



Functional unit and unit of selection

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Overview

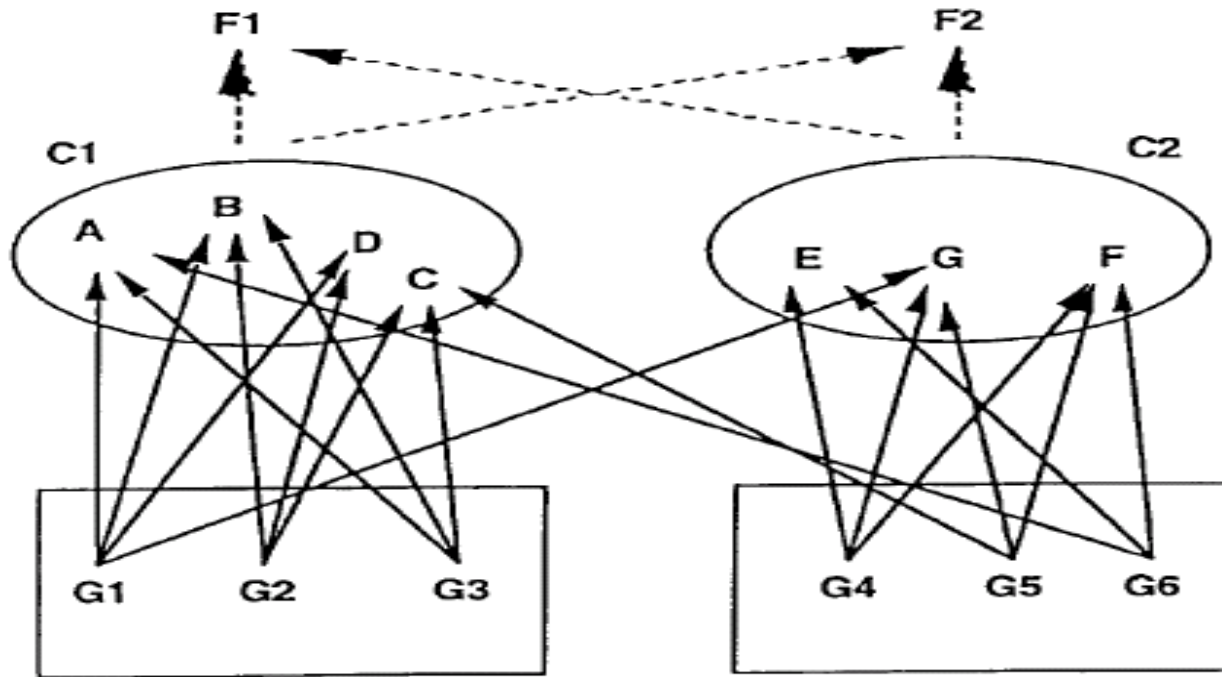
- Adaptation and Function in the Modern Synthesis
- Unit of selection/functional unit in taxonomy
- The question of the unit of selection in Modern Synthesis

Adaptation and Function in the Modern Synthesis

Functional unit = unit of selection

- Adaptive evolution by natural selection
 - a change of gene frequency through phenotypic traits (having a function corresponding to an environmental pressure), and through them affects the genetic basis of the latter (R. Brandon, 1999).
- **Selective pressure → [functional unit → (phenotypic traits → genes)]**
- Functional unit and unit of selection - matches sharing
 - The same function
 - Commonly inherited
 - Contributing to the fitness
 - (mimetic or camouflaging wing patterns of butterflies)

Functional unit = unit of selection



Mostly inner pleiotropy: traits/genes matches are weakly connected to other traits/genes (R. Brandon, 1999)

Functional unit = unit of selection

- The evolution of one unit does not necessarily entail the evolution of another one:
 - *“Quasi-independence means that there is a great variety of alternative paths by which a given characteristic may change, so that some of them will allow selection to act on the characteristic without altering other characteristics of the organism in a countervailing fashion”* (R. Lewontin, 1978:230).

Functional unit = unit of selection

- Functional unit
 - The cladistics' aim is to define taxa and to establish phylogenetic relationships between them
 - Homologies and symplesiomorphic properties.
- Unit of selection
 - The adaptationism's aim is to explain features as responses to common selective pressure
 - **homoplasies** and **synapomorphic** properties (similar properties between no related species, called also evolutionary **convergences** or evolutionary **analogies**).
 - Adaptation – selected feature, i.e. resulting from natural selection

Unit of selection/functional unit in
taxinomy

Functional unit in taxonomy

- Adaptive characters are valueless to the cladistics:

“ For animals, belonging to the most distinct lines of descent, may readily become adapted to similar conditions, and thus assume a close external resemblance; but such resemblances will not reveal, will rather tend to conceal their blood-relationship to their proper line of descent” (Ch. Darwin, 1859:chap.XIII).

Functional unit in taxonomy

- The greater is the contribution of common ancestry, the lesser the role of natural selection is.
 - The more similar, but the less related the species are, the greater role of environmental selective pressure we attribute to their origin,
 - e.g. common selective pressure is the evolutionary cause for white plumage and coats of arctic animals.

Functional unit in taxonomy

- *common cause explanation* (B. Russell, 1948:216)
 - the deduction from two correlated properties of one common cause, rather than of two independent causes.
 - If every bulb in the house blows at the same time, we will find more likely that the fuse has gone (and have recourse to *common cause explanation*) rather than each bulb has blown independently (and have recourse to *separate common explanation*, E. Sober, 1984:212).
- The same goes for homoplasies and synapomorphic properties (not inherited from common ancestor) from which we deduce the contribution of a common environmental cause (E. Sober, 1984:225)

Functional unit in taxonomy

- Similarities between species does not automatically imply their phylogenetic relationship
- The more similar species are (event if related), the greater is the chance that they result from common selective pressure and constitute adaptations.

Functional unit in taxonomy

- Inherited element or adaptation? –
 - not exclusive (either the first or the second), but asymmetrical (E. Sober et St. Orzak, 2003:428).
 - the common origin - a necessary but not sufficient condition for a property to be shared in succession by species within a lineage
 - a continuous control of stabilizing natural selection is still required:
 - if predators and with them selective pressure disappear, mimetic ocella on the wings of *Papilio dardanus*, resembling the eyes of insectivorous predators of butterfly's predator, disappear too (E. Mayr, 1994/1963:165-166).

Functional units and units of selection (adaptations)

- Units - trait/gene matches sharing the same function and commonly inherited.
 - Such associations are engendered by phenomena such as
 - genetic linkage (association of genes on the same chromosome, that causes them to be inherited together),
 - epistasis (one nonallelic gene determines whether other genes are expressed or not),
 - pleiotropy,
 - polygeny,
 - recessiveness, etc.

Functional units and units of selection (adaptations)

- There exist the possibility that selectively harmful or neutral proprieties are in, entered thanks to the association with other advantageous properties of the unit - *free riders*.
- Properties that are one of many effects of pleiotropic gene can enter the next generation thanks to other phenotypic effects the gene has:
 - If a selectively harmful or neutral propriety X is linked by association to an advantageous property Y, X will be transmitted to the next generation.
- Is X selected? Is X an adaptation (E. Sober, 1984:196-197)

Functional units and units of selection (adaptations)

- Recessiveness: Mutations can slip into the genetic pool of the next generation in spite of their harmfulness when in recessive condition.
 - Recessive means of little or of no effect when accompanied with a contrasting allele, expressed only in pair with identical allele, i.e. in homozygous condition.
 - Dominant means expressed also in heterozygous condition, i.e. in pair with recessive allele.
 - homozygous condition - in diploid organism mother's and father's alleles are identical.

The question of the unit of selection in Modern Synthesis

The problem of unit of selection

- Unit of selection – level of natural selection's action
 - Gene (R. Dawkins, 1975)
 - Diploid genotype (R. Lewontin, E. Sober, 1982)
 - Properties - all factors contributing to a given property: genes + environmental cues (M. Mamei, 2005)

	Anémie falciforme	Paludisme	Sélection au niveau du gène seul	Avantage sélectif
<i>AA</i>	non	oui		
<i>aa</i>	oui	Mort de toute manière	oui	oui
<i>Aa</i>	Un peu malade	non	non	Seulement si le paludisme sévit dans l'environnement

Du point de vue du gène:

allèle *a* **augmente** la fitness si accompagné par *A*
allèle *a* **diminue** la fitness si accompagné par *a*

il n'y a pas de sélection pour l'hétérozygote *Aa*
il y a la sélection pour l'homozygote *aa*

Level of selection

- Soit *contexte independent*, soit ce n'est pas LA cause sélective
 - « *Si la fitness de x varie en fonction du contexte, ce n'est pas x qui est sujet à la sélection, mais plutôt un niveau d'organisation supérieur à x* » (E. Sober, et R. Lewontin, 1982:162)
- « *si la fitness de x varie en fonction du contexte, alors*
 - *soit 1) aucune sélection ne s'opère à un niveau d'organisation supérieur à x ;*
 - *soit 2) plusieurs processus sélectifs différents s'opèrent au niveau de x* » (K. Waters, 1991)

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aa : il y a la sélection pour le gène seul

Aa : il y a la sélection pour l'environnement du gène i.e.:
le gène A
la présence de la malaria)

- L'unité de sélection \neq l'unité du développement:
 - Ce qui est sélectionné (hérité) – gène;
 - Ce qui sélectionne – la fitness et tout ce qui y contribue, c'est-à-dire:
 - Le gène (R. Dawkins);
 - Le développement ontogénétique (acquisition individuelle) qui dépend de:
 - génotype diploïde (R. Lewontin);
 - environnement développemental (S. Oyama, Griffiths);
 - environnement (y compris d'autres espèces, cf. Van Valen);
 - apprentissage (J. M. Baldwin).
- **La sélection opère sur la fitness**

The power of natural selection – Theory of death

- In principle:
 - lethal mutations can enter genetic pool if mutation occurs on the gene in heterozygous condition, that is the gene is not expressed. Lethal mutation could not slip to the next generation if gene is in homozygous condition, because it causes the death of its bearer.
- BUT: *Housekeeping genes* - switch on chronologically, and some of them after reproductive age of organisms.
 - if a disadvantageous mutation occurs on such a lethal gene, its selective value is neutral and it is transmitted to the next generation (St. Cebrat, 1998).
 - The more genes switch on late in the ontogenesis, the greater chance they are disadvantageous, or that they are *genes of death* responsible for senescence illnesses, like Alzheimer, Parkinson, etc.

Thank you for your attention

You are all welcomed to visit the web site of the virtual
seminar

« Adaptation and representation »

at:

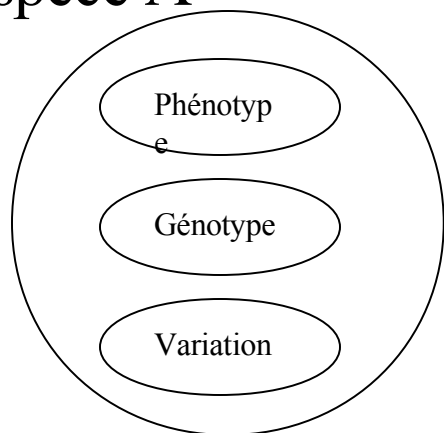
www.interdisciplines.org/adaptation

Niche construction - references

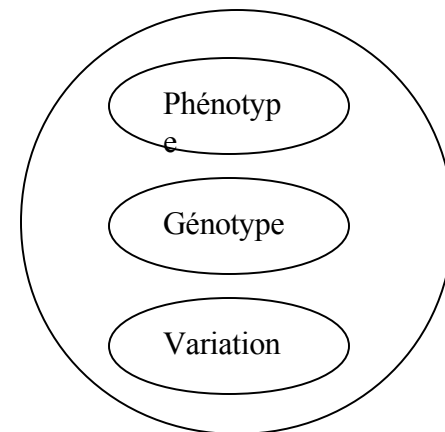
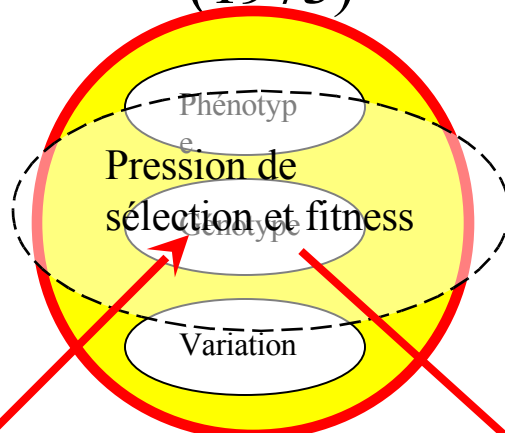
- <http://www.st-andrews.ac.uk/~seal/niche/publications.html>
- **Odling-Smee**, F.J., Laland, K.N. et Feldman, M.W. 1996. Niche construction. *American Naturalist*. 147(4):641-648.
- **Odling-Smee**, J. ; Laland, K. et Feldman, M. 2003. *Niche construction : the neglected process in evolution*. Princeton University Press.
- **Day**, R.; Laland, K. et Odling-Smee, J. 2003. Rethinking adaptation: the niche-construction perspective. *Perspectives in Biology and Medicine* 46, n° 1. pp. 80-95.

Contre l'asymétrie causale: la Théorie de la Reine Rouge (1973)

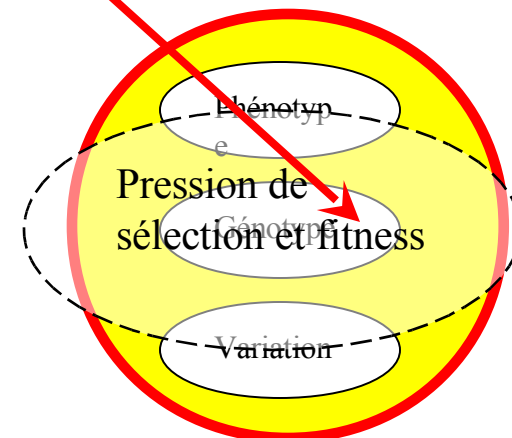
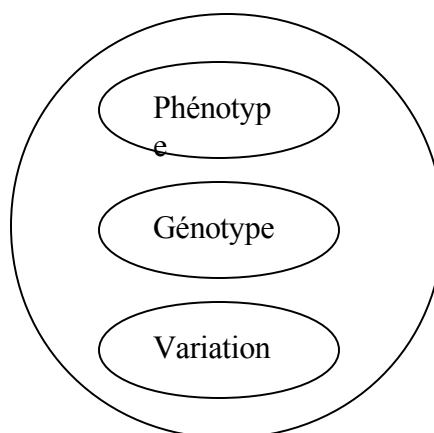
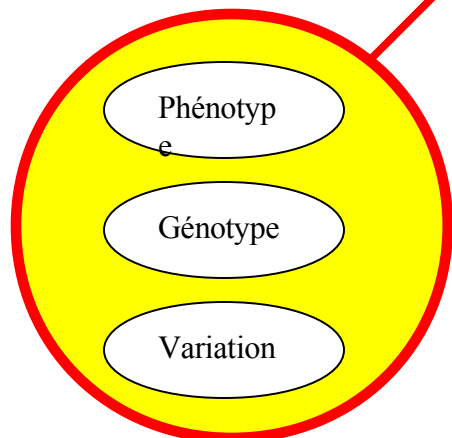
Espèce A



(1973)



Espèce B



generation: n

$n + 1$

$n + \dots + n$

Construction de Niche

