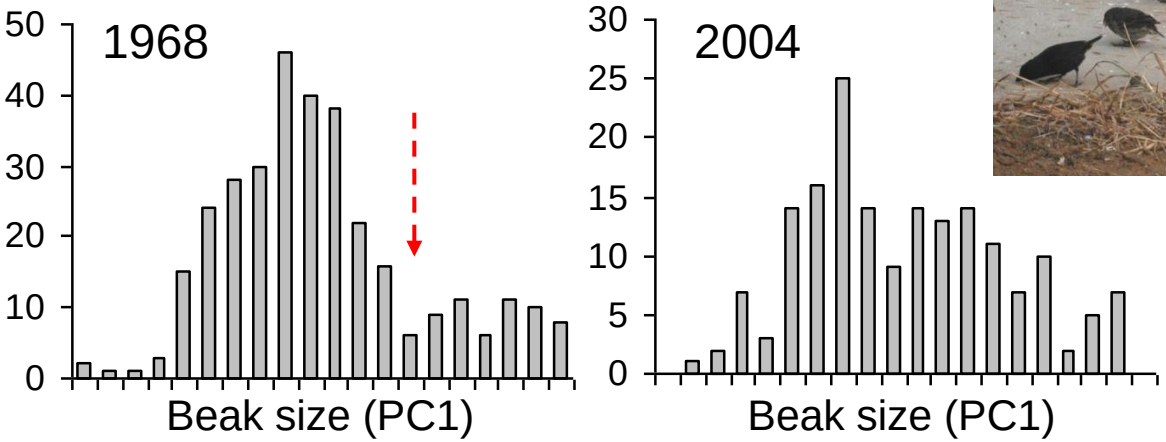


Bryne and Nichols (1999 – Heredity)

A new peak reduces distinction of old peaks

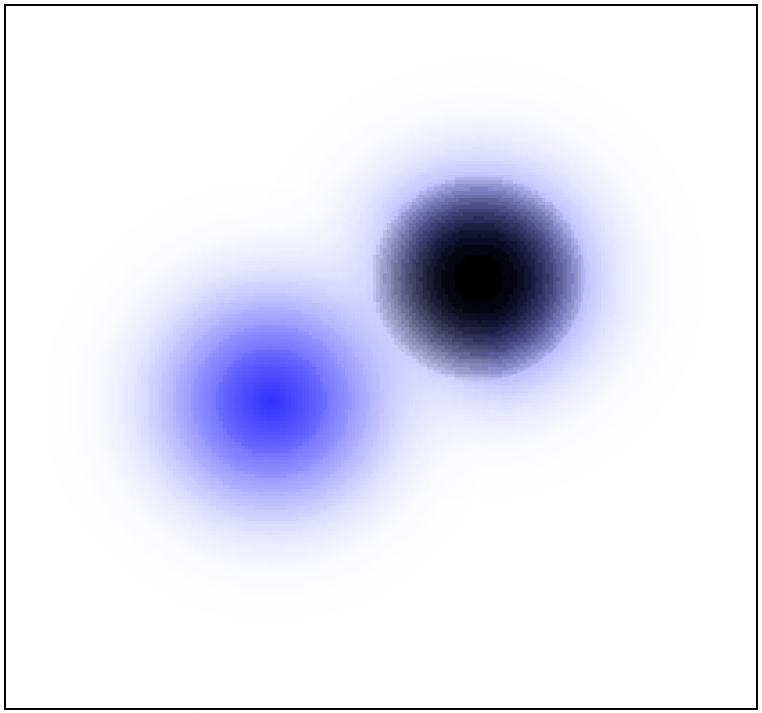
Possible example: collapse of bimodality in Darwin's finches



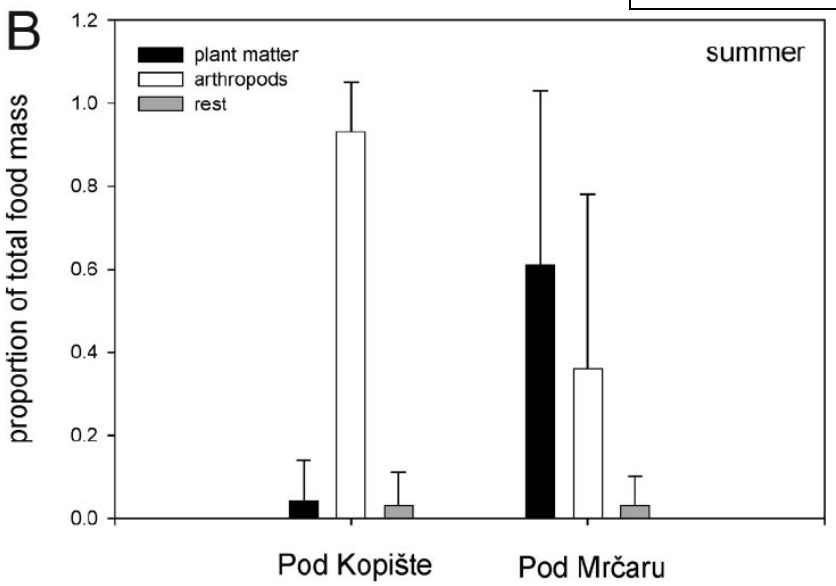


Hendry et al. (2006 - Proc. Roy. Soc. B)

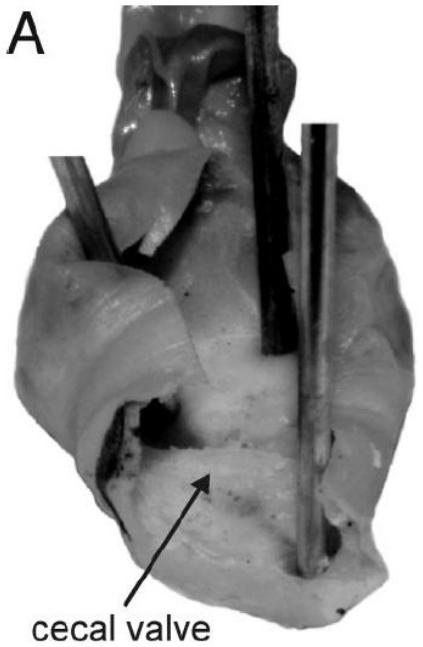
Elimination of an old peak leading to attraction by a new peak



Example: populations introduced to new environments



Herrel et al. (2008 - Proc Natl Acad Sci USA)



General conclusions

1. Populations can respond adaptively to environmental change

2. Humans cause particularly rapid changes.

3. This adaptation can aid population persistence.

4. Human-caused rapid evolution can enhance or constrain adaptive radiation.

5. EVOLUTION NOW … MATTERS FOR BIODIVERSITY LATER.

Thank you.