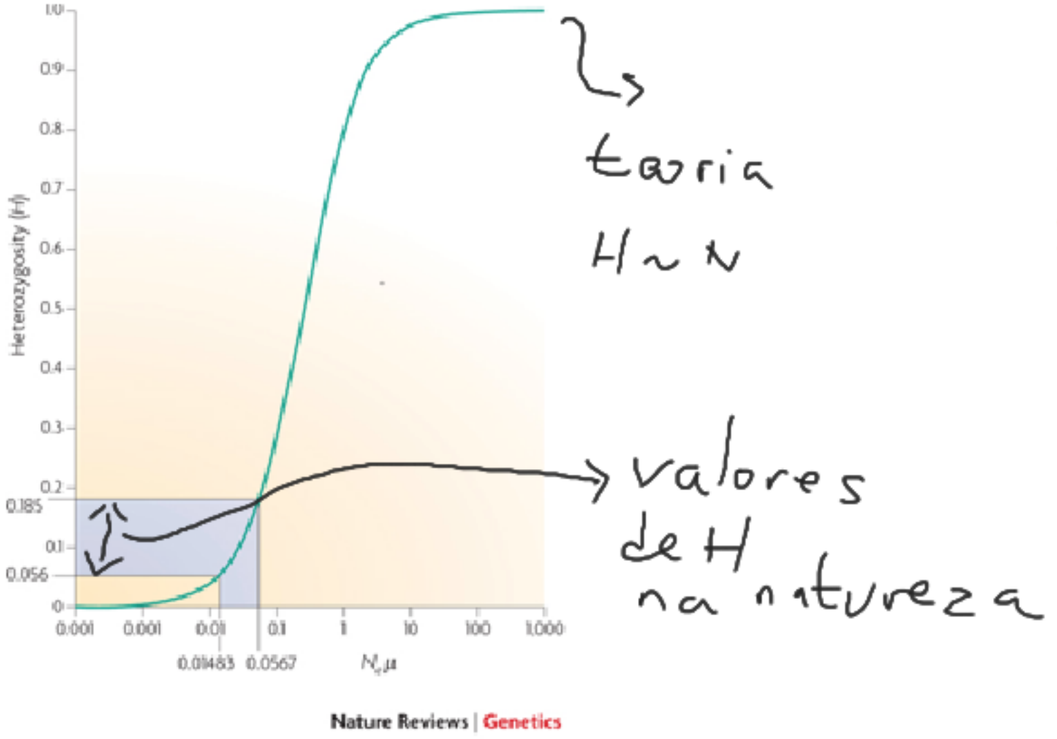
A questão

Teoria neutra prevê ->
diversidade genética aumenta de modo proporcional a tamanha populacional

Mas... essa relação não é observada de modo tão claro na natureza

Paradoxo de Lewontin



Nature Reviews | Genetics

Unsolved Mystery

Revisiting an Old Riddle: What Determines Genetic Diversity Levels within Species?

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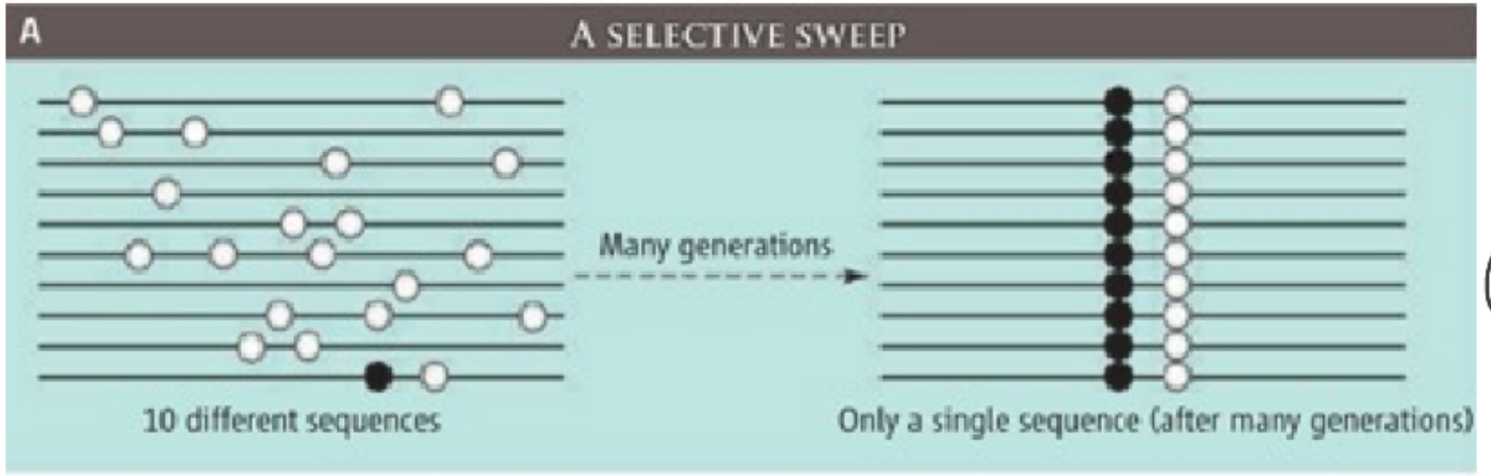
https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1001388


0.01
0.05
0.1
0.5
1
5
10
Green plants
Chlorophyta (2)
Magnoliophyta (12)
Pinophyta (9)
Animals
Arthropoda (60)
Chordata (53)
Echinodermata (3)
Mollusca (1)
Nematoda (3)
Porifera (1)
Fungi
Ascomycota (6)
Basidiomycota (1)
Chromalveolates
Apicomplexa (2)
Ciliophora (12)
Heterokontophyta (2)
Caenorhabditis remanei
Paramecium quadecaurelia
Ciona roulei
Capsella grandiflora
Ceratitis capitata
Anopheles gambiae
Strongylocentrotus pallidus
Amphimedon queenslandica
Paramecium primaurelia
Daphnia pulex
Histoplasma capsulatum
Drosophila simulans
Drosophila santomea
Daphnia pulicaria
Drosophila bipectinata
Drosophila buzzatii
Drosophila pseudoananassae
Paracoccidioides lutzii
Drosophila melerkotliana
Arabidopsis halleri
Strongylocentrotus droebachiensis
Limenitis arthemis
Drosophila parabipectinata
Peromyscus maniculatus
Anopheles merus
Drosophila pseudoobscura
Lutzomyia intermedia
Paramecium decaurelia
Drosophila suboobscura
Melanopus oregonensis
Paramecium novaurelia
Gryllus firmus
Ixodes ricinus
Apis mellifera
Oryctolagus cuniculus
Drosophila arizonae
Paramecium tetraurelia
Paramecium dodecaurelia
Pinus taeda
Mus musculus castaneus
Capsella rubella
Zonotrichia albicollis
Cryptococcus neoformans
Drosophila bogotana
Arabidopsis thaliana
Anopheles scanloni
Pinus sylvestris
Danio rerio
Cryptomeria japonica
Drosophila miranda
Volvox carteri
Takifugu rubripes
Balaenoptera bonaerensis
Paramecium sexaurelia
Varecia variegata variegata
Paramecium octaurelia
Paramecium septaurelia
Ficedula hypoleuca
Eulemur coronatus
Mus musculus domesticus
Hylobates agilis/lar/moloch/pileatus
Nomascus gabriellae/leucogenys
Chlorocebus aethiops
Aquilegia formosa/pubescens
Nycticebus coucang
Saccharomyces paradoxus
Hoolock leuconedys
Drosophila novamexicana
Aphanarthrum subglabrum/glabrum
Pan troglodytes
Mus musculus musculus
Monodelphis domestica
Dasypus novemcinctus
Plasmodium falciparum
Pinus pinaster
Rattus norvegicus
Gorilla beringei/gorilla
Aquila clanga/pomarina
Pan paniscus
Phytophthora infestans
Pinus radiata
Gulo gulo
Lynx lynx
Ciona savignyi
Ciona intestinalis B
Crassostrea gigas
Drosophila kikkawai
Drosophila yakuba
Silene latifolia
Chlamydomonas reinhardtii
Heliconius cydno
Drosophila ananassae
Anopheles quadriannulatus
Anopheles arabiensis
Drosophila americana
Heliconius hecale
Pieris rapae
Drosophila melanogaster
Heliconius melpomene
Heliconius pachinus
Papilio dardanus
Strongylocentrotus purpuratus
Lutzomyia whitmani
Populus tremula
Anopheles cruzii
Aedes aegypti
Daphnia magna
Mesobuthus cyprius/gibbosus
Mailurus melanocephalus
Daphnia obtusa
Cecidostiba fungosa
Ciona intestinalis A
Anopheles dirus
Gryllus pennsylvanicus
Picea glauca
Acyrthosiphon pisum
Cichla pleiozona
Apis cerana
Arabidopsis lyrata
Drosophila navojoa
Drosophila mojavensis
Drosophila persimilis
Picea abies
Propithecus coquereli
Taeniopygia guttata
Paramecium triaurelia
Sceloporus undulatus
Phytophthora capsici
Agelaius phoeniceus
Anopheles melas
Anopheles baimai
Tupaia belangeri
Picea mariana
Populus trichocarpa
Phlebotomus ariasi
Populus balsamifera
Ficedula albicollis
Paramecium biaurelia
Caenorhabditis elegans
Boechera stricta
Pongo abelii/pygmaeus
Macaca mulatta
Oncorhynchus tshawytscha
Spermophilus parryii
Eulemur mongoz
Neurospora crassa
Bactrocera depressa
Gasterosteus aculeatus
Paracoccidioides brasiliensis PS2/PS3/S1
Daphnia arenata
Galago moholi
Picea breweriana
Canis latrans/lupus
Paramecium pentaurelia
Symphalangus syndactylus
Nasonia vitripennis
Eichhornia paniculata
Saccharomyces cerevisiae
Ailuropoda melanoleuca
Callithrix jacchus
Eschrichtius robustus
Homo sapiens
Drosophila sechellia
Daubentonia madagascariensis
Plasmodium vivax
Sistrurus catenatus
Caenorhabditis briggsae
0.01
0.05
0.1
0.5
1
5
10
diversity (% per site)

A estratégia/hipótese

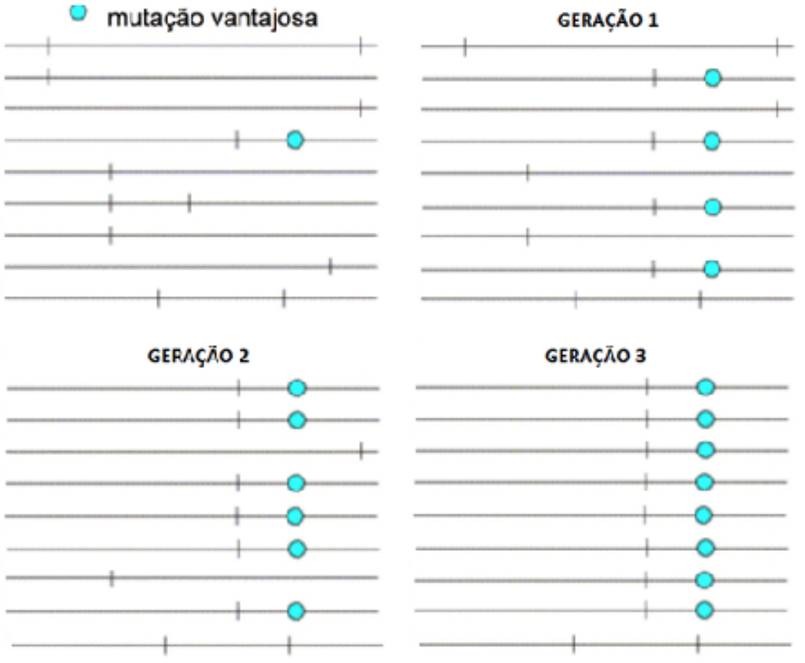


HH e BGS ->

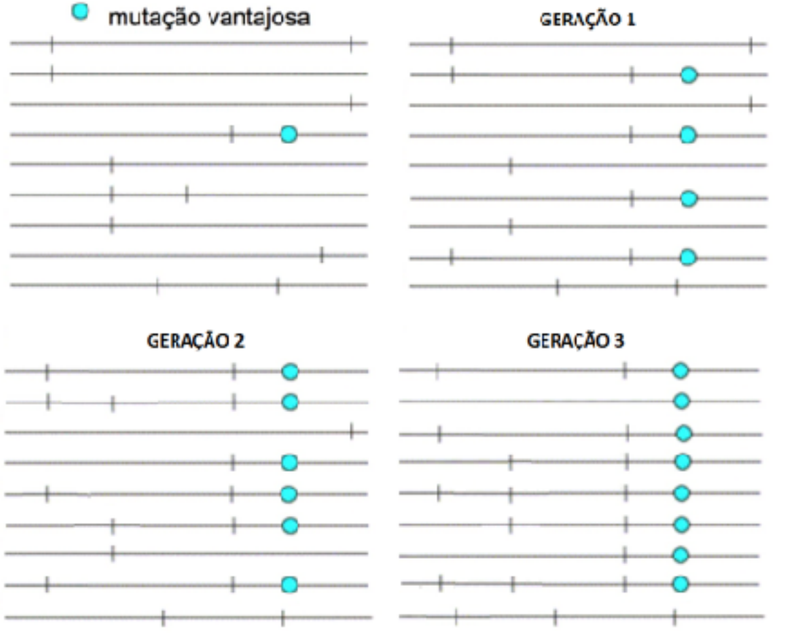
faz previsão sobre variabilidade

Papel da recombinação no efeito da carona

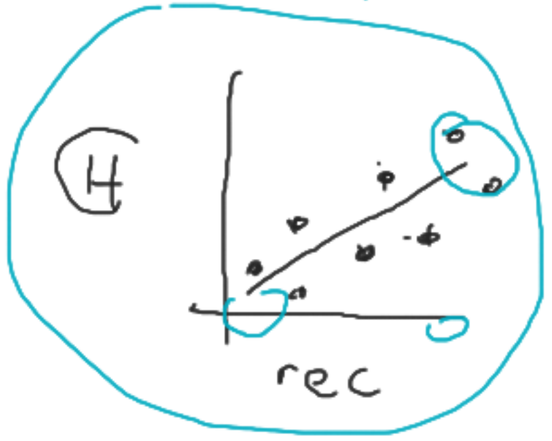
Sem recombinação



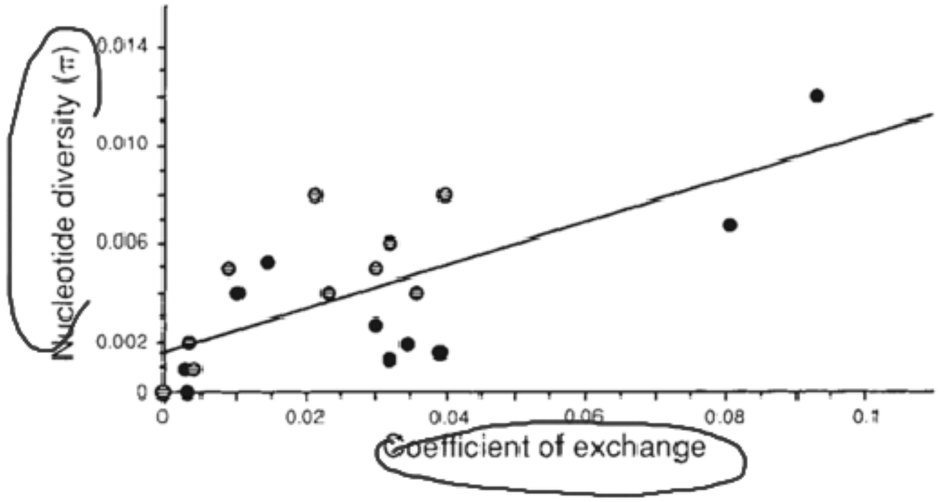
Com recombinação



Recombinação -> evita que a fixação da mutação vantajosa implique também na fixação de mutações neutras vizinhas



"To test this prediction, we relied on the fact that the impact of natural selectionon linked neutral diversity depends on the local recombinational environment. In regions ofrelatively low recombination, selected variants affect more neutral sites through linkage, andvice versa, in regions of relatively high recombination."

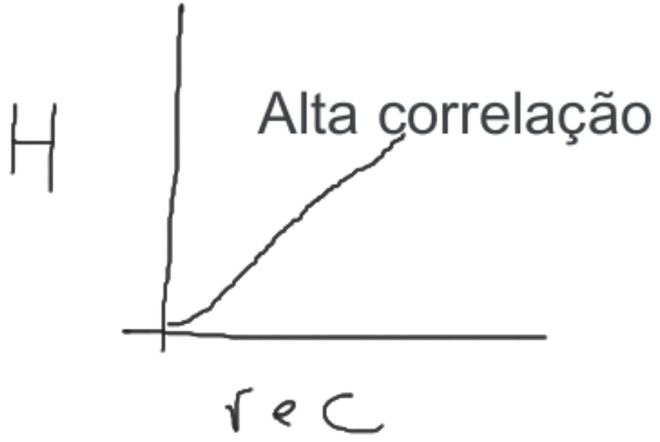


1994

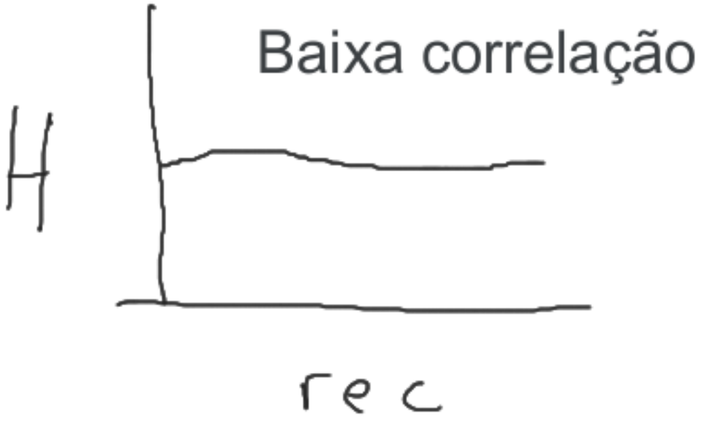
Hipótese: que espécies com N maior sofrem mais carona

Deriva é força fraca
Seleção predomina

Deriva é força forte
Seleção tem menor efeito



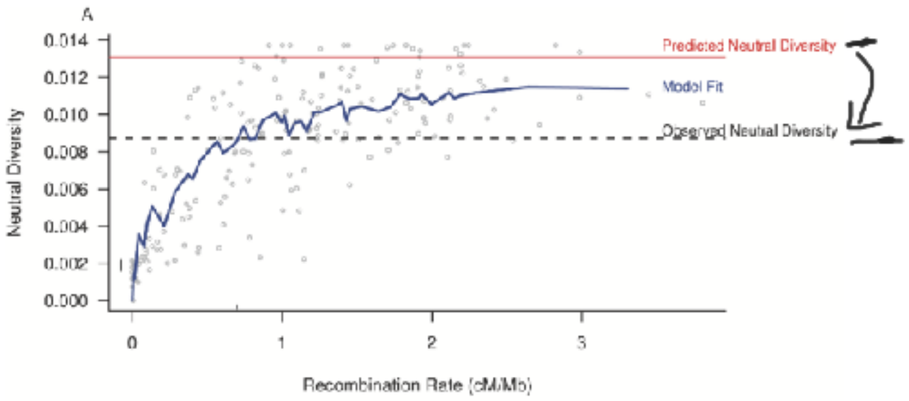
Carona genética está atuando



Predominando deriva, carona genética não é força importante

Hipótese: que espécies com N maior sofrem mais carona

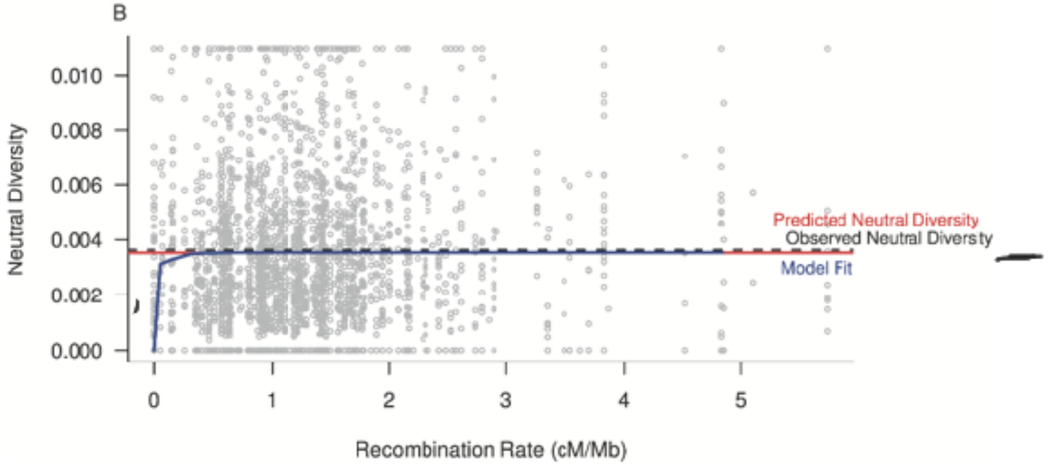
Deriva é força fraca
Seleção predomina



Drosophila melanogaster

Carona genética está atuando

Deriva é força forte
Seleção tem menor efeito



Equus ferus przewalskii

Predominando deriva, carona genética não é força importante

Genet. Res., Camb. (1974), 23, *pp.* 23–35
With 2 text-figures
Printed in Great Britain

The hitch-hiking effect of a favourable gene

BY JOHN MAYNARD SMITH AND JOHN HAIGH
University of Sussex, Falmer, Brighton BN1 9QH

(*Received* 22 *May* 1973)

SUMMARY

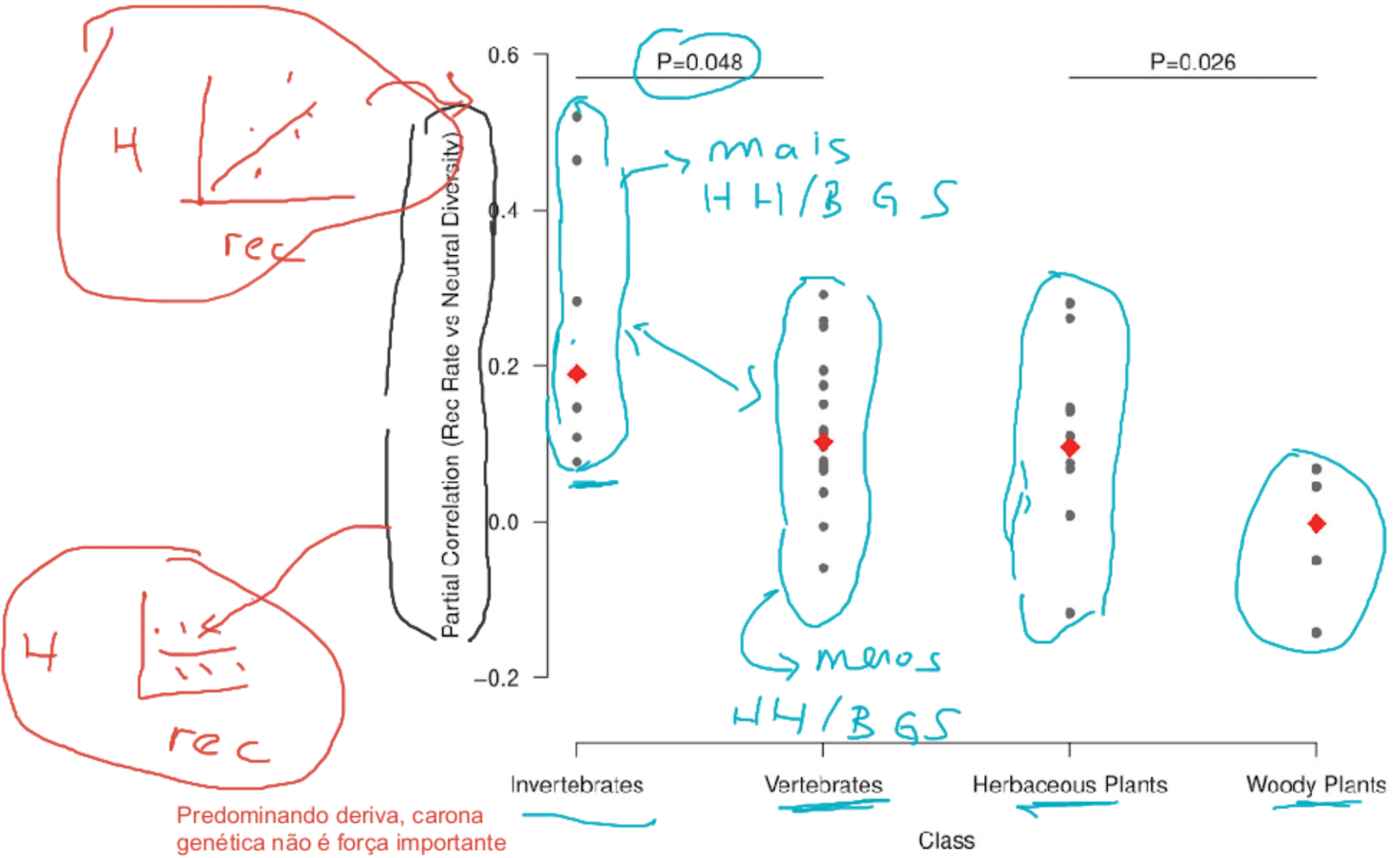
When a selectively favourable gene substitution occurs in a population, changes in gene frequencies will occur at closely linked loci. In the case of a neutral polymorphism, average heterozygosity will be reduced to an extent which varies with distance from the substituted locus. The aggregate effect of substitution on neutral polymorphism is estimated; in populations of total size 10^6 or more (and perhaps of 10^4 or more), this effect will be more important than that of random fixation. This may explain why the extent of polymorphism in natural populations does not vary as much as one would expect from a consideration of the equilibrium between mutation and random fixation in populations of different sizes. For a selectively maintained polymorphism at a linked locus, this process will only be important in the long run if it leads to complete fixation. If the selective coefficients at the linked locus are small compared to those at the substituted locus, it is shown that the probability of complete fixation at the linked locus is approximately $\exp(-Nc)$, where c is the recombinant fraction and N the population size. It follows that in a large population a selective substitution can occur in a cistron without eliminating a selectively maintained polymorphism in the same cistron.

Os resultados

Non-model based

criada pela carona

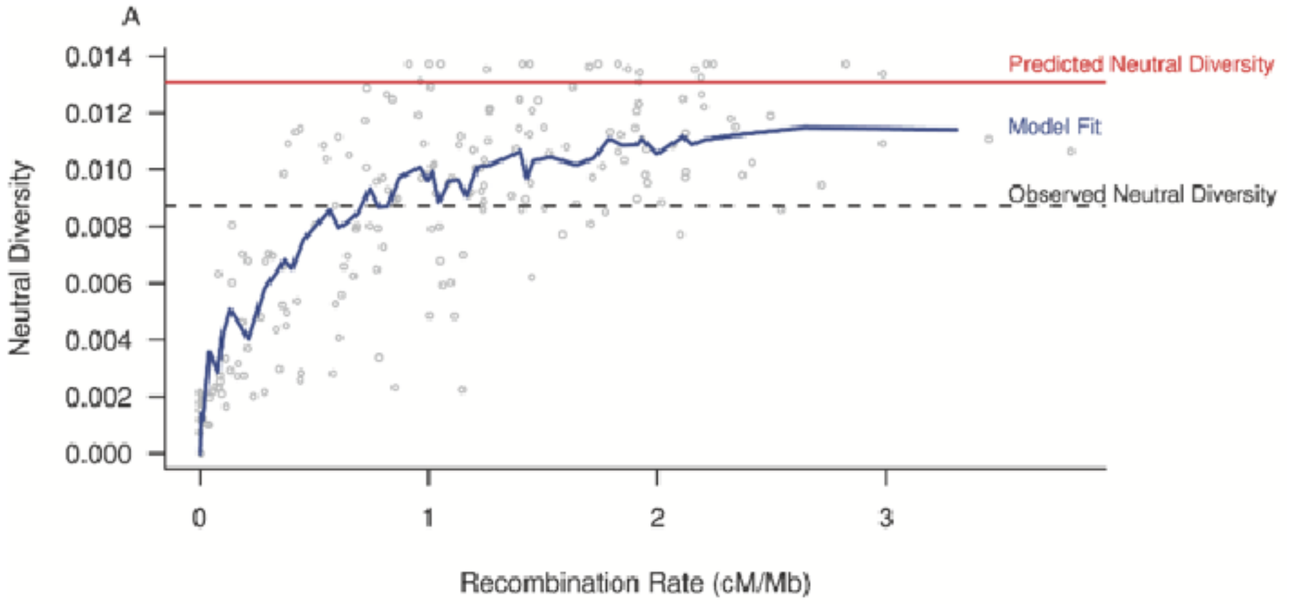
Carona genética está atuando



Predominando deriva, carona genética não é força importante

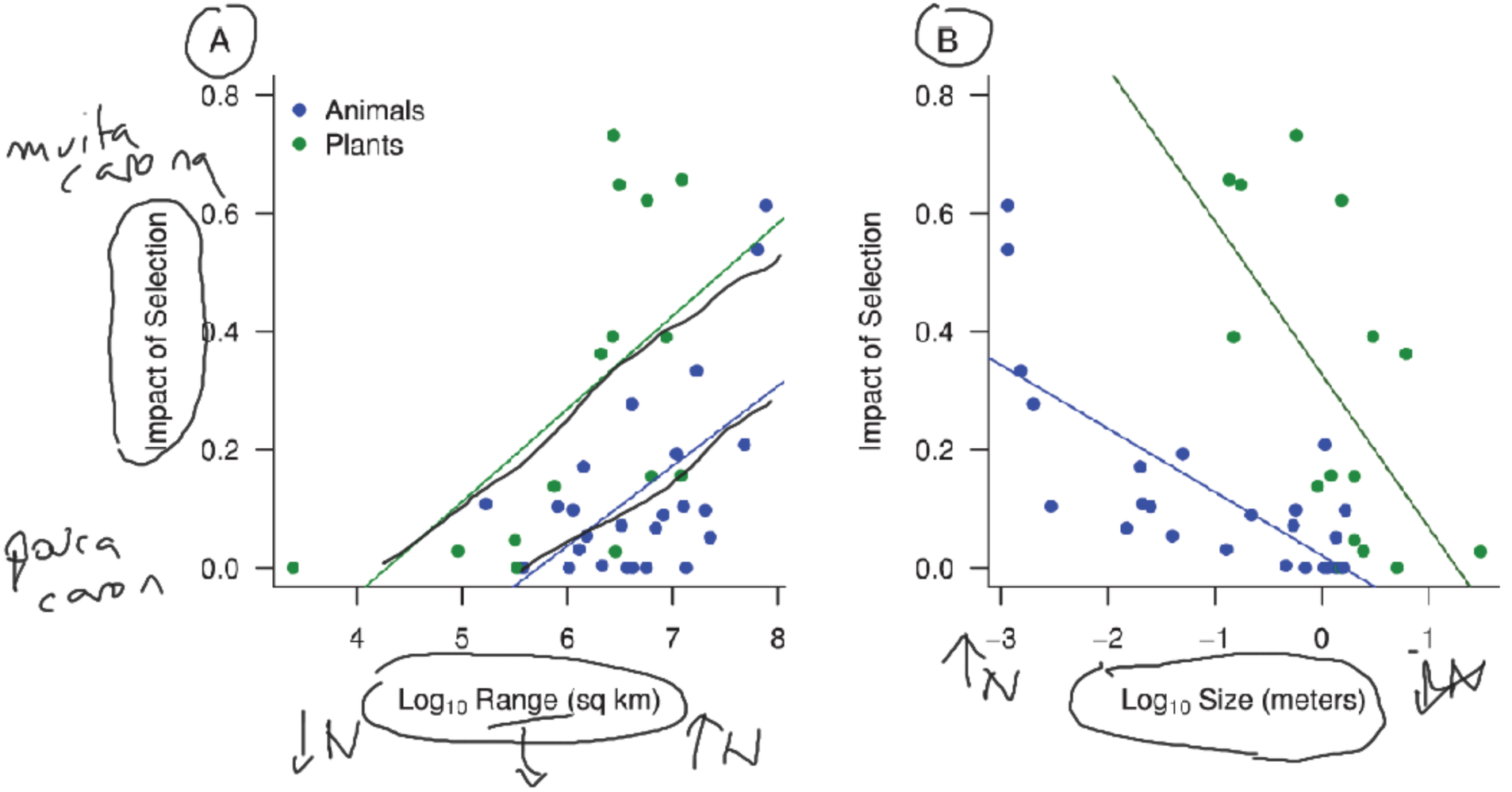
Model-based test

$$E[\pi] = \frac{\theta}{1/exp(-G) + \alpha/rbp}$$



impact of selection

Model-based test



Confundidores e robustez

Inovação trazida e implicação para o campo

-> Porque algumas espécies com N muito grande, tem diversidade pequena?

-> Teste empírico com muitas espécies do papel da carona genética

-> Carona genética atuando sobre espécies com N grande é uma explicação possível

-> Consequência: diversidade de espécies com N grande ou pequeno torna-se parecido.

he difference here is likely due primarily to the fact that, in many plant species, gene density and recombination rate are strongly correlated, which makes estimating a correlation coefficient tricky (since we expect more linked selection in regions of low recombination or high gene density, but if high recombination = high gene density these effects tend to counteract each other). So the correlation coefficients are likely underestimated. Another important factor is that many plants are at least partially selfing, which needs to be accounted for but is difficult to do with high precision. These two factors make it difficult to directly compare whether plants or animals have “more linked selection”, and also explain the differences in the figures.