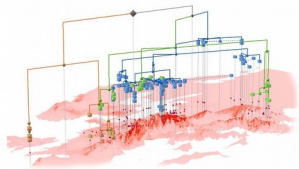


Bem vindos a:



Princípios de Sistemática & **Biogeografia**



Fernando Portella de Luna Marques
Renato Mello Silva
Instituto de Biociências – USP



Conceitos fundamentais:

Observação vs. inferência

Método científico

Essencialismo Biológico

Linhagens históricas

Relações tocoogenéticas e filogenéticas

Descendência com modificação

Cladogênese

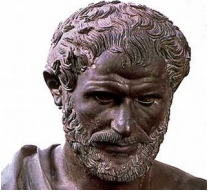
Anagênese

Divergência

Diversidade Biológica

Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



Período essencialista

384 a.C.

Carolus Linnaeus
1707-1778



Buffon
1707-1788



Lamarck
1744 -1829



St-Hilair
1772 -1844



Cuvier
1769 -1832



Mundo dinâmico

Resistência e Nova Síntese

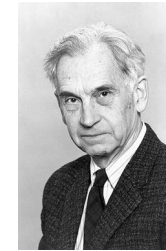
Sistemática Evolutiva

1859

1936 - 1947

1960's

Ernest Mayr
1904 - 2005



G.G. Simpson
1902 - 1984

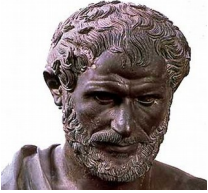


Theodosius Dobzhansky
1900 -1975

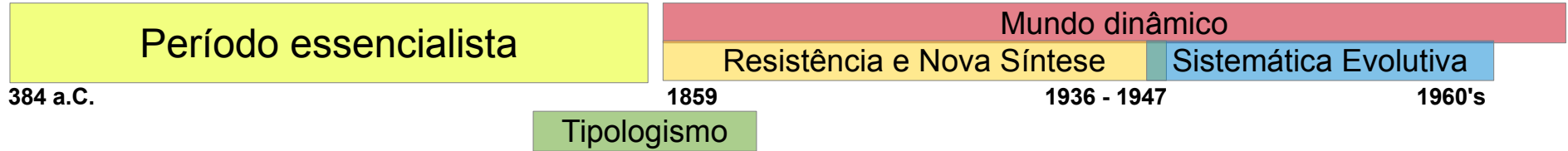


Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



organismos → fenômeno estrutural
estudos comparativos → reconstrução dos elementos típicos

“All idealistic morphologists subscribed to the same initial idea that the organism is a structural phenomenon and that the purpose of comparative morphological studies must be an exact mental reconstruction of the fundamentals, the typical elements, of this structure. (Levit & Miester, 2006:285)



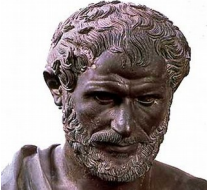
Johann W. von Goethe
1749–1832

Gestalt → conformação crucial oculta da natureza
Bauplan → plano ideal expresso pelos elementos básicos

'Describing plants, Goethe attempted to reconstruct the crucial conformation (*Gestalt*) of nature as a whole hidden behind the observable things. This was the ultimate objective of his idealistic morphology (Goethe, 1790b, pp. 1817–1823). The type was for Goethe an ideal body plan (*Bauplan*) of an organism partly expressed in the basic elements of real organismic organisation: “Thence appears a proposition about an anatomical type, a general entity, which covers (as far as possible) the structures (*Gestalten*) of all animals and allows to specify each animal in a certain system (Ordnung)” (Goethe, 1932, p. 315).' (apud Levit & Meister, 2006:285)

Desenvolvimento epistemológico da Sistemática:

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Período essencialista

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Tipologismo

Erro Historiográfico: Tipologismo = essencialismo
Tipo = entidade invariável



Johann W. von Goethe
1749–1832

“[T]ypological theories, as a kind of essentialism, propagated the idea of the type as an invariable entity, which is “sharply demarcated against all other such essences”
(Mayr, 2001b, p. 74)

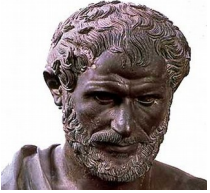
Tipologismo (método):

- * Não requer que as entidades sejam discretas
- * Tipos = abstrações matemáticas

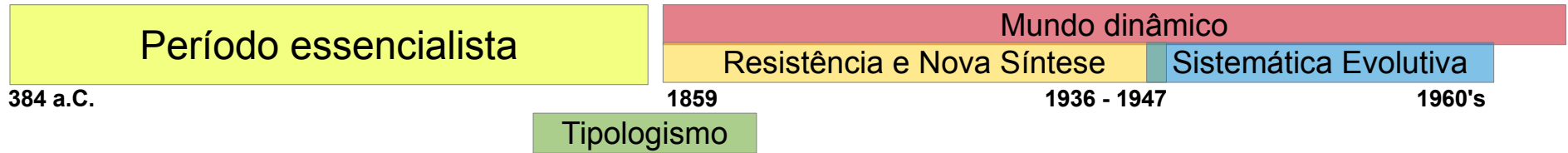
“[T]he typological method does not necessarily require that types are sharply demarcated. In typology, types are mathematical abstractions and it depends on the level and methods of abstraction and on the purposes of the researcher, whether the derived types have sharp boundaries or gradually flow into each other.”
(Levit & Meister, 2006:299-300)

Desenvolvimento epistemológico da Sistemática:

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Johann W. von Goethe
1749–1832

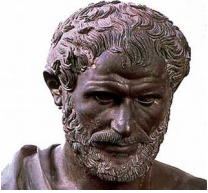
* Instrumento para fazer sistemática e não para discutir fenômenos evolutivos.

* Não rejeitava nem aceitava teorias causais de descendências, pois o programa de pesquisa operava em outra dimensão teórica.

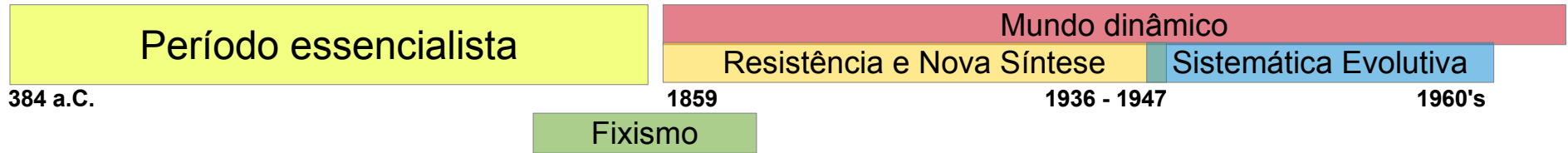
Typology was understood as a tool for doing systematics and was not instrumental for discussing evolutionary mechanisms of any kind. [...] Thus, pure typology was not essential for rejecting or accepting causal theories of descent, because it is a research programme operating in another theoretical dimension.
(Levit & Meister, 2006:299)

Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



No começo do século XVII, as crenças tradicionais estavam sendo abaladas por uma série de questionamentos sobre a constância e estabilidade do mundo. [...]

A teologia cristã derivou o fixismo das espécies da narrativa da criação do Gênesis. Fixismo tem sido sustentado pelas doutrinas do idealismo Platônico e o essencialismo Aristotélico. [...]



Carolus Linnaeus
1707-1778

Darwin's job was like that of Copernicus – the overthrow of an ancient belief in stability.

(Amindson, 2005:35)

Transmutacionaistas



Buffon
1707-1788



Lamarck
1744 -1829



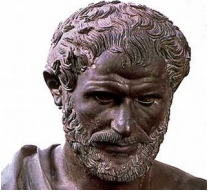
St-Hilaire
1772 -1844



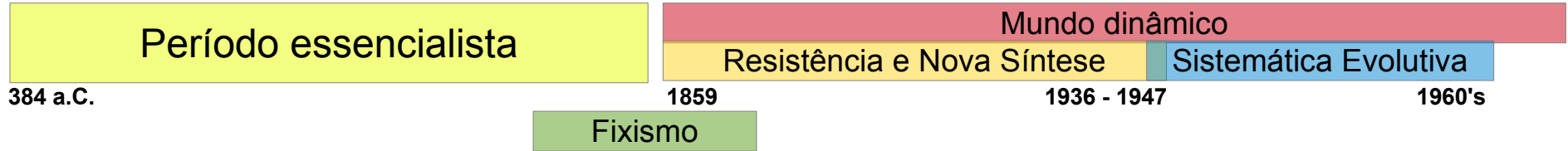
Cuvier
1769 -1832

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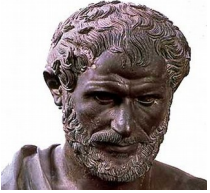
Fixismo: amplamente aceita entre naturalistas e teólogos durante o século XVIII.

Linnaeus: referências ao fixismo e criacionismo

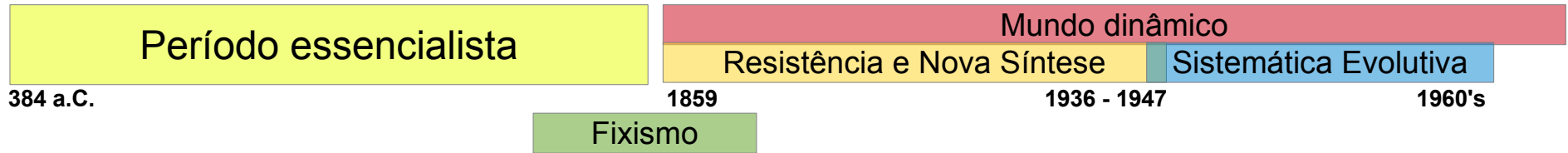
“It may come as a surprise to the reader (as it certainly did to the author) that the fixity of biological species is not an ancient belief. It became widely accepted for the first time both among naturalists and theologians during the eighteenth century, only about a century before Darwin (Zirkle 1951: 48–49; Zirkle 1959: 642). Carl Linnaeus is widely known for his unequivocal statements of species fixism and special creationism.”
(Amindson, 2005:35)

Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



Biologia evolutiva: criou o cenário sobre o qual se construiria o *Systema Naturae*.



Carolus Linnaeus
1707-1778

Imagine construir uma sistema de taxonomia coerente no qual trigo poderia dar origem à centeio, vermes à insetos, barro à sapos e cracas a gansos.

(Amundson, 2005, p. 37-38)

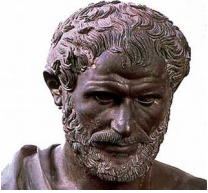
“Species fixism was important to the origin of evolutionary biology because it set the stage for the construction of the Natural System. [...]

This systematic pattern was constructed between the time of Linnaeus and Darwin. It was called the Natural System. Species fixism was necessary to the growth of the Natural System.

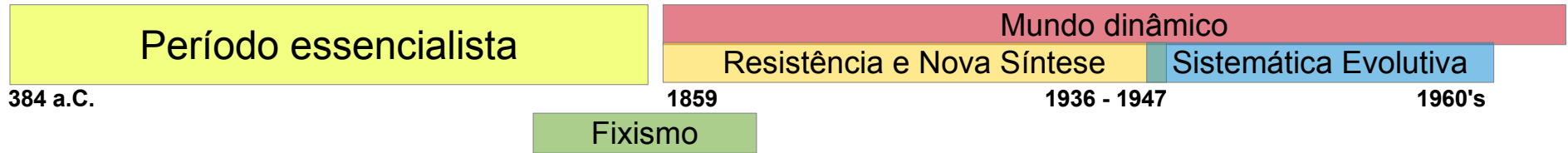
(Amundson, 2005, p. 37-38)

Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



Essencialismo: doutrina sobre as entidade naturais.

A triangle cannot change into a square because their essences are distinct.

vs.

Fixismo: doutrina sobre relações causais.

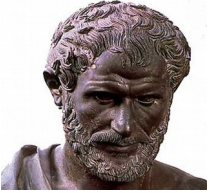
The causal relation of generation between parents and offspring.

"**Essentialism** is a doctrine about natural kinds, not about the causal relations between these kinds. Its paradigmatic application is to items like geometric figures: A triangle cannot change into a square because their essences are distinct. In contrast, species fixism is a doctrine about causal relations – the causal relation of generation between parents and offspring. Essentialism may entail that a dog cannot transform into a cat, but it cannot (by itself) entail that a dog cannot give birth to a cat."

(Amundson, 2005, p. 209).

Desenvolvimento epistemológico da Sistemática:

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Período essencialista

384 a.C.

Mundo dinâmico

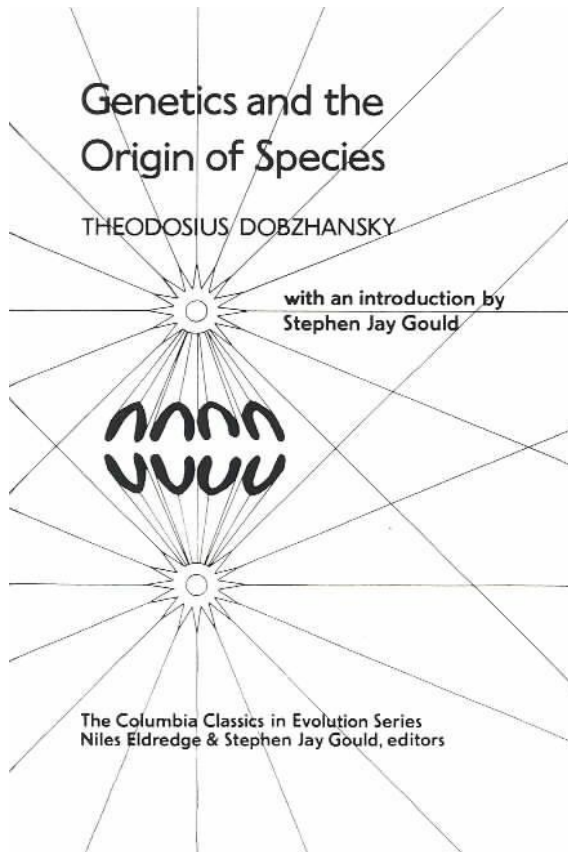
Resistência e Nova Síntese

Sistemática Evolutiva

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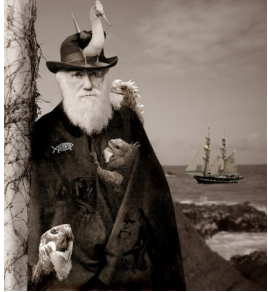


Theodosius Dobzhansky
1900 -1975

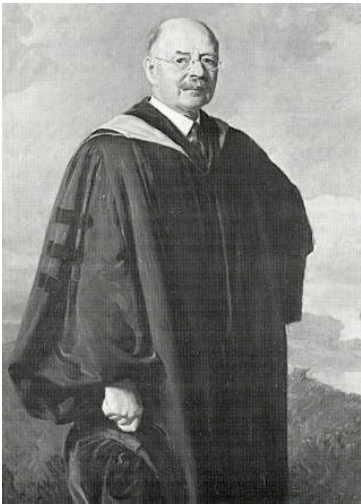


No IB: Dreyfus, Chana, Dobzhansky, Martha Wedel, Antonio Cordeiro (sentados), Hans Burla e Antonio Cavalcanti (em pé).

A revolução que falhou: filosofia da ciência



Darwin (1859:420): **Seleção natural** → Método de inferência considerado não científico diante do paradigma empiricista (positivismo lógico) da época.



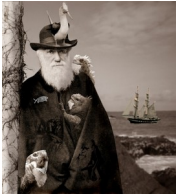
"Even if the theory of natural selection were as firmly established as Newton's theory of the attraction of gravity, scientific method would still require frequent examination of its claims, and scientific honesty should welcome such examination and insist on its thoroughness."

(Bumpus, 1899)

Hermon Carey Bumpus (1862-1943)*

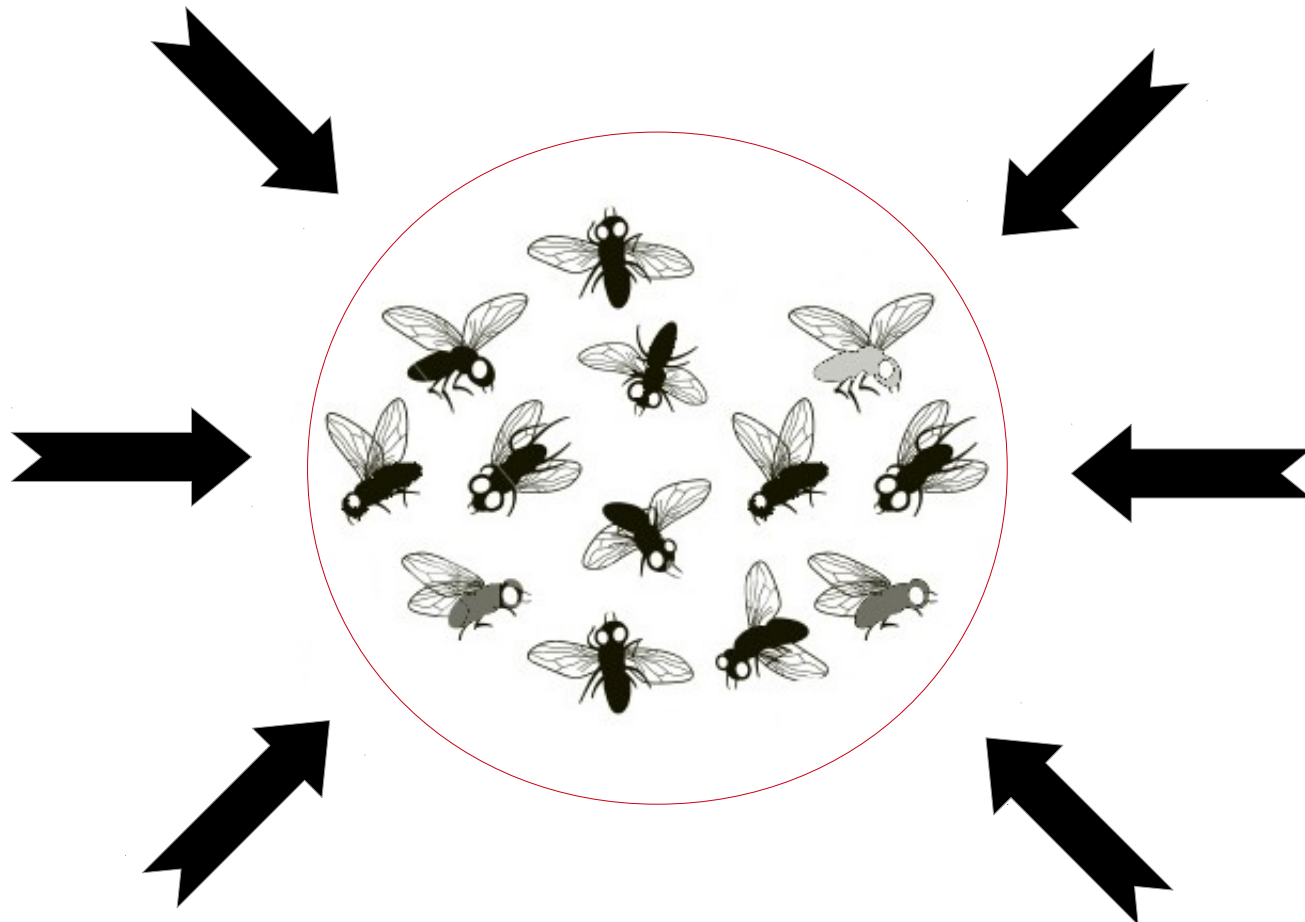
O que é seleção natural?

O mecanismo: Seleção natural



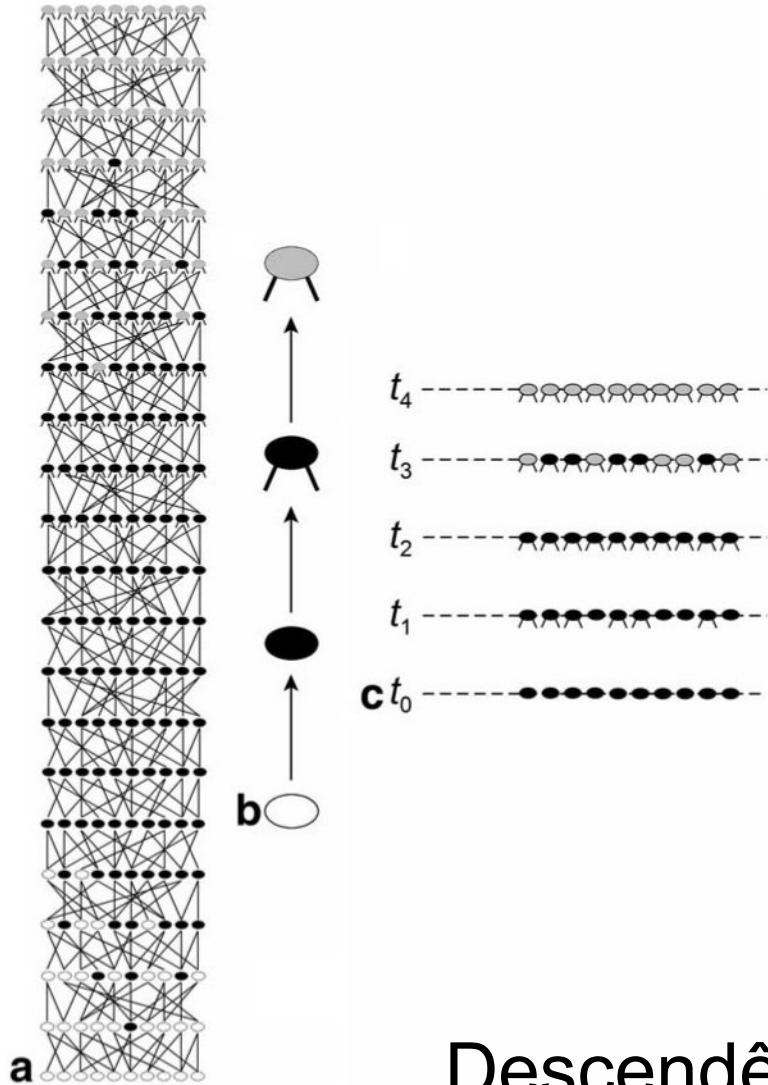
Teorias de Darwin encontram resistências até a década de 30.

VARIABILIDADE, PRESSÃO SELETIVA E HERANÇA

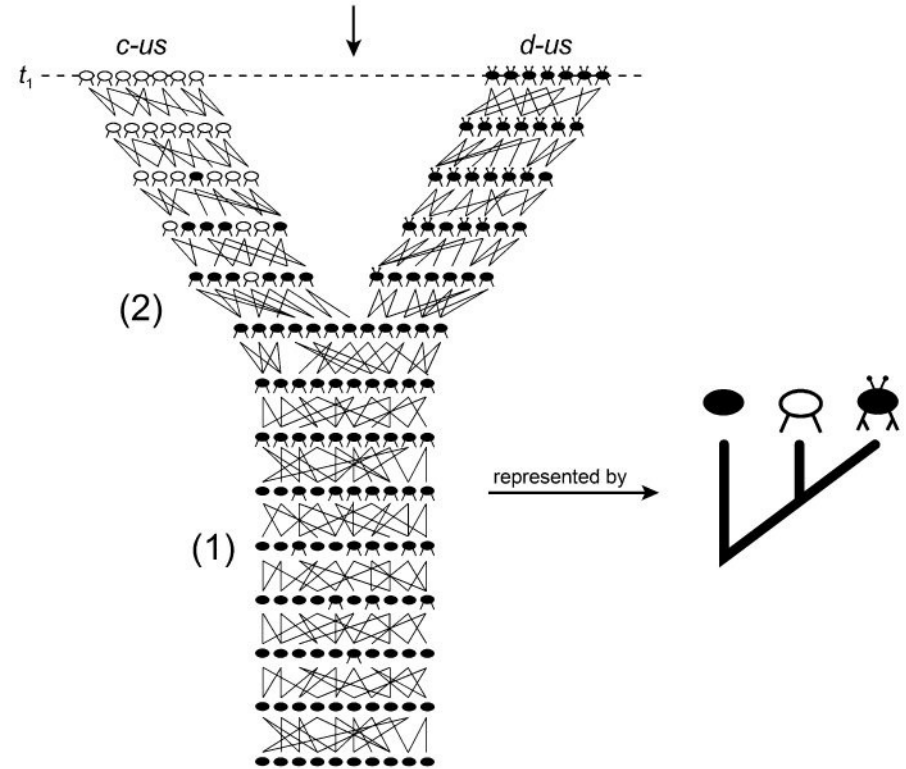


Linhagens históricas:

Anagênese e relações toco genéticas



Cladogênese e relações toco genéticas

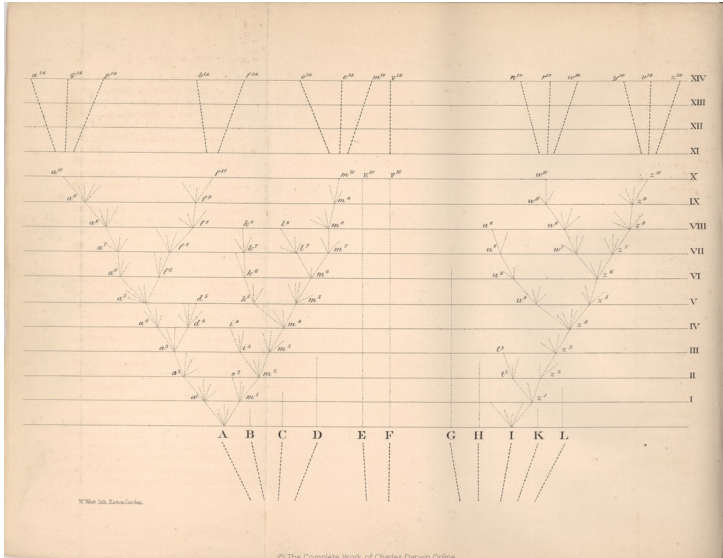


Descendência com modificação

A revolução que falhou: filosofia da ciência



Darwin (1859:420): "**community of descent** is the hidden bound which naturalists have been unconsciously seeking, and not some unknown plan of creation, or enunciation of general propositions, and the mere putting together and separation of objects more or less alike"



Huxley(1874:101): “Darwin, by laying a novel and solid foundation for the theory of Evolution, introduced a new element into Taxonomy. Is species, like an individual, is the product of a process of development, its mode of evolution must be taken into account in determining its likeness or unlikeness to other species; and thus "**phylogeny**" becomes not less important than embryogeny to the taxonomist. But while the logical value of phylogeny must be fully admitted, it is to be recollected that, in the present state of science, absolutely nothing is positively known respecting the phylogeny of any of the larger groups of animals. Valuable and important as **phylogenetic speculations** are, as guides to, and suggestions of, investigation, they are pure **hypotheses incapable of any objective test**; and there is no little danger of introducing confusion into science by mixing up such hypotheses with Taxonomy, which should be a precise and logical arrangement of **verifiable facts**.”

Fatos observáveis → Compartilhamento de caracteres

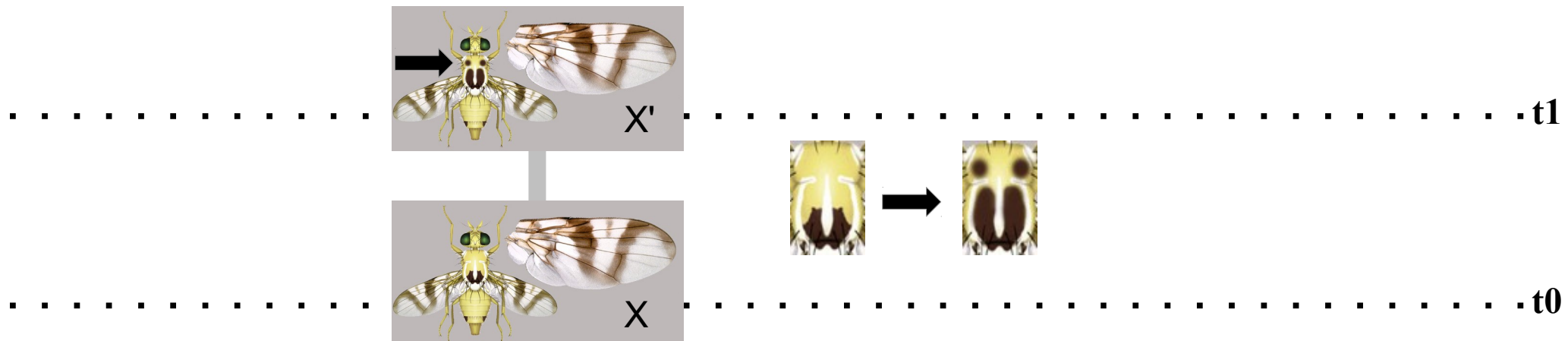
Compartilhamento de semelhanças:



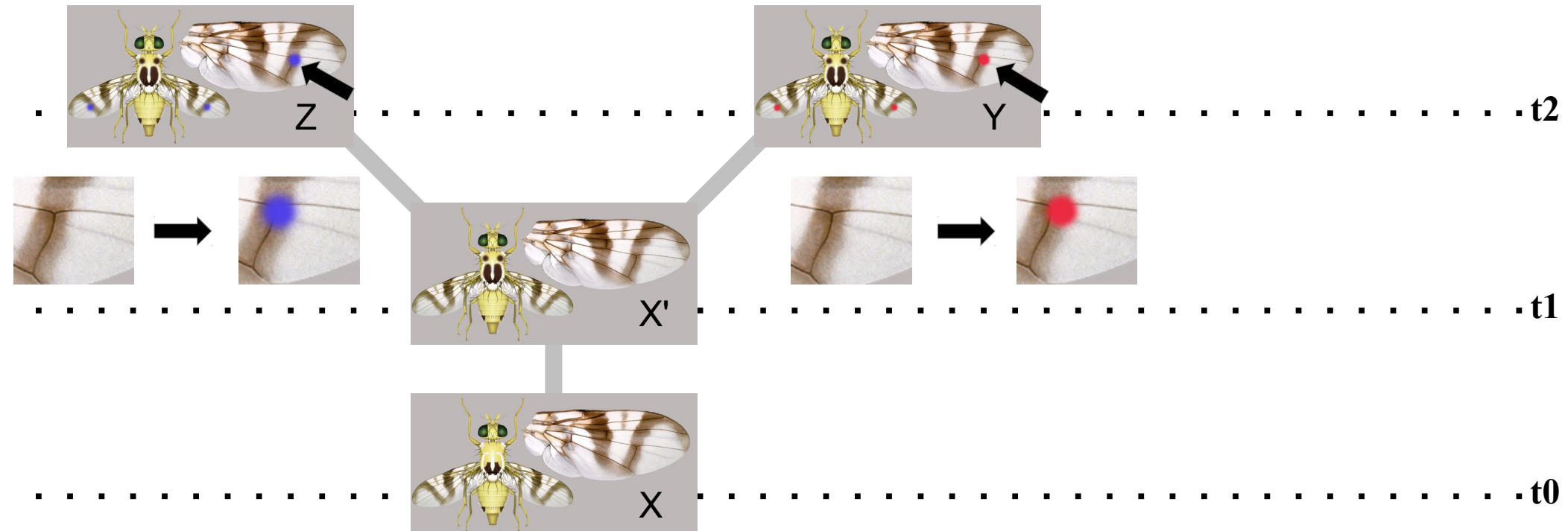
X

Compartilhamento de semelhanças:

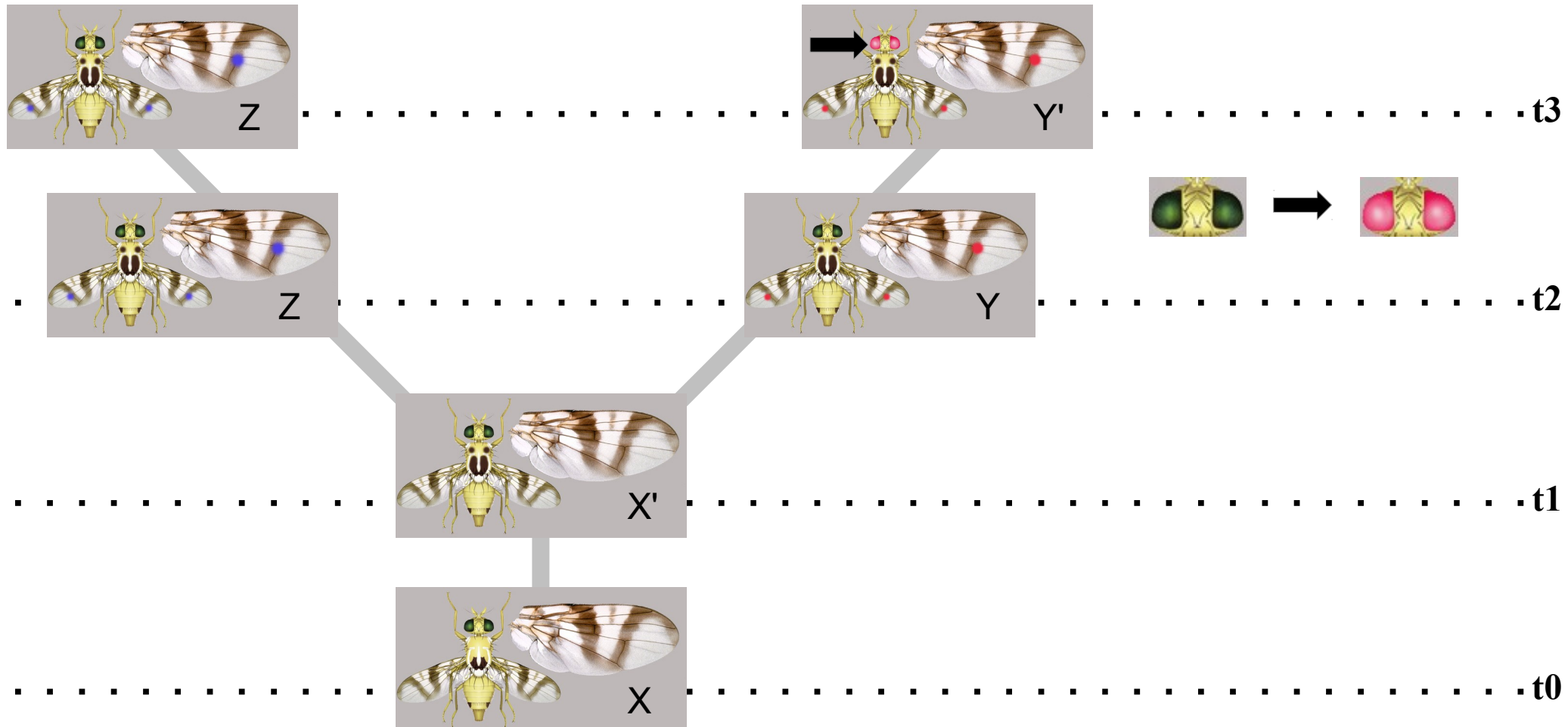
De X a X' representa uma linhagem!



Compartilhamento de semelhanças:



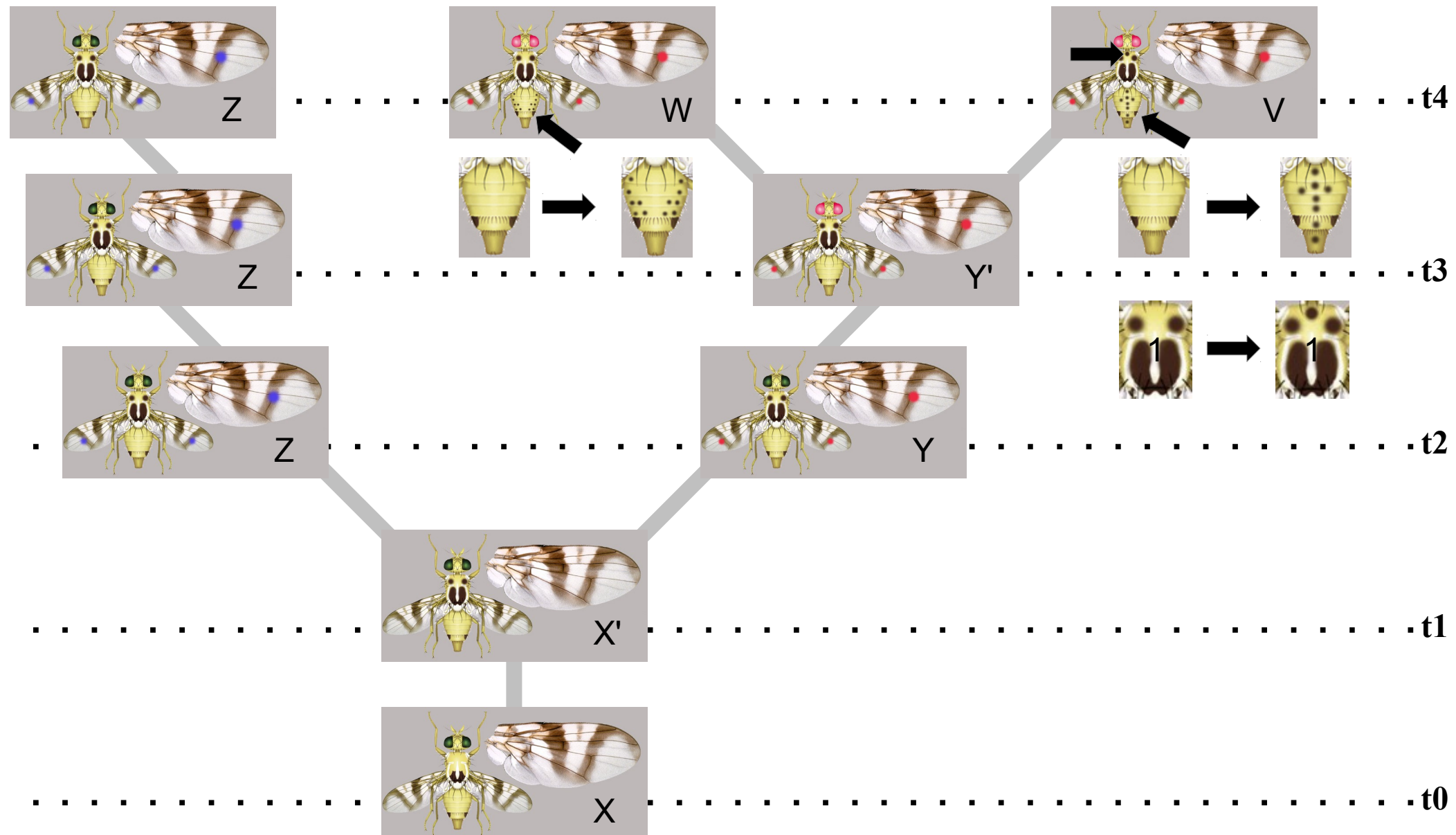
Compartilhamento de semelhanças:



Compartilhamento de semelhanças:



Compartilhamento de semelhanças:



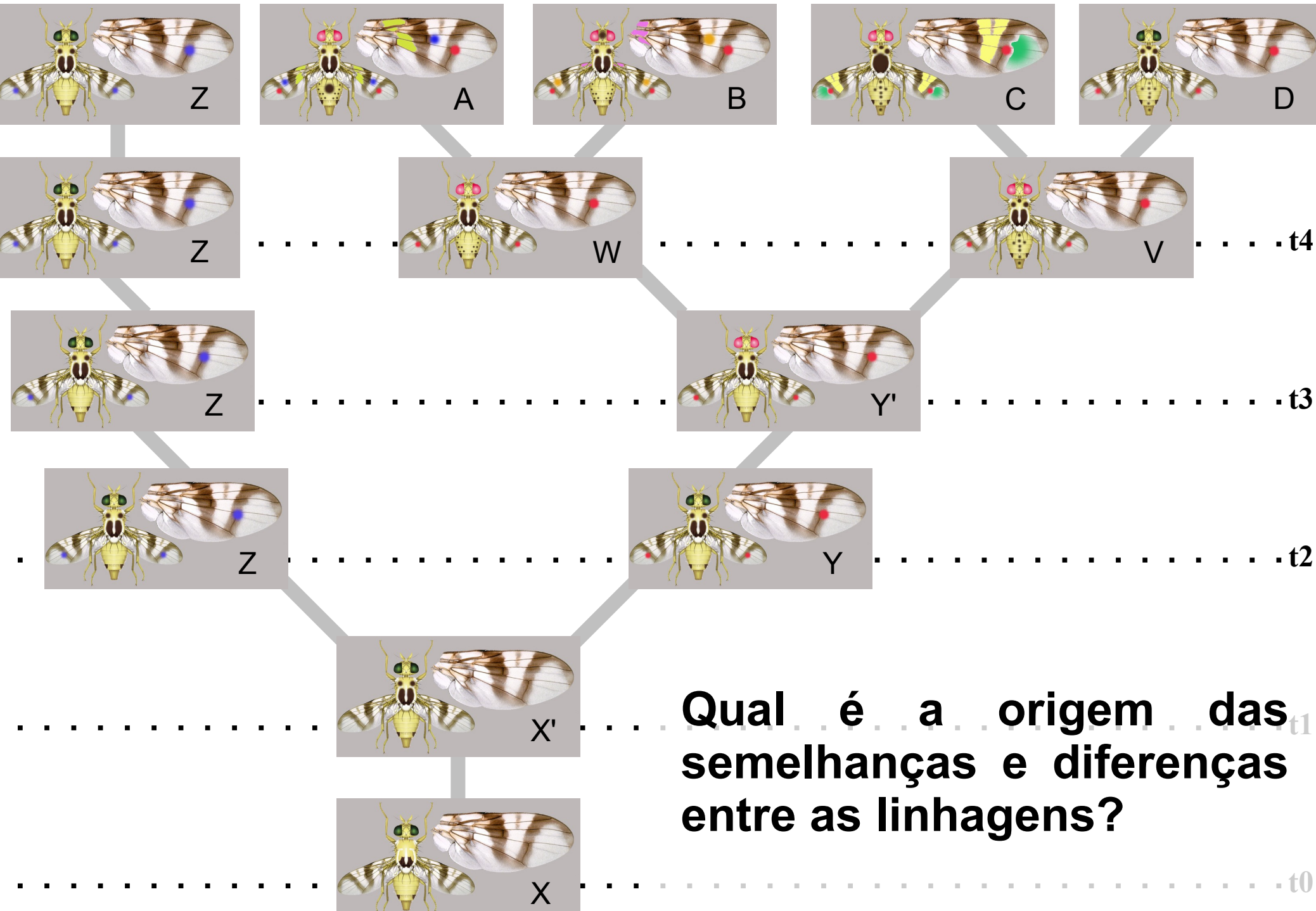
Compartilhamento de semelhanças:



Compartilhamento de semelhanças:

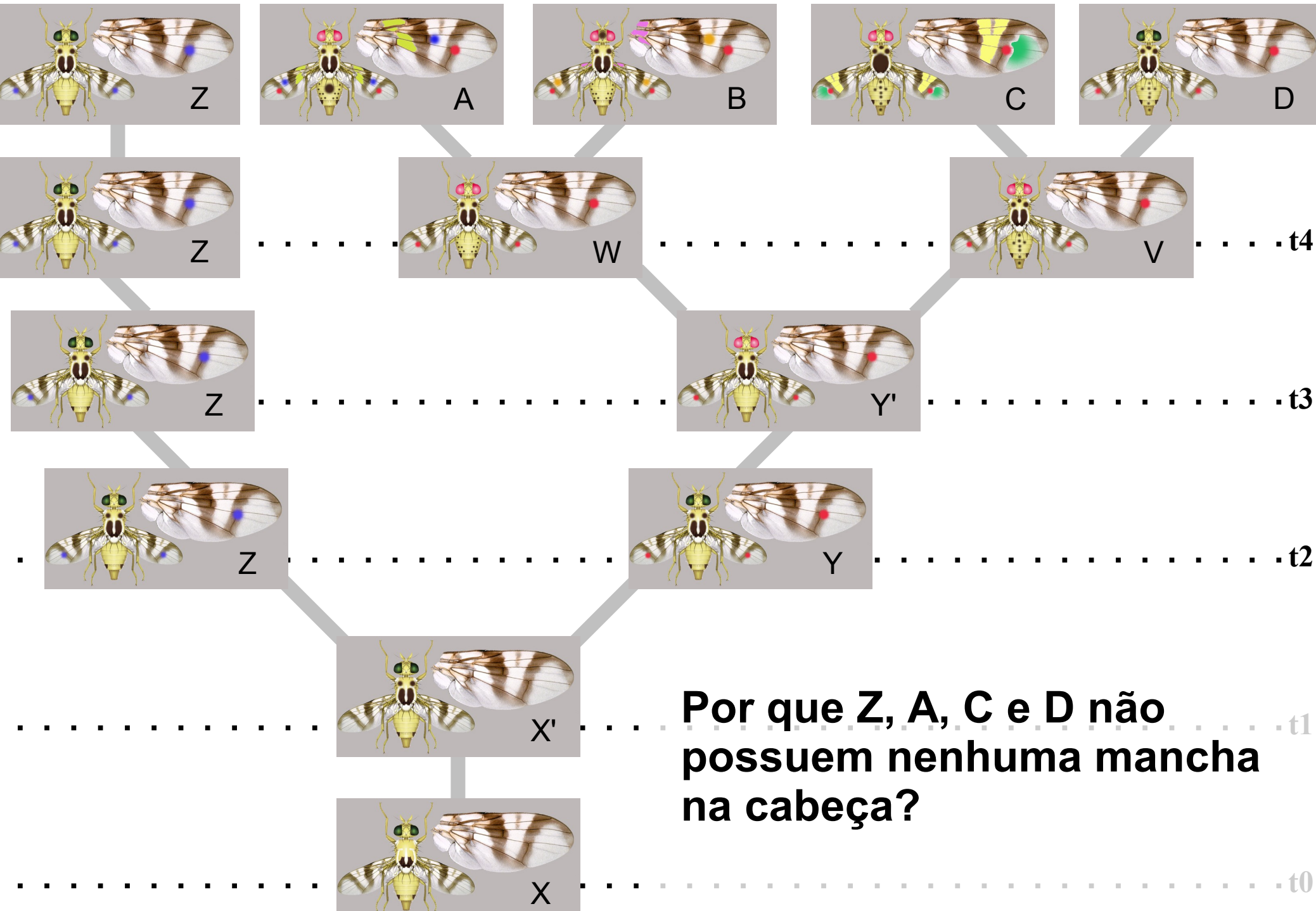


Compartilhamento de semelhanças:



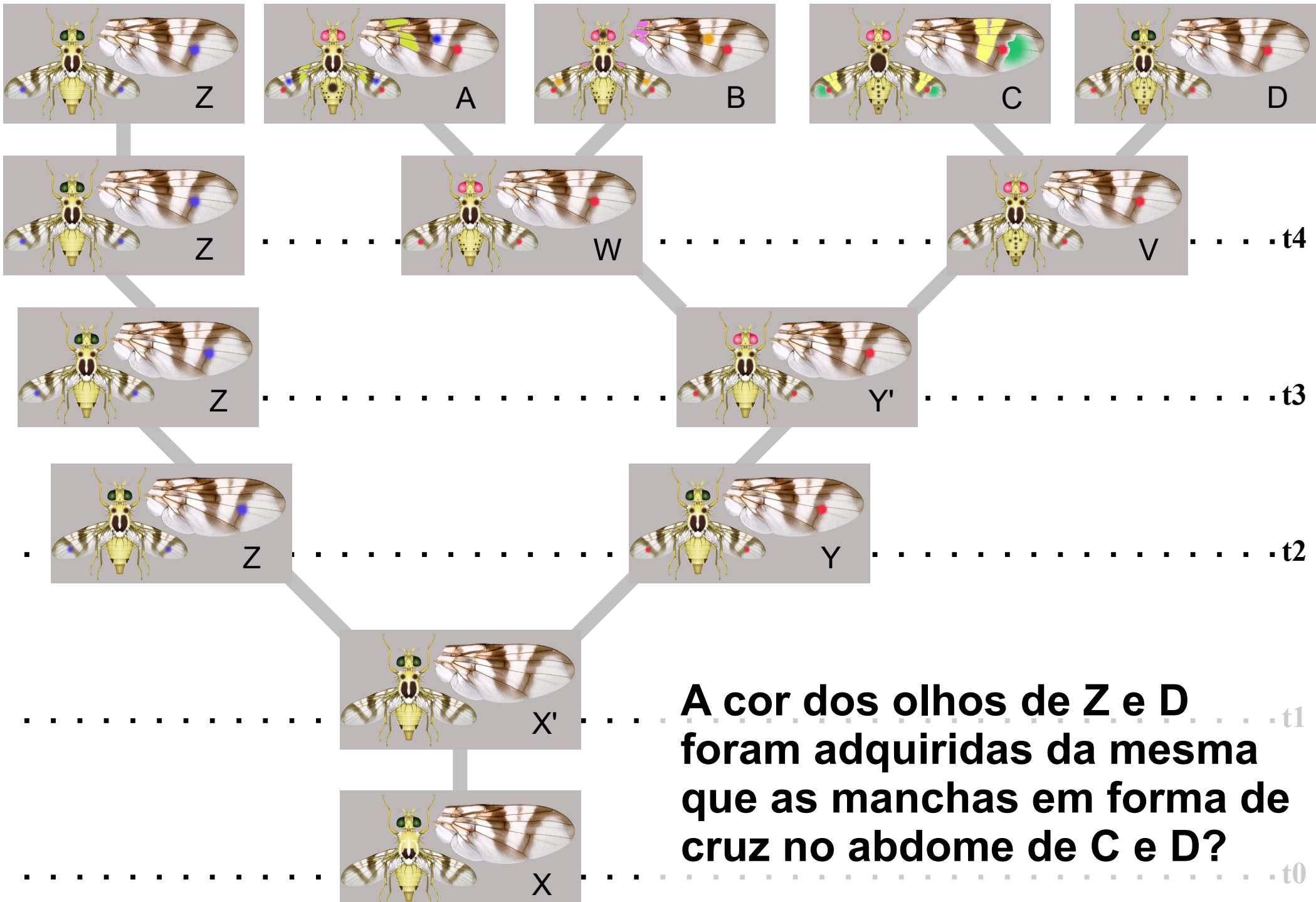
Qual é a origem das semelhanças e diferenças entre as linhagens?

Compartilhamento de semelhanças:



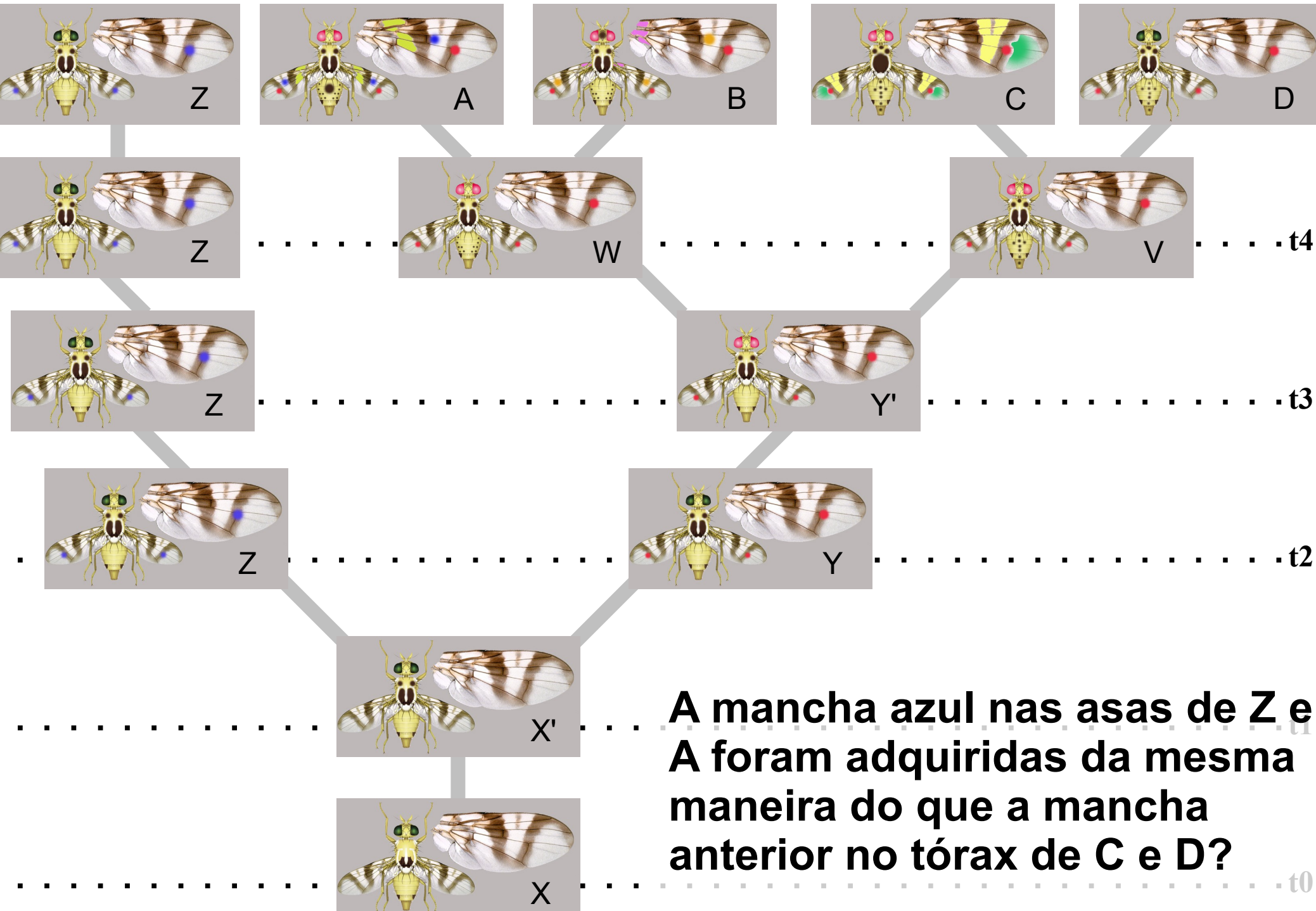
Por que Z, A, C e D não possuem nenhuma mancha na cabeça?

Compartilhamento de semelhanças:



A cor dos olhos de Z e D foram adquiridas da mesma que as manchas em forma de cruz no abdome de C e D?

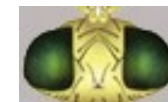
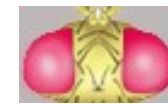
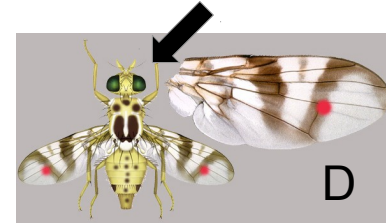
Compartilhamento de semelhanças:



A mancha azul nas asas de Z e A foram adquiridas da mesma maneira do que a mancha anterior no tórax de C e D?

Compartilhamento de semelhanças:

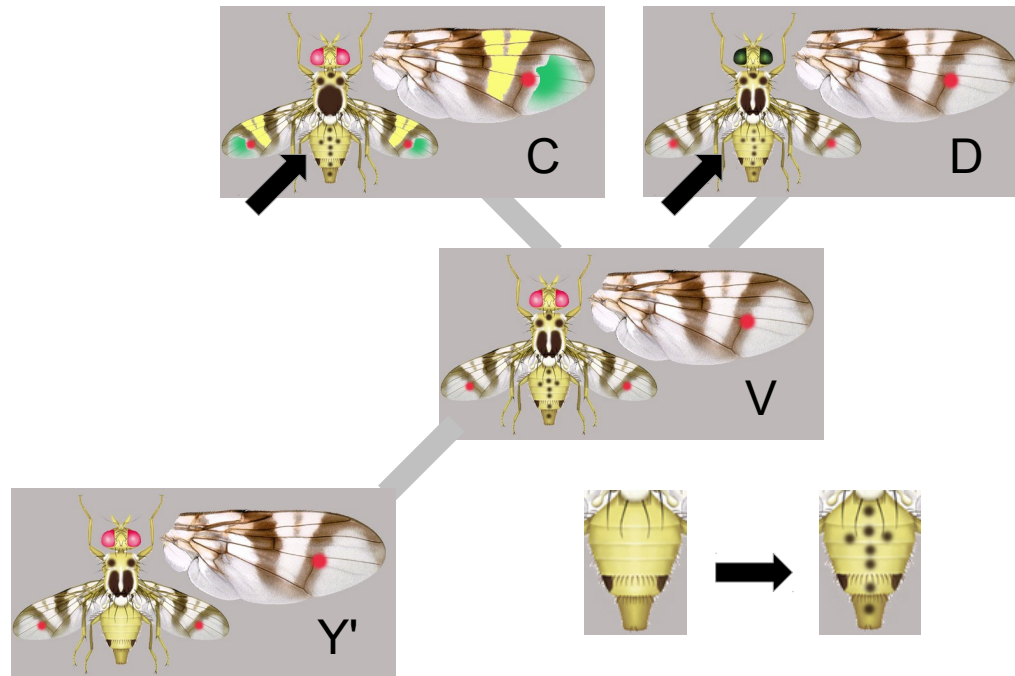
Características aparentemente iguais são historicamente distintas!



.....t0

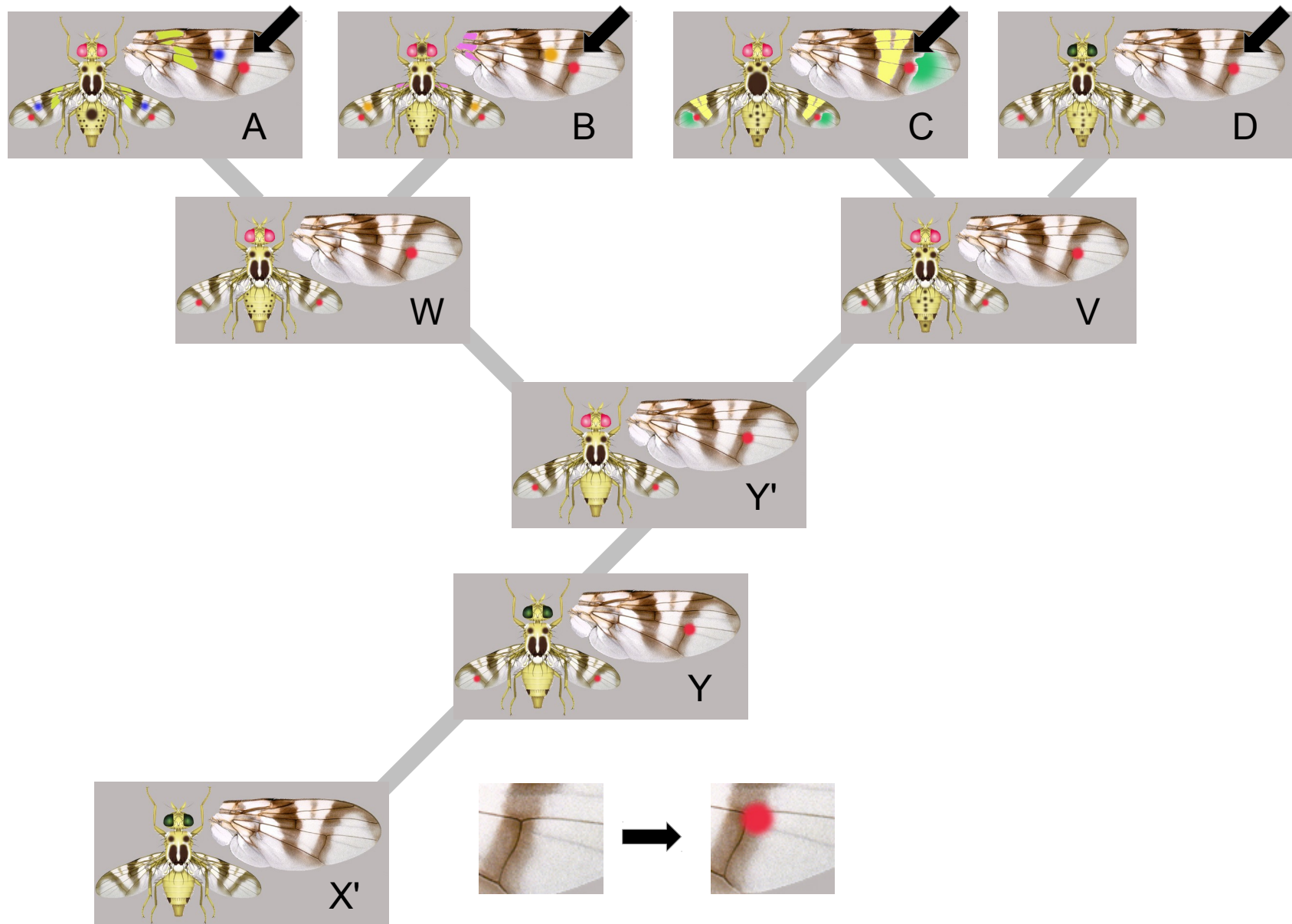
Compartilhamento de semelhanças:

Algumas semelhanças decorrem da herança de ancestrais imediatos.



Compartilhamento de semelhanças:

Outras da herança de ancestrais mais remotos.



Compartilhamento de semelhanças:

Algumas semelhanças decorrem da herança de ancestrais imediatos.

vs.

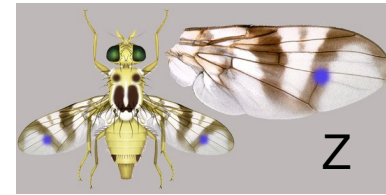
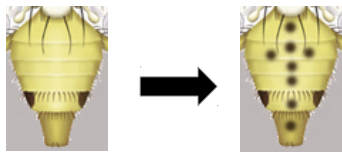
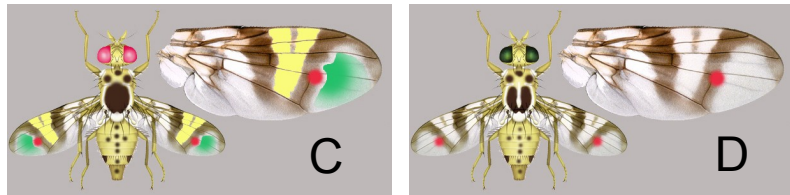
Outras da herança de ancestrais mais remotos.



Níveis de generalidade distintos

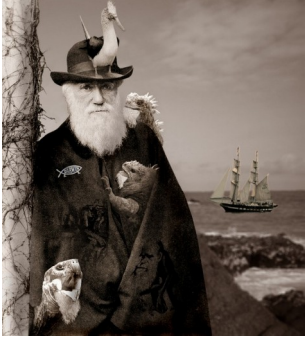
Compartilhamento de semelhanças:

Similaridades de origem completamente diferente:



Compartilhamento de semelhanças:

Similaridades de origem completamente diferente:



Posterior a Darwin (1859), aquelas similaridades que indicam ancestral comum (homologias) tornaram-se mais importantes em classificação que aquelas similaridades que não decorrem de ancestrais comuns.



Sir Edwin Ray Lankester
1847 — 1929

Lankester (1870a,b): conceito inicial de homologia

'Homogenia': similaridade decorrente de ancestrais comuns.

'Homoplasia': similaridade decorrente de função similar e causalidade.

Nixon & Carpenter (2012): conceito mais recente de homologia

'Homologia': similaridade decorrente de ancestrais comuns.

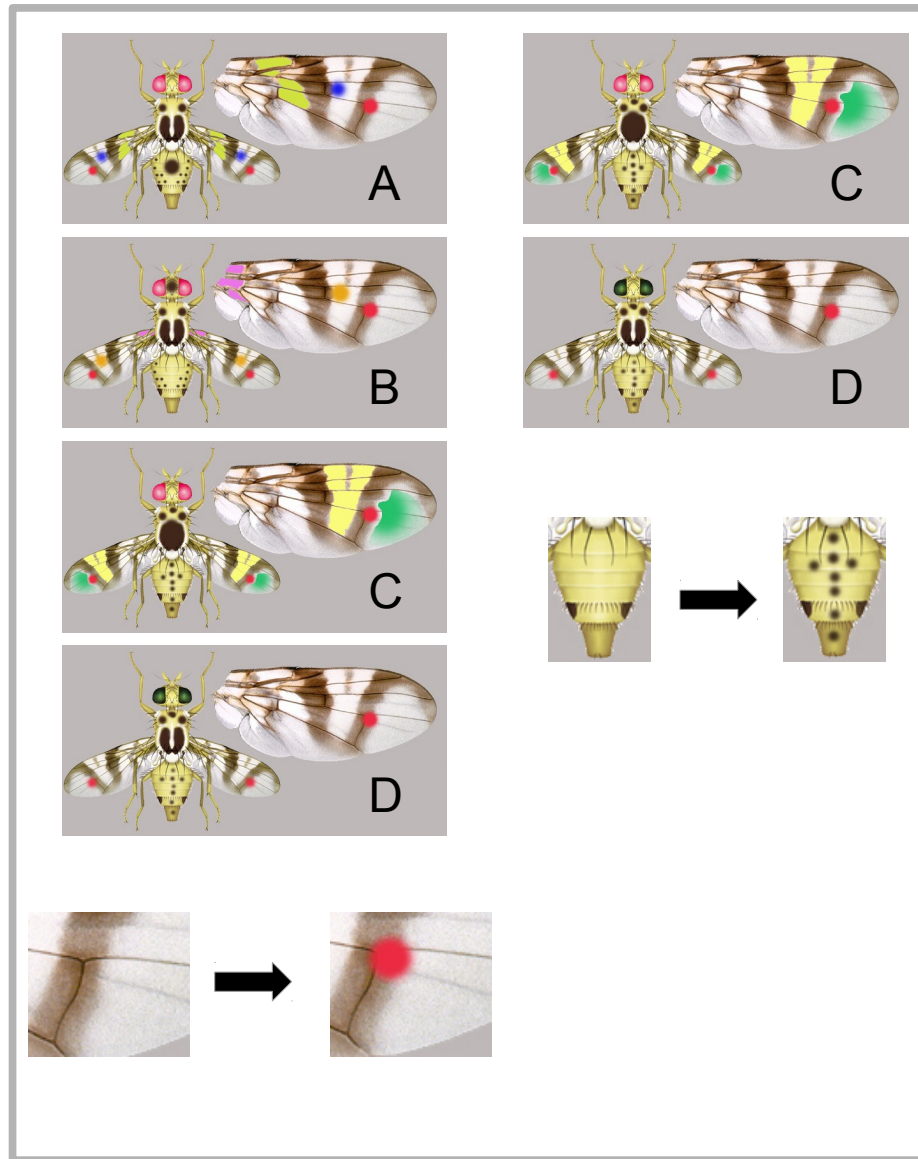
'Homoplasia': similaridade não-homóloga.

Lankester, E.R., 1870a. On the use of the term homology in modern zoology, and the distinction between homogenetic and homoplastic agreements. Ann. Mag. Nat. Hist. ser. 4. 6, 34–43.

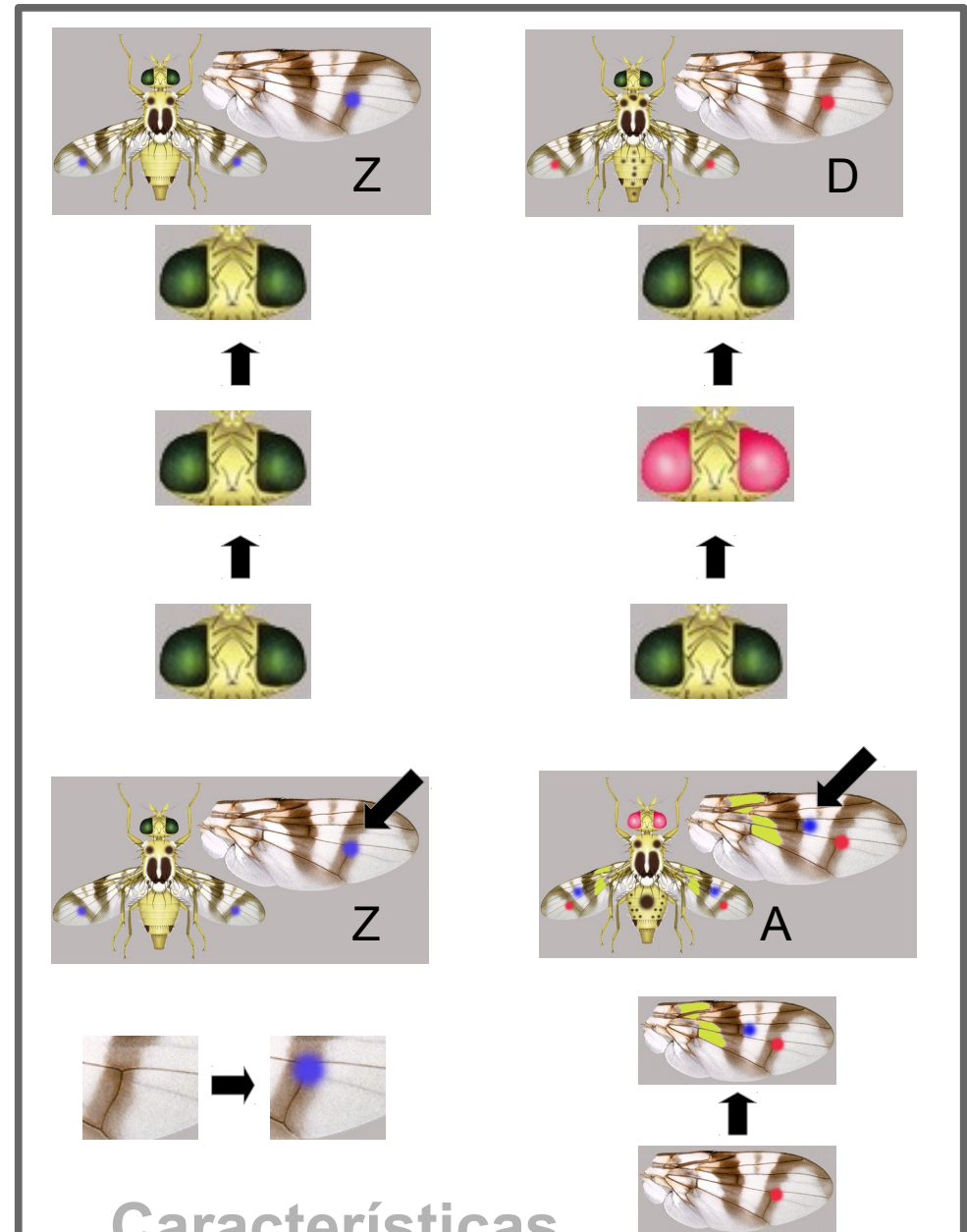
Lankester, E.R., 1870b. On the use of the term "homology". Ann. Mag. Nat. Hist. ser. 4. 6, 342.

Nixon & Carpenter 2012. On homology. Cladistics 28(2)160–169.

Compartilhamento de semelhanças:



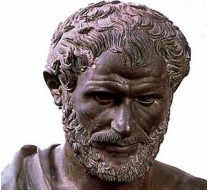
Características HOMÓLOGAS



Características HOMOPLÁSTICAS

Desenvolvimento epistemológico da Sistemática:

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Período essencialista

384 a.C.

Darwin – 1809-1882



Mundo dinâmico

Resistência e Nova Síntese

Sistemática Evolutiva

1859

1936 - 1947

1960's

“The first period was initiated by the publication of *Genetics and the Origin of Species* (1937) by the Russian-born American evolutionist Theodosius Dobzhansky (1880–1959).

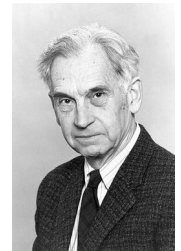
[...]

The second period in the development of the Synthesis, after 1947, Mayr labelled “post-Synthesis” to emphasise that in this period Darwinians were in agreement about the fundamental principles; the post-Synthetic developments just specified and strengthened an already existing paradigm.”

(Levit & Meister, 2006:282)



Theodosius Dobzhansky
1900 -1975



Ernest Mayr
1904 - 2005



G.G. Simpson
1902 - 1984

A revolução que se inicia

Genética Populacional: R. A. Fisher (1890-1962), J. B. S. Haldane (1892-1964) e Sewall Wright (1889-1988).

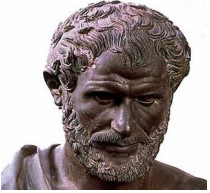
Introduziram modelos matemáticos à biologia, e testaram os limites teóricos dos processos evolutivos dado algumas premissas.

Fisher (1930): Teorema fundamental da seleção natural.

Por aproximadamente um século após *A origem das espécies* (Darwin, 1859) não havia nenhuma escola de classificação bem definida. Não havia metodologias competindo entre si. No entanto, havia unanimidade em reconhecer que classificações deveriam reconhecer “grau de parentesco” entre os organismos.

Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



Período essencialista

384 a.C.

Mundo dinâmico

Resistência e Nova Síntese

Sistemática Evolutiva

1859

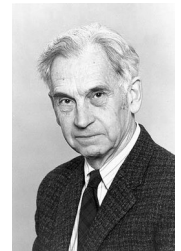
1936 - 1947

1960's

Theodosius Dobzhansky
1900 - 1975



Ernest Mayr
1904 - 2005



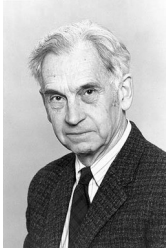
G.G. Simpson
1902 - 1984



Desafios:

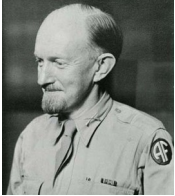
1. Entender o processo (mecanismo) de seleção natural e seus requisitos;
2. Explicar como ele pode ser promotor de diversidade; e
3. Incorporar os preceitos desta síntese na prática da Sistemática.

Sistemática Evolutiva



Ernest Mayr
1904 - 2005

Mayr (1942:103:)"...no system of nomenclature and no hierarchy of systematic categories is able to represent adequately the complicated set of interrelationships and divergencies in nature"



G.G. Simpson
1902 - 1984

G. G. Simpson (1961) *Principles of Animal Taxonomy* --> táxons superiores devem ser **monofiléticos**.

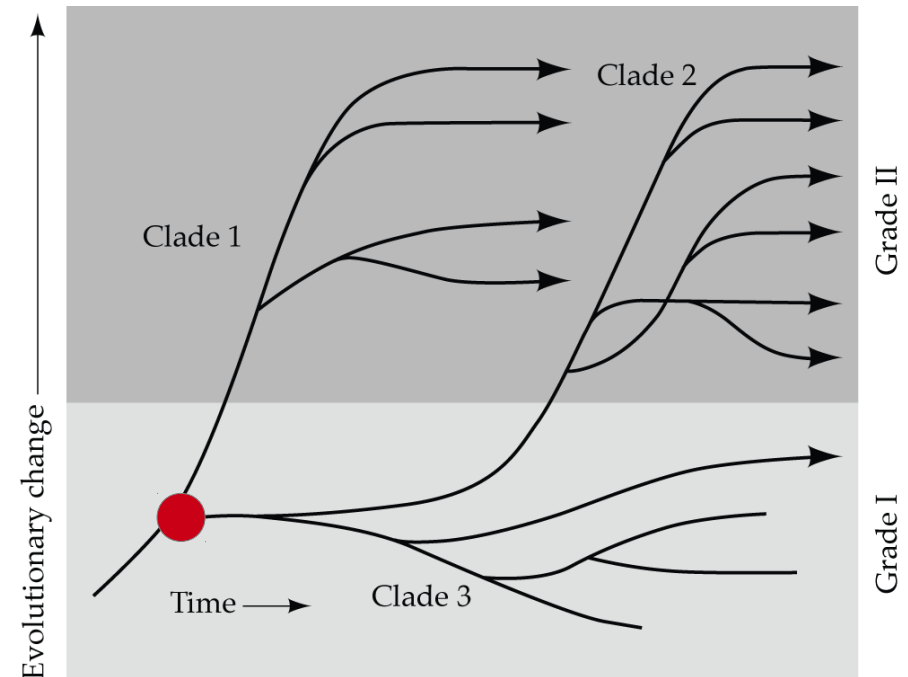
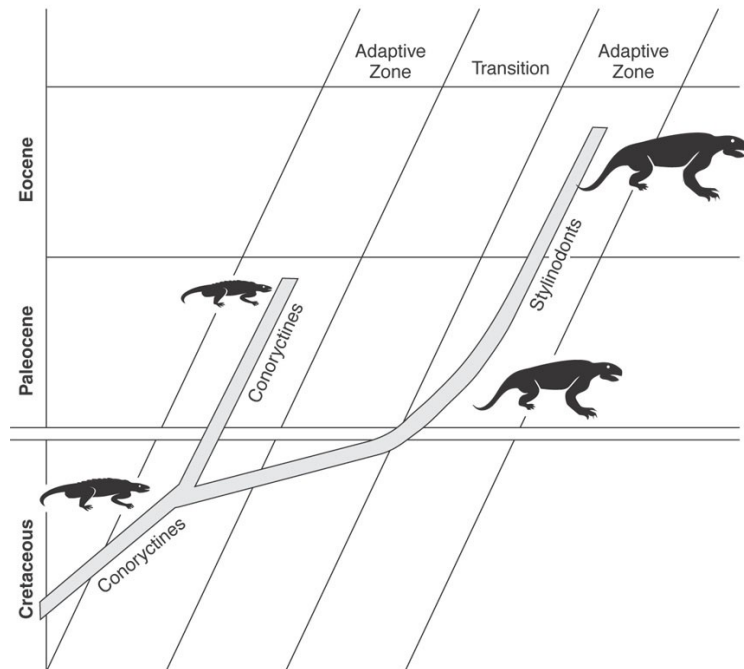
Classificações não podem e não deveriam expressar filogenia, no entanto devem ser consistentes com as mesmas.

E. Mayr (1969) *Principles of Systematic Zoology*

Mayr enfatiza que adaptação também é parte do processo evolutivo. Linhagens periodicamente invadem novas **zonas adaptativas** e proliferam; estes graus adaptativos devem ser reconhecidos em classificação.

Sistemática Evolutiva [Gradismo]

Grupos monofiléticos, Grados e Zonas adaptativas

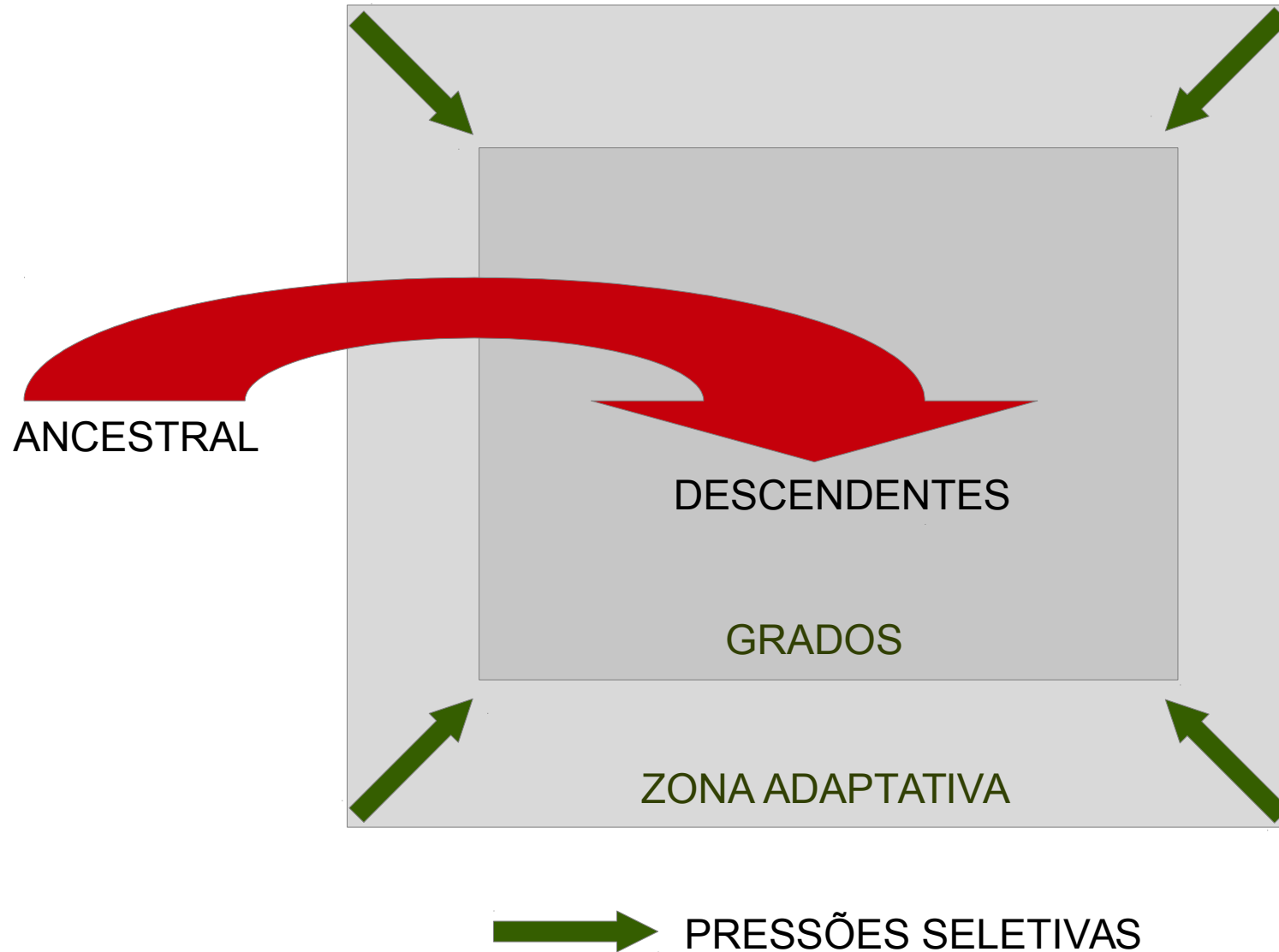


● = ancestral comum

GRADOS: “Táxons caracterizados por um nível de organização semelhante”. (Huxley, 1958)

Sistemática Evolutiva [Gradismo]

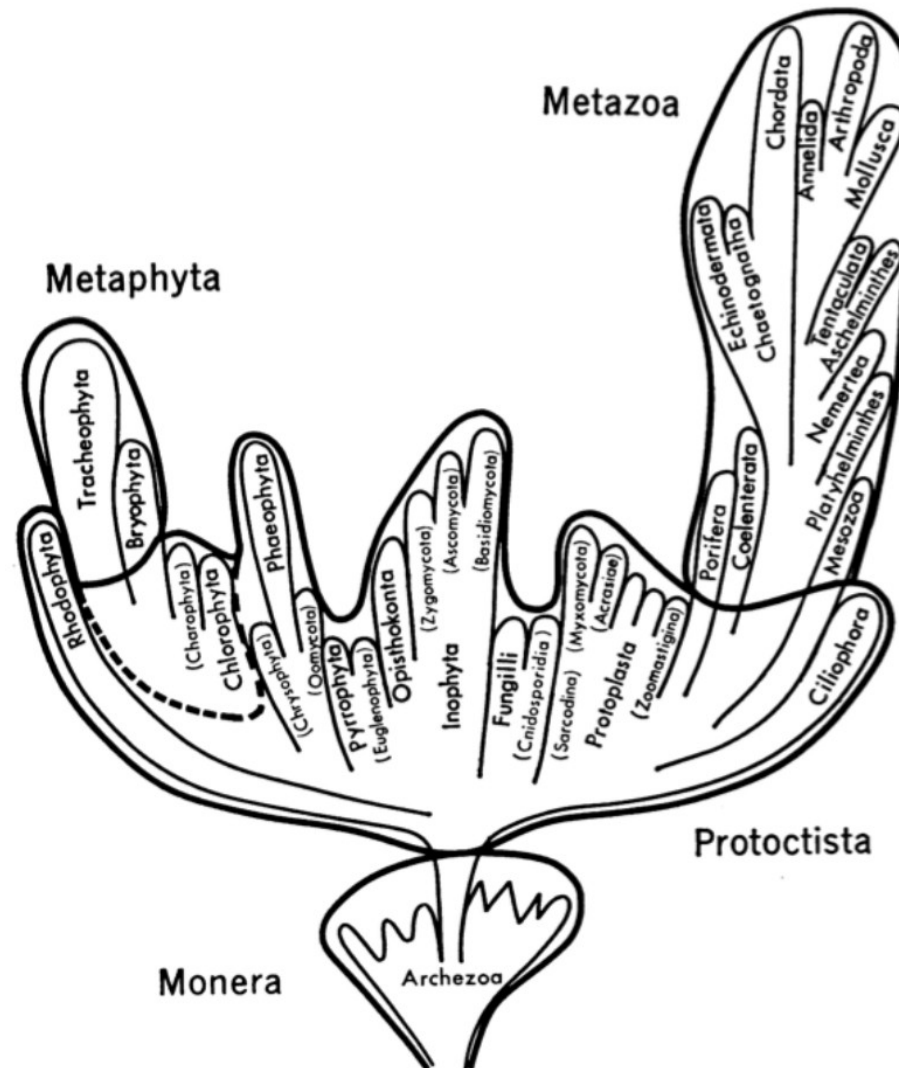
Grados e Zonas adaptativas



Sistemática Evolutiva [Gradismo]

Exemplos em outra disciplina:

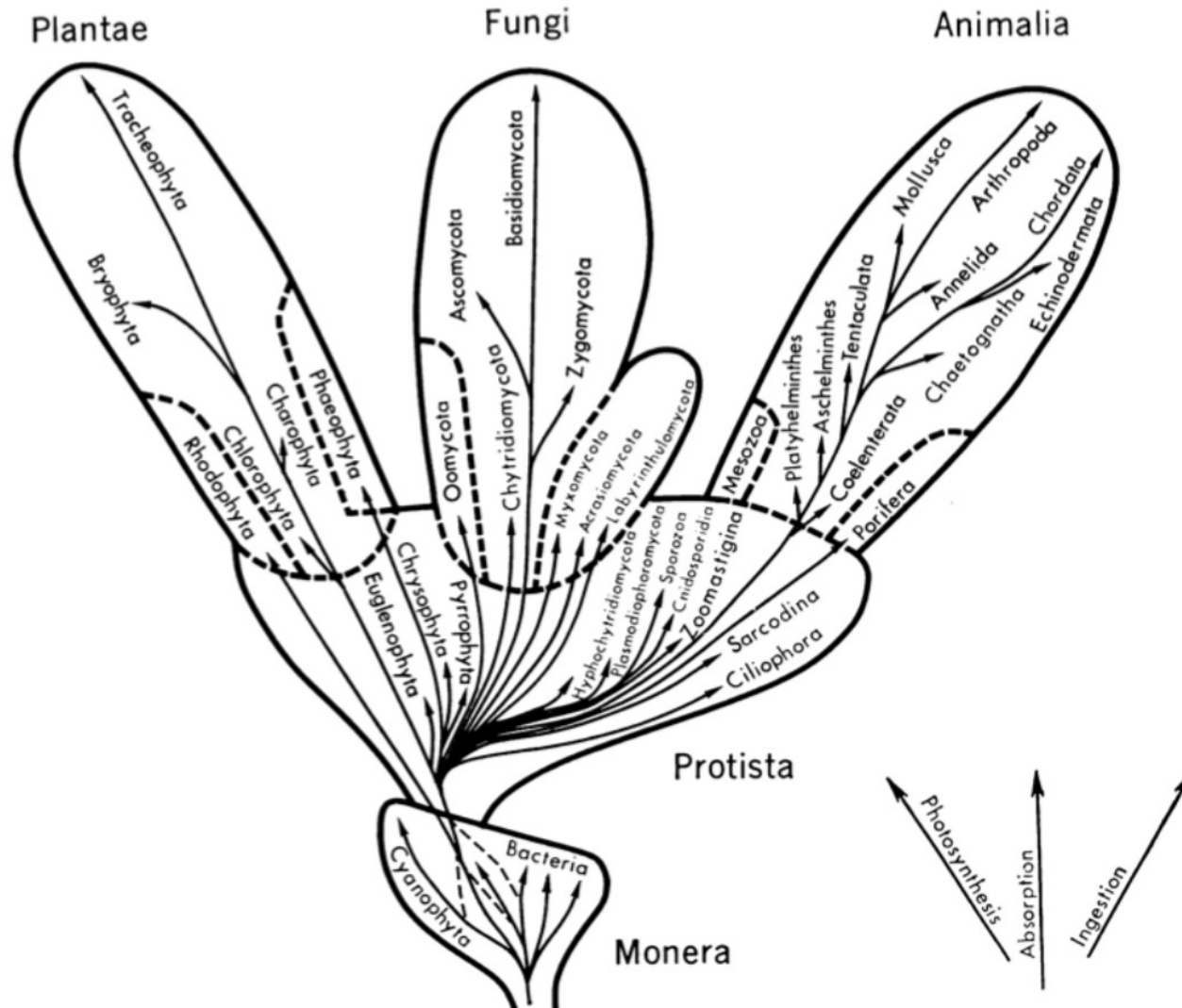
Copeland 1938



Sistemática Evolutiva [Gradismo]

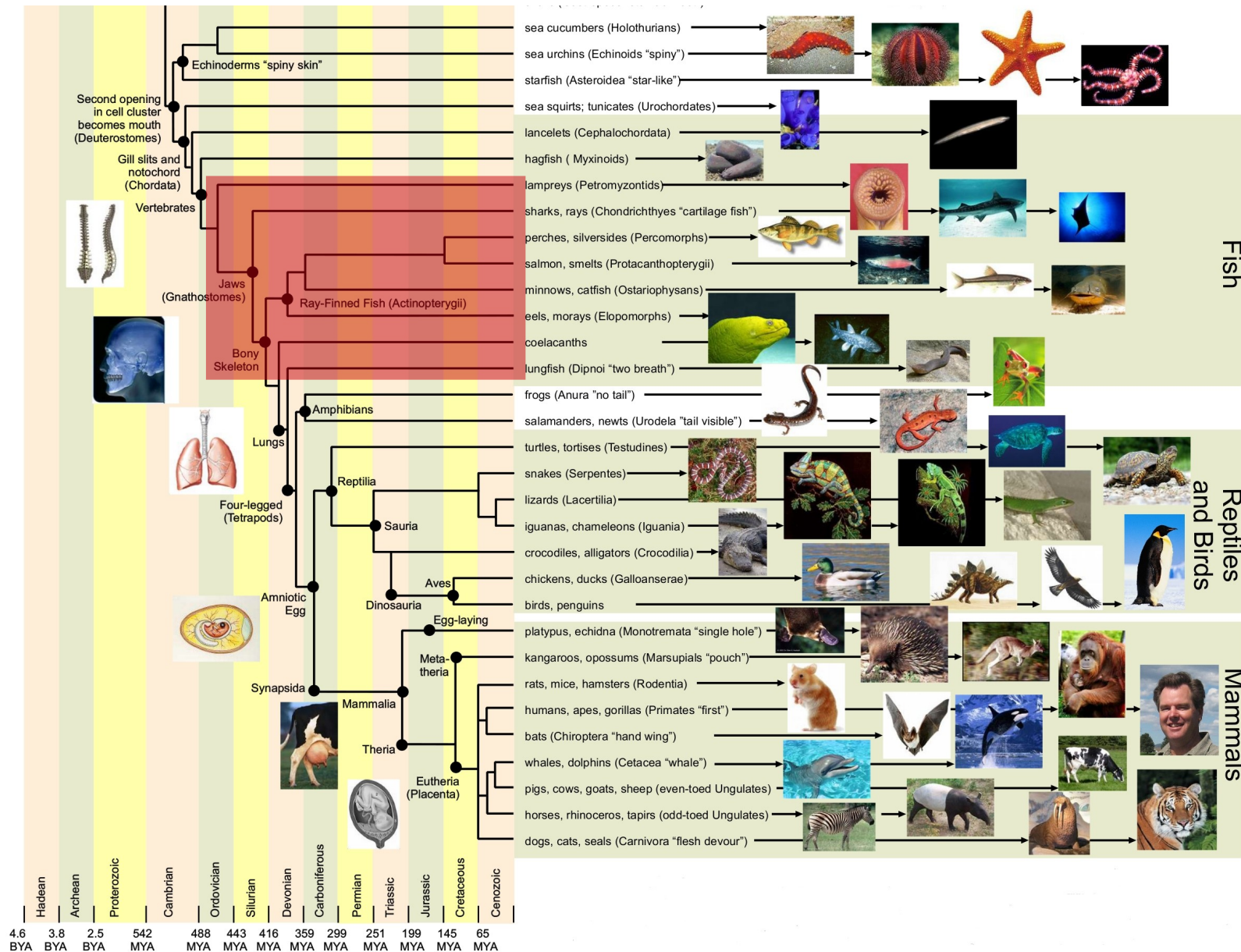
Exemplos em outra disciplina:

Whittaker 1969



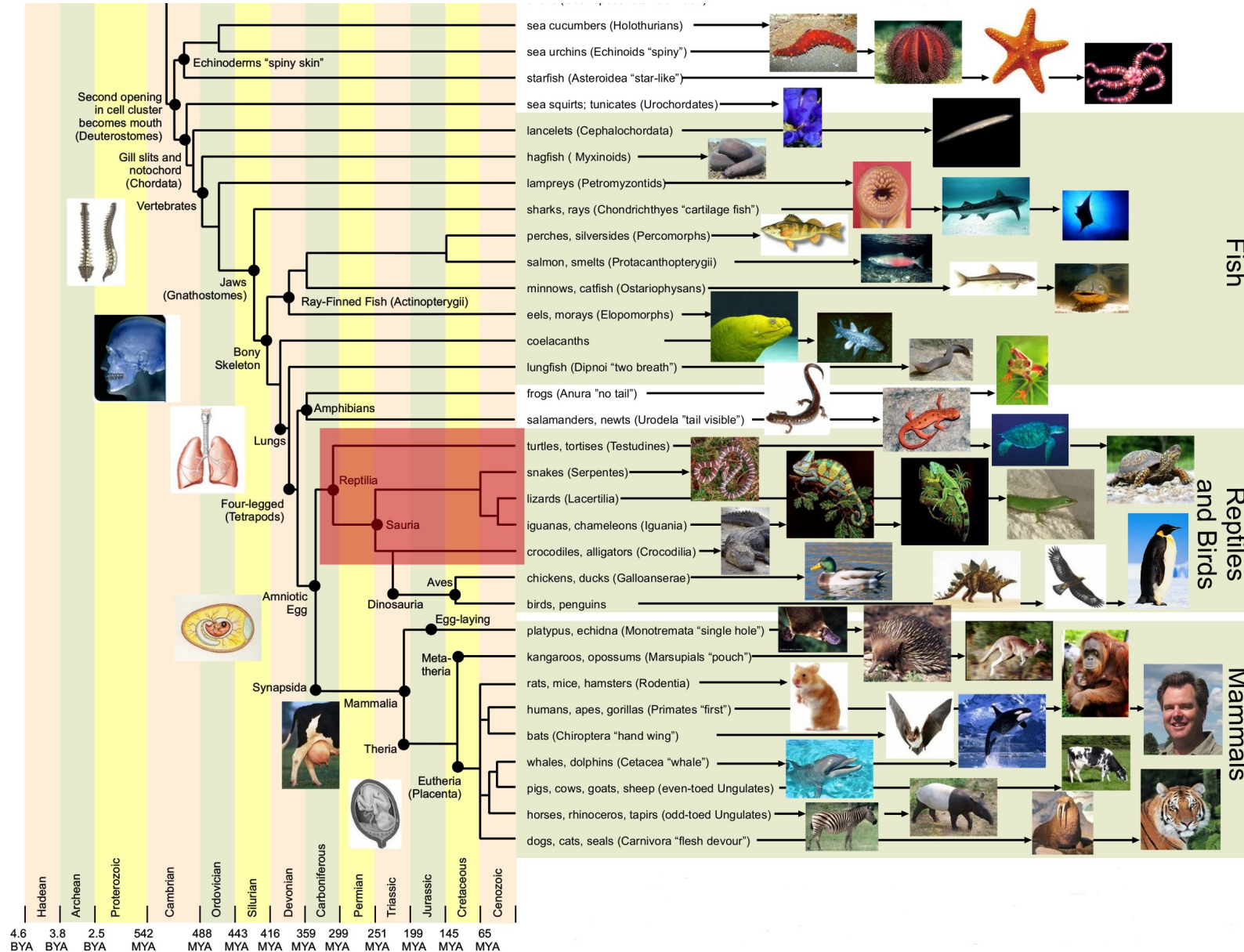
Sistemática Evolutiva [Gradismo]

Exemplos de grupos monofiléticos de acordo com a escola:



Sistemática Evolutiva [Gradismo]

Exemplos de grupos monofiléticos de acordo com a escola:



Conceitos fundamentais desta aula:

Essencialismo, Tipologismo e Fixismo

Homologia vs. Homoplasia

Seleção Natural: variabilidade, pressão seletiva e herança

Nova síntese e Sistemática Evolutiva (Gradismo)

Grupos monofiléticos, Zonas adaptativas e Grados