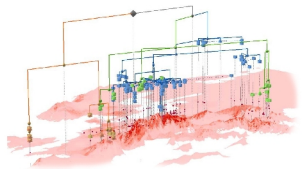


*Bem vindos a:*



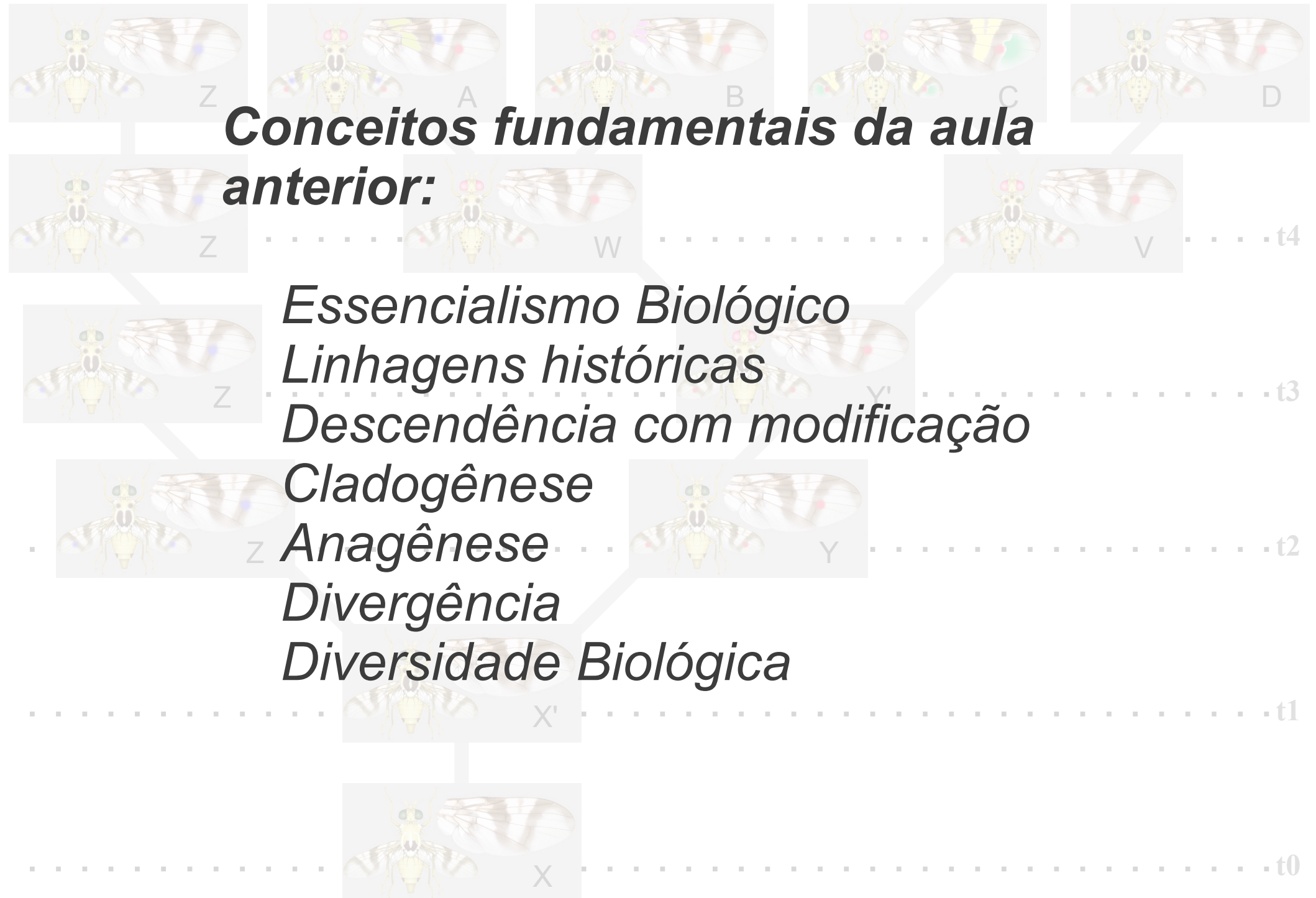
# Princípios de Sistemática & Biogeografia



Fernando Portella de Luna Marques  
Renato Mello Silva  
Sergio A. Vanin  
Instituto de Biociências – USP

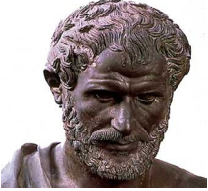
**Conceitos fundamentais da aula anterior:**

- Essencialismo Biológico*
- Linhagens históricas*
- 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.

Mundo dinâmico

Resistência e Nova Síntese

Sistemática Evolutiva

1859

1936 - 1947

1960's

Carolus Linnaeus  
1707-1778



Buffon  
1707-1788



Lamarck  
1744 -1829



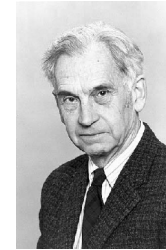
St-Hilair  
1772 -1844



Cuvier  
1769 -1832



Ernest Mayr  
1904 - 2005



G.G. Simpson  
1902 - 1984

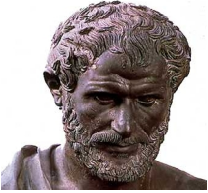


Theodosius Dobzhansky  
1900 -1975

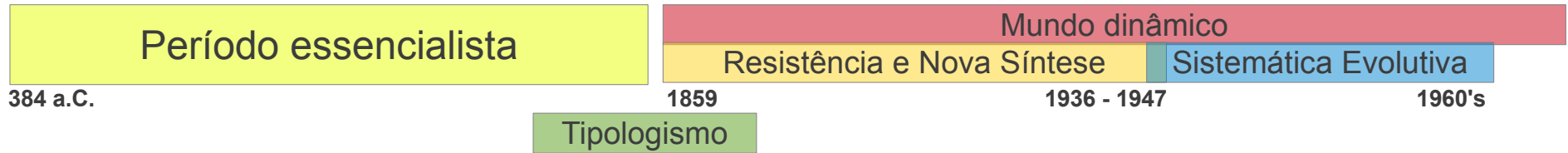


# Desenvolvimento epistemológico da Sistemática:

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)

## Transmutacionaistas



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)



Buffon  
1707-1788



Lamarck  
1744 -1829



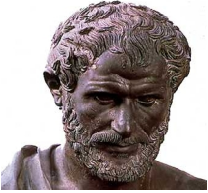
St-Hilaire  
1772 -1844



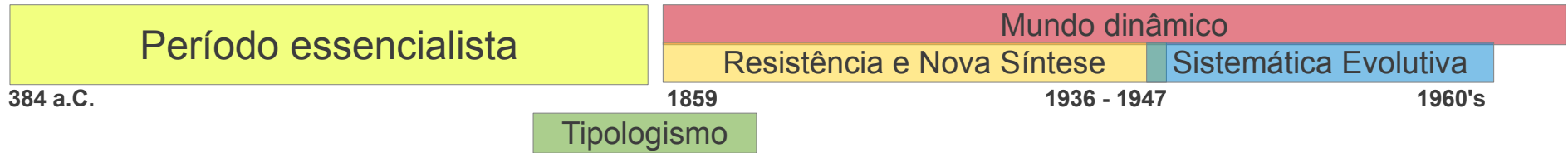
Cuvier  
1769 -1832

# Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



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)

## Transmutacionaistas



Buffon  
1707-1788



Lamarck  
1744 -1829



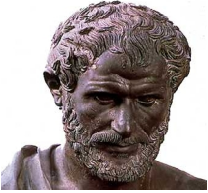
St-Hilair  
1772 -1844



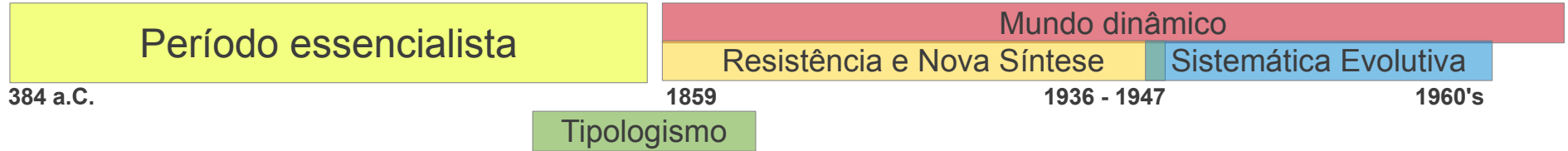
Cuvier  
1769 -1832

# Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



Johann W. von Goethe  
1749–1832

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

\* Não rejeitava nem aceitava teorias cuasais 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)

## Transmutacionaistas



Buffon  
1707-1788



Lamarck  
1744 -1829



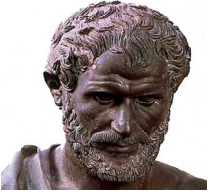
St-Hilair  
1772 -1844



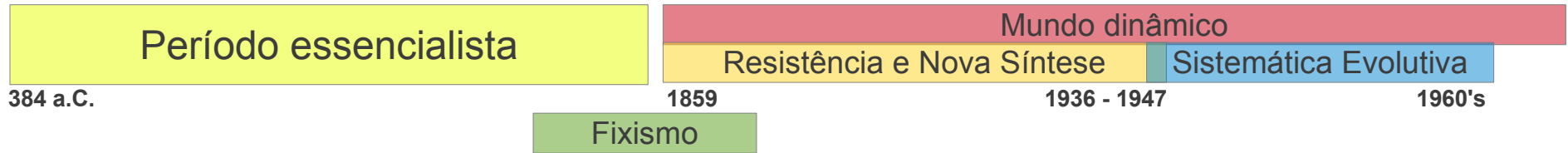
Cuvier  
1769 -1832

# Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



Beginning in the early seventeenth century, traditional beliefs were shaken by a series of challenges to the world's constancy and stability. [...]

Christian theology had derived the fixity of species from the Genesis account of creation. Fixity had been underpinned by the doctrines of Platonic idealism and Aristotelian essentialism. [...]

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

(Amindson, 2005:35)



Carolus Linnaeus  
1707-1778

## Transmutacionaistas



Buffon  
1707-1788



Lamarck  
1744 -1829



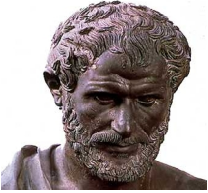
St-Hilaire  
1772 -1844



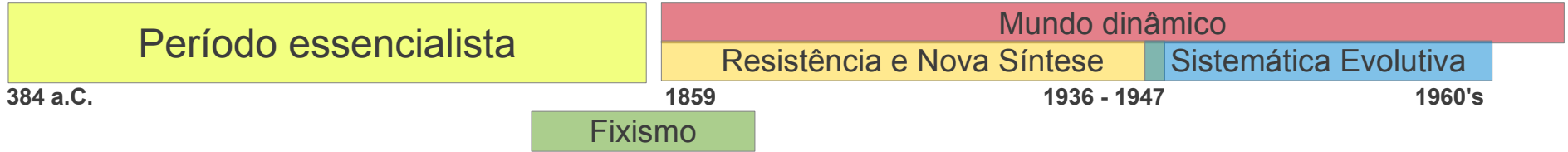
Cuvier  
1769 -1832

# Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



Carolus Linnaeus  
1707-1778

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

**Linnaeus:** referências ao fixismo e criacionismo

Transmutacionaistas



Buffon  
1707-1788



Lamarck  
1744 -1829



St-Hilair  
1772 -1844



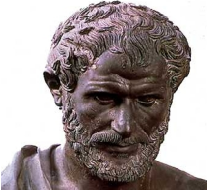
Cuvier  
1769 -1832

“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)

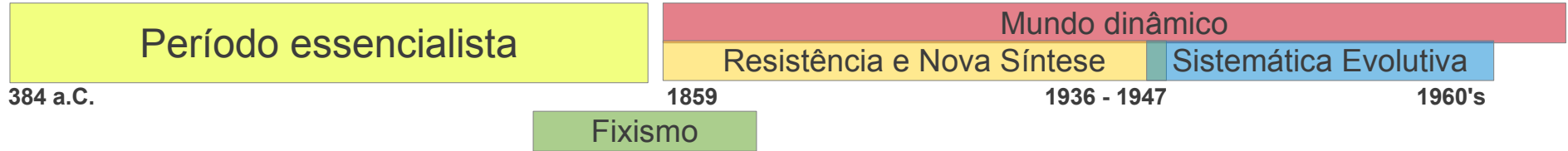


# Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



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

*Imagine trying to construct a coherent taxonomic system in which wheat could give rise to rye, worms to insects, mud to frogs, and barnacles to geese.*

(Amundson, 2005, p. 37-38)



Carolus Linnaeus  
1707-1778

“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)

## Transmutacionaistas



Buffon  
1707-1788



Lamarck  
1744 -1829



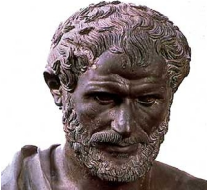
St-Hilaire  
1772 -1844



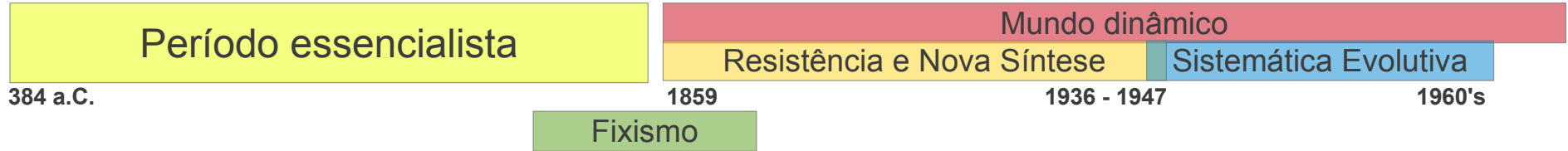
Cuvier  
1769 -1832

# 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.*

**Fixismo:** doutrina sobre relações causais.

*The causal relation of generation between parents and offspring.*



Carolus Linnaeus  
1707-1778

"**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).

Transmutacionaistas



Buffon  
1707-1788



Lamarck  
1744 -1829



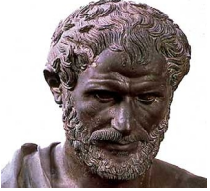
St-Hilaire  
1772 -1844



Cuvier  
1769 -1832

# Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Darwin – 1809-1882



Período essencialista

384 a.C.

Mundo dinâmico

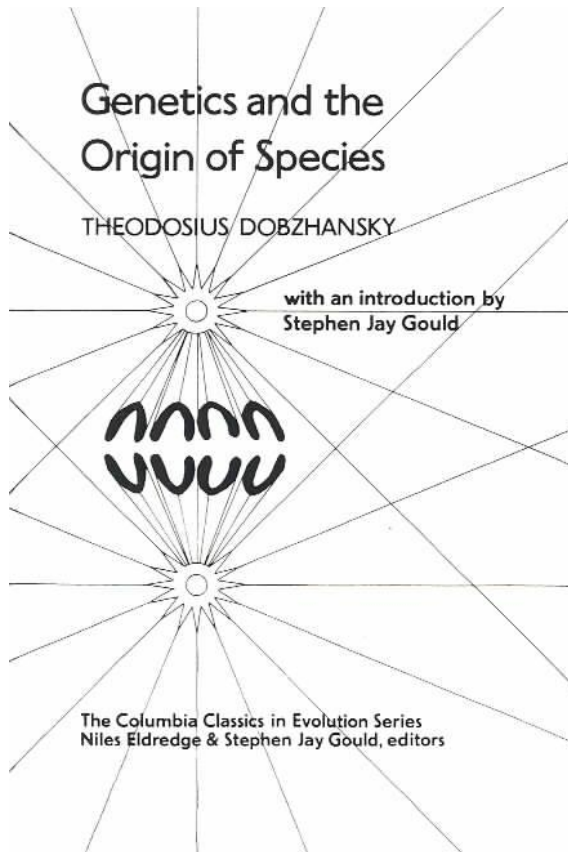
Resistência e Nova Síntese

Sistemática Evolutiva

1859

1936 - 1947

1960's

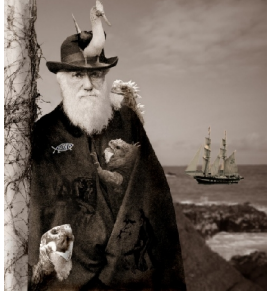


Theodosius Dobzhansky  
1900 -1975

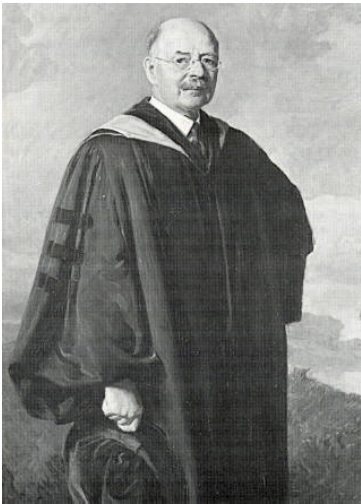


No IB: Dreyfus, Chana, Dobzhansky, Martha Wedel, Antonio Cordeiro (sentados), Hans Burla e Antonio Cavalcanti (em pé).

# *A revolução que falhou: filosofia da ciência*



Darwin (1859:420): Seleção natural → Método de inferência considerado não científico diante no 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."*

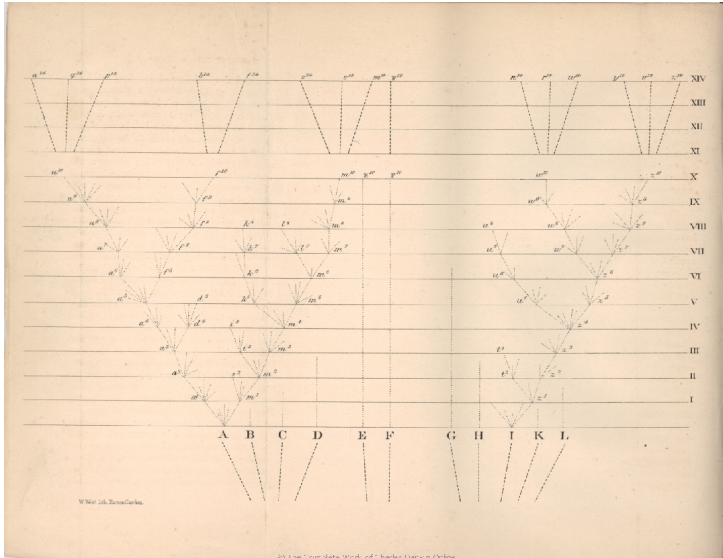
*Bumpus (1899)*

Hermon Carey Bumpus (1862-1943)\*

# 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"



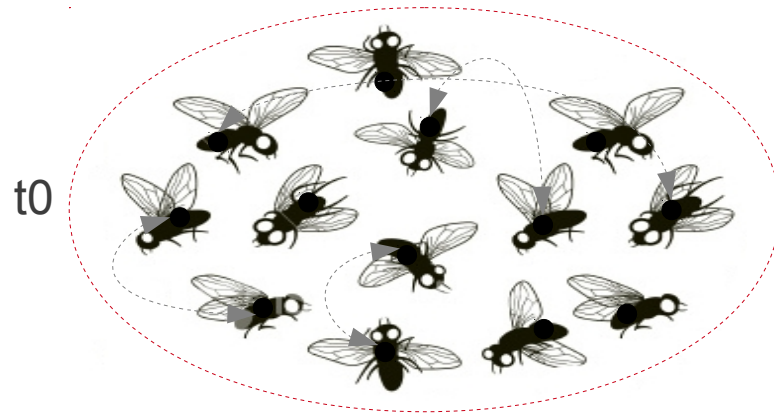
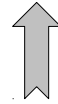
Huxley(1874:101): "Darwin, by laying a novel and solid foundation for the theory of Evolution, introduced a new element into Taxonomy. Is species, like an individual, is the product of a process of development, its mode of evolution must be taken into account in determining its likeness or unlikeness 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, there 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.**"

Compartilhamento de caracteres --> fatos observáveis  
Homologias --> muito especulativa

# *Linhagens históricas:*

Coesão horizontal → fluxo gênico intra-populacional

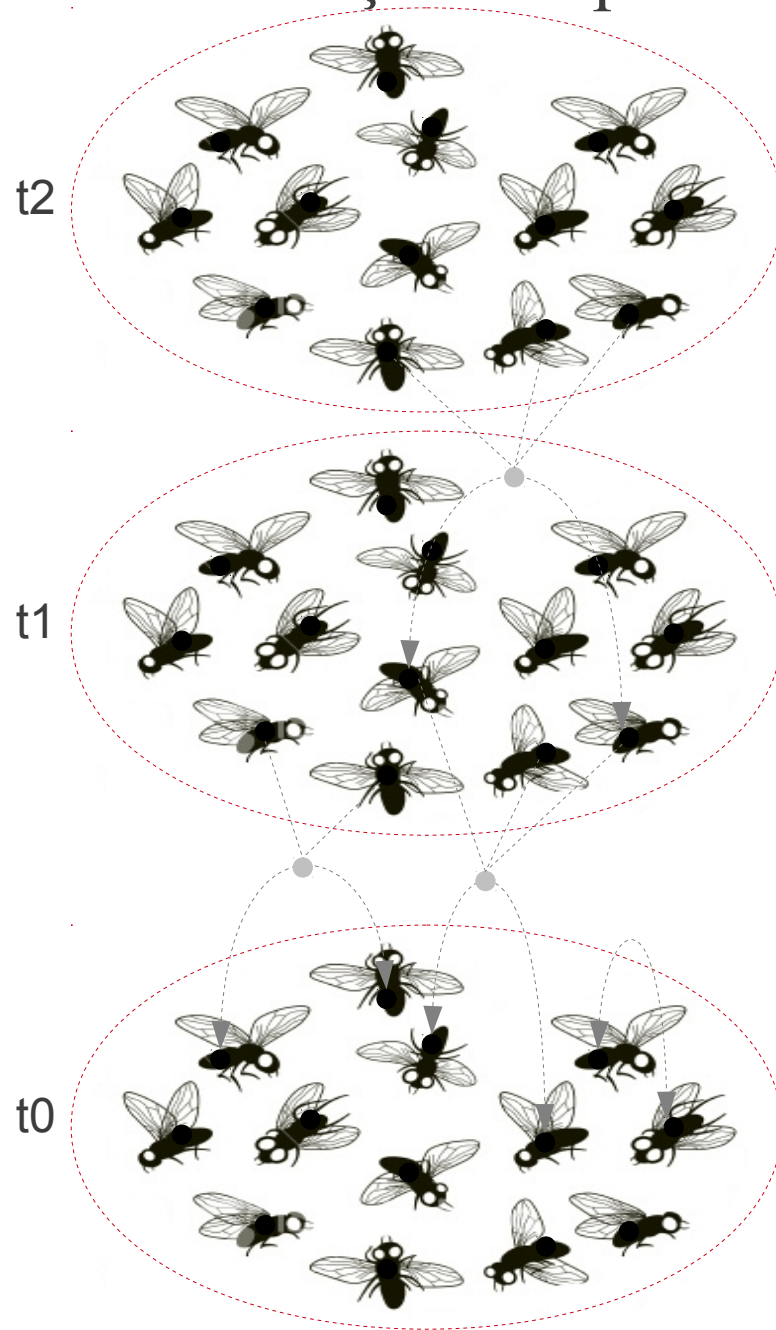
Todos os membros podem  
potencialmente gerar descendentes



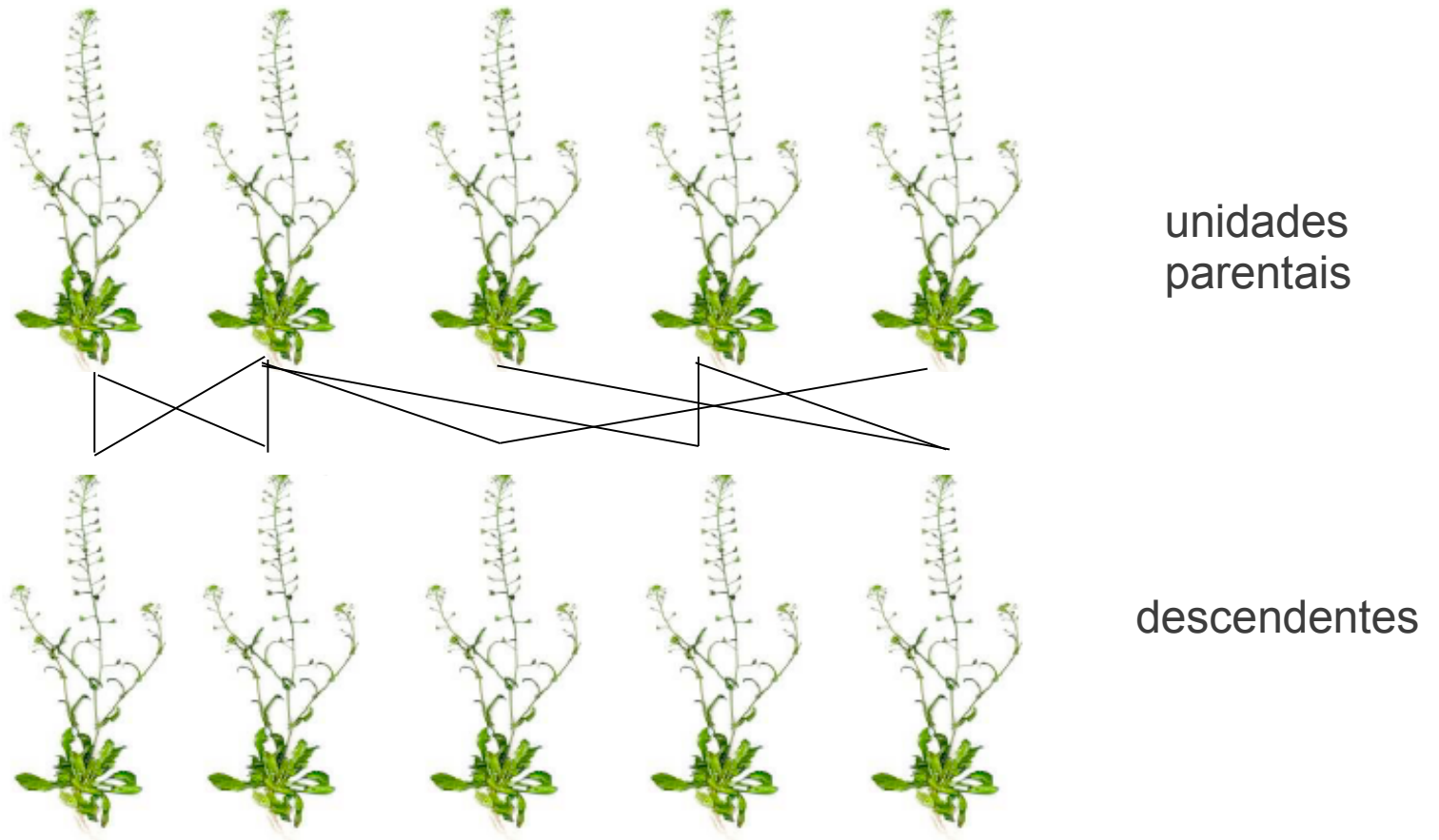
circunscrição no  
espaço e no tempo

# *Linhagens históricas:*

Coesão vertical  $\rightarrow$  relações de parentesco entre gerações

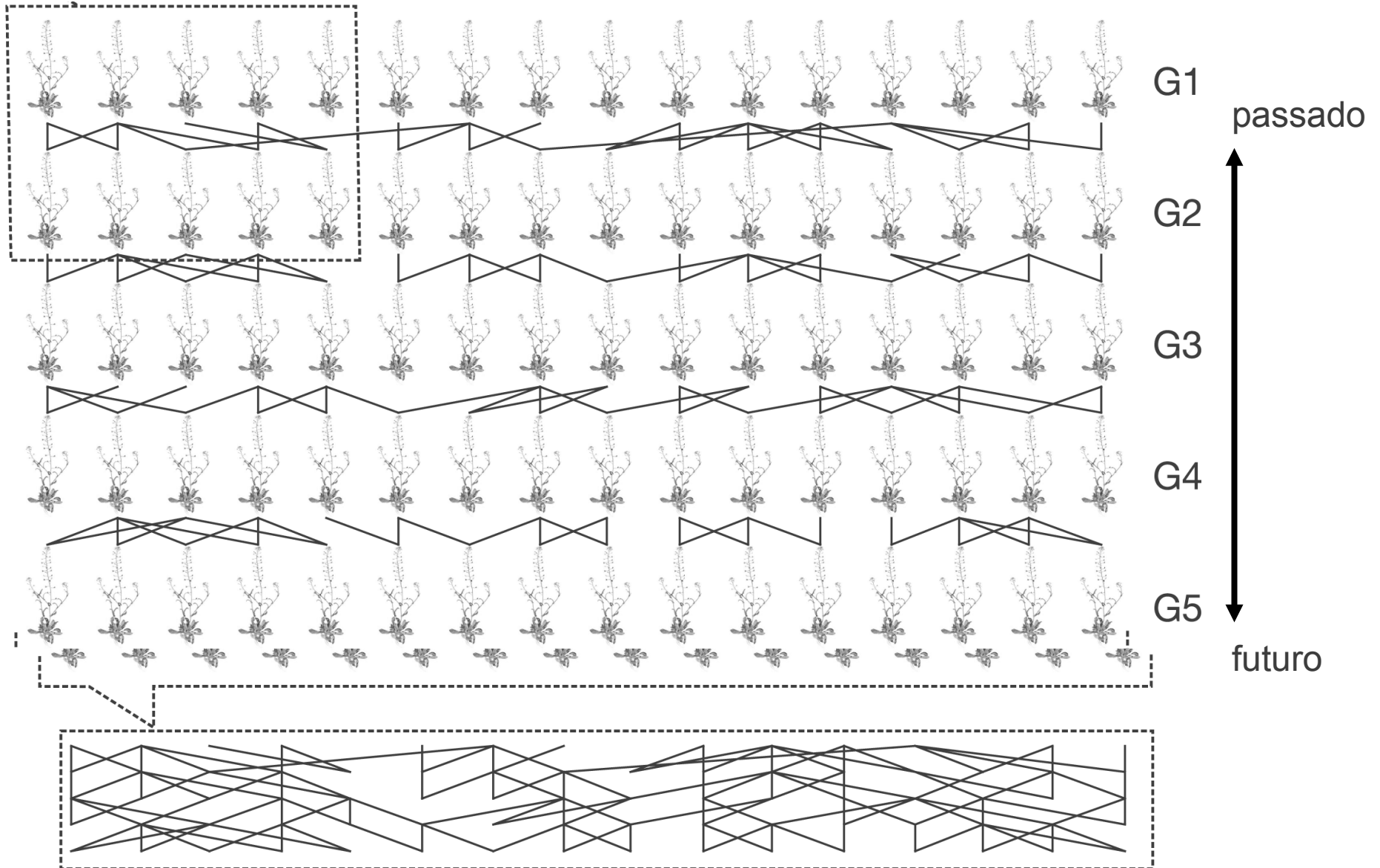


# *Linhagens:*

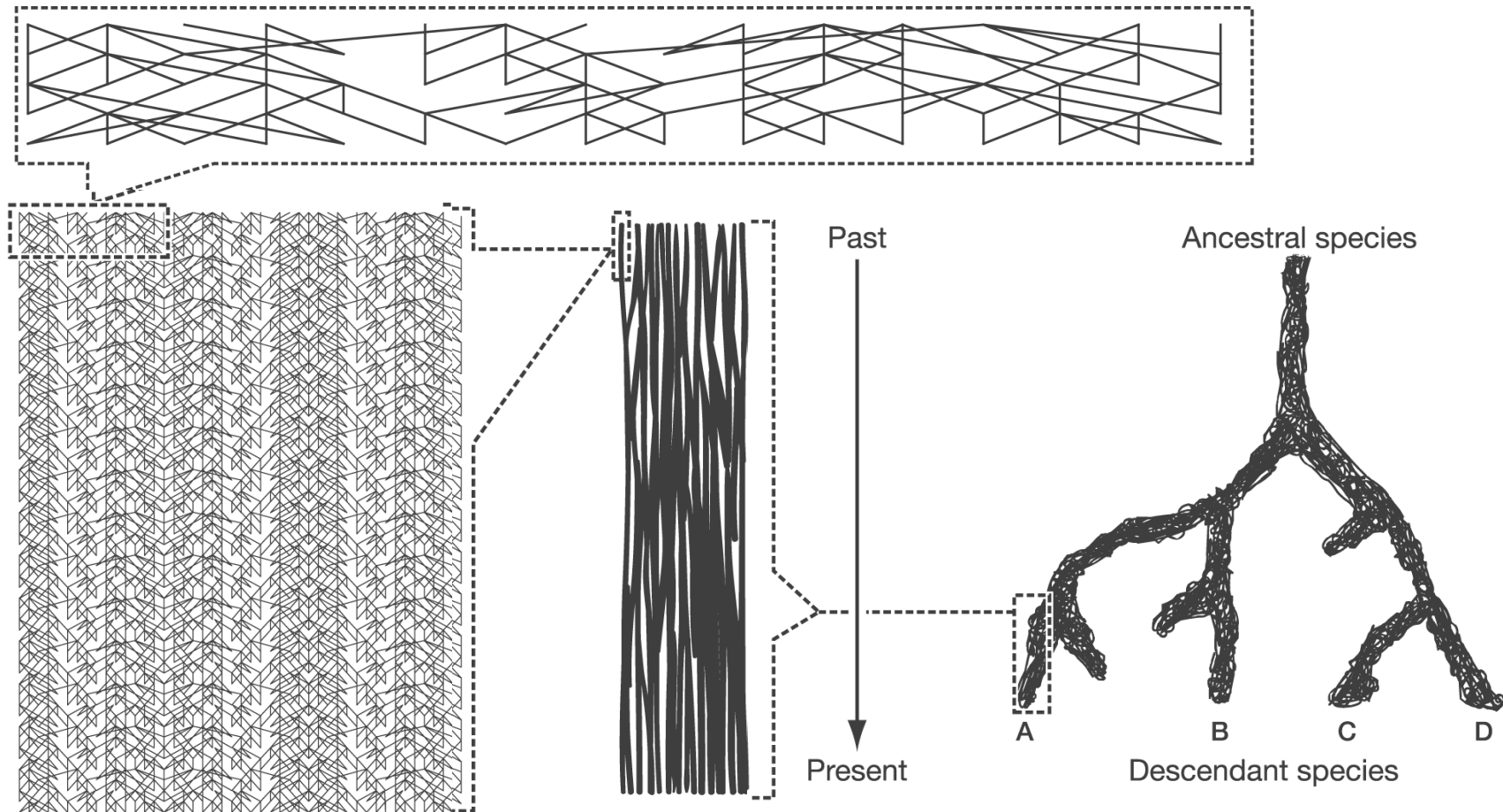




# ***Linhagens:***



# *Linhagens:*



**Evolutionary lineage:** Line of descent of a taxon from its ancestral taxon. A lineage ultimately extends back through the various taxonomic levels, from the species to the genus, from the genus to the family, from the family to the order, etc.

**Lineage:** Any continuous line of descent; any series of organisms connected by reproduction by parent of offspring.

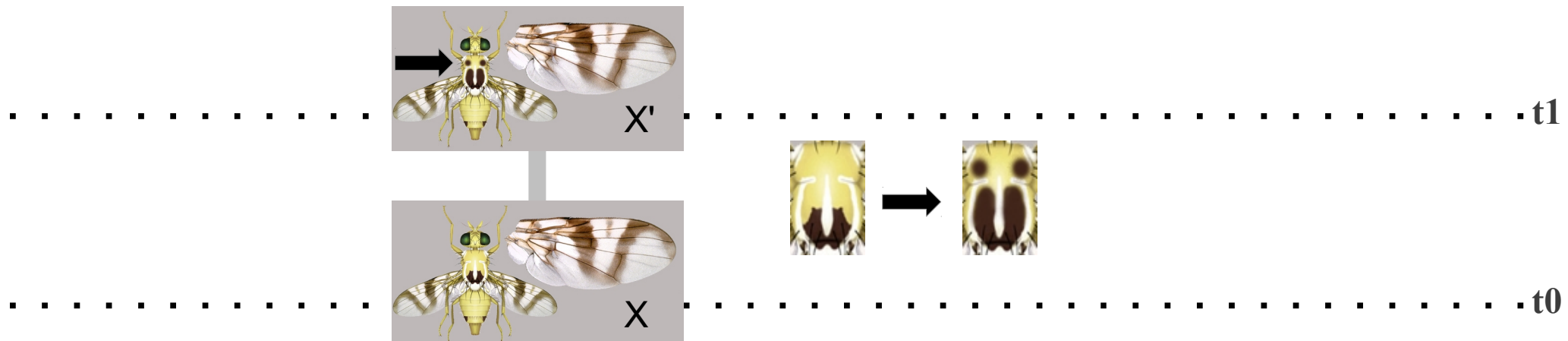
# *Descendência com modificação:*



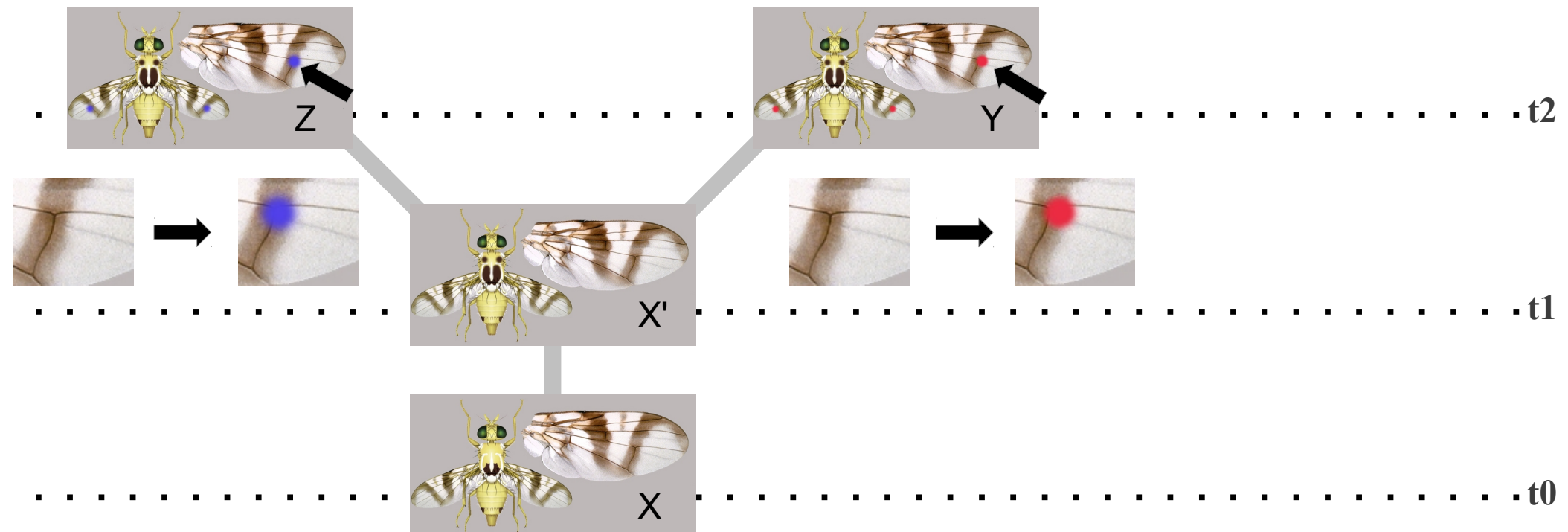
X

# *Descendência com modificação:*

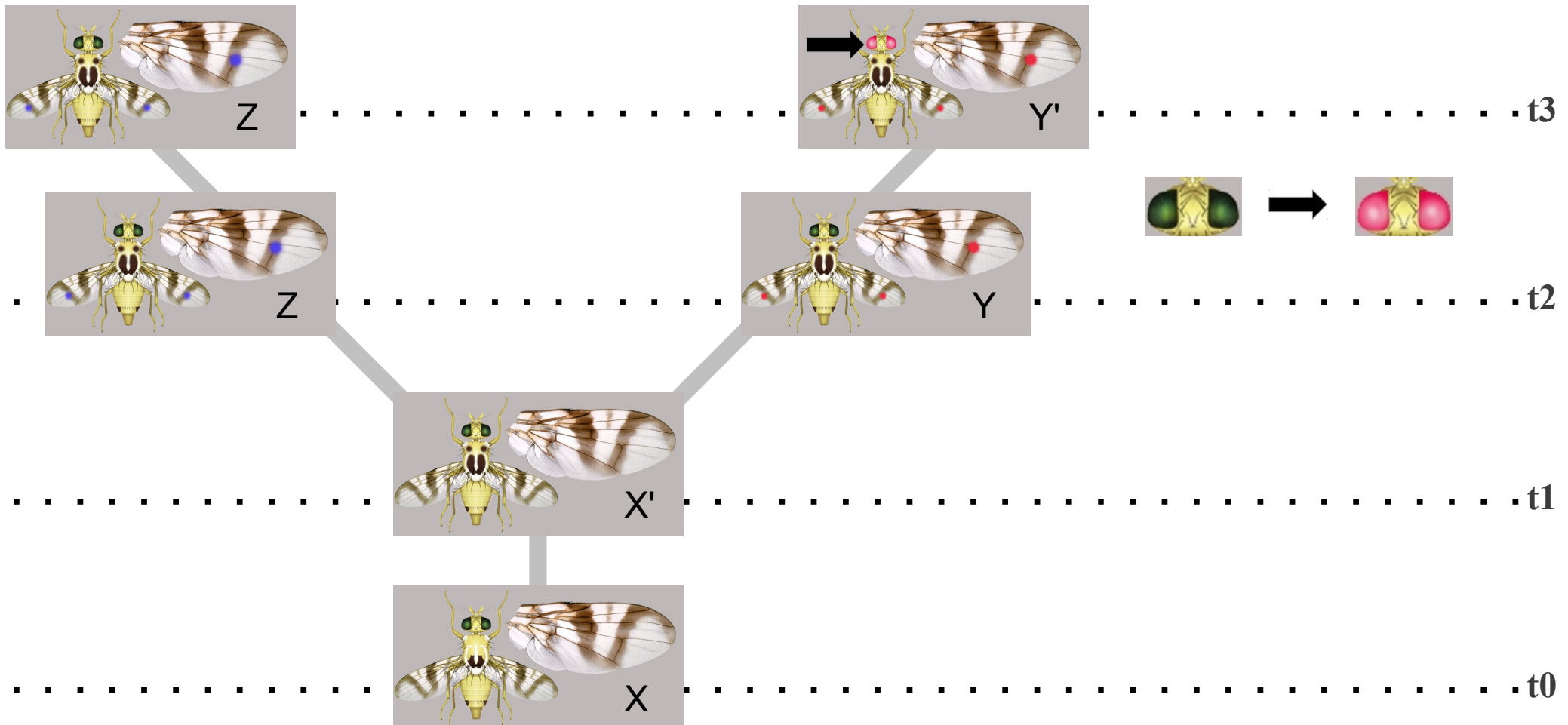
De X a X' representa uma linhagem!



# *Descendência com modificação:*



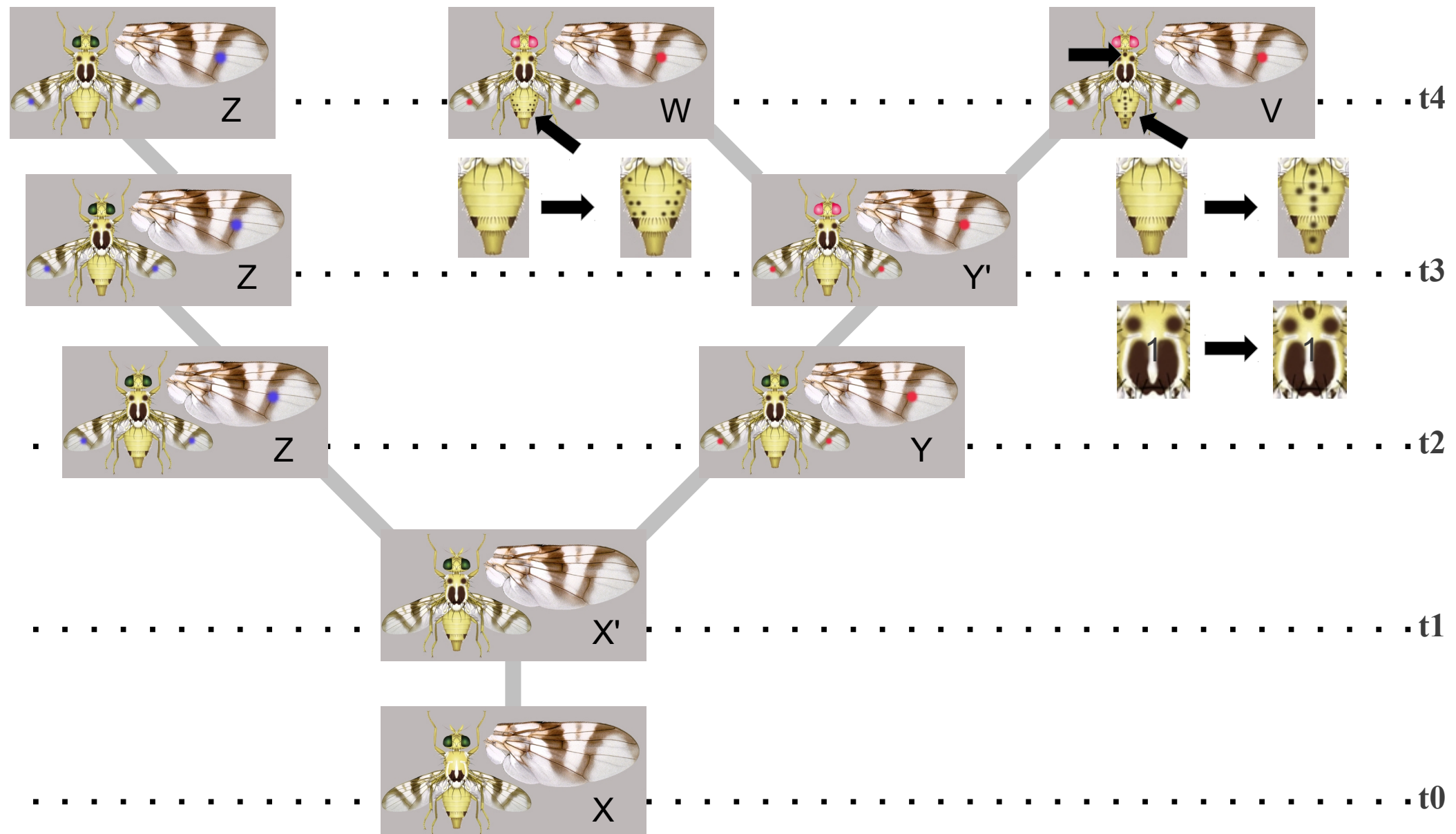
# *Descendência com modificação:*



# *Descendência com modificação:*



# *Descendência com modificação:*





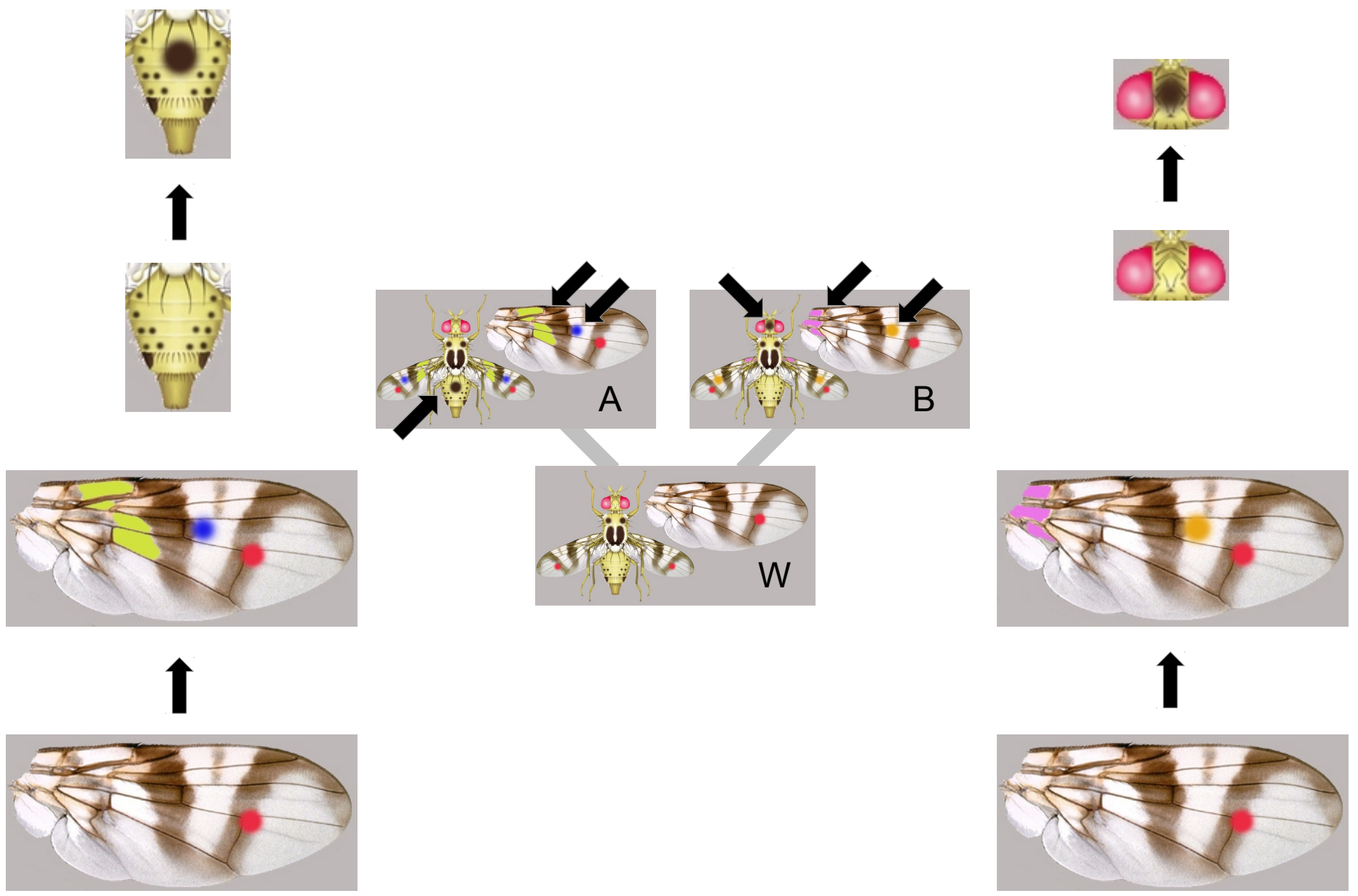
# *Descendência com modificação:*



# *Descendência com modificação:*



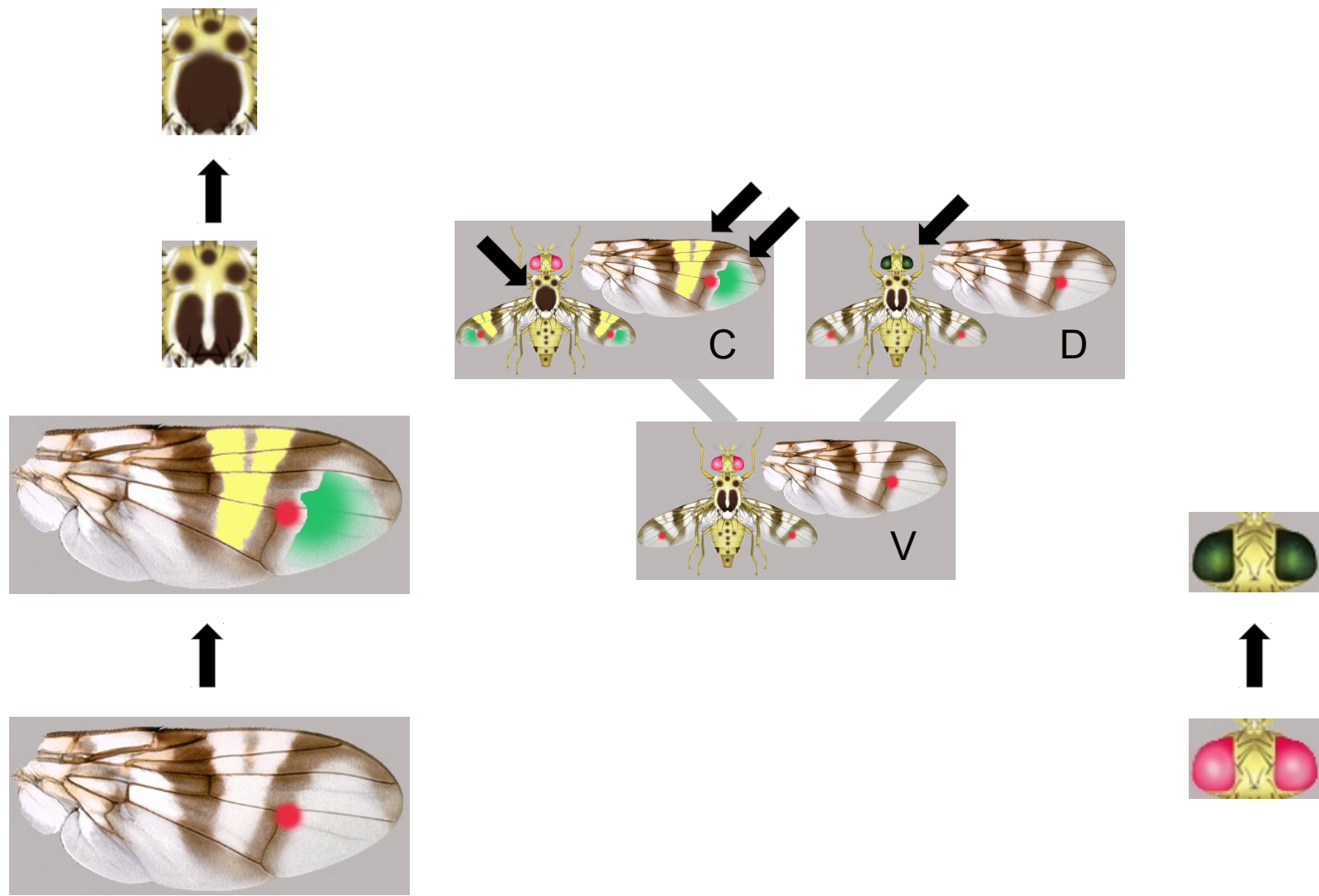
# *Descendência com modificação:*



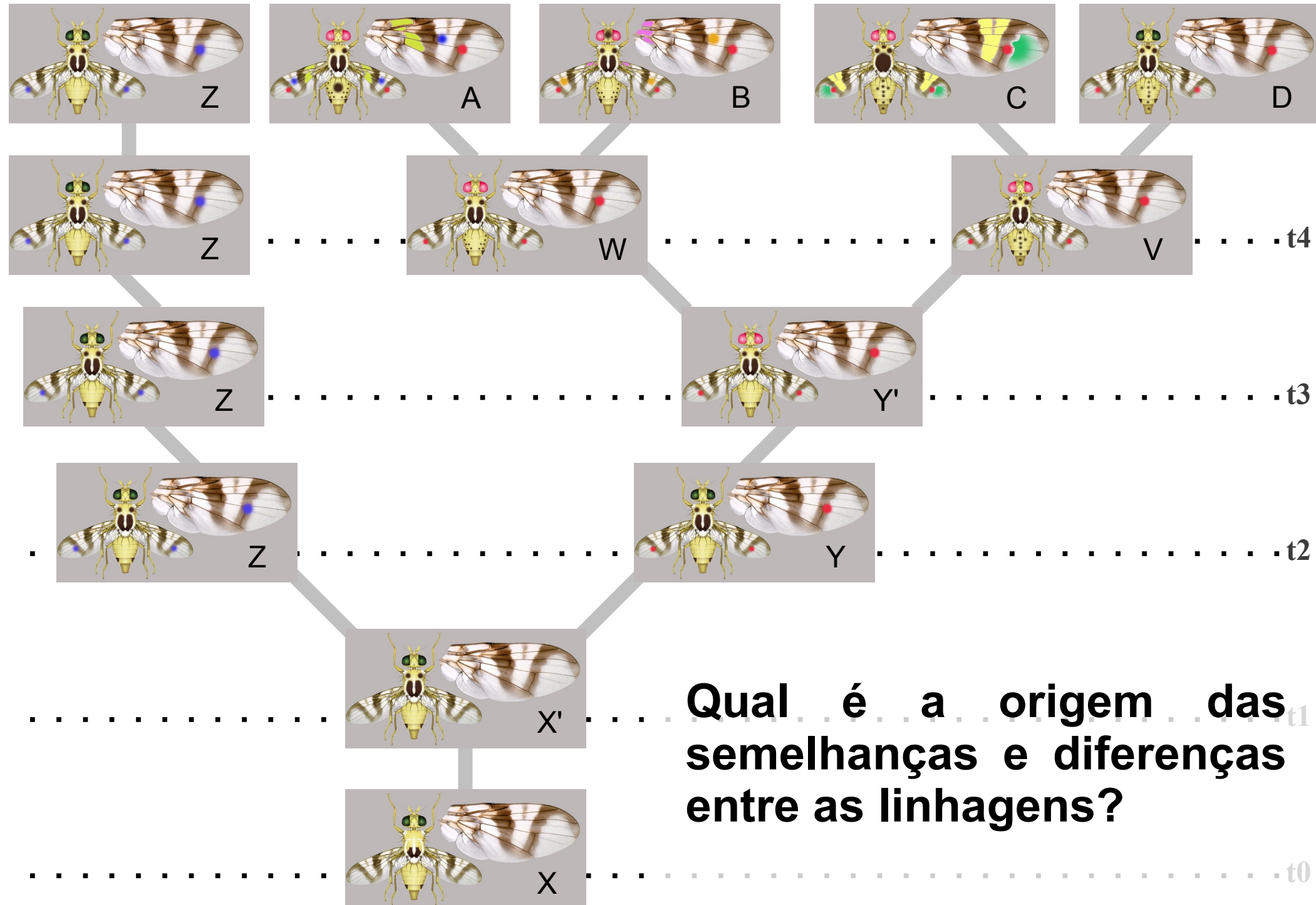
# *Descendência com modificação:*



# *Descendência com modificação:*

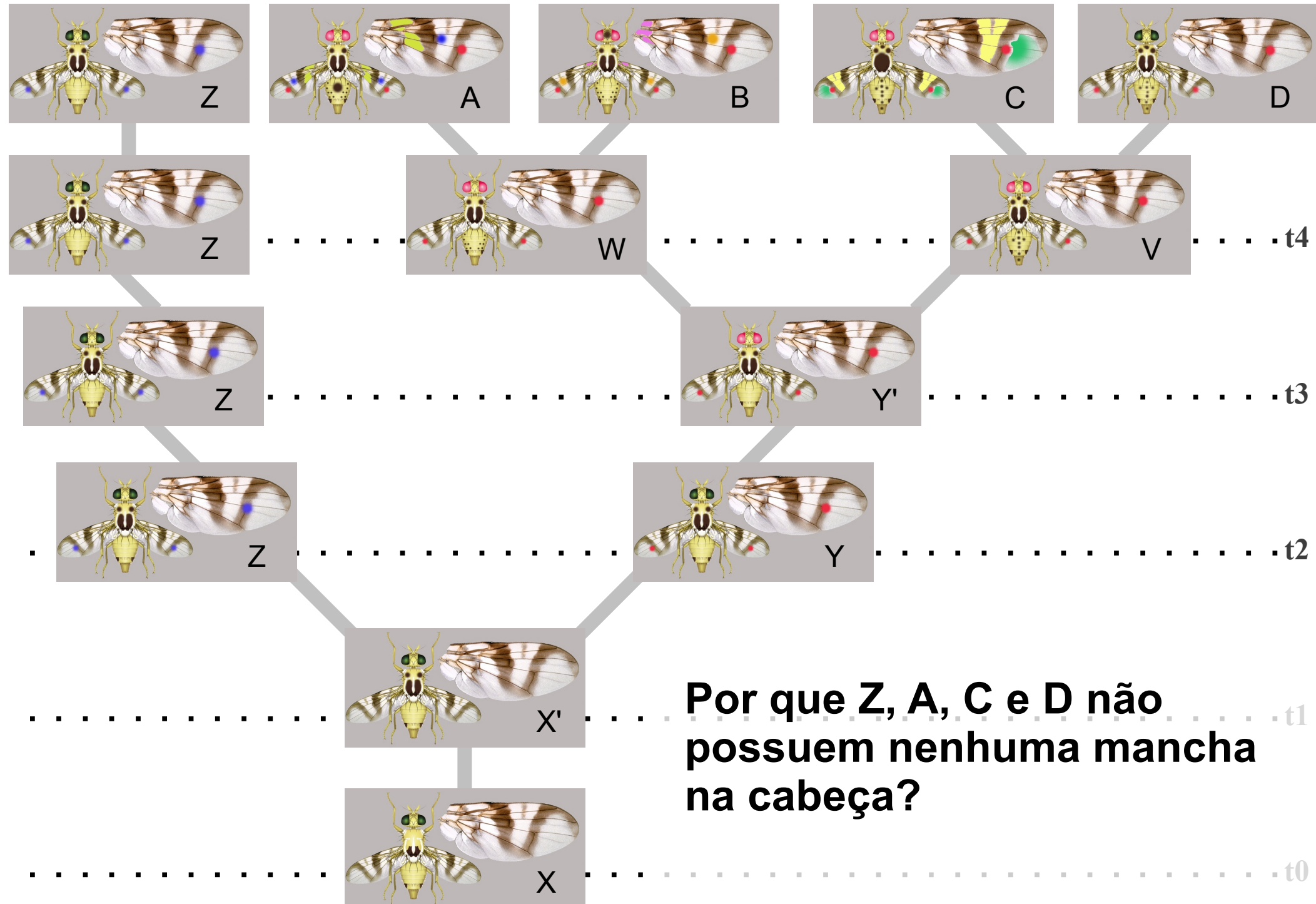


# *Descendência com modificação:*

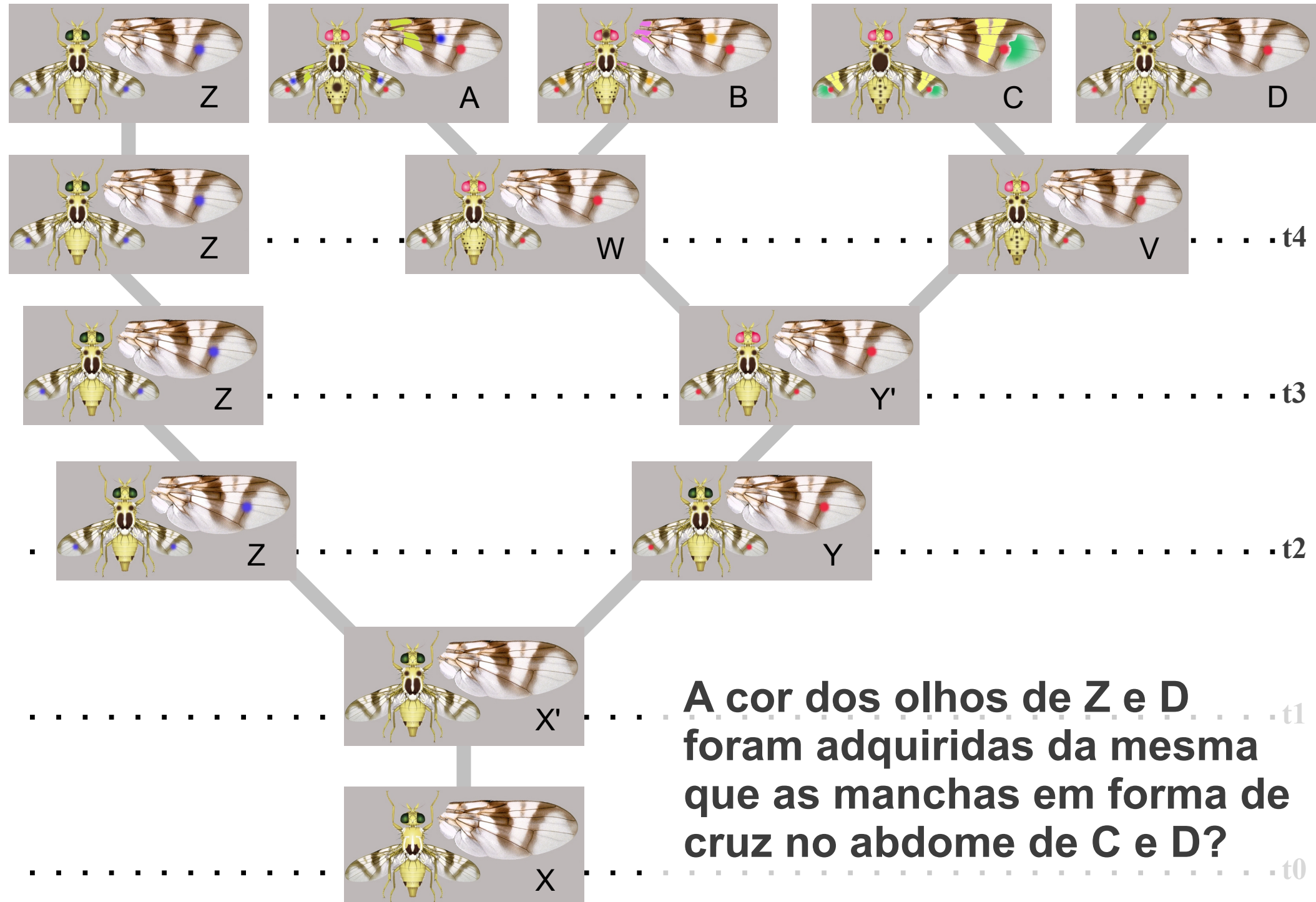


**Qual é a origem das  
semelhanças e diferenças  
entre as linhagens?**

# *Descendência com modificação:*



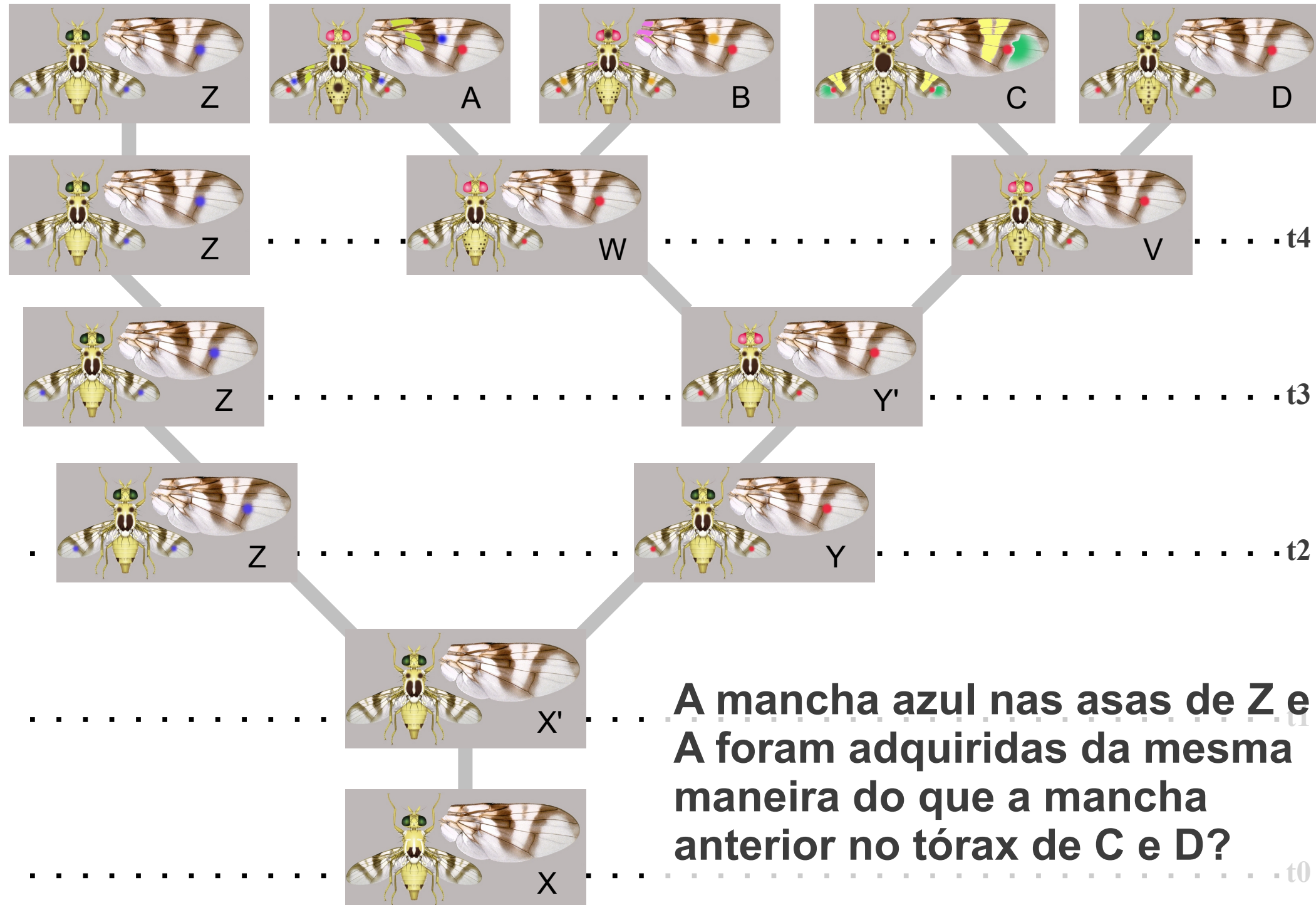
# *Descendência com modificação:*



**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?**



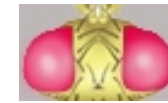
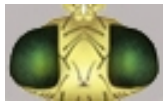
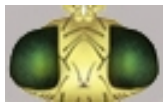
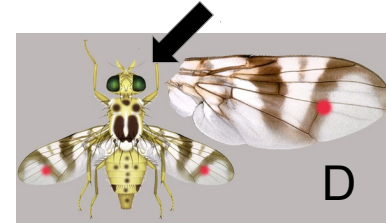
# *Descendência com modificação:*



**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?**

# *Descendência com modificação:*

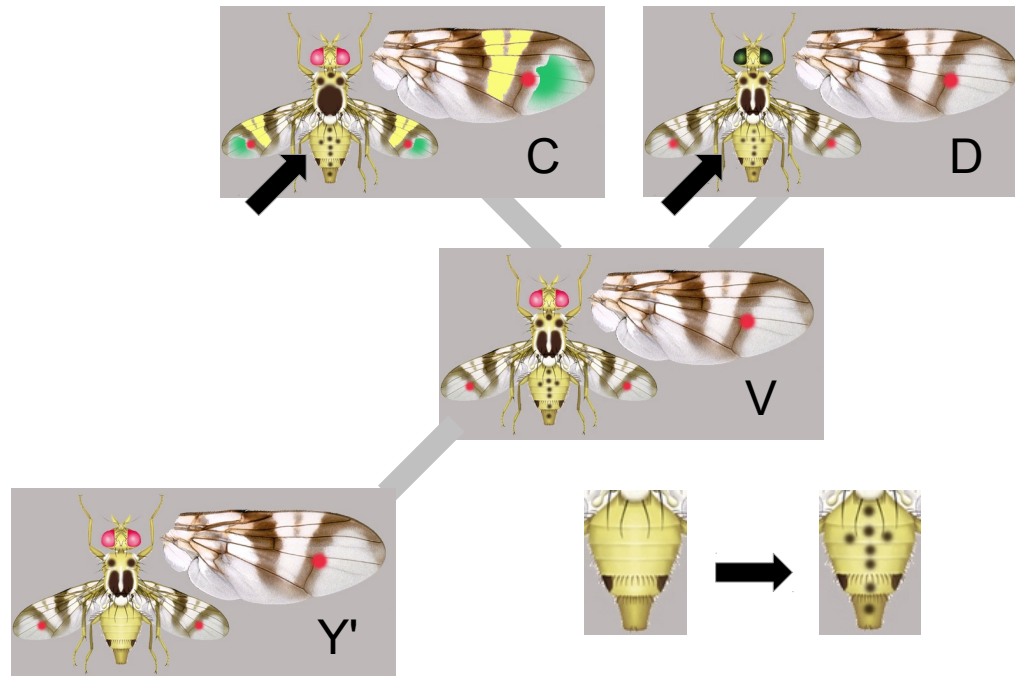
Características aparentemente iguais são historicamente distintas!



.....t0

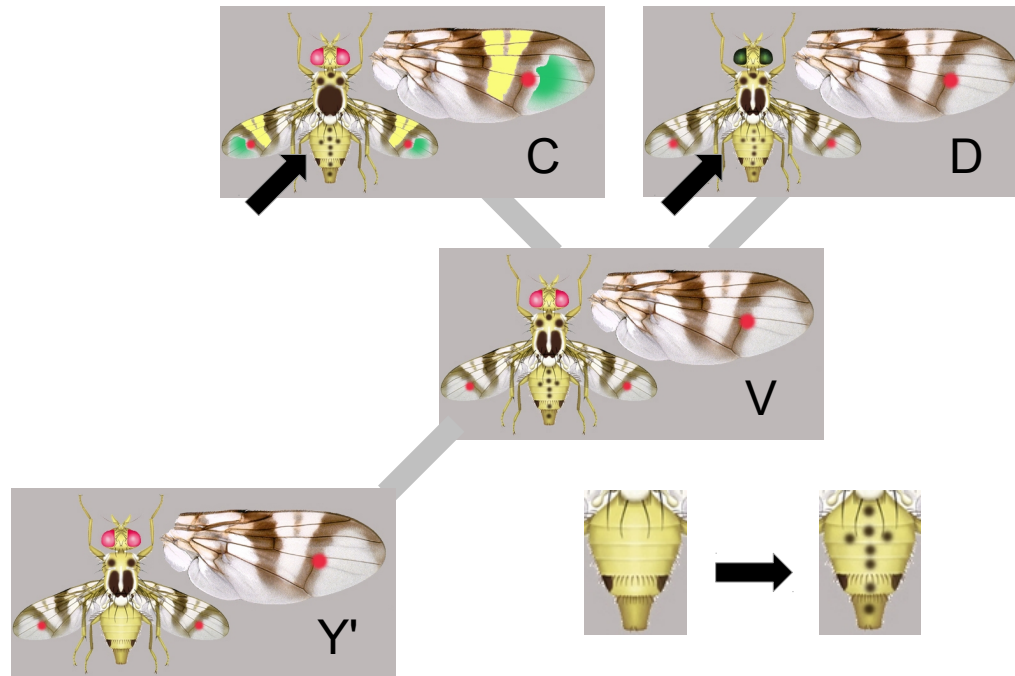
# *Descendência com modificação:*

Algumas semelhanças decorrem da herança de ancestrais imediatos.



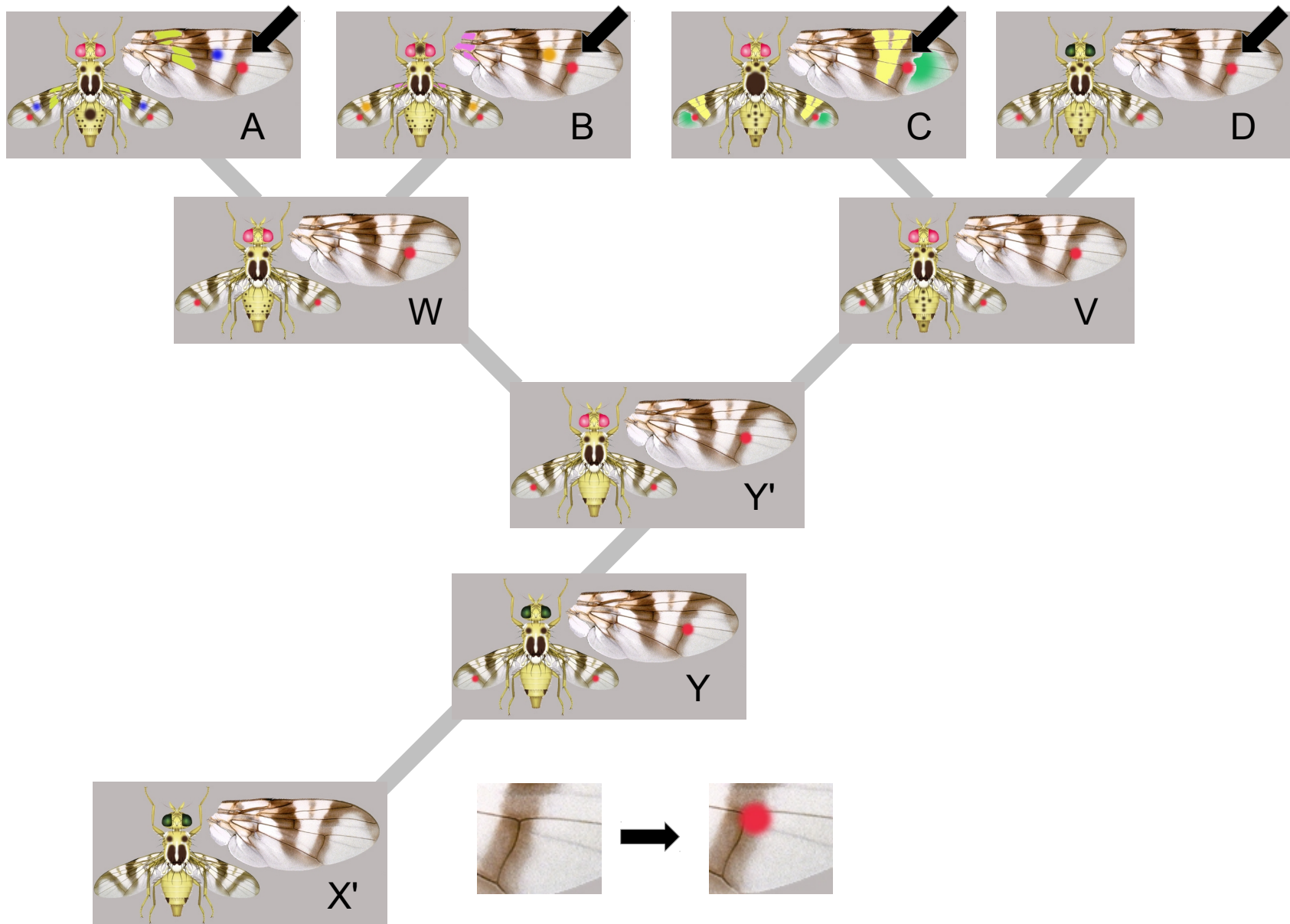
# *Descendência com modificação:*

Algumas semelhanças decorrem da herança de ancestrais imediatos.



# *Descendência com modificação:*

Outras da herança de ancestrais mais remotos.



*Descendência com modificação:*

Algumas semelhanças decorrem da herança de ancestrais imediatos.

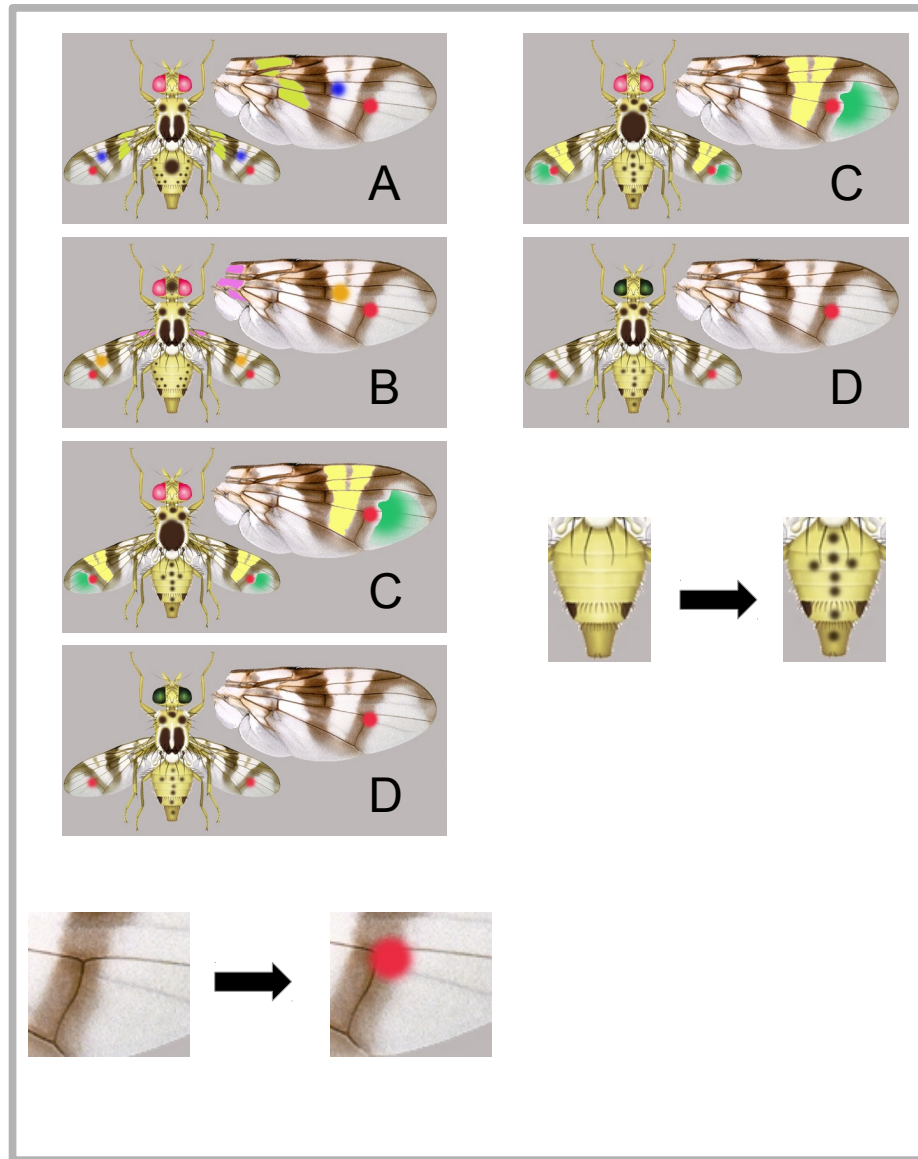
vs.

Outras da herança de ancestrais mais remotos.

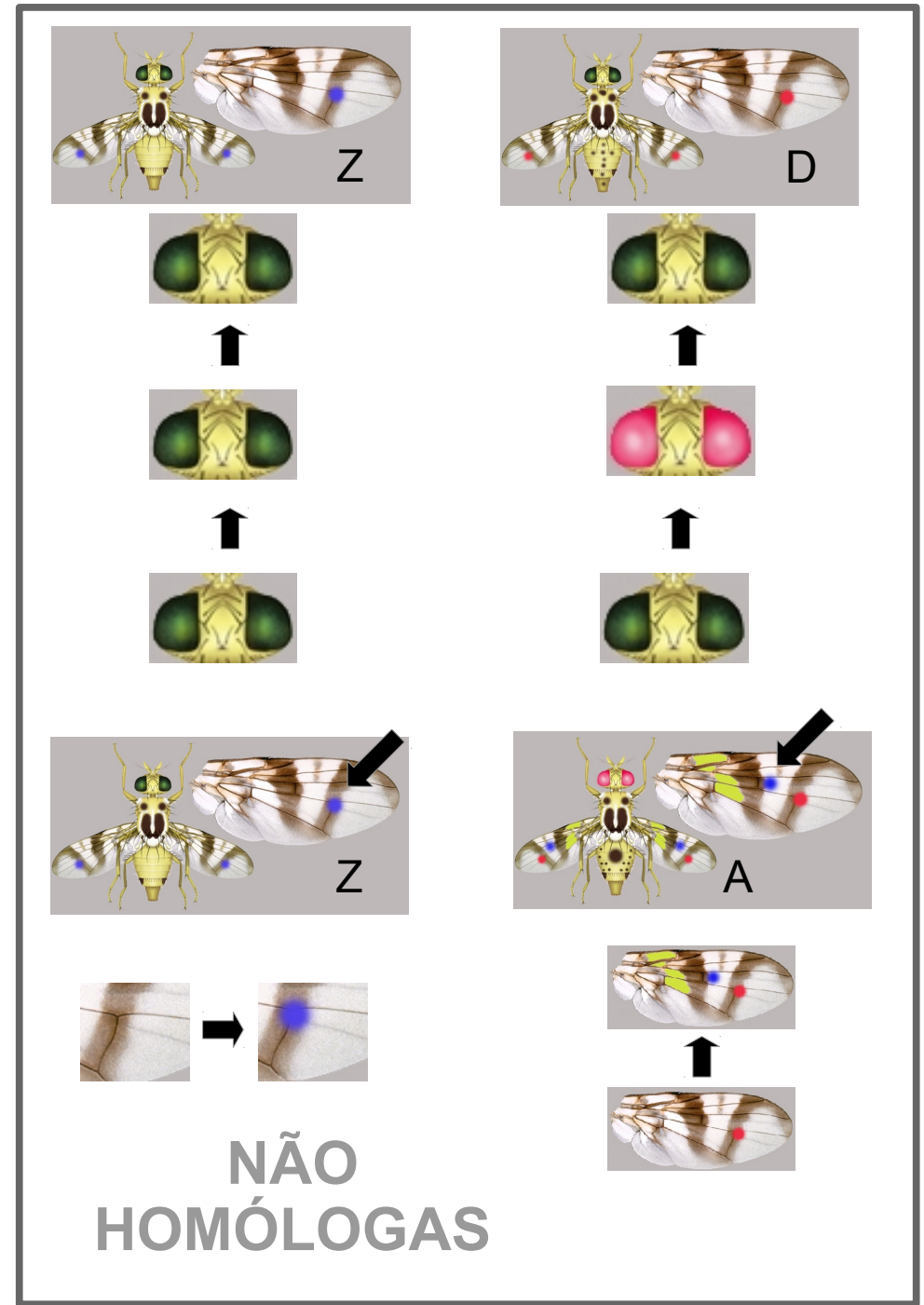


**Níveis de generalidade distintos**

# *Descendência com modificação:*



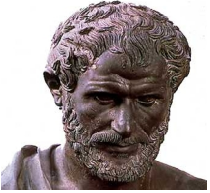
Características  
HOMÓLOGAS



NÃO  
HOMÓLOGAS

# Desenvolvimento epistemológico da Sistemática:

Aristóteles – 384-322 A.C.



Período essencialista

384 a.C.

Darwin – 1809-1882



Mundo dinâmico

Resistência e Nova Síntese

Sistemática Evolutiva

1859

1936 - 1947

1960's

Theodosius Dobzhansky  
1900 - 1975



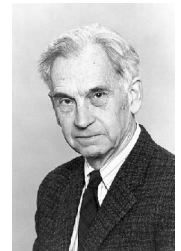
“The first period was initiated by the publication of *Genetics and the Origin of Species* (1937) by the Russian-born American evolutionist Theodosius Dobzhansky (1880–1959).

[...]

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Ernest Mayr  
1904 - 2005

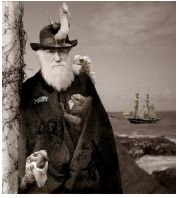


G.G. Simpson  
1902 - 1984





# *O mecanismo: Seleção natural*



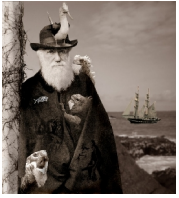
Teorias de Darwin encontram resistências até a década de 30.

## **VARIABILIDADE**



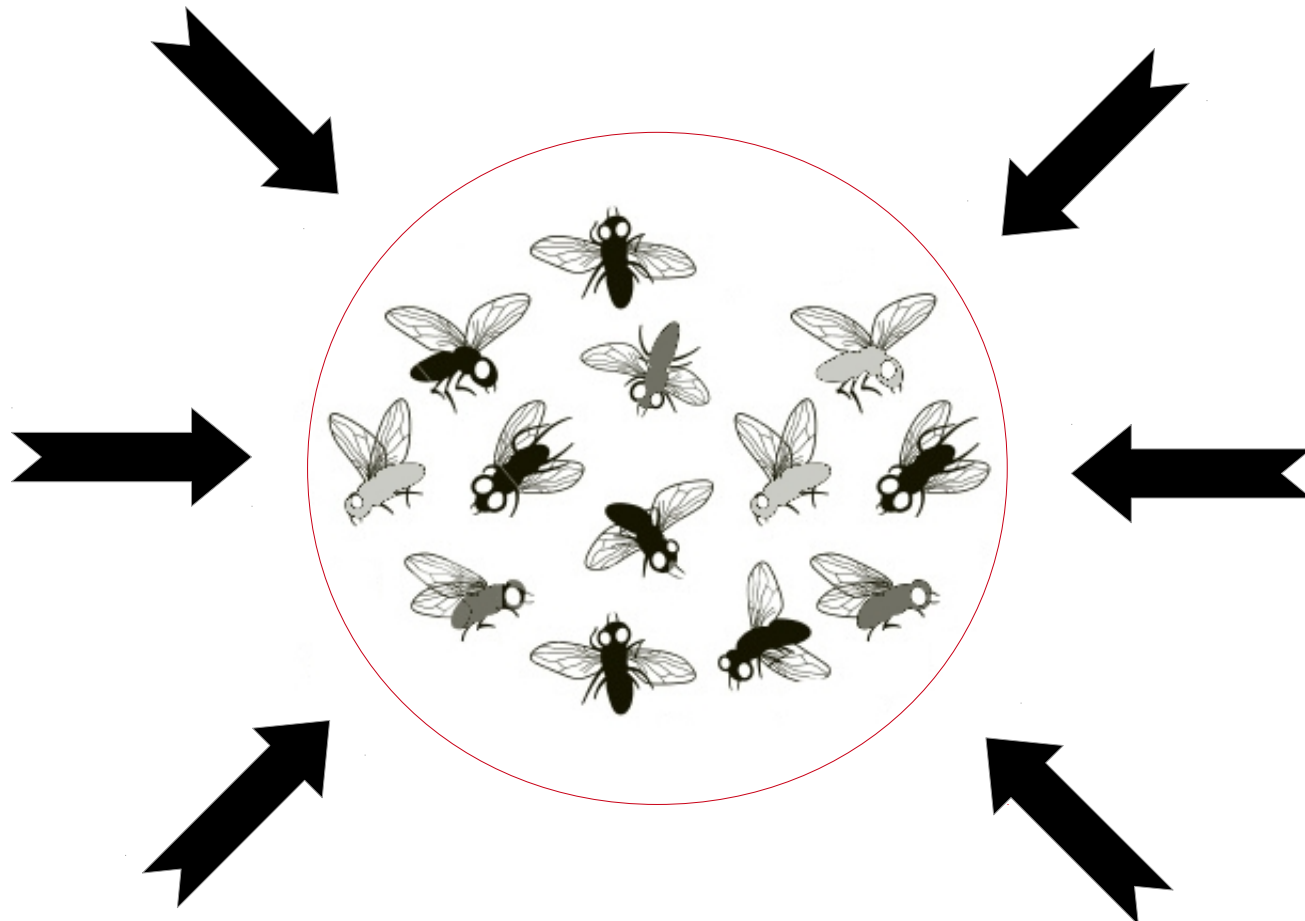
**TIPOLOGISMO vs. POPULACIONISMO**

# *O mecanismo: Seleção natural*



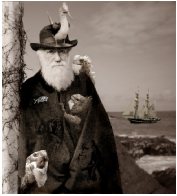
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**AGENTE SELECIONADOR**



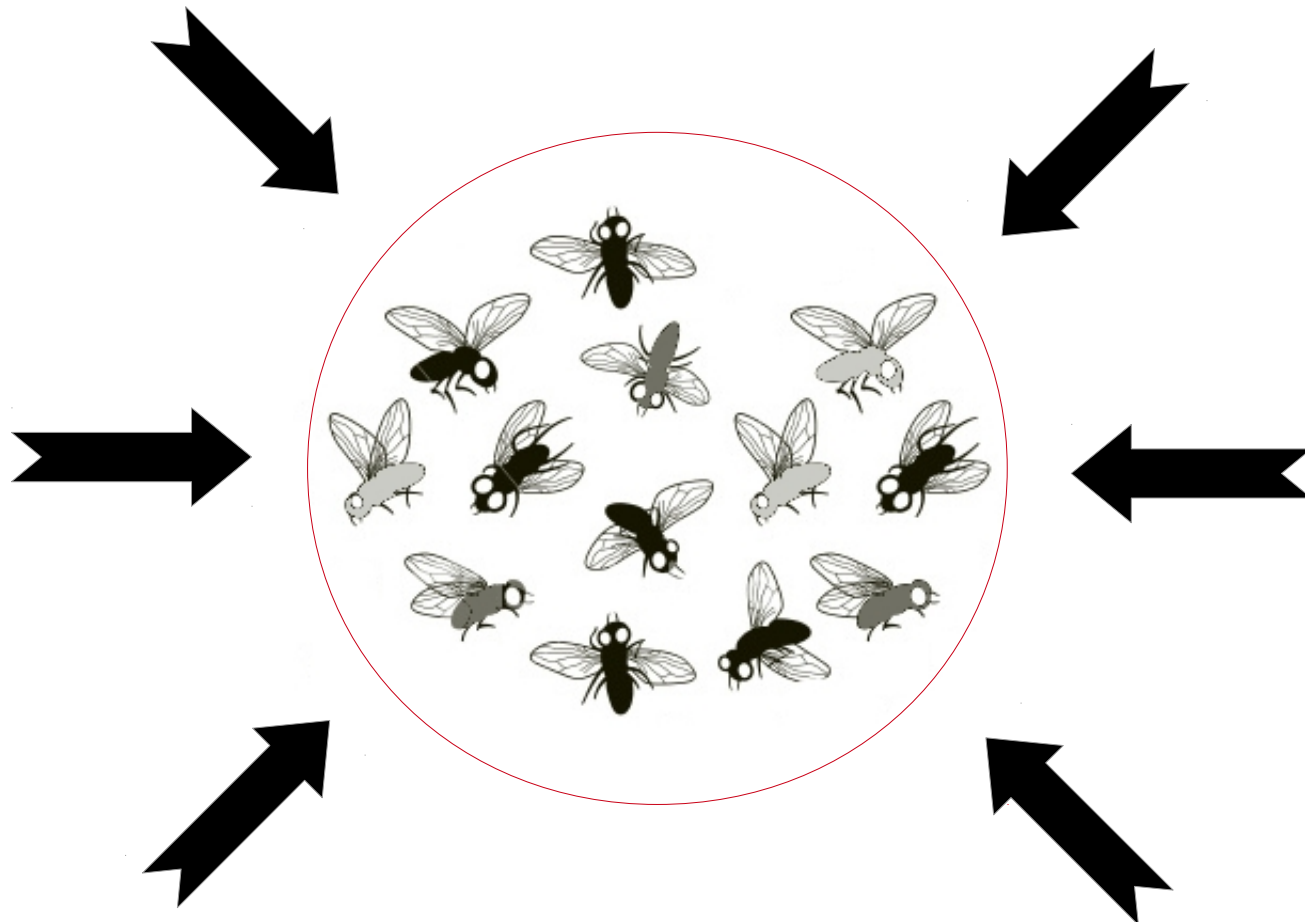
**PRESSÃO SELETIVA**

# *O mecanismo: Seleção natural*



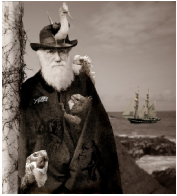
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## **SELEÇÃO E HERANÇA**



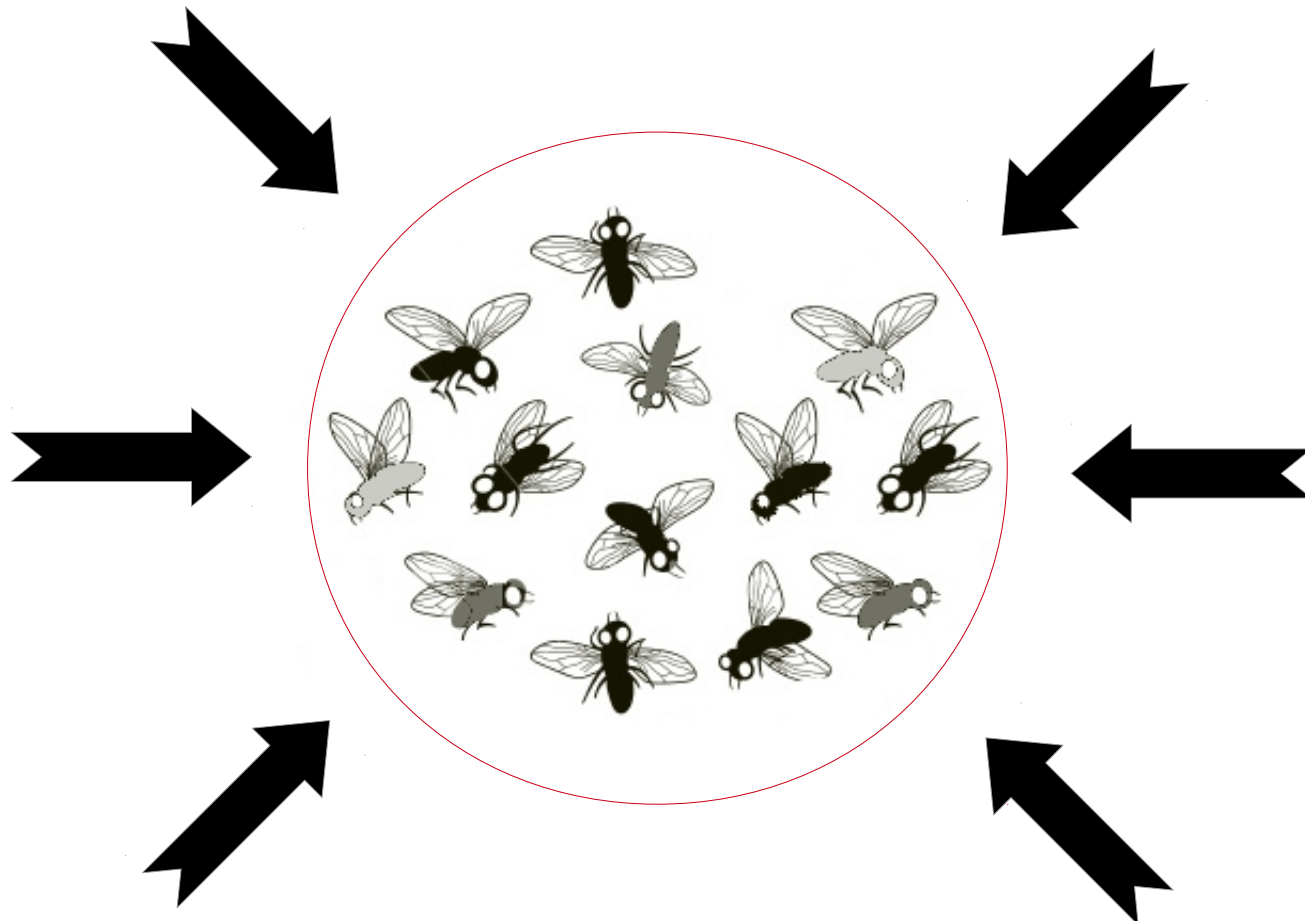
tempo  
geracional

# *O mecanismo: Seleção natural*



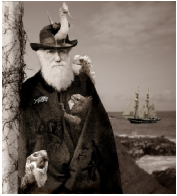
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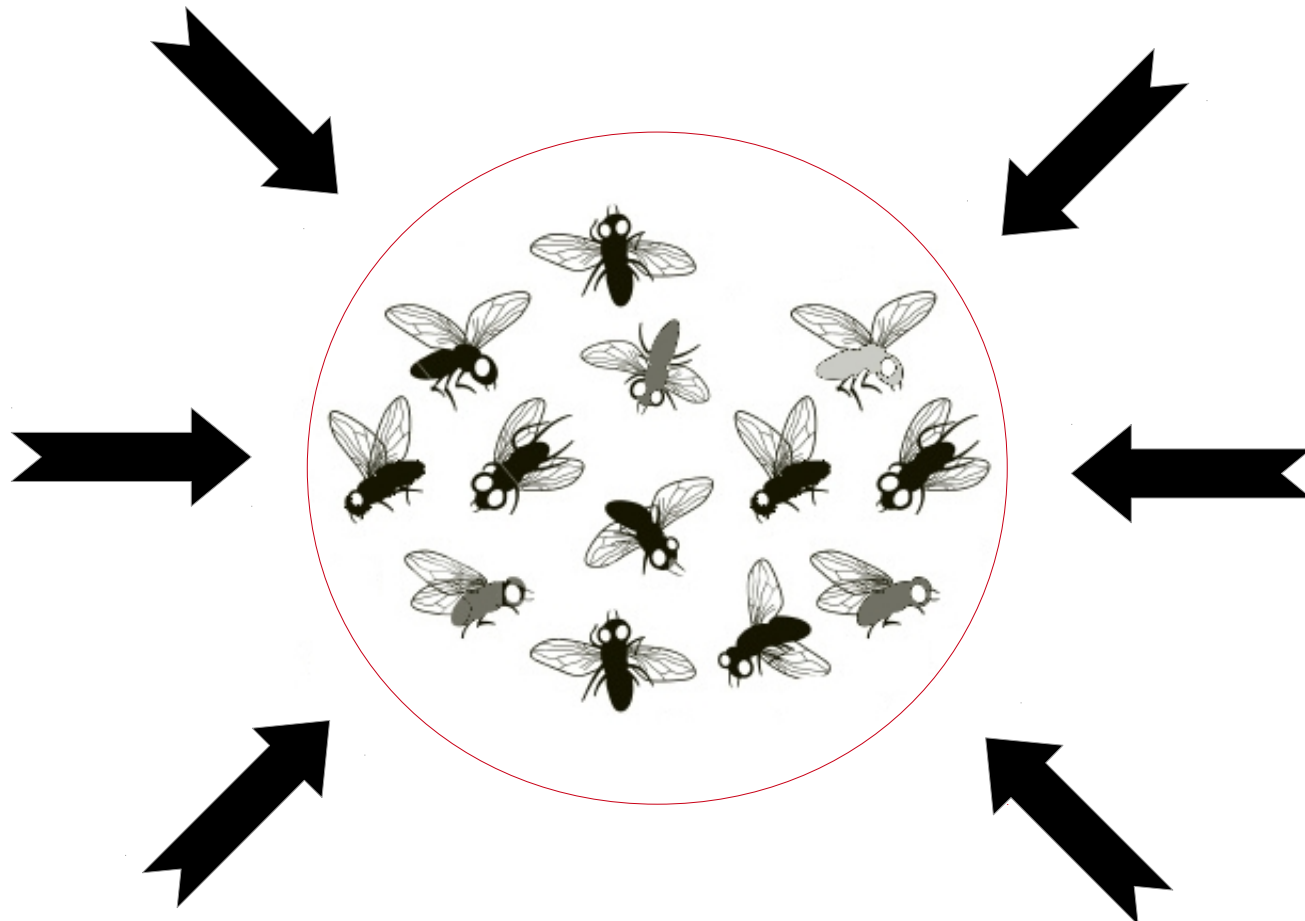
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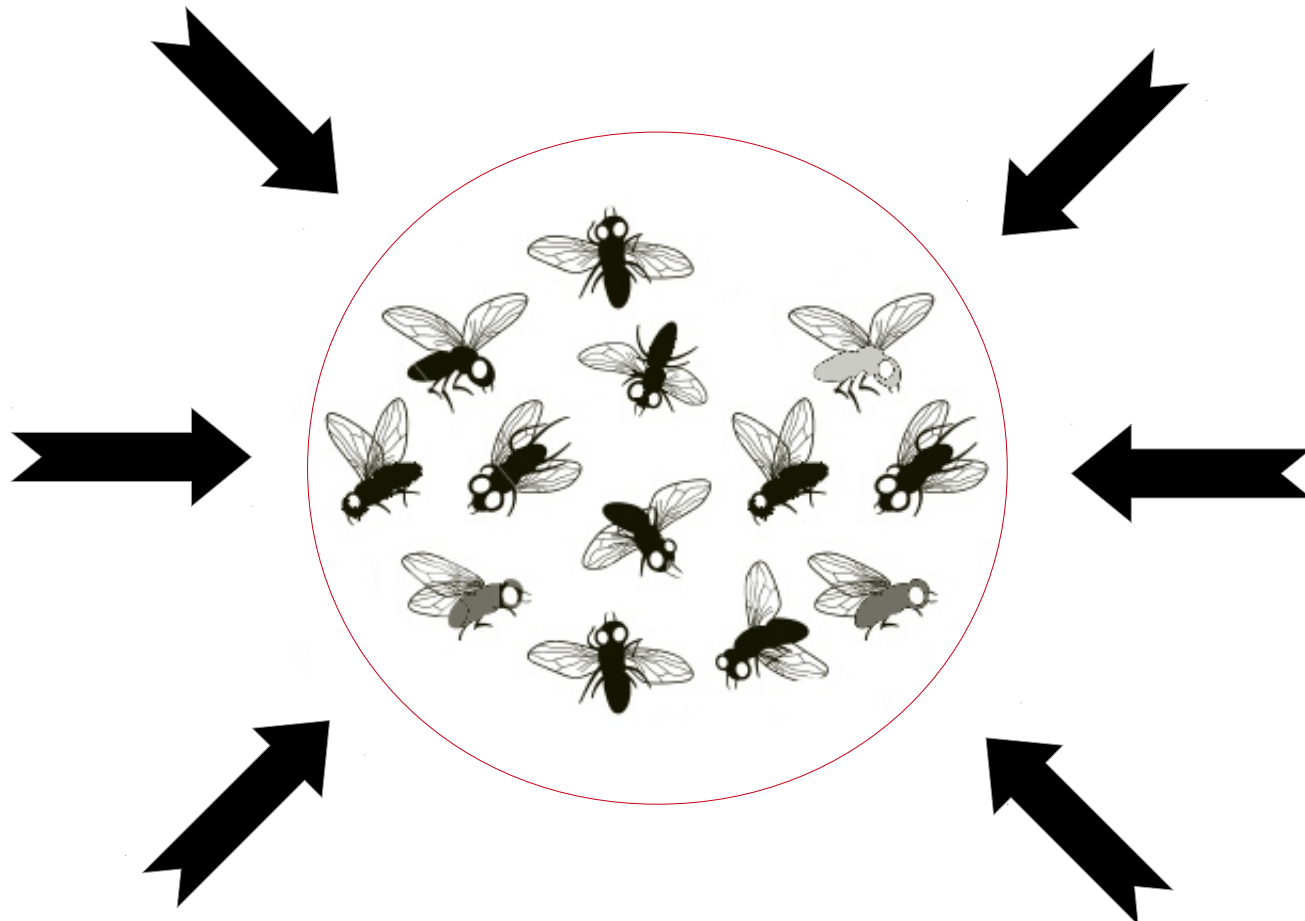
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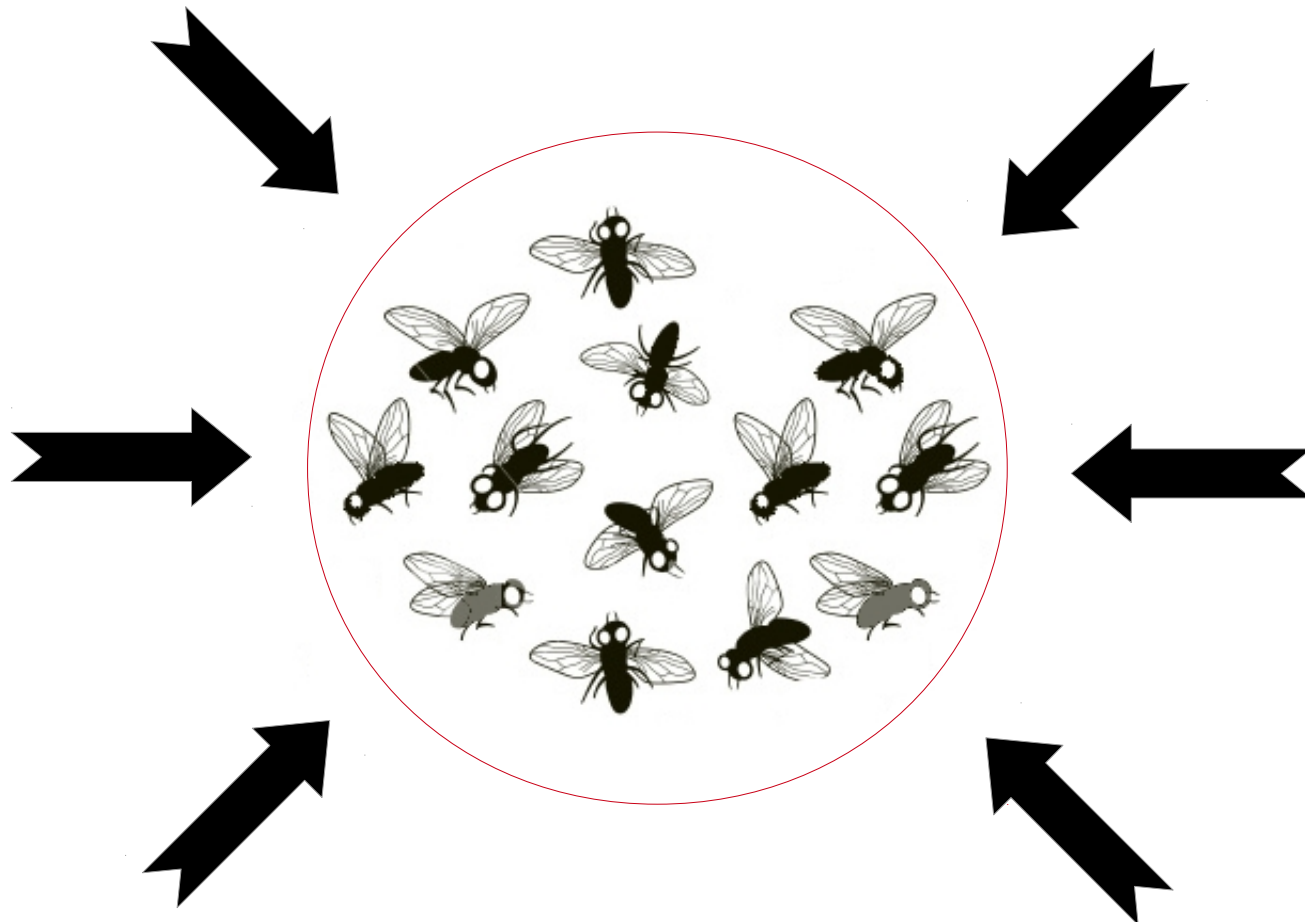
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tempo  
geracional

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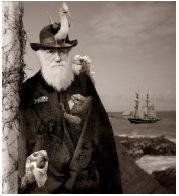
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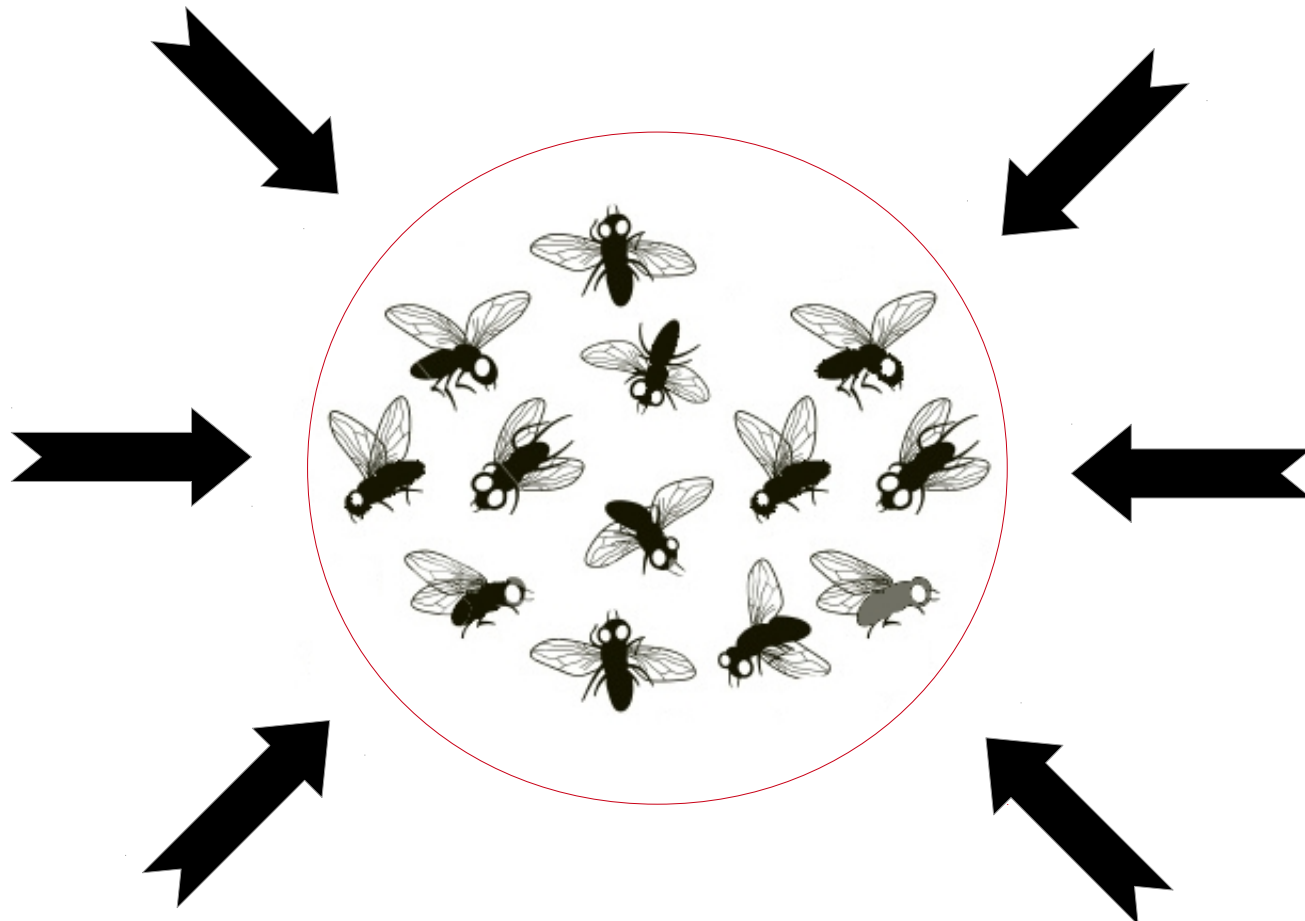
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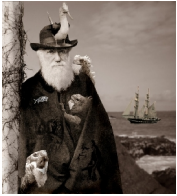
## **SELEÇÃO E HERANÇA**



tempo geracional

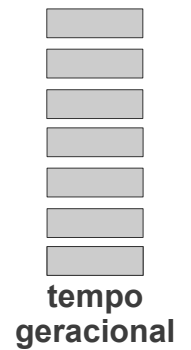
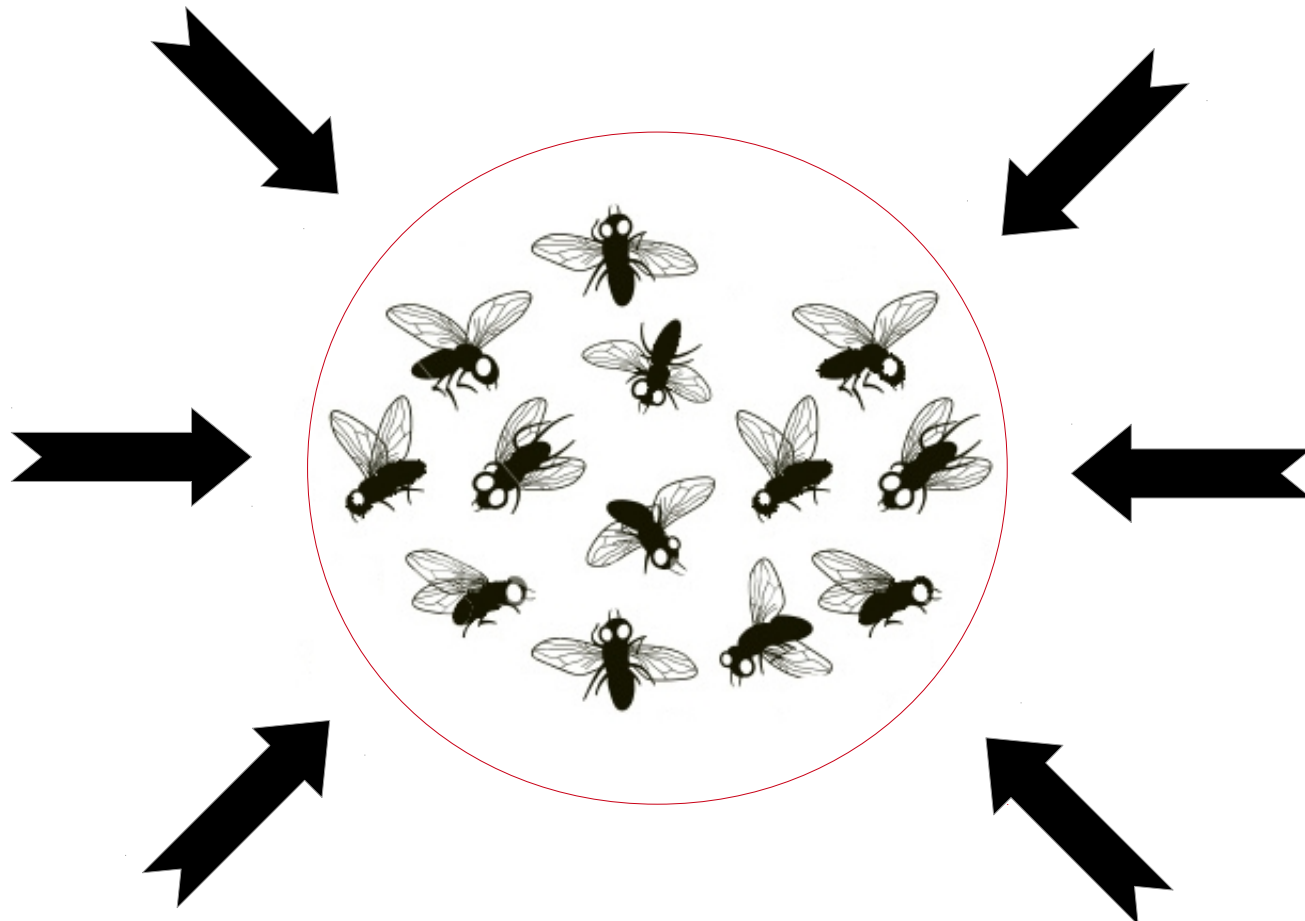


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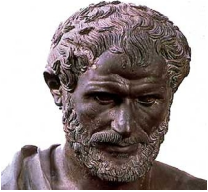
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## **SELEÇÃO E HERANÇA**



# 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



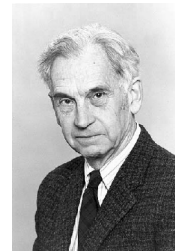
“The first period was initiated by the publication of *Genetics and the Origin of Species* (1937) by the Russian-born American evolutionist Theodosius Dobzhansky (1880–1959).

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Ernest Mayr  
1904 - 2005



G.G. Simpson  
1902 - 1984



# *A revolução que se inicia*

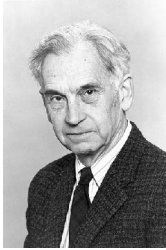
Genética Populacional: R. A. Fisher (1890-1962), J. B. S. Haldane (1892-1964) e Sewall Wright (1889-1988).

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.

# *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**.

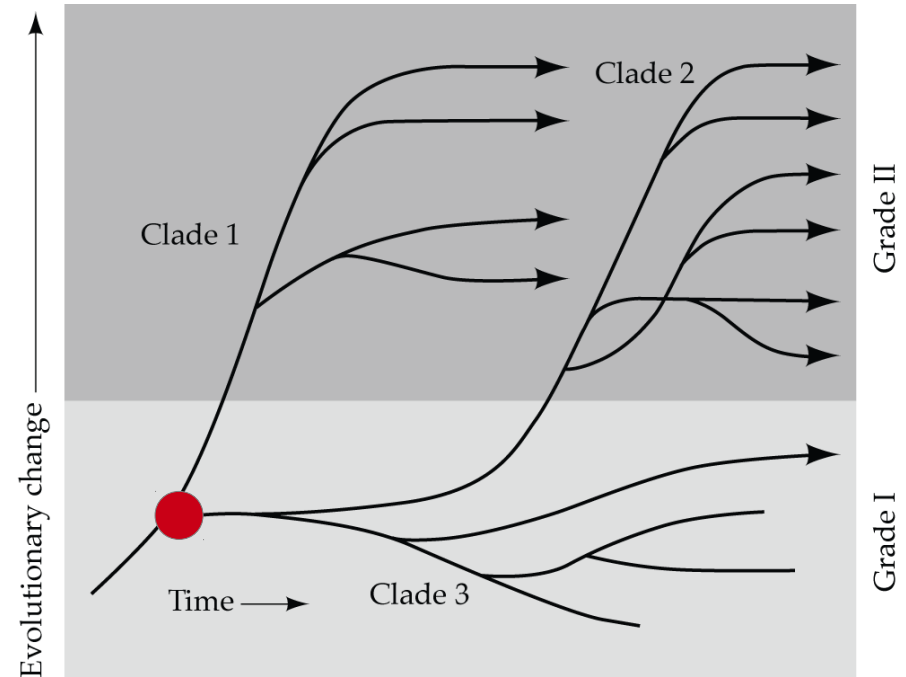
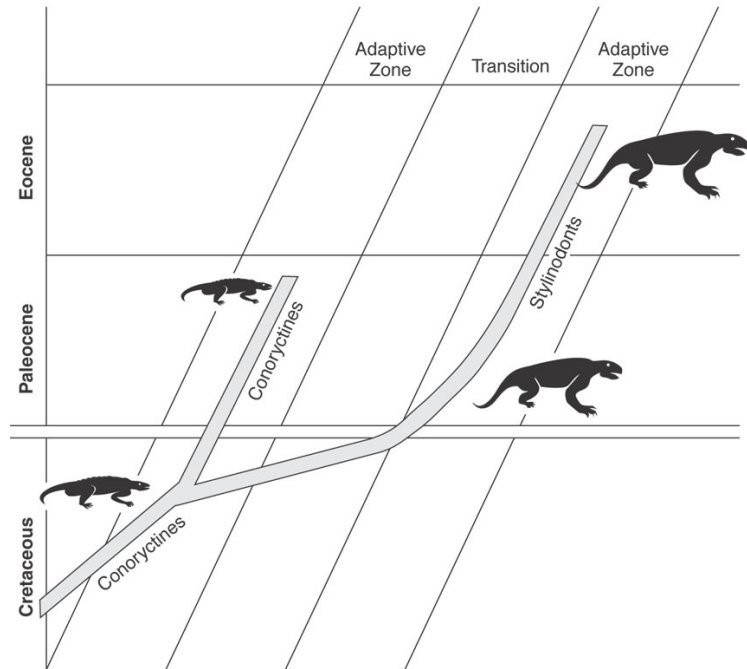
Classificações não podem e não deveriam expressar filogenia, no entanto devem ser consistentes com as mesmas.

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

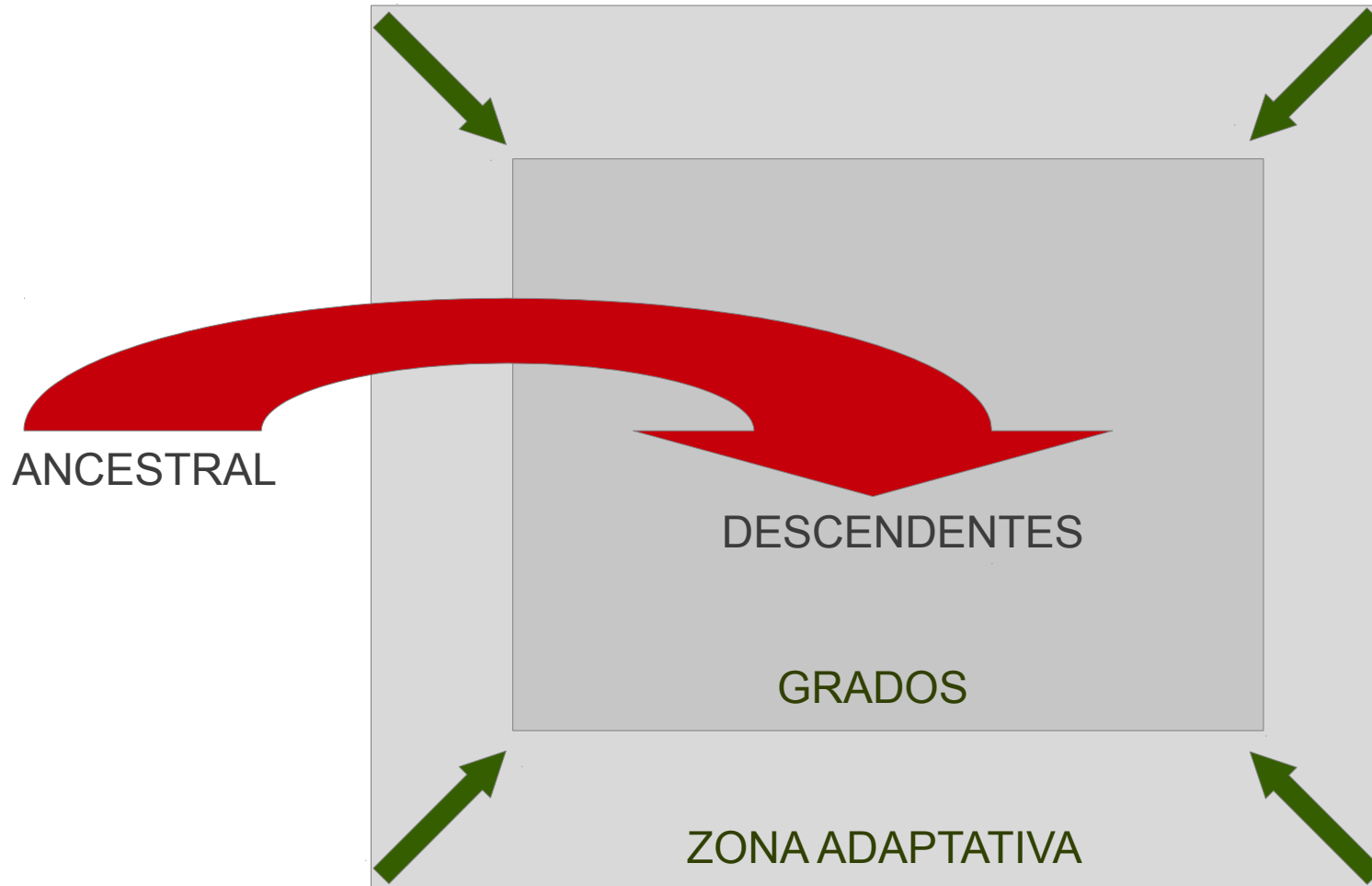


● = ancestral comum

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

# *Sistemática Evolutiva* [Gradismo]

## Grados e Zonas adaptativas



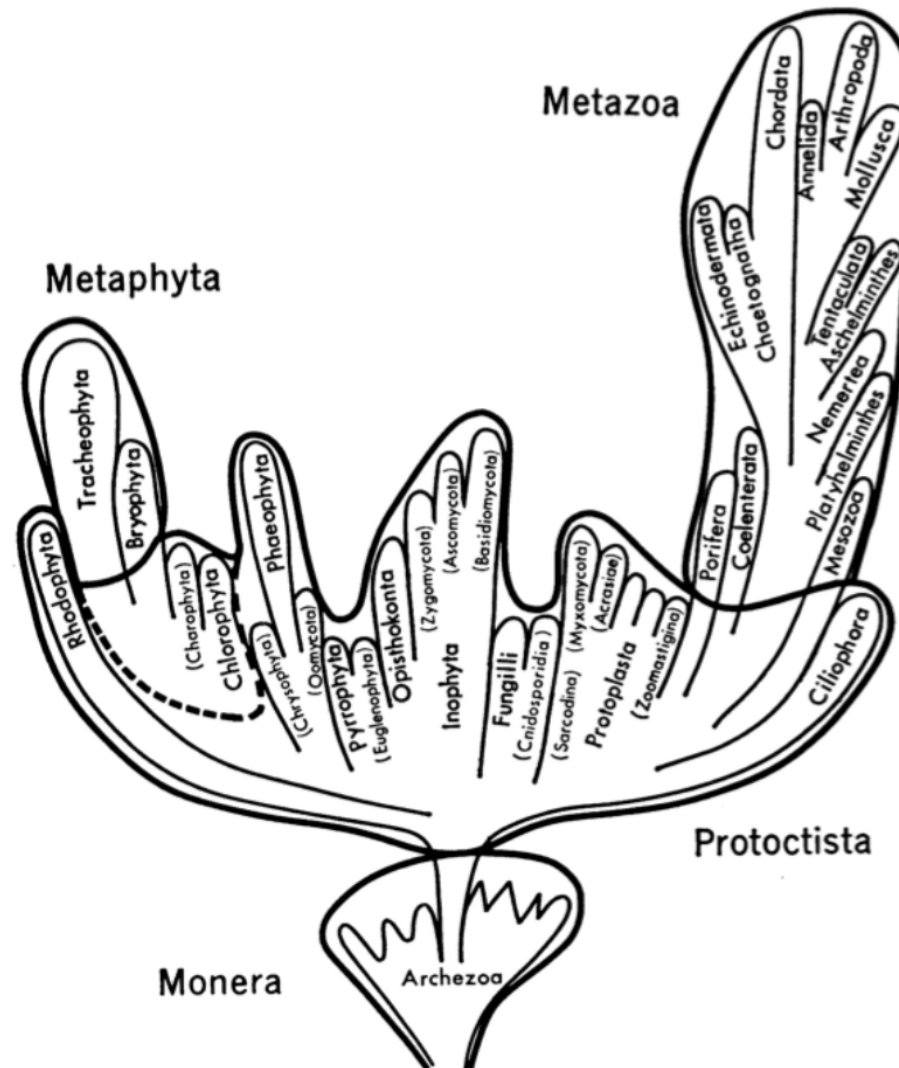
➔ PRESSÕES SELETIVAS

# *Sistemática Evolutiva* [Gradismo]

Exemplos em outra disciplina:

## Copeland 1938

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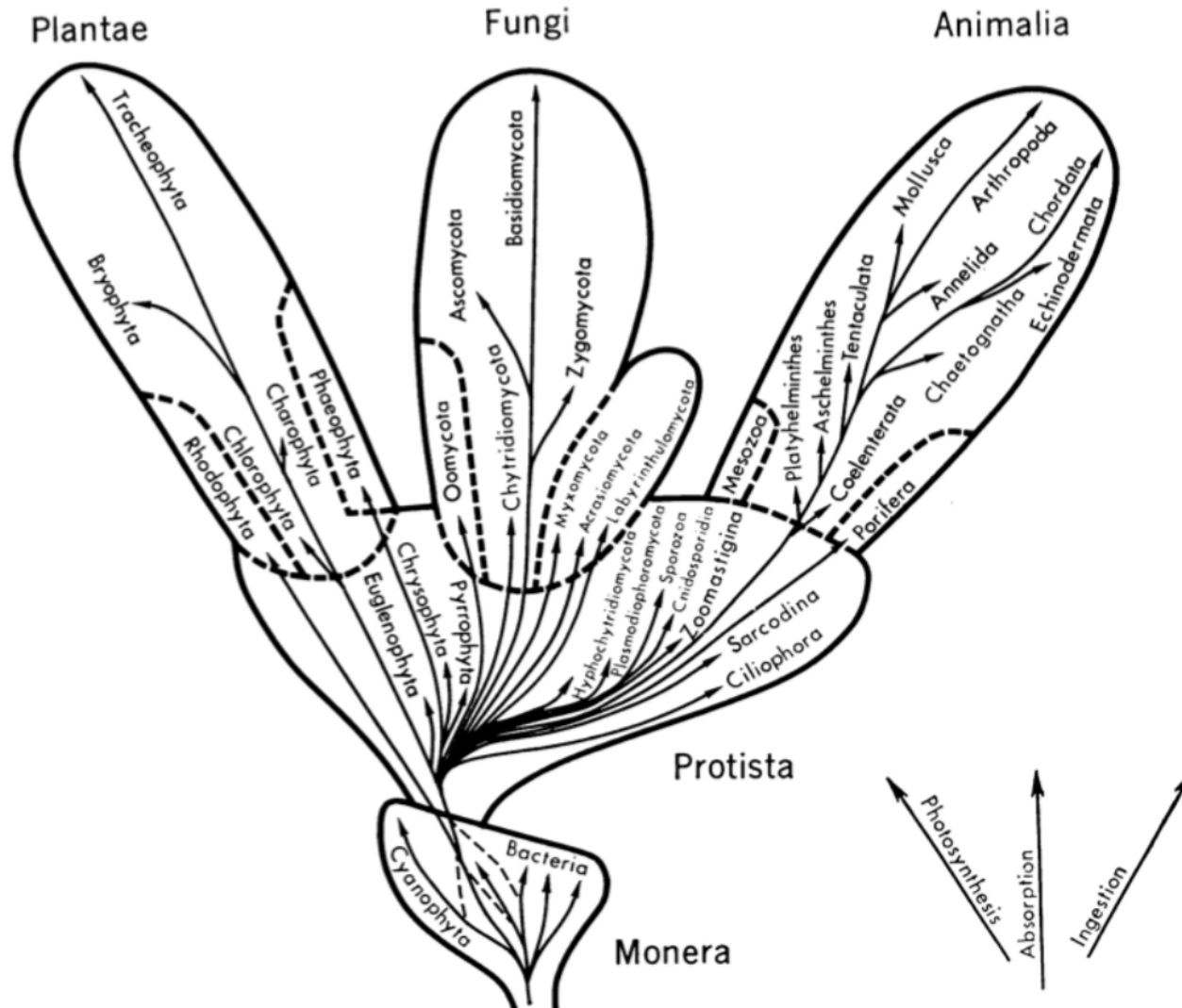


# *Sistemática Evolutiva* [Gradismo]

Exemplos em outra disciplina:

## Whittaker 1969

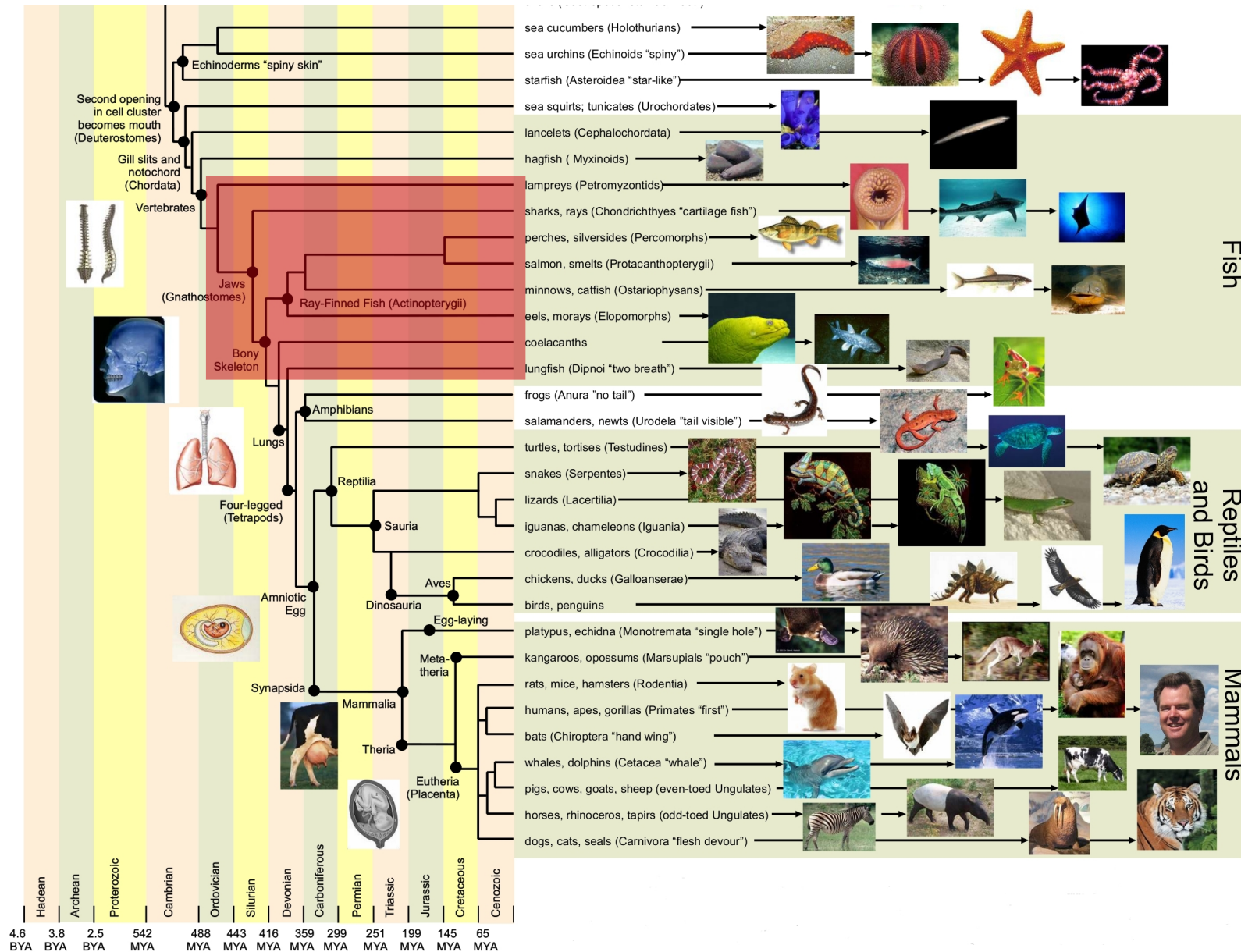
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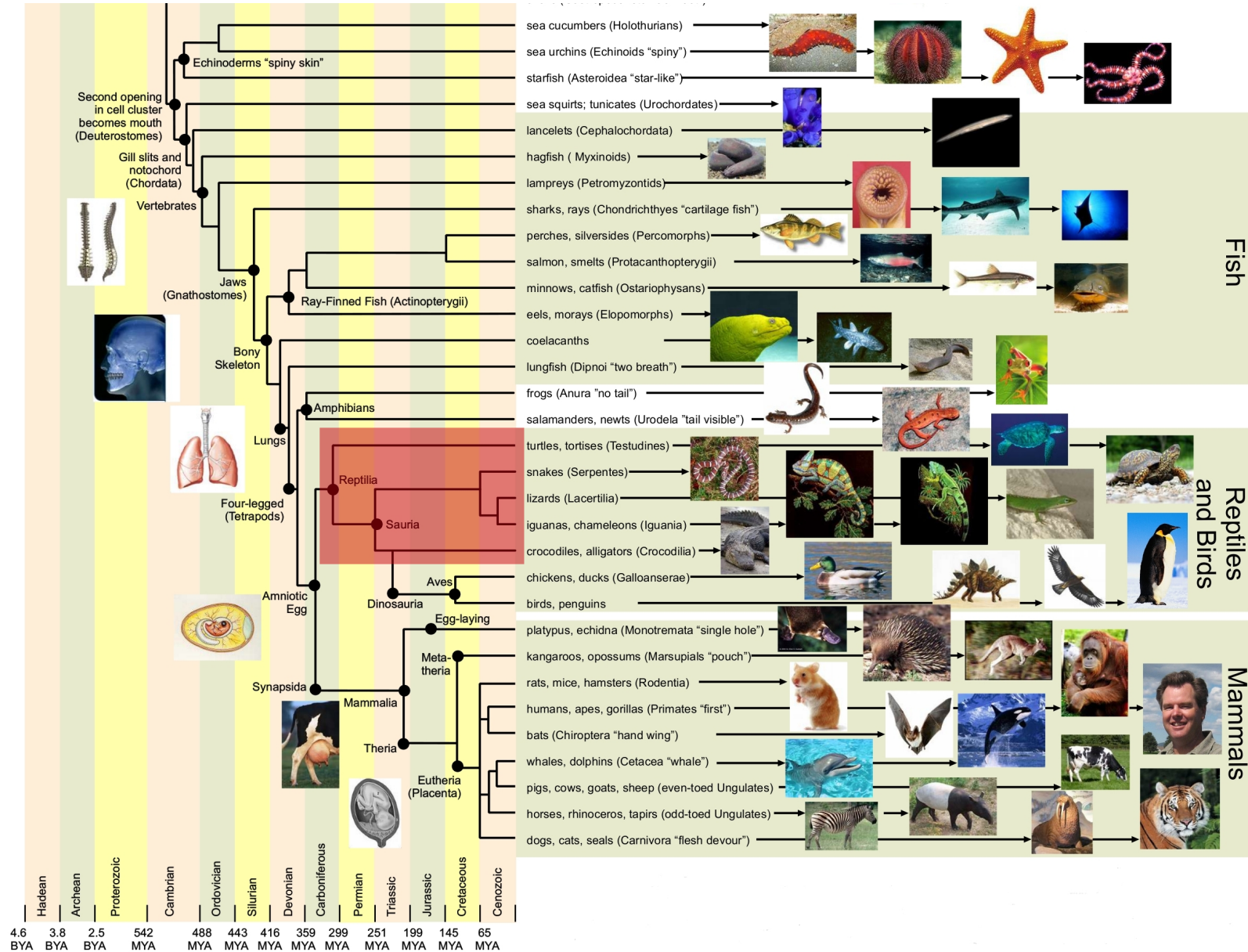
# Sistemática Evolutiva [Gradismo]

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. não homologia (analogia/paralogia)*

*Seleção Natural: variabilidade, pressão seletiva e herança*

*Nova síntese e Sistemática Evolutiva (Gradismo)*

*Grupos monofiléticos, Zonas adaptativas e Grados*