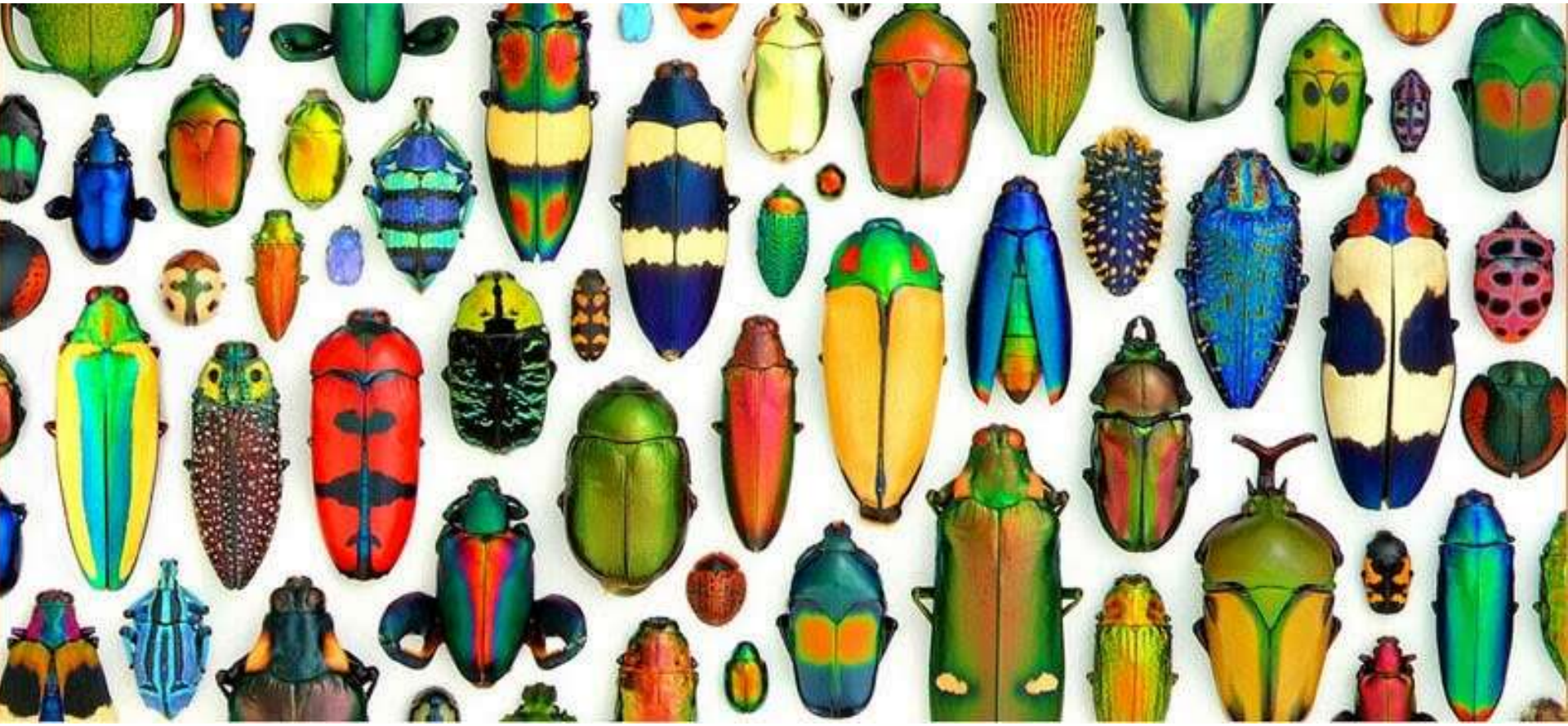
“O mistério dos mistérios”



~300.000 espécies de besouros descritas.
~10.000.000 de espécies de insetos.

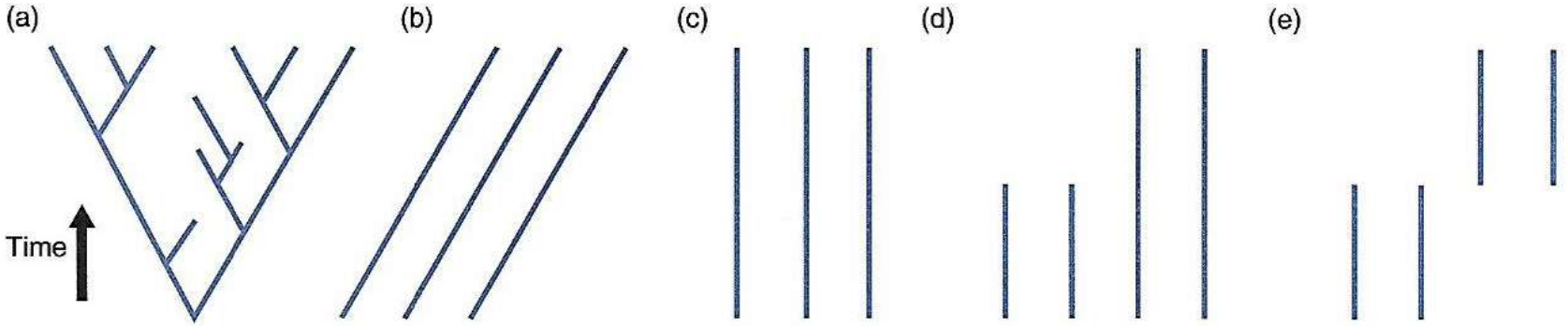
Sécs. XVIII / XIX:
"O mistério dos mistérios"

- Qual a origem da diversidade biológica?
- Pré-Darwin: deus tinha arquétipos biológicos?
- As famílias (felinos, canídeos, coleópteros, etc) derivavam de um plano básico.
- A variação era exceção e não a regra.

“O mistério dos mistérios”

Mark Ridley - Evolution

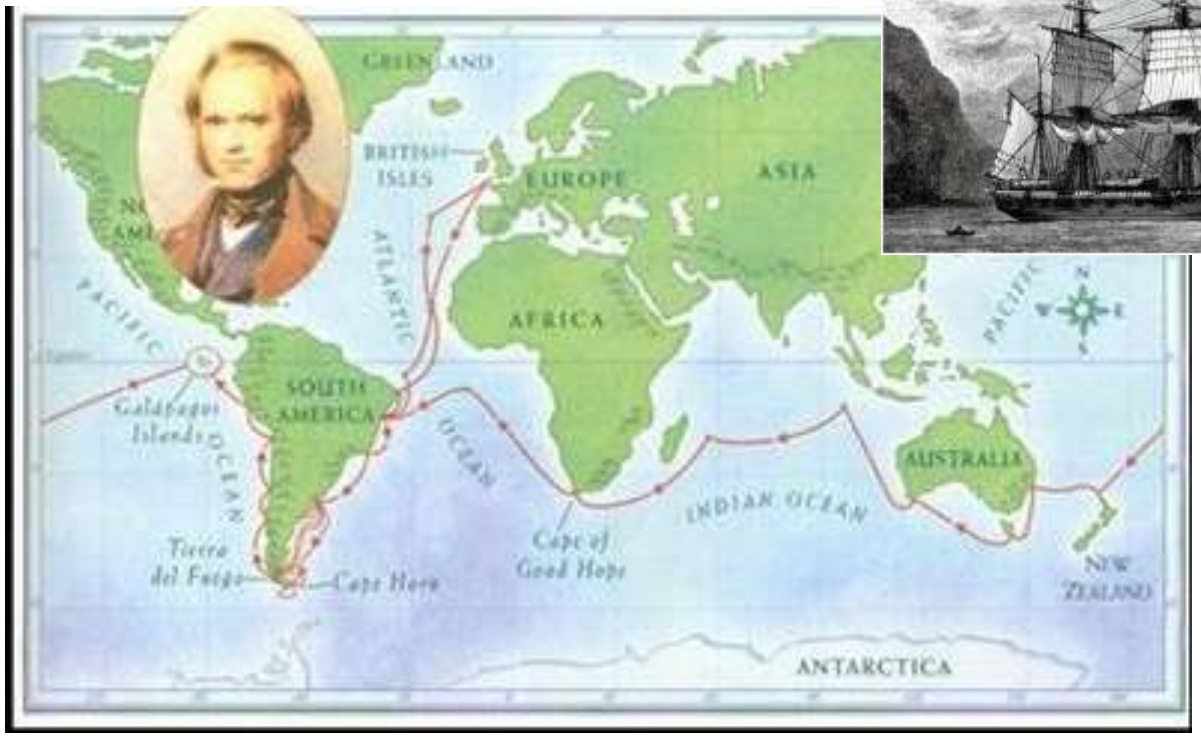
Figure 3.1 Three theories of the history of life: (a) evolution, (b) transformism, and (c–e) creationism. In (a) evolution, all species have a common origin, and they may change through time. In (b) transformism, species have separate origins, but they may change. In (c–e) separate creation, species have separate origins and do not change. (c), (d), and (e) represent different versions of the theory of separate creation that might be proposed to explain extinct fossil forms; they do not differ in their two essential features (species have separate origins and do not change). Each line represents a species in time. If the line moves up vertically, then the species is constant; if it deviates to the left or right, the species is changing in form.



Darwin e a Evolução Biológica

- Charles Darwin, 1809-1882.
- Inglaterra Vitoriana: estudou para se tornar pastor Anglicano.
- Crescente interesse pela História Natural e Geologia.

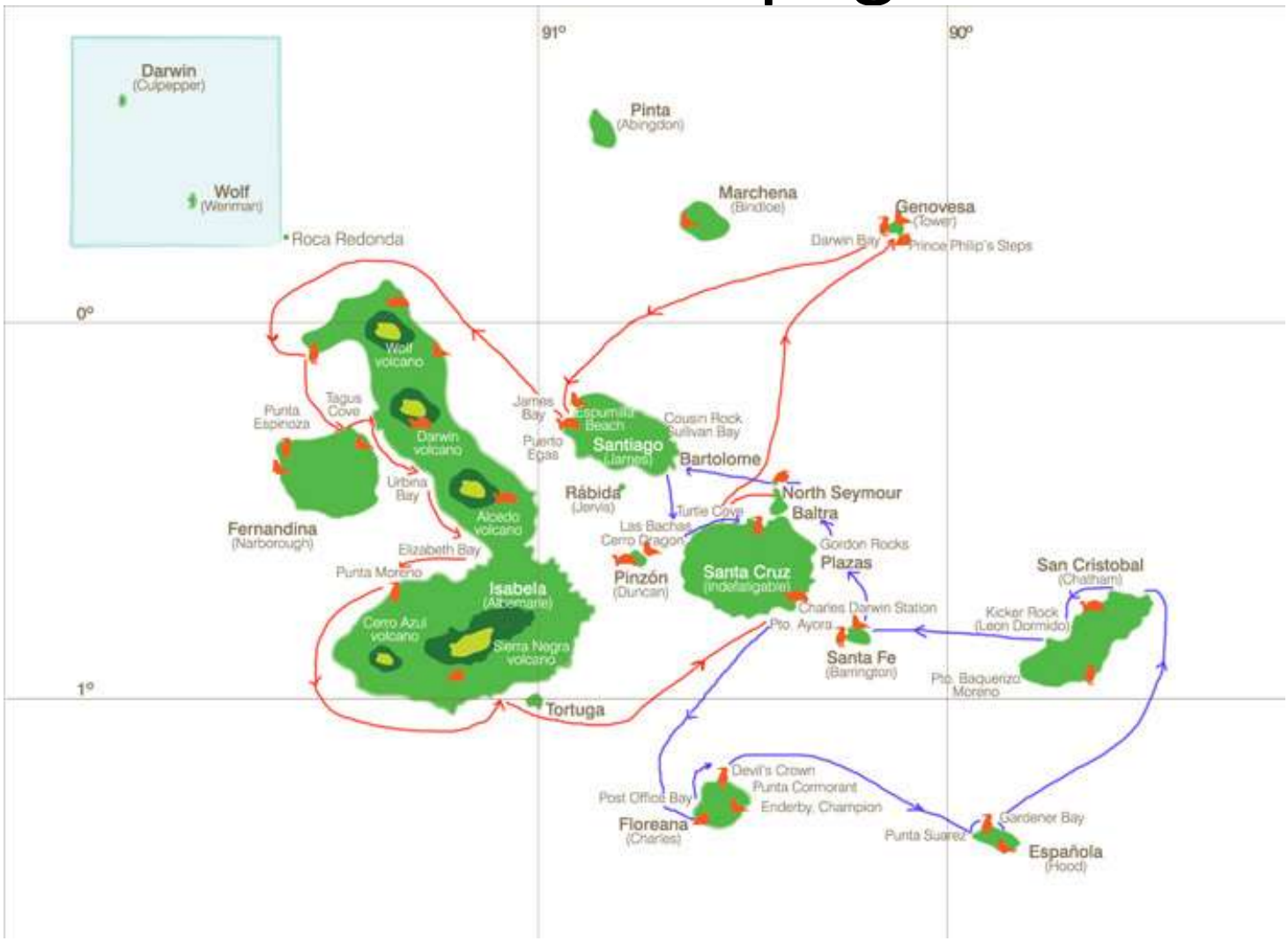
Darwin uniformitarista:
A viagem do Beagle 1832-1836



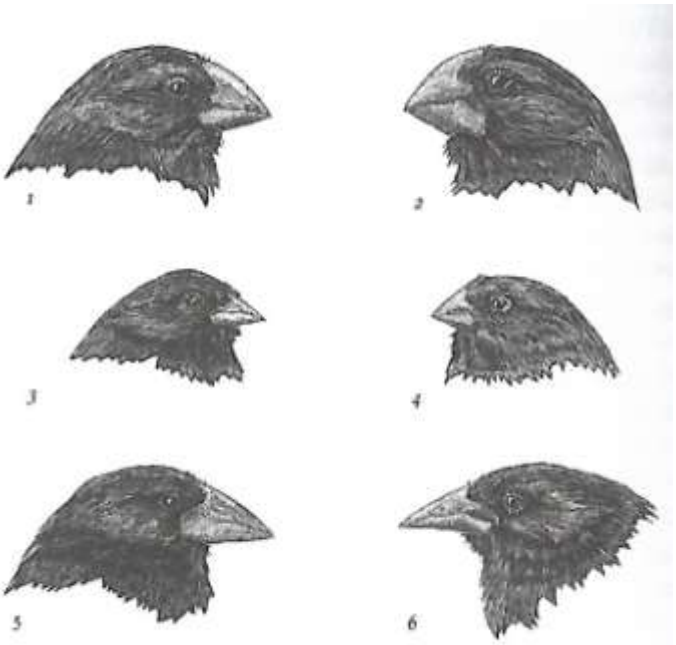


- Fitzroy
- Milhares de espécies coletadas
- Geologia e Paleontologia
- Fueguinos
- Escravatura

Darwin e o transformismo: As Ilhas Galápagos



Darwin e o transformismo: A origem das espécies



Bicos de seis espécies dos tentilhões de Darwin, por Thalia Grant

Darwin e o transformismo: A origem das espécies



Retrato de uma iguana-do-mar e de uma iguana-da-terra em poses características, por Thalia Grant





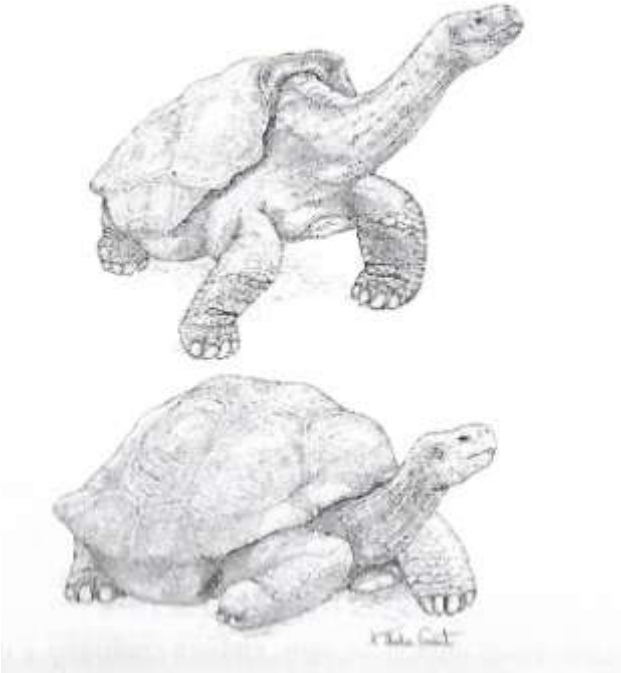








Darwin e o transformismo: A origem das espécies





Galápagos (cágados) com cascos em forma de domo e de sela, por Thalia Grant



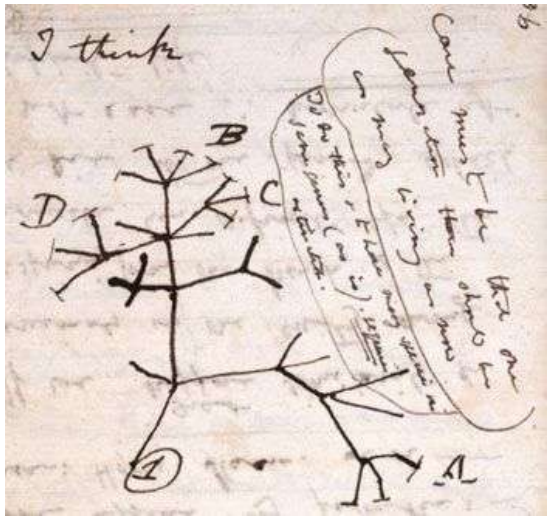
Alone and surrounded by devastated vegetation, Lonesome George spends his last days on Pinta before being moved to the Tortoise Rearing Center in 1972.

Solo y rodeado de vegetación destruida, el Solitario George pasa sus

Darwin e o transformismo

- Charles Darwin, 1809-1882.
- Inglaterra Vitoriana: estudou para se tornar pastor Anglicano.
- Crescente interesse pela História Natural e Geologia.
- Após a viagem do *Beagle*, lê **Thomas Malthus.** Conceito da luta pela sobrevivência.
- Em 1835, percebe que animais e pássaros isolados, nos dois lados dos Andes, pressupõe que, ou a mesma espécie foi criada em dois lugares distintos, ou as espécies não eram imutáveis.
- Em 1837, o anatomista Richard Owen confirma que exemplares de grandes mamíferos extintos na América do Sul e na Austrália eram relacionados a espécies existentes.
- Em 1858, publica um ensaio junto com Alfred Russel Wallace, sobre a Evolução por Seleção Natural.
- Em 1859 publica “A Origem das Espécies”.

Afinal, qual a origem das espécies?



On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection. By Charles Darwin, Esq., F.R.S., F.L.S., & F.G.S., and Alfred Wallace, Esq. Communicated by Sir Charles Lyell, F.R.S., F.L.S., and J. D. Hooker, Esq., M.D., V.P.R.S., F.L.S., &c.

[Read July 1st, 1858.]

London, June 30th, 1858.

My Dear Sir,—The accompanying papers, which we have the honour of communicating to the Linnean Society, and which all relate to the same subject, viz. the Laws which affect the Production of Varieties, Races, and Species, contain the results of the investigations of two indefatigable naturalists, Mr. Charles Darwin and Mr. Alfred Wallace.

These gentlemen having, independently and unknown to one another, conceived the same very ingenious theory to account for the appearance and perpetuation of varieties and of specific forms on our planet, may both fairly claim the merit of being original thinkers in this important line of inquiry; but neither of them having published his views, though Mr. Darwin has for many years past been repeatedly urged by us to do so, and both authors having now unreservedly placed their papers in our hands, we think it would best promote the interests of science that a selection from them should be laid before the Linnean Society.

Taken in the order of their dates, they consist of:—

1. Extracts from a MS. work on Species*, by Mr. Darwin, which was sketched in 1839, and copied in 1844, when the copy was read by Dr. Hooker, and, its contents afterwards communicated to Sir Charles Lyell. The first Part is devoted to "The Variation of Organic Beings under Domestication and in their Natural State;" and the second chapter of that Part, from which we propose to read to the Society the extracts referred to, is headed, "On the Variation of Organic Beings in a state of Nature; on the Natural Means of Selection; on the Comparison of Domestic Races and true Species."

2. An abstract of a private letter addressed to Professor Asa Gray, of Boston, U.S., in October 1857, by Mr. Darwin, in which

* This MS. work was never intended for publication, and therefore was not written with care.—C. D. 1858.



MECANISMO DA SELEÇÃO NATURAL

HIPERFECUNDIDADE



VARIABILIDADE



HERDABILIDADE



Recursos limitados: luta pela sobrevivência = COMPETIÇÃO

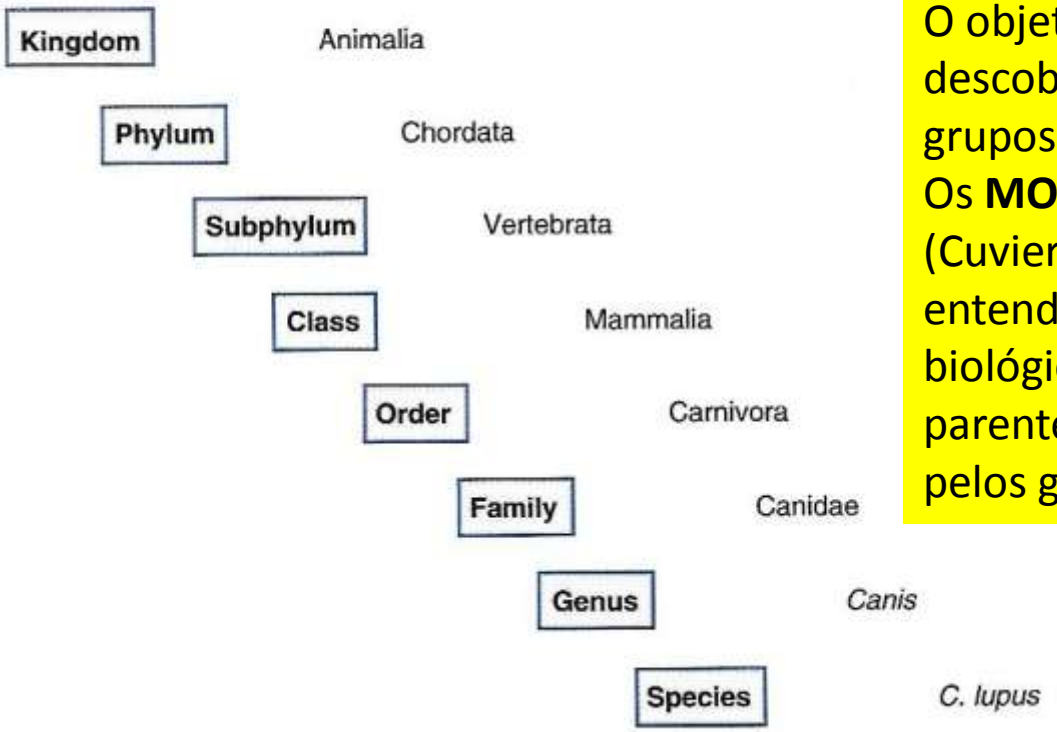
Sobrevivência preferencial do mais adaptado ao meio

SELEÇÃO NATURAL

A SELEÇÃO NATURAL É CONSEQUÊNCIA DO PROCESSO E NÃO A CAUSA! *

HIERARQUIA NA CLASSIFICAÇÃO BIOLÓGICA - LINEU

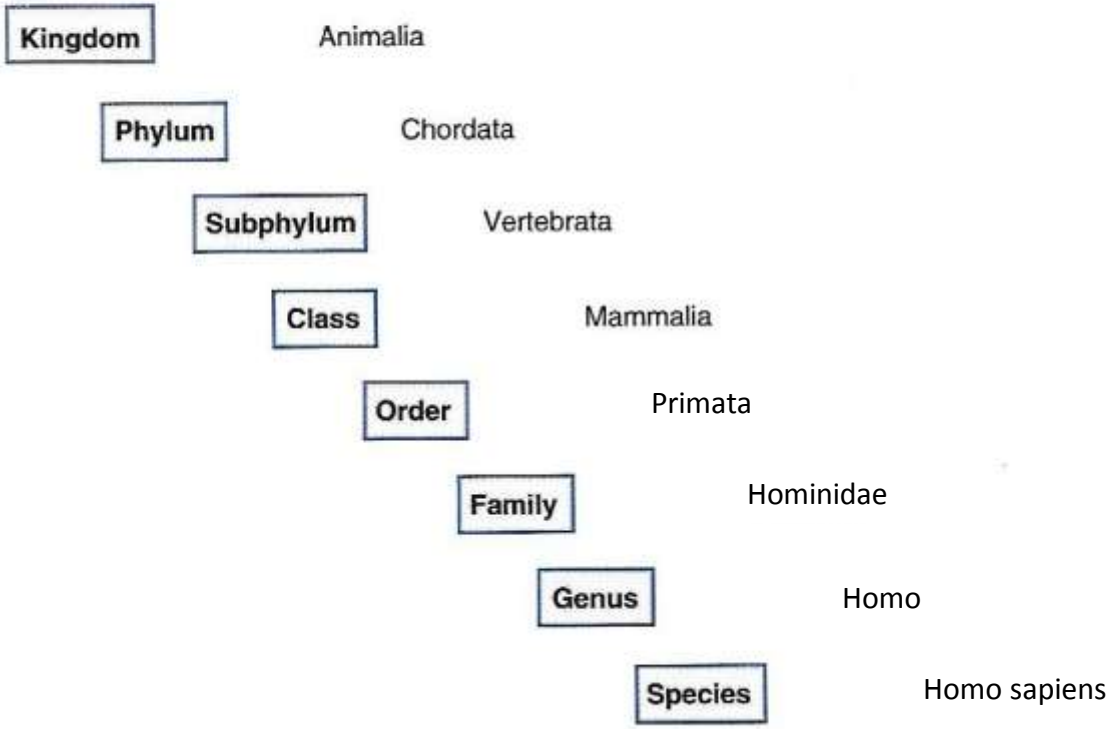
Figure 3.5 Each species in a biological classification is a member of a group at each of a succession of more inclusive hierarchical levels. The figure gives a fairly complete classification of the gray wolf *Canis lupus*. This way of classifying living things was invented by the eighteenth-century Swedish biologist who wrote under the latinized name Carolus Linnaeus.



O objetivo, além de agrupar, era descobrir a "ordem natural "dos grupos.
Os **MORFOLOGISTAS RACIONAIS** (Cuvier, Goethe, Kant) queriam entender os "arquétipos" biológicos, mas nunca sugeriram parentesco como responsável pelos grupos.

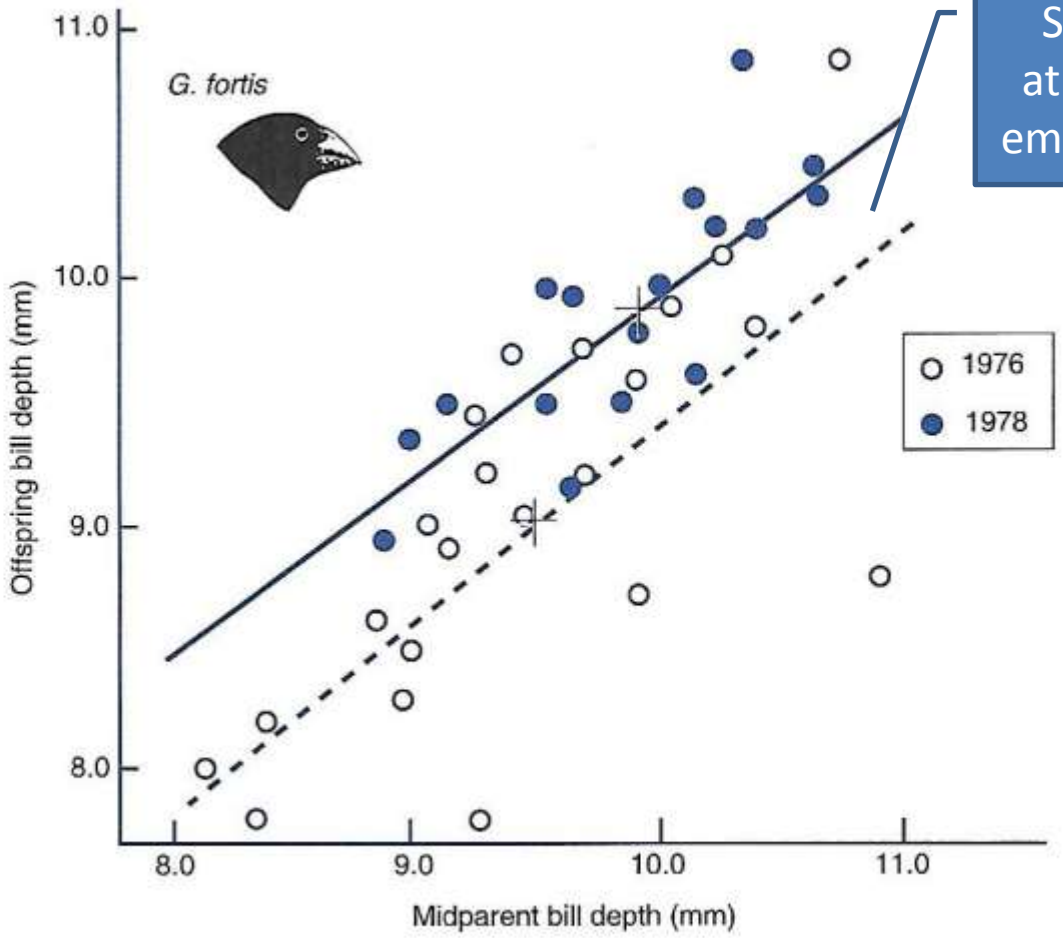
Mark Ridley, Evolution

HIERARQUIA NA CLASSIFICAÇÃO BIOLÓGICA - LINEU



EVIDÊNCIAS DA EVOLUÇÃO BIOLÓGICA

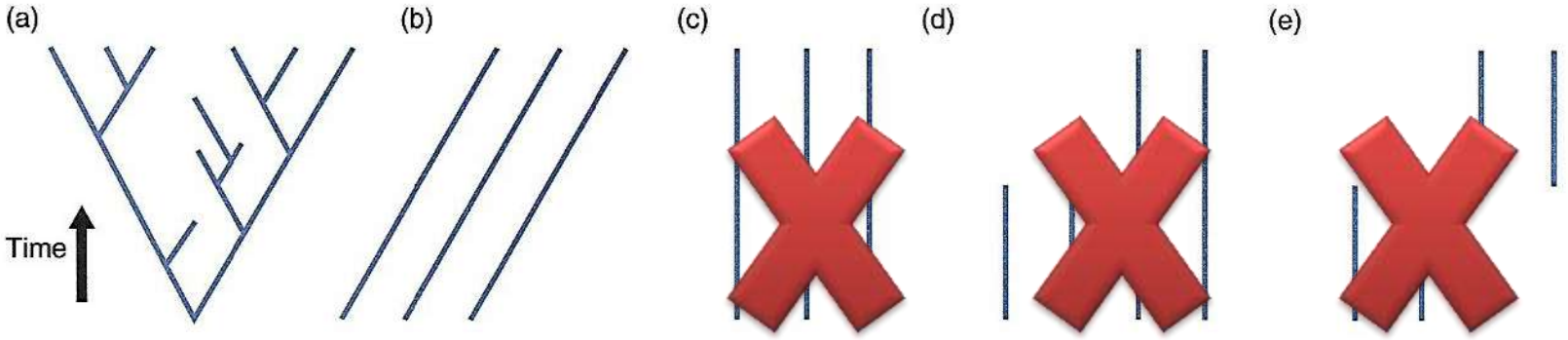
Figure 9.1 Parents with larger than average beaks produce offspring with larger than average beaks in *Geospiza fortis* on Daphne Major. Beak size is inherited. Reprinted, by permission of the publisher, from Grant (1986).



Mark Ridley, Evolution

TEORIAS DA ORIGEM DAS ESPÉCIES

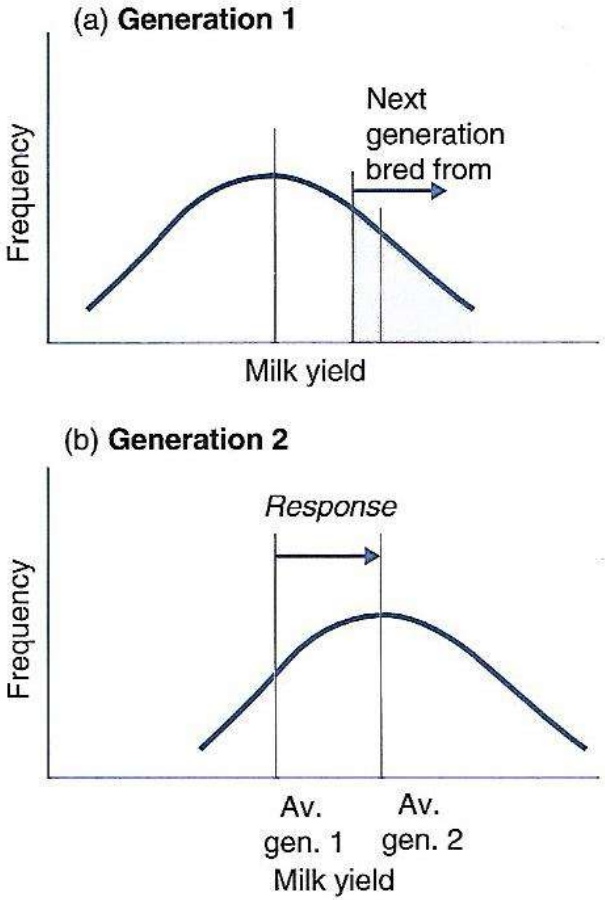
Figure 3.1 Three theories of the history of life: (a) evolution, (b) transformism, and (c–e) creationism. In (a) evolution, all species have a common origin, and they may change through time. In (b) transformism, species have separate origins, but they may change. In (c–e) separate creation, species have separate origins and do not change. (c), (d), and (e) represent different versions of the theory of separate creation that might be proposed to explain extinct fossil forms; they do not differ in their two essential features (species have separate origins and do not change). Each line represents a species in time. If the line moves up vertically, then the species is constant; if it deviates to the left or right, the species is changing in form.



Também comprovado pela seleção artificial

A EVOLUÇÃO TAMBÉM PODE SER PRODUZIDA EXPERIMENTALMENTE

Figure 3.3 An artificial selection experiment. Generation 2 is formed by breeding from a selected minority (shaded area) of the members of generation 1. Here, for example, we imagine a population of cows and selectively breed for high milk yield. In nearly all cases, the average in the second generation changes from the first generation in the selected direction.

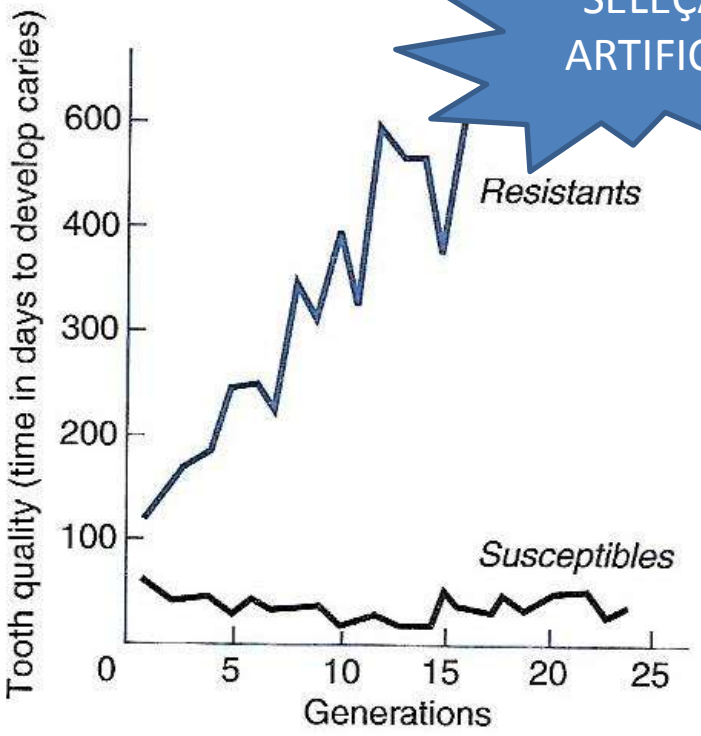


Mark Ridley, Evolution

EVIDÊNCIAS DA EVOLUÇÃO BIOLÓGICA

SELEÇÃO ARTIFICIAL

Figure 3.4 Selection for better and worse teeth in rats. Hunt *et al.* (1955) selectively bred each successive generation of rats from parental rats that developed caries later (resistants) or earlier (susceptibles) in life. The age (in days) at which their descendants developed caries was measured.

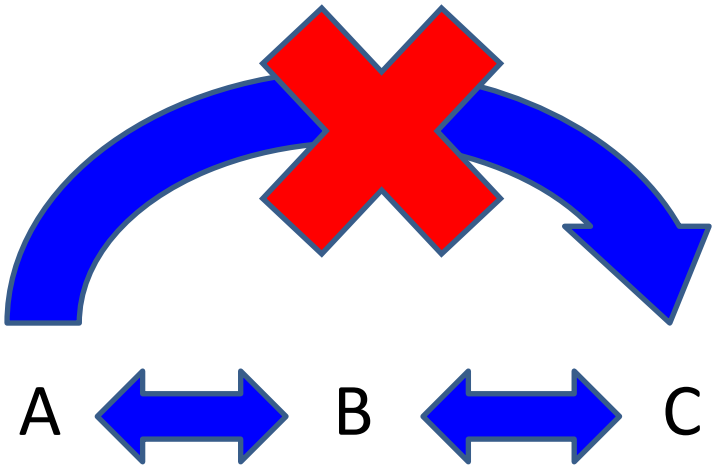


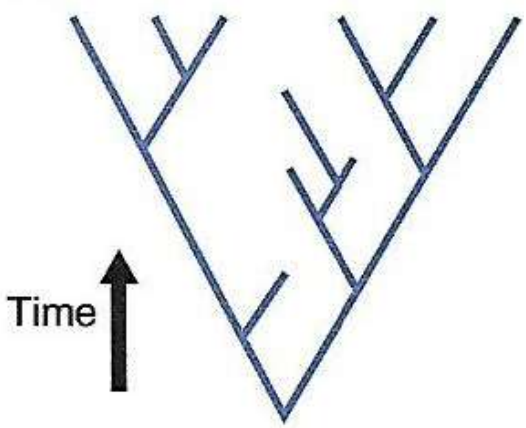
Mark Ridley, Evolution

NA VARIAÇÃO DENTRO DE ESPÉCIES É FÁCIL RECONHECER UM MECANISMO EVOLUTIVO, MAS DUAS POPULAÇÕES DE UMA MESMA ESPÉCIE PODEM SE DIFERENCIAR PROGRESSIVAMENTE ATÉ A FORMAÇÃO DE ESPÉCIES DISTINTAS?

ESPECIAÇÃO

O CONCEITO DE ESPÉCIE É COMPLEXO

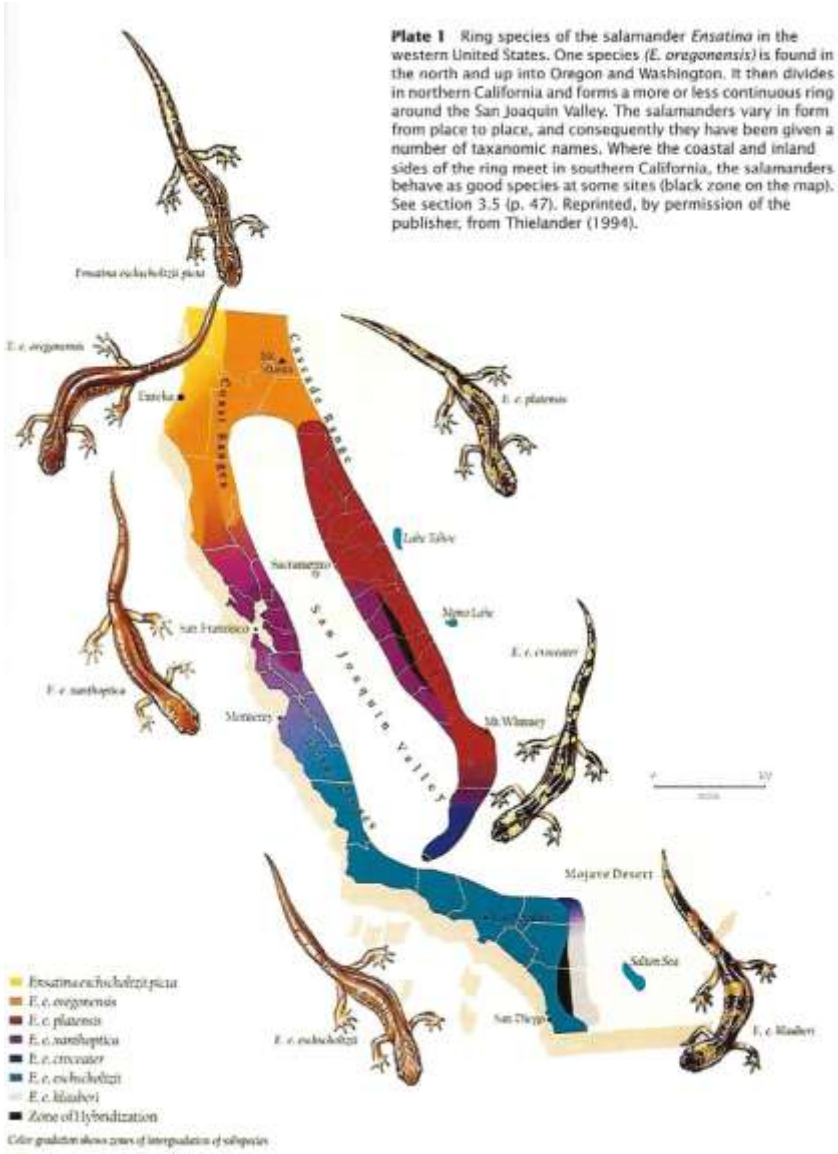




Embora o conceito de espécie seja complexo

REPRODUÇÃO E SIMILARIDADE FENOTÍPICA FORMAM DOIS DOS PRINCIPAIS FENÔMENOS PARA CONCEITUAR ESPÉCIES

ESPECIAÇÃO EM DISTRIBUIÇÃO CIRCULAR (RING SPECIES – MARK RIDLEY)



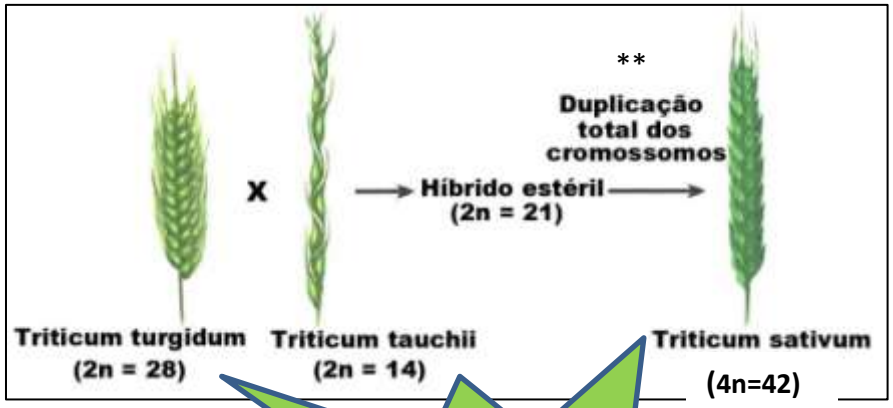
Mark Ridley, Evolution

ESPECIAÇÃO PODE SER REPRODUZIDA EXPERIMENTALMENTE!!!

Conceito "reprodutivo" de espécie



Conceito "fenotípico" de espécie

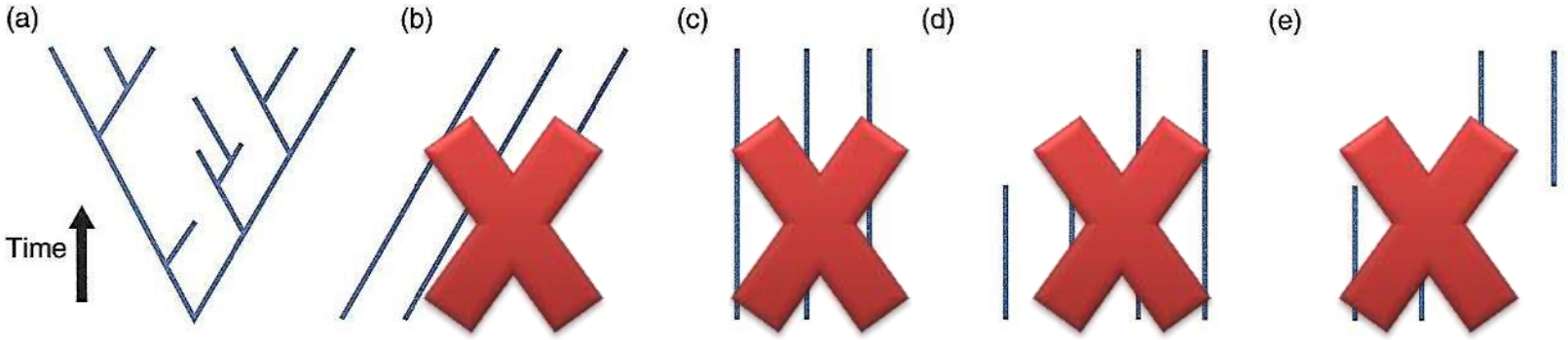


Prof Djalma Santos

~50% das plantas que produzem flores são híbridos poliplóides

TEORIA DA ORIGEM DAS ESPÉCIES

Figure 3.1 Three theories of the history of life: (a) evolution, (b) transformism, and (c–e) creationism. In (a) evolution, all species have a common origin, and they may change through time. In (b) transformism, species have separate origins, but they may change. In (c–e) separate creation, species have separate origins and do not change. (c), (d), and (e) represent different versions of the theory of separate creation that might be proposed to explain extinct fossil forms; they do not differ in their two essential features (species have separate origins and do not change). Each line represents a species in time. If the line moves up vertically, then the species is constant; if it deviates to the left or right, the species is changing in form.



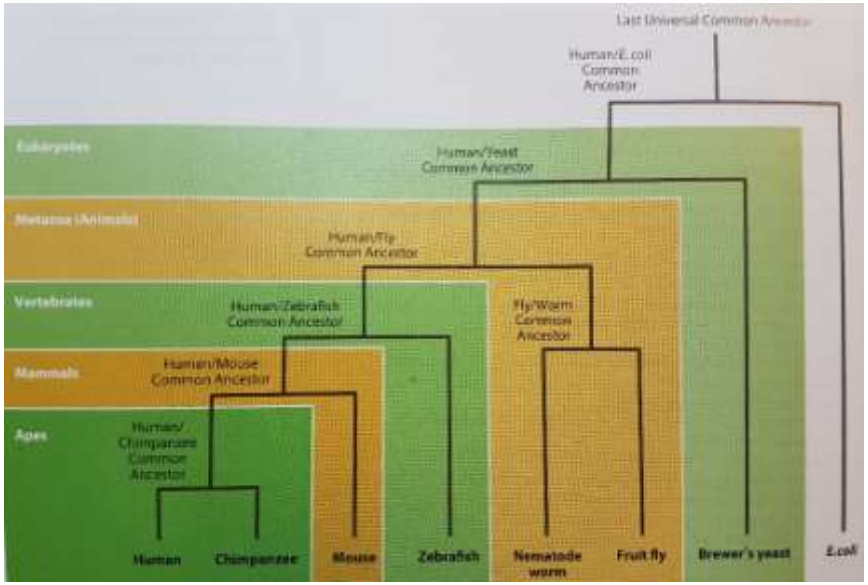
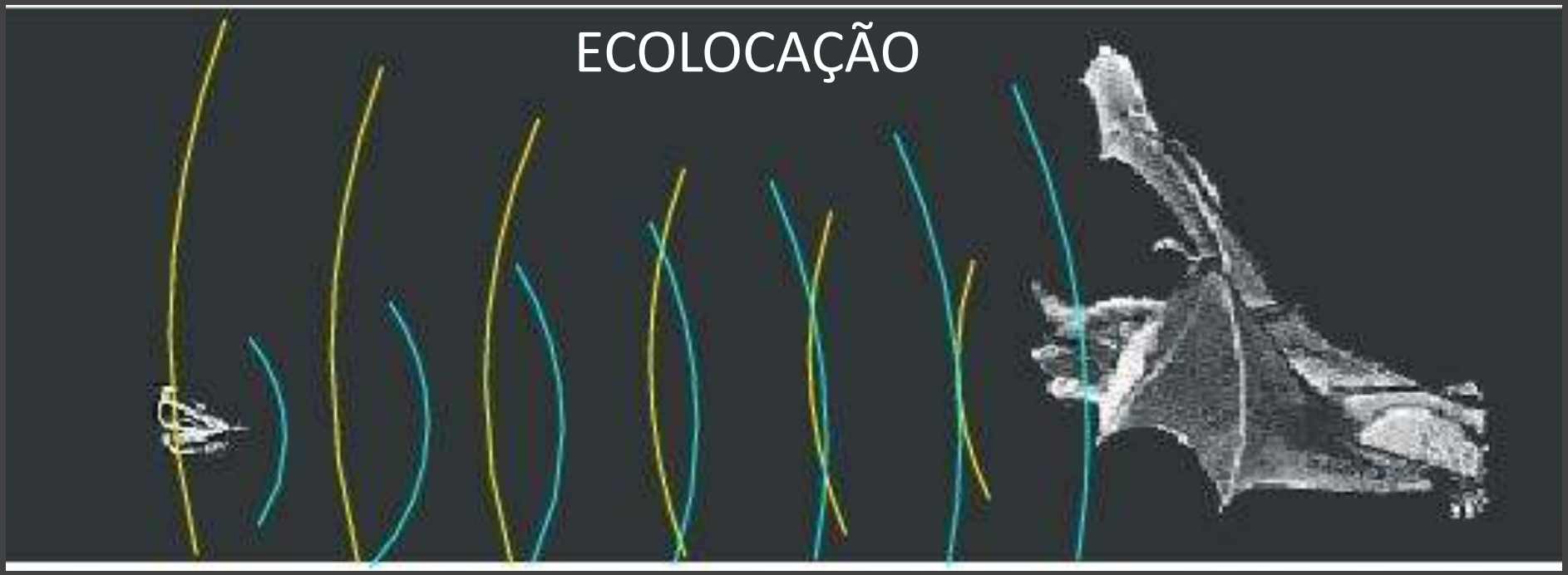


Figure 1.2: Cousins, not ancestors. A **phylogenetic tree** relates different branches of modern species, showing that they are all equally derived from their common ancestors in terms of time. Here branch lengths reflect evolutionary time, rather than evolutionary change.

Os animais, plantas, fungos e bactérias são nossos parentes!

Como explicar as ADAPTAÇÕES?



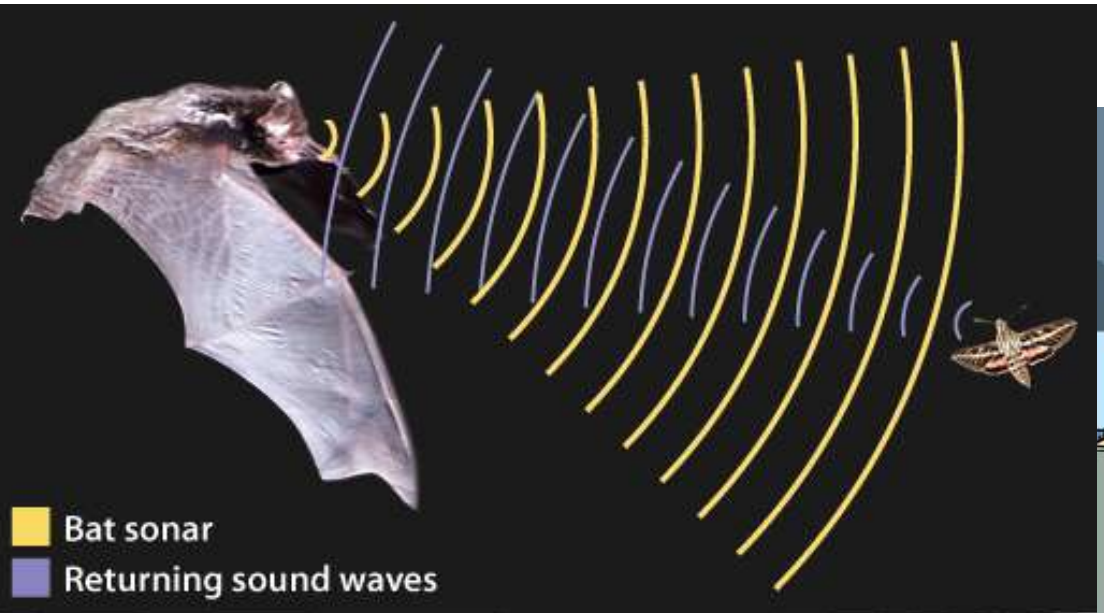
Design ou PROJETO

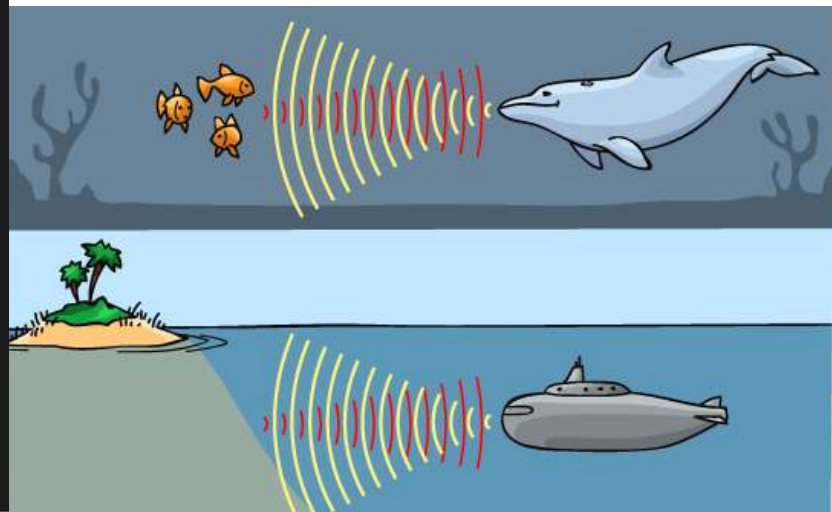
Animais apresentam “design” adequado para as funções que desempenham

P ex: Ecolocalização

- só em animais que necessitam caçar no escuro
- surgiu n vezes de maneira independente
- ideal: 200 pulsos/s (caro)
- real: 10 pulsos/s aumenta p/ 200 p/s quando há presa
- produção de som intensa encobre sensibilidade ao eco:

SOLUÇÃO: silenciador de sensibilidade auditiva ao emitir som





A questão do Design

William Paley, 1802 – Teologia natural



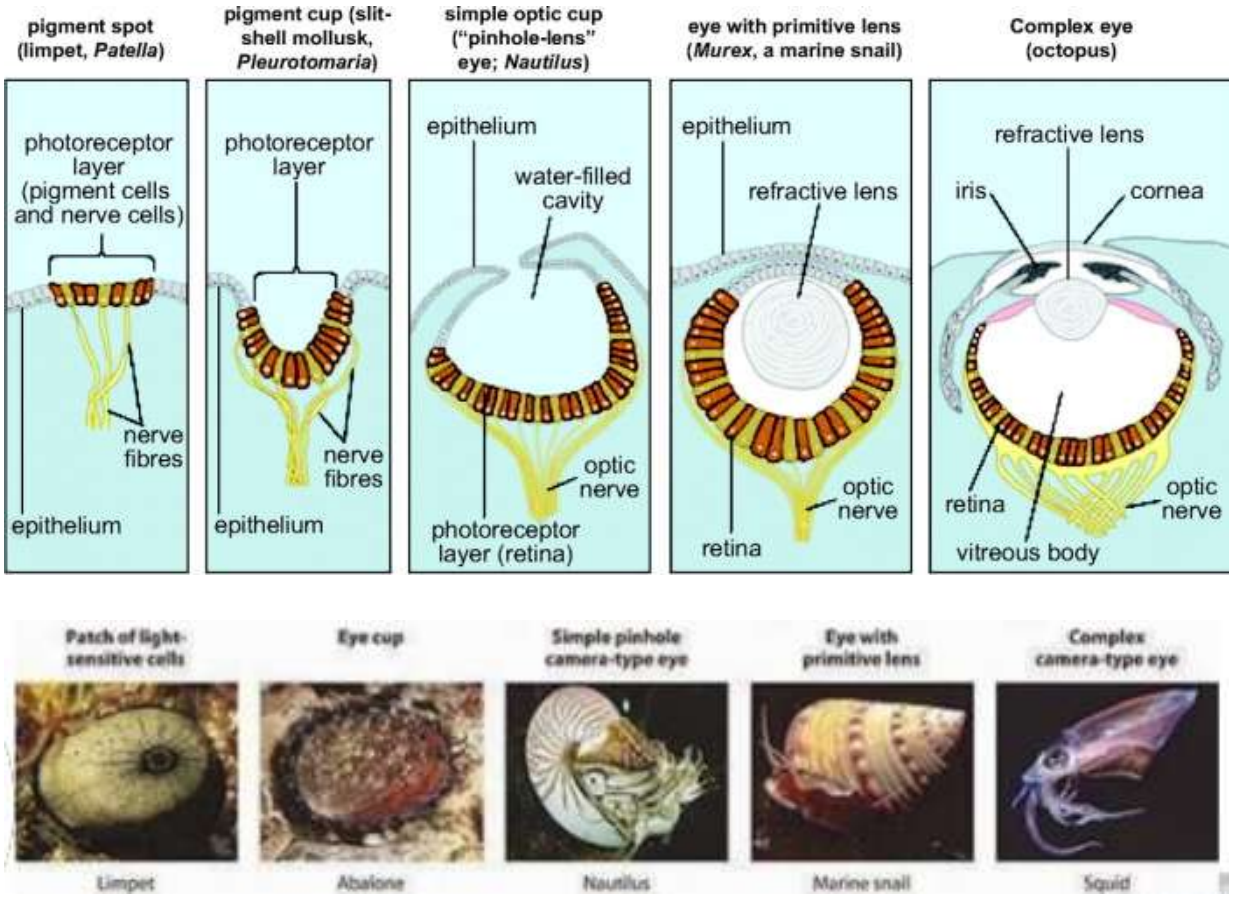
Inteligent design x SN



A produção da variação é ao acaso, mas as adaptações são produto da evolução por SN.



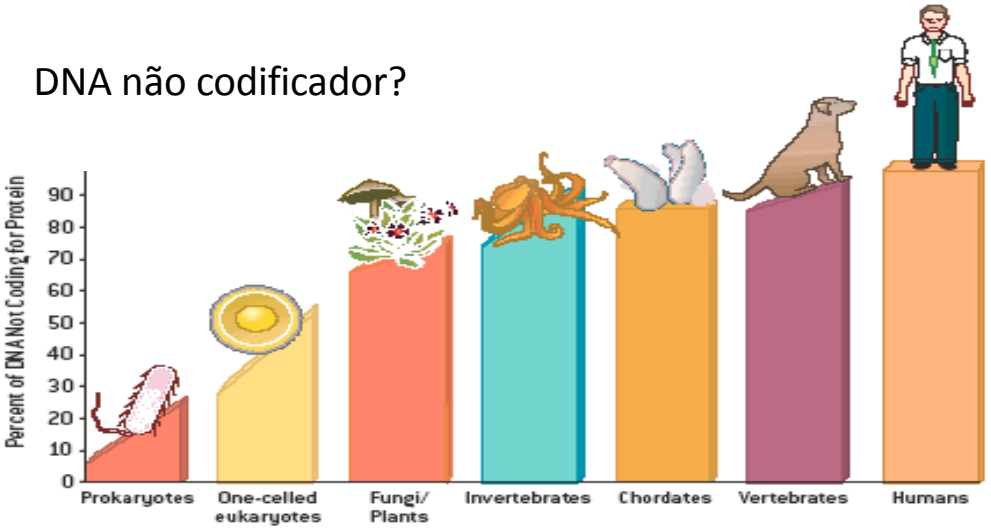
GRADUALISMO



A Biologia Evolutiva também precisa explicar as situações MAL-ADAPTATIVAS: CÂNCER, MORTE PREMATURA, DESIGN INADEQUADO

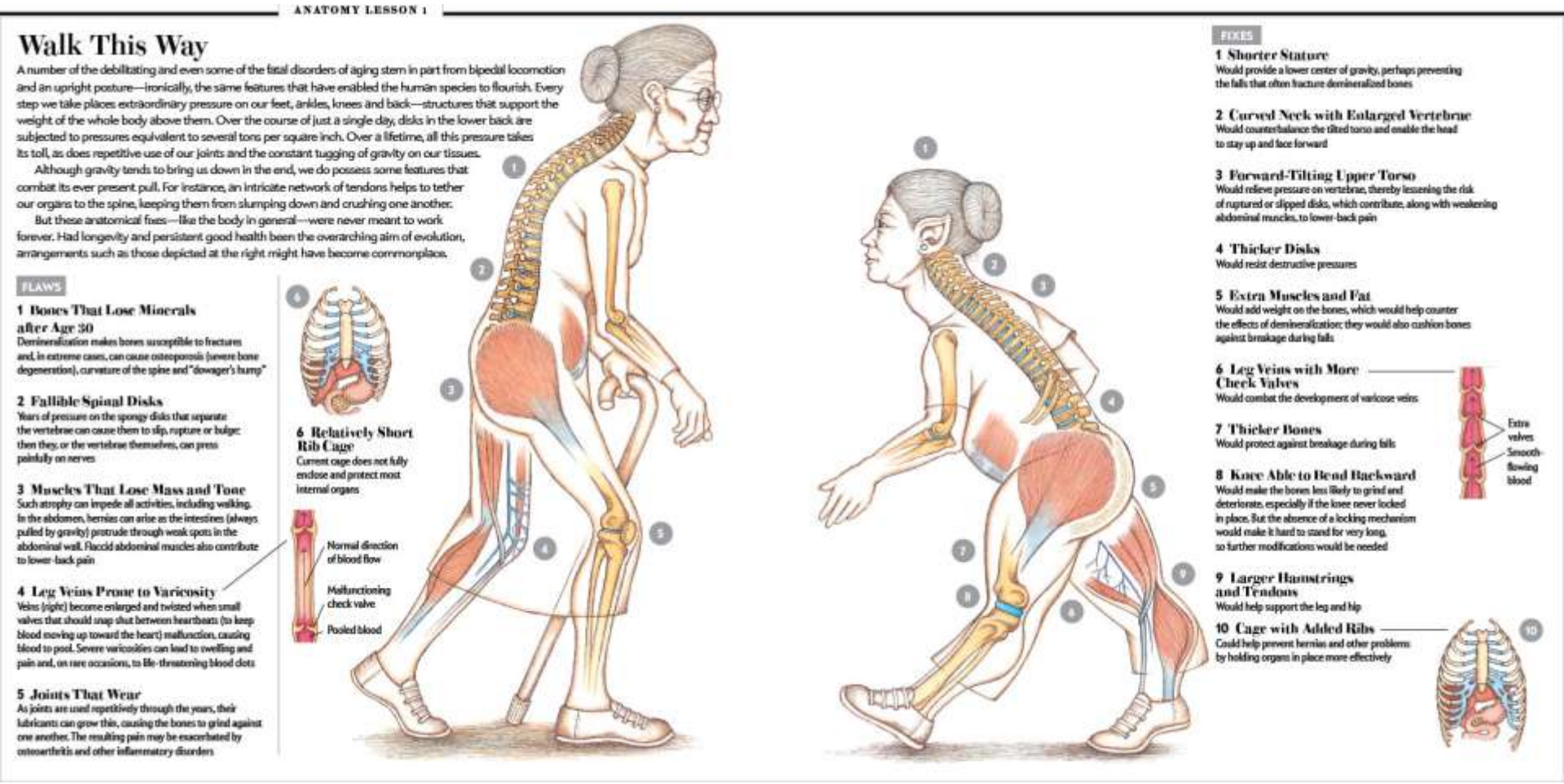
- A inversão da retina – o ponto cego do olho
- A glote cruzando os sistemas respiratórios e digestivo*
- Uretra masculina usada para excreção e reprodução
- Tumores

DNA não codificador?

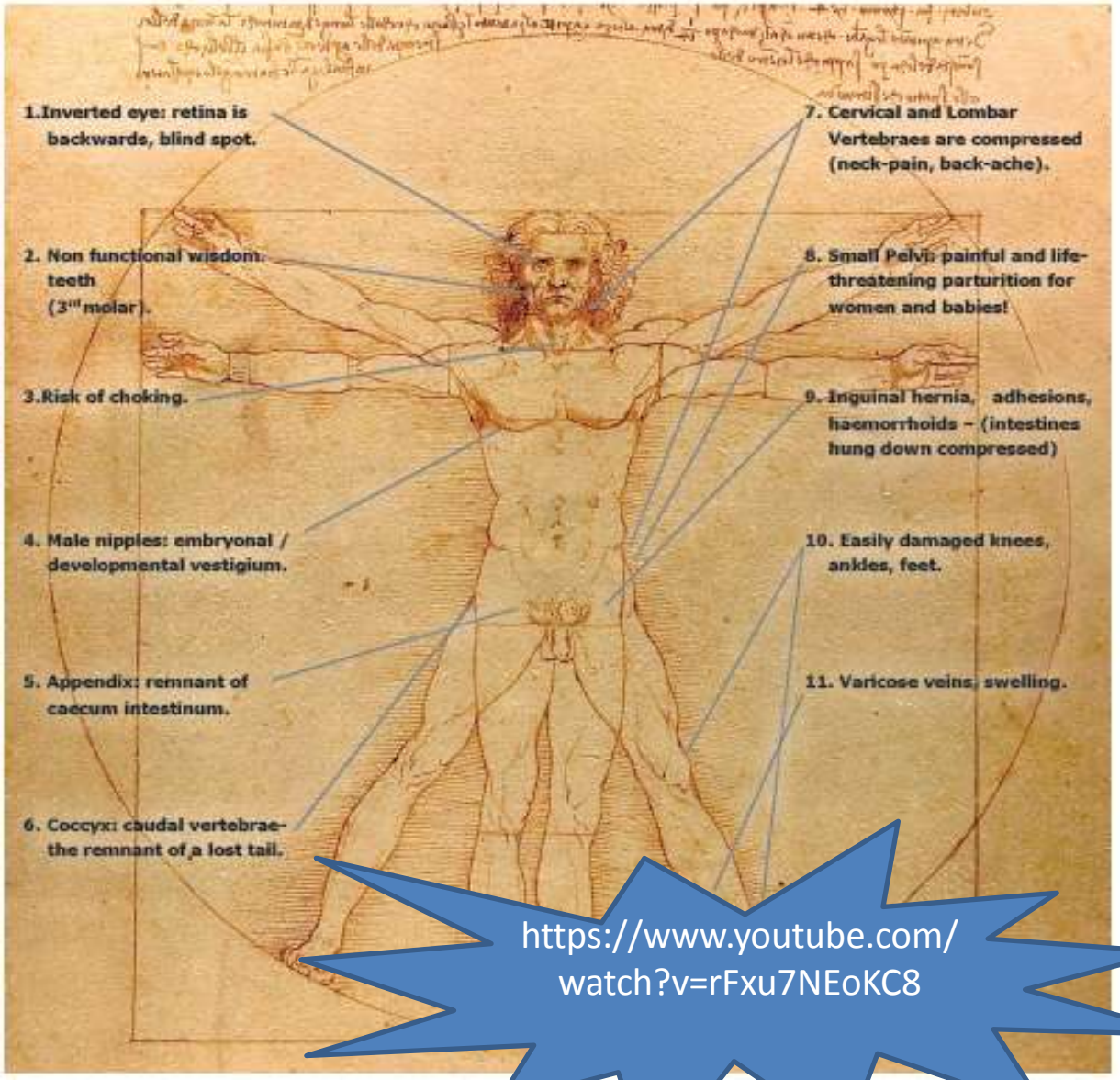


NONPROTEIN-CODING SEQUENCES make up only a small fraction of the DNA of prokaryotes. Among eukaryotes, as their complexity increases, generally so, too, does the proportion of their DNA that does not code for protein. The noncoding sequences have been considered junk, but perhaps it actually helps to explain organisms' complexity.

IF HUMANS WERE BUILT TO LAST



Olshanski *et al.*, 2015



https://www.youtube.com/watch?v=rFxu7NEoKC8

Why human evolution should be a basic science for medicine and psychology students

Paola Palanza & Stefano Parmigiani

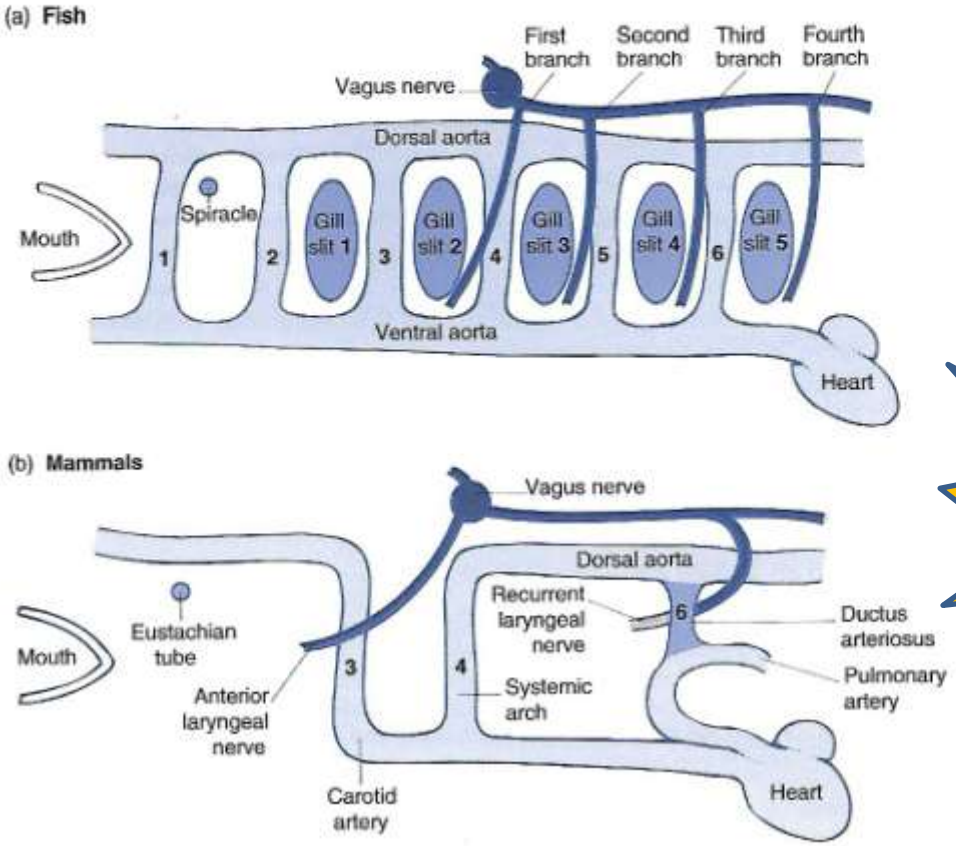
Journal of Anthropological Sciences
Vol. 94 (2016), pp. 183-192

Fig. 1 - Homo vitruvianus, the "perfect human body"…or not ?
N. 1, 3: trade offs and evolutionary constraints;
n. 2,4,5,6: vestigial stuctures;
n. 7-11: consequences of erect, bipedal posture.

Image credit: Luc Viatour (www.Lucnix.be). The colour version of this figure is available at the JASs website.

RESTRIÇÕES EVOLUTIVAS
nervo laríngeo recorrente

Figure 13.11 Evolution of the recurrent laryngeal nerve. (a) In fish, the vagus nerve sends direct branches between successive gill arches. (b) In mammals, the gill arches have evolved into a very different circulatory system. The descendant nerve of the fish's fourth vagus no passes from the brain, down to the heart (in the thorax) and back up to the larynx. Reprinted, by permission of the publisher, from Strickberger (1990), modified from De Beer.



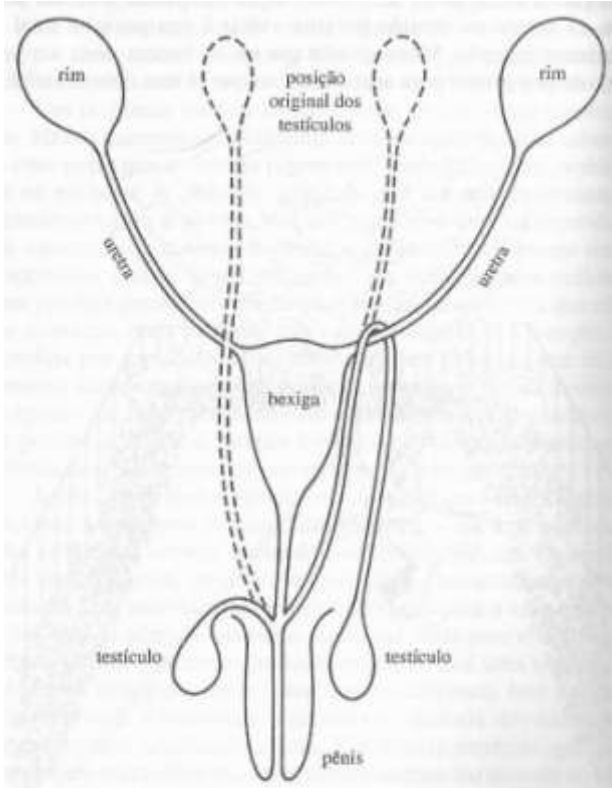
https://www.youtube.com/watch?v=cO1a1Ek-HD0

Mark Ridley, Evolution

RESTRIÇÕES EVOLUTIVAS
pulmões de cetáceos



RESTRIÇÕES EVOLUTIVAS



O testículo (à direita) dobrado sobre o ureter mostra a atual configuração masculina humana. É o resultado do deslocamento gradual (na evolução e no desenvolvimento individual) dos testículos do interior do corpo (as linhas pontilhadas) para o escroto. O testículo à esquerda mostra o que poderia ter acontecido se a evolução pudesse prever necessidades futuras ou corrigir erros passados.

George Williams

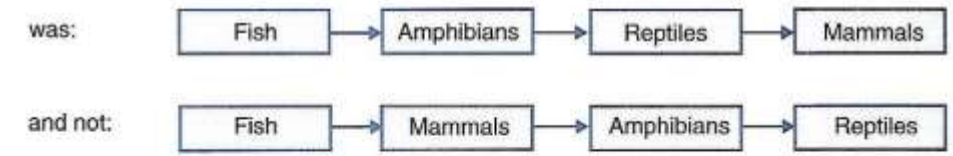
EVIDÊNCIAS DA EVOLUÇÃO BIOLÓGICA

- Restrições evolutivas
- Registro fóssil
- Comparações genéticas entre espécies (filogenia molecular)
- Homologias (homeoplasias)
- Orgãos vestigiais
- Atavismos

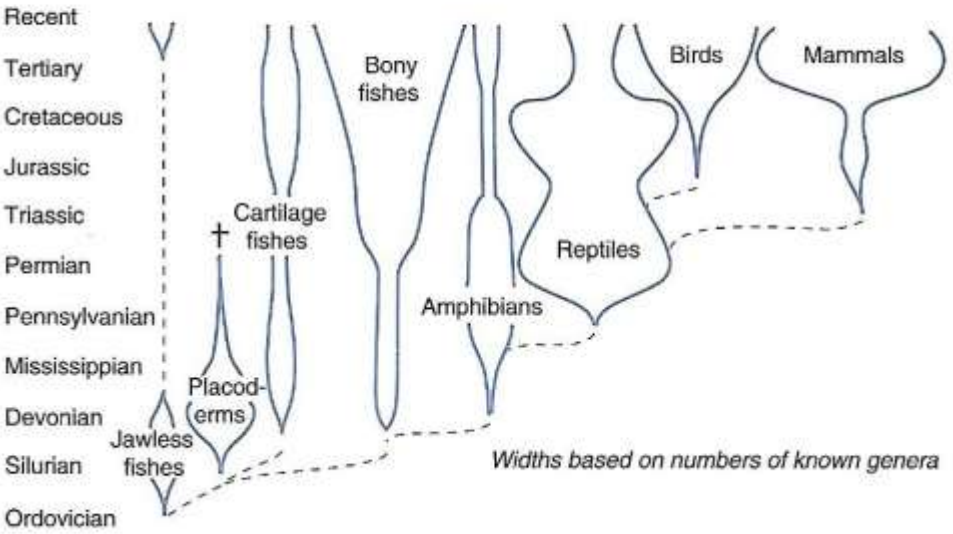
REGISTRO FÓSSIL – Filogenia dos vertebrados

Figure 3.12 (a) Anatomical analysis of modern forms indicates that amphibians and reptiles are evolutionarily intermediate between fish and mammals. This order fits with (b) the geological succession of the major vertebrate groups. The width of each group indicates the diversity of the group at that time. Reprinted, by permission of the publisher, from Simpson (1949).

(a) **Anatomy of modern forms suggests order of evolution**



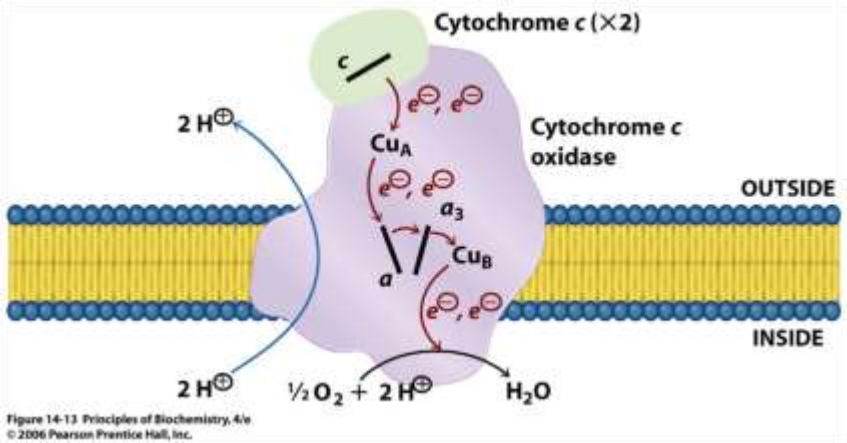
(b) **Order of main vertebrate groups in fossil records**

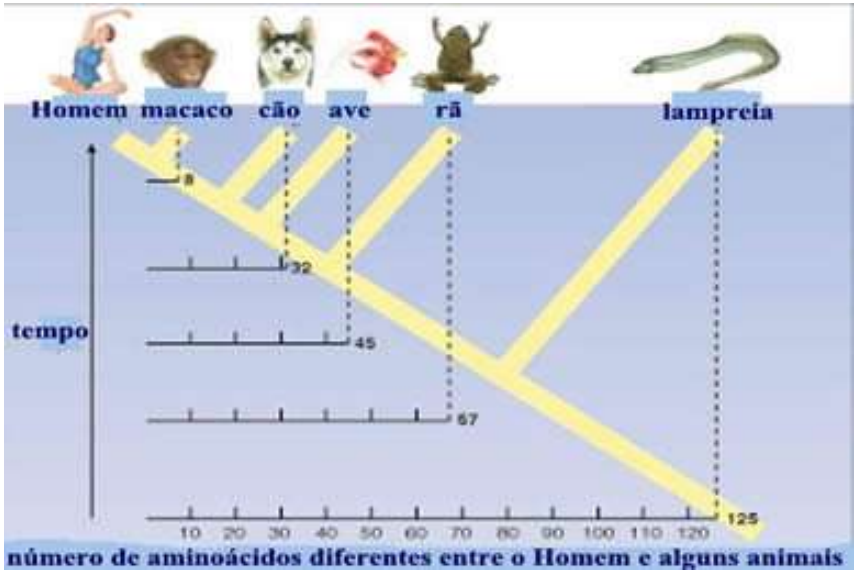


Mark Ridley, Evolution

Evolução molecular

Citocromo c – mitocôndria





Evolução molecular

Citocromo c – mitocôndria

```
citocromo_c_humano          MGDVEKGKKIFIMKCSQCHTVEKGGKHKTGPNLHGLFGRKTGQAPGYSYT 50
citocromo_c_chimpanze       MGDVEKGKKIFIMKCSQCHTVEKGGKHKTGPNLHGLFGRKTGQAPGYSYT 50
citocromo_c_bonobo          MGDVEKGKKIFIMKCSQCHTVEKGGKHKTGPNLHGLFGRKTGQAPGYSYT 50
citocromo_c_gorila          MGDVEKGKKIFIMKCSQCHTVEKGGKHKTGPNLHGLFGRKTGQAPGYSYT 50
citocromo_c_orangotango     MGDVEKGKKIFIMKCSQCHTVEKGGKHKTGPNLHGLFGRKTGQAPGYSYT 50
citocromo_c_macaco          MGDVEKGKKIFIMKCSQCHTVEKGGKHKTGPNLHGLFGRKTGQAPGYSYT 50
                            **************************************************

citocromo_c_humano          AANKNKGIIWGEDTLMEYLENPKKYIPGTKMIFVGIKKKEERADLIAYLK 100
citocromo_c_chimpanze       AANKNKGIIWGEDTLMEYLENPKKYIPGTKMIFVGIKKKEERADLIAYLK 100
citocromo_c_bonobo          AANKNKGIIWGEDTLMEYLENPKKYIPGTKMIFVGIKKKEERADLIAYLK 100
citocromo_c_gorila          AANKNKGIIWGEDTLMEYLENPKKYIPGTKMIFVGIKKKEERADLIAYLK 100
citocromo_c_orangotango     AANKNKGIIWGEDTLMEYLENPKKYIPGTKMIFVGIKKKEERADLIAYLK 100
citocromo_c_macaco          AANKNKGITWGEDTLMEYLENPKKYIPGTKMIFVGIKKKEERADLIAYLK 100
                            ******** **************************************** 

citocromo_c_humano          KATNE 105
citocromo_c_chimpanze       KATNE 105
citocromo_c_bonobo          KATNE 105
citocromo_c_gorila          KATNE 105
citocromo_c_orangotango     KATNE 105
citocromo_c_macaco          KATNE 105
                            *****
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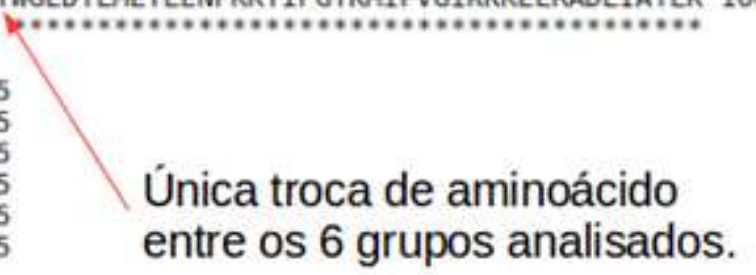
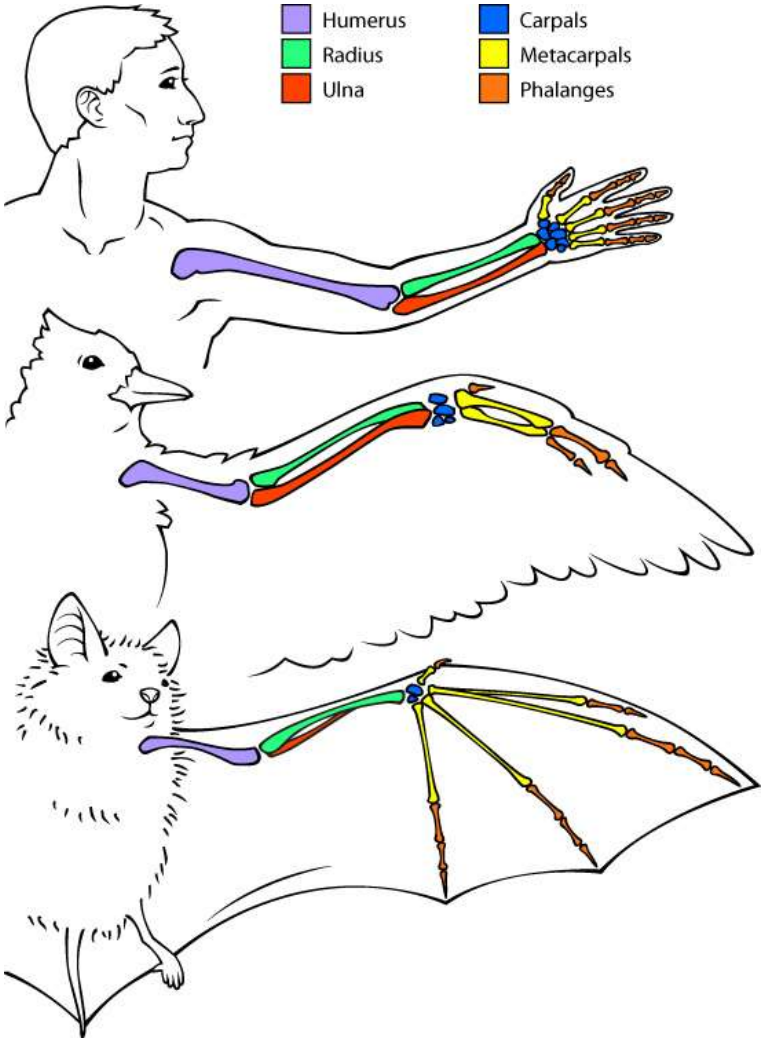
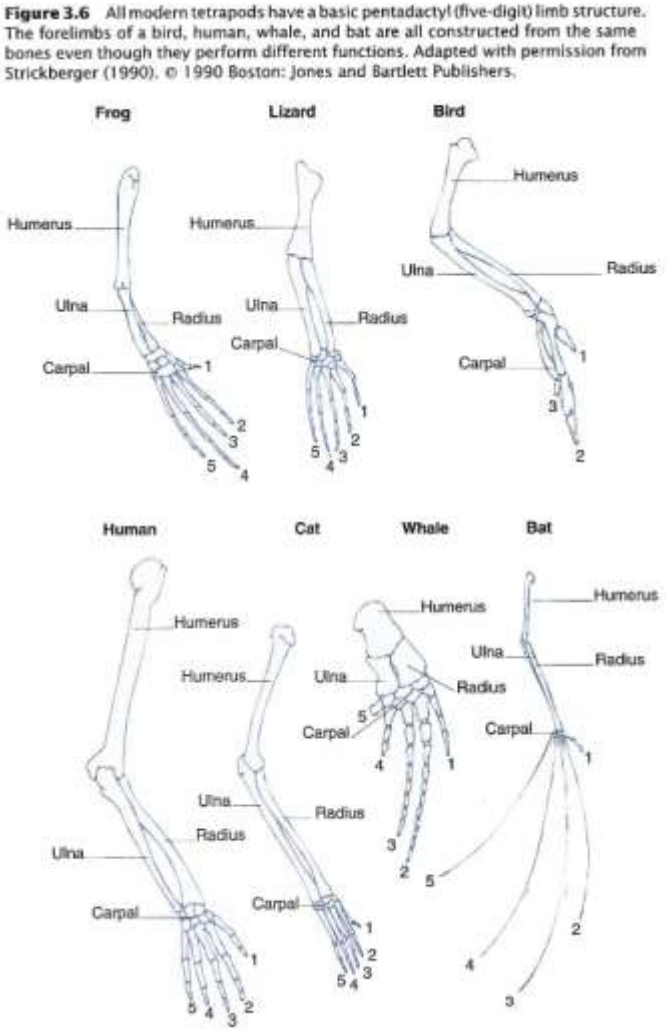


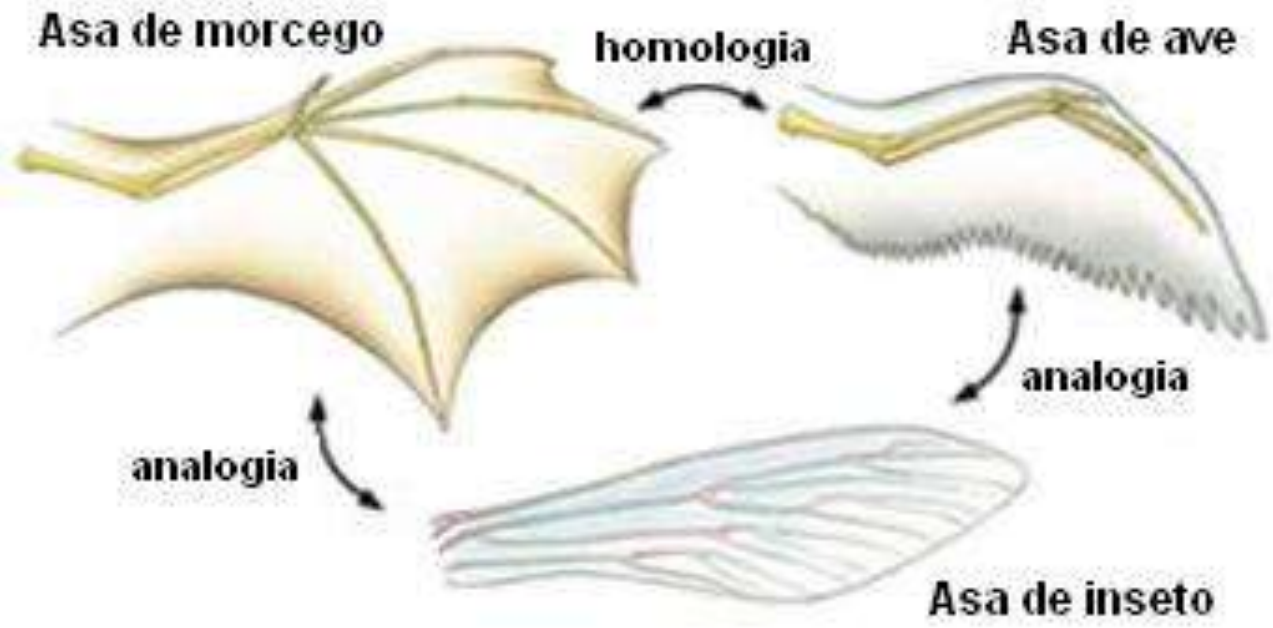
HOMOLOGIA

Semelhança de estruturas, genes ou processos entre diferentes espécies decorrente de **ancestralidade comum**

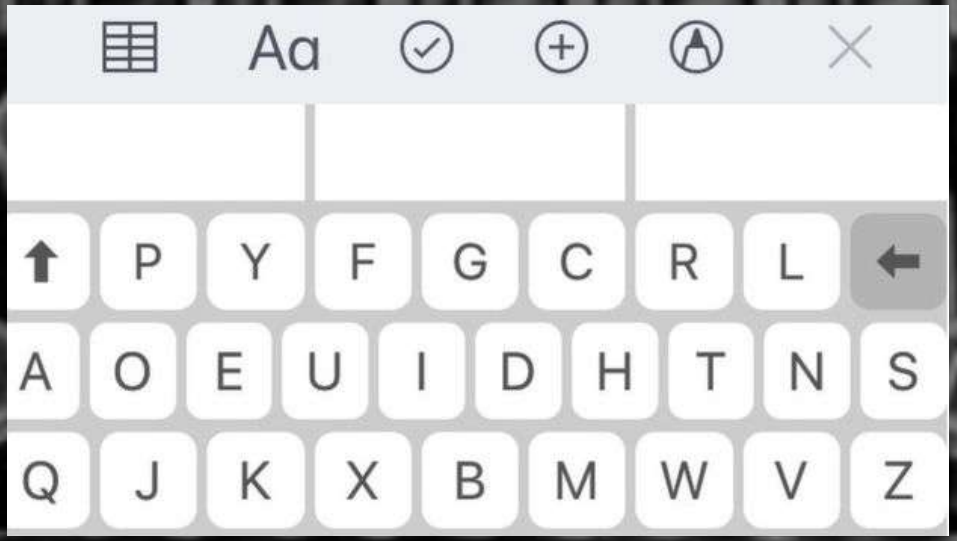




Homologias ⇄ Analogias



História evolutiva
=
fenômeno “QWERTY” X Dvorak
(Daniel Dennett)



https://www.bbc.com/portuguese/geral-48043045

História evolutiva

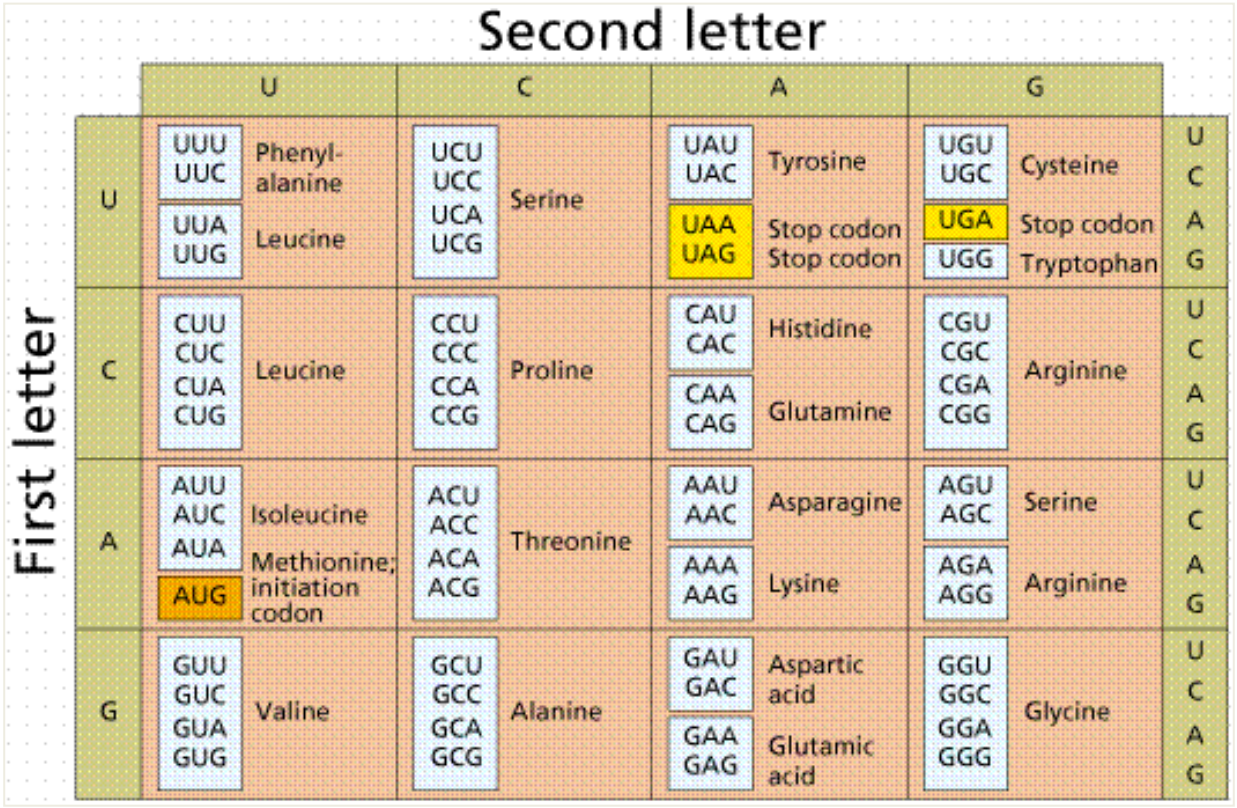
=

fenômeno “QWERTY” (D. Dennett)

=

acidente congelado (F. Crick)

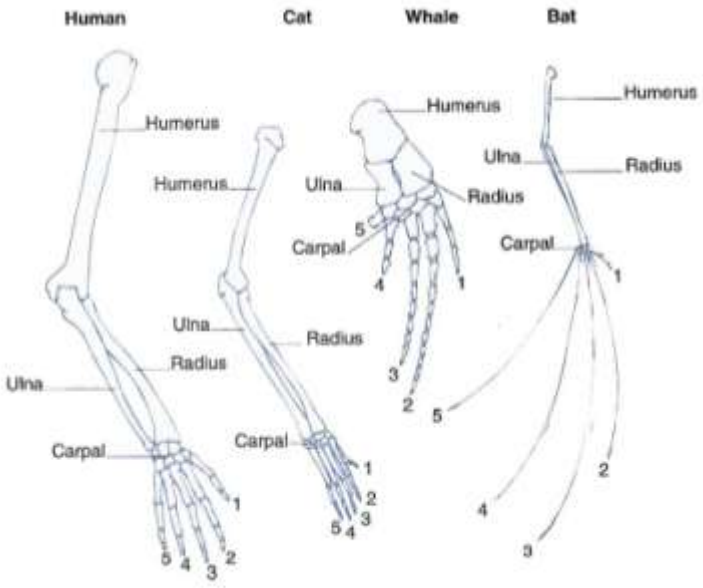
O código genético também pode ser considerado uma homologia



First letter	Second letter: U		Second letter: C		Second letter: A		Second letter: G		Third letter
U	UUU, UUC	Phenyl-alanine	UCU, UCC, UCA, UCG	Serine	UAU, UAC	Tyrosine	UGU, UGC	Cysteine	U, C
	UUA, UUG	Leucine			UAA	Stop codon	UGA	Stop codon	A
					UAG	Stop codon	UGG	Tryptophan	G
C	CUU, CUC, CUA, CUG	Leucine	CCU, CCC, CCA, CCG	Proline	CAU, CAC	Histidine	CGU, CGC, CGA, CGG	Arginine	U, C, A, G
					CAA, CAG	Glutamine			
A	AUU, AUC, AUA	Isoleucine	ACU, ACC, ACA, ACG	Threonine	AAU, AAC	Asparagine	AGU, AGC	Serine	U, C
	AUG	Methionine; initiation codon			AAA, AAG	Lysine	AGA, AGG	Arginine	A, G
G	GUU, GUC, GUA, GUG	Valine	GCU, GCC, GCA, GCG	Alanine	GAU, GAC	Aspartic acid	GGU, GGC, GGA, GGG	Glycine	U, C, A, G
					GAA, GAG	Glutamic acid			

EXAPTAÇÃO = “pré-adaptação”

adaptação biológica que evoluiu para funções distintas da atual





Nepente
folhas modificadas em jarros para pegar insetos

Vênus Atrapamosca
folhas modificadas em maxilas para pegar insetos

Bico de Papagaio
folhas vermelho brilhante lembram pétalas de flores

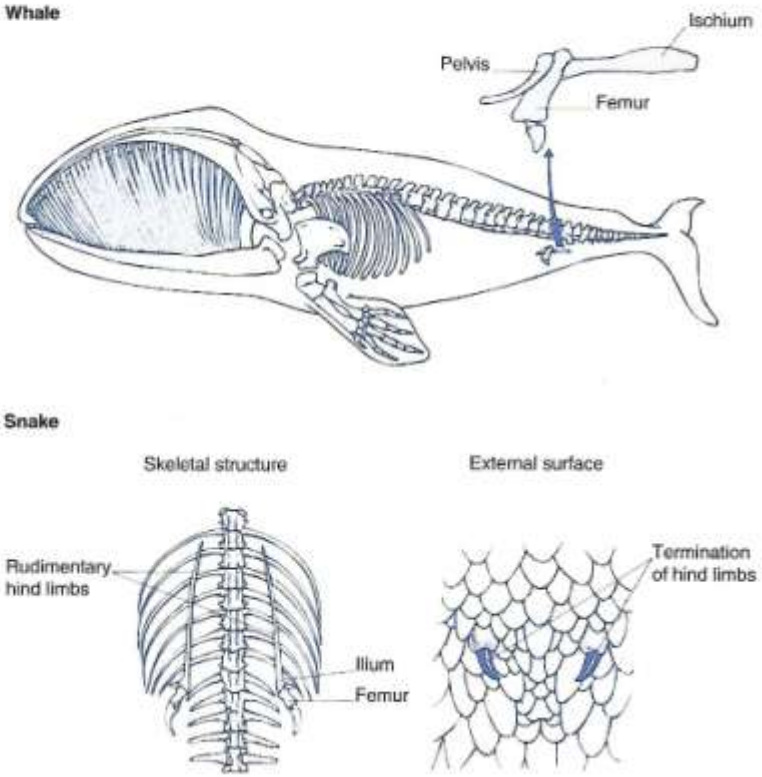
Cacto
folhas se tornaram espinhos

Mark Ridley, Evolution

ORGÃOS VESTIGIAS

- Apêndice humano

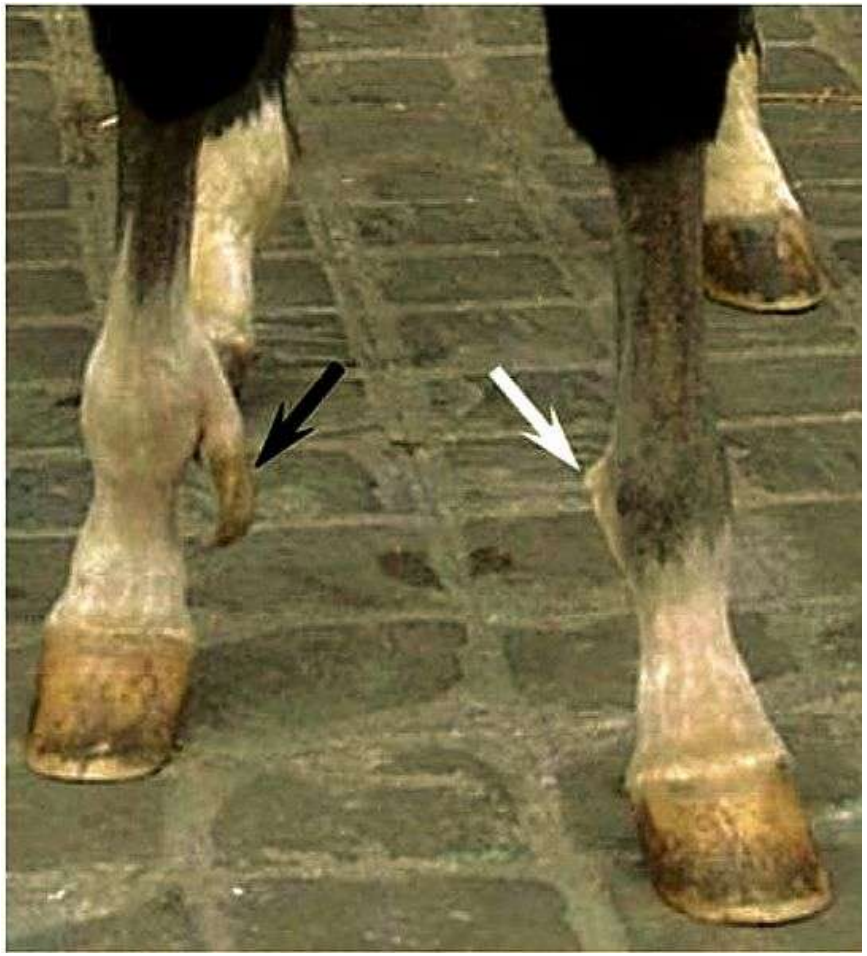
Figure 3.9 Whales have a vestigial pelvic girdle, even though they do not have bony hind limbs. The pelvic bones are homologous with those of other tetrapods.



Mark Ridley, Evolution

ATAVISMO

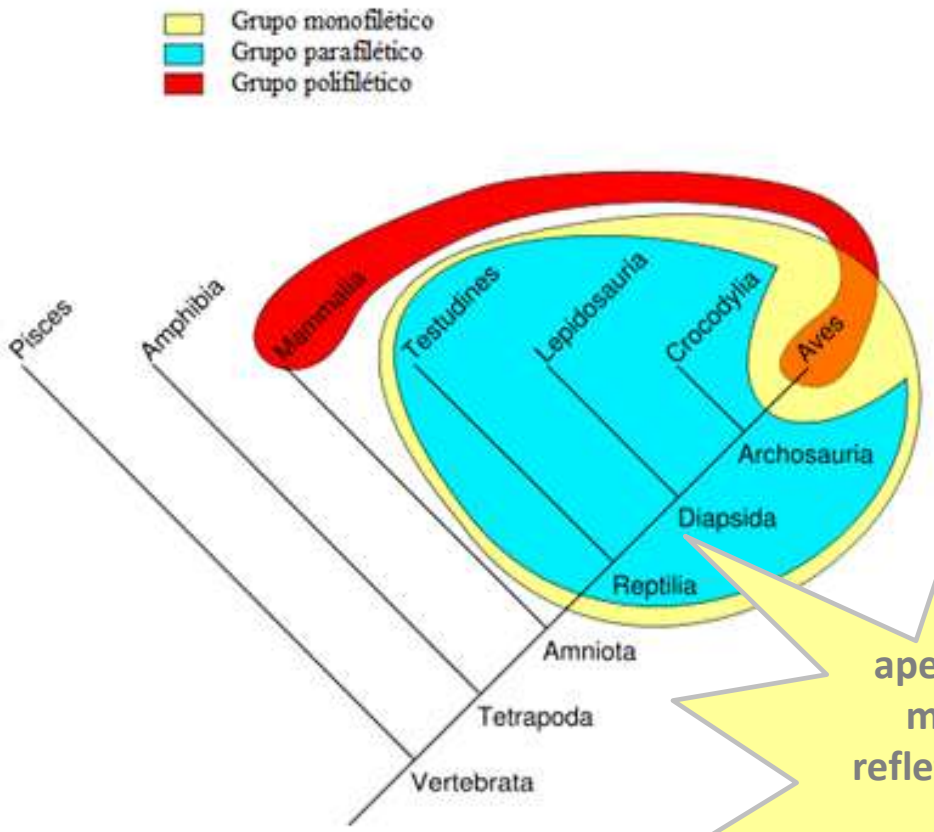
Reaparecimento de uma estrutura ancestral extinta, mas que ficou silenciada no genoma



OUTROS EXEMPLOS:

- Tubérculo de Darwin
- Cauda em Humanos
- Pseudogenes

A classificação biológica agrupa homologias e não analogias



apenas os grupos monofiléticos refletem a evolução biológica

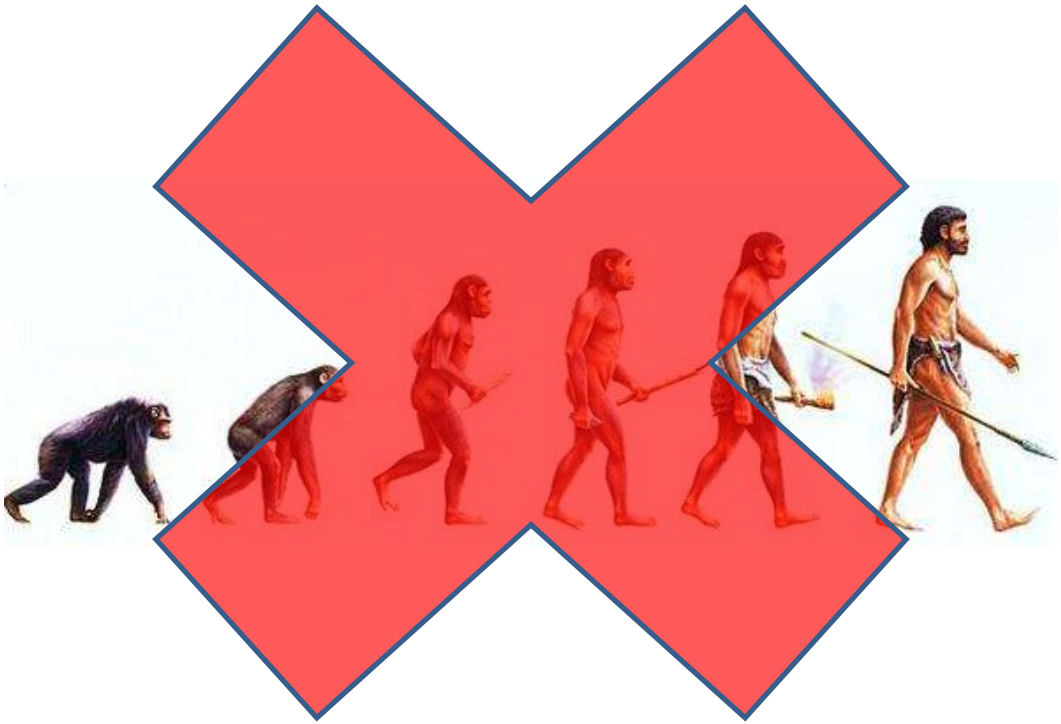
EVOLUÇÃO BIOLÓGICA

- Seleção natural e evolução biológica não são sinônimos:
  - A SN é um dos 5 mecanismos que leva a alteração da frequência de genes nas populações.

Evolução e genética de populações:
5 mecanismos alteram a frequência de genes nas populações:

- DERIVA GENÉTICA E EFEITO DE FUNDADOR
- CRUZAMENTOS PREFERENCIAS E ENDOGAMIA
- MIGRAÇÃO
- MUTAÇÃO
- SELEÇÃO NATURAL

Erros comuns na compreensão da teoria da Evolução



- **NÃO EXISTE PROGRESSO NA EVOLUÇÃO BIOLÓGICA. TODOS OS SERES VIVOS SÃO IGUALMENTE BEM SUCEDIDOS.**
- **NÃO EXISTE FINALIDADE NA EVOLUÇÃO BIOLÓGICA. A EVOLUÇÃO DAS ESPÉCIES RESPONDE A PRESSÕES AMBIENTAIS, QUE SE MODIFICAM IMPREVISIVELMENTE.**

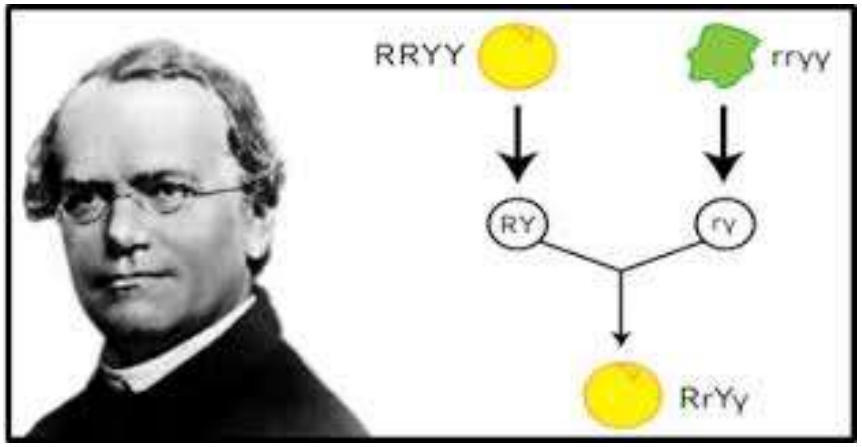
Sarcoptes scabiei





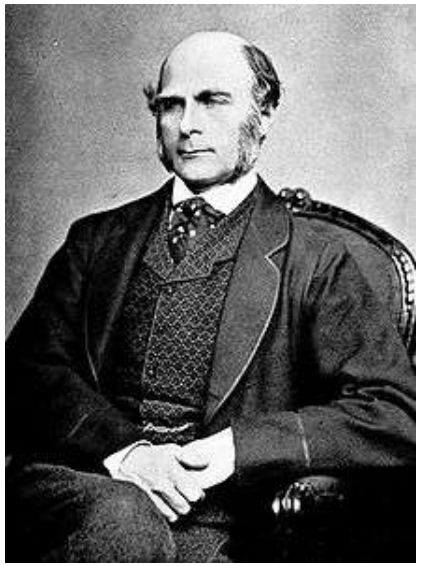
a idéia de que seres vivos sempre se tornam mais complexas é errônea. Os insetos evoluíram de artrópodes com mais de seis patas. Aves e cobras perderam partes. Seres humanos não possuem mais cauda. A direção da evolução é geralmente em direção a perda de partes ou comportamentos – se tornando mais simples e não mais complexo.

O Neo-Darwinismo ou síntese moderna



- No início do século XX a redescoberta das Leis de Mendel (herança particulada) e o desenvolvimento da genética de populações, refinaram a teria da Evolução Biológica, levando à Síntese Moderna.

Francis Galton:
Regression toward the mean



- Galton (1822-1911) estatístico inglês. Estudou a variação humana e a herança quantitativa. Cunhou o termo EUGENIA e foi um dos primeiros a refutar cientificamente o Lamarckismo.
- Regressão para a média de caracteres herdados era uma desafio para a teoria darwiniana (pai alto + mãe baixa = filho médio).
- No entanto, após a compreensão das leis de Mendel e da herança particulada, ficou claro que não há total mistura no nível genético

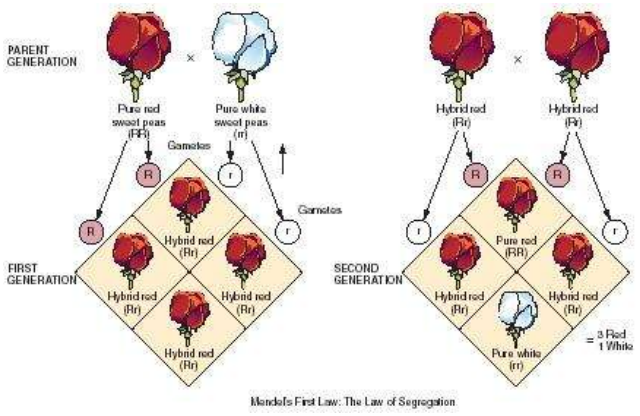
= **Síntese Moderna da biologia evolutiva ou Neodarwinismo.**

A Síntese Moderna: incorporando Genética

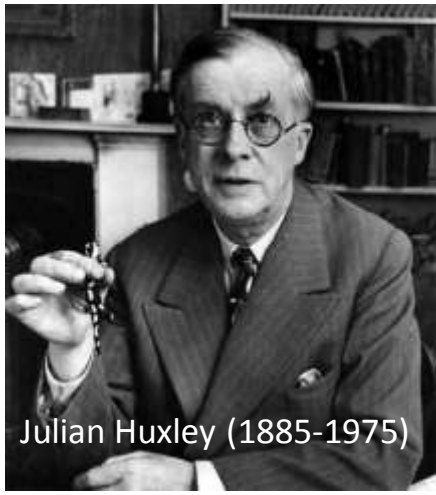
Darwin não conhecia genética mendeliana (teoria hereditária aceita era a pangênese: gêmulas se misturavam para originar gametas).
Herança ERA tida como resultado de mistura.

Mendel: “partículas de herança” não se misturam!


Mendel (1822-84)



Mendel's First Law: The Law of Segregation


Julian Huxley (1885-1975)

No início do sec XX Darwinismo e Mendelismo eram considerado opostos.

Darwinismo+Mendelismo+Genética de populações
= Síntese moderna da Evolução (J Huxley, 1942)

Seleção Natural = mudanças na frequência relativa de genes em dada população ao longo do tempo = **sobrevivência preferencial de genes** que conferem melhor capacidade de utilizar recursos naturais e em consequência, maior adaptabilidade.

Erros comuns na compreensão da teoria da Evolução

Racialist evolutionism



- Ernst Haeckel developed "Darwinismus", a mix of Lamarck, Darwin and Goethe

- He believed that evolution was progressive, and that races were part of a spectrum from apes to Aryans (mid-Europeans)



John Wilkins

O Darwinismo Social e a Eugenia

SPENCERISMO/DARWINISMO SOCIAL FORAM CIENTIFICAMENTE DESACREDITADOS JÁ NA 2ª METADE DO SÉC XX.



Racialist evolutionism after Haeckel

- In the period from 1890 to 1930, there were many racialist evolution books and pamphlets
- About this time, genetics developed
- Many early geneticists were both evolutionists and eugenicists
- But not all: a famous opponent of eugenics was the leading evolutionary geneticist, Theodosius Dobzhansky



John Wilkins

How culture shaped the human genome: bringing genetics and the human sciences together

Kevin N. Laland, John Odling-Smee† and Sean Myles§‖*

Abstract | Researchers from diverse backgrounds are converging on the view that human evolution has been shaped by gene–culture interactions. Theoretical biologists have used population genetic models to demonstrate that cultural processes can have a profound effect on human evolution, and anthropologists are investigating cultural practices that modify current selection. These findings are supported by recent analyses of human genetic variation, which reveal that hundreds of genes have been subject to recent positive selection, often in response to human activities. Here, we collate these data, highlighting the considerable potential for cross-disciplinary exchange to provide novel insights into how culture has shaped the human genome.

Table 2 | **Genes identified as having been subject to recent rapid selection and their inferred cultural selection pressures**

Genes	Function or phenotype	Inferred cultural selection pressure	Refs
LCT, MAN2A1, SI, SLC27A4, PPARD, SLC25A20, NCOA1, LEPR, LEPR, ADAMTS19, ADAMTS20, APEH, PLAU, HDAC8, UBR1, USP26, SCP2, NKX2-2, AMY1, ADH, NPY1R, NPY5R	Digestion of milk and dairy products; metabolism of carbohydrates, starch, proteins, lipids and phosphates; alcohol metabolism	Dairy farming and milk usage; dietary preferences; alcohol consumption	6,7,16,41,63, 102,118, 144,145
Cytochrome P450 genes (*CYP3A5, CYP2E1, CYP1A2* and *CYP2D6*)	Detoxification of plant secondary compounds	Domestication of plants	6,63,146,147
CD58, APOBEC3F, CD72, FCRL2, TSLP, RAG1, RAG2, CD226, IGJ, TJP1, VPS37C, CSF2, CCNT2, DEFB118, STAB1, SP1, ZAP70, BIRC6, CUGBP1, DLG3, HMGCR, STS, XRN2, ATRN, G6PD, TNFSF5, HbC, HbE, HbS, Duffy, α-globin	Immunity, pathogen response; resistance to malaria and other crowd diseases	Dispersal, agriculture, aggregation and subsequent exposure to new pathogens; farming	6–8,14,16,50, 63,148,149
LEPR, PON1, RAPTOR, MAPK14, CD36, DSCR1, FABP2, SOD1, CETP, EGFR, NPPA, EPHX2, MAPK1, UCP3, LPA, MMRN1	Energy metabolism, hot or cold tolerance; heat-shock genes	Dispersal and subsequent exposure to novel climates	14,150
SLC24A5, SLC25A2, EDAR, EDA2R, SLC24A4, KITLG, TYR, 6p25.3, OCA2, MC1R, MYO5A, DTNBP1, TYRP1, RAB27A, MATP, MC2R, ATRN, TRPM1, SILV, KRTAPs, DCT	The externally visible phenotype (skin pigmentation, hair thickness, eye and hair colour, and freckles)	Dispersal and local adaptation and/or sexual selection	9,14,63,97, 101,151
CDK5RAP2, CENPJ, GABRA4, PSEN1, SYT1, SLC6A4, SNTG1, GRM3, GRM1, OLRA2, OR4C13, OR2B6, RAPSN, ASPM, RNT1, SV2B, SKP1A, DAB1, APPBP2, APBA2, PCDH15, PHACTR1, ALG10, PREP, OPM6A, DGKI, ASPM, MCPH1, FOXP2	Nervous system, brain function and development; language skills and vocal learning	Complex cognition on which culture is reliant; social intelligence; language use and vocal learning	6,7,14,63, 68–70,78,149
BMP3, BMPR2, BMP5, GDF5	Skeletal development	Dispersal and sexual selection	6,63
MYH16, ENAM	Jaw muscle fibres; tooth-enamel thickness	Invention of cooking; diet	80,113

A sombra do criacionismo



ISSO PODE Aula de religião: para o STF, ela não fere o princípio do Estado laico

A sombra do criacionismo

- EUA: 40% acham que a Evolução Biológica é falsa e que os seres humanos foram criados na sua forma atual, há menos de 10.000 anos atrás...
- Criacionismo científico = pseudocientífico
- A evolução é apenas uma teoria X evidências
- A teoria é tautológica X SQN
- O registro fóssil é incompleto X tafonomia
- Acaso não explica adaptações complexas X SN

"I´d rather descend from the apes by both maternal and paternal lineages, then to be the son of a man blinded by faith (Wilberforce Bishop)"
Thomas Huxley (1825-95)



A sombra do criacionismo

- A origem do homem como primata, incomoda mais que a ideia das espécies se transformando.

- Encíclica Papal ¨*Humanis Genesis*¨ (1951): admitiu após quase 100 anos a ascendência biológica do homem.

- João Paulo II (1997): deixou de considerar a evolução biológica como uma teoria cientifica e passou a considera-la um fato.

Nada em biologia faz sentido,
a não ser à luz da evolução.

THEODOZIUS DOBZHANSKY