Journées AFSCET, La systémique face à la question du déterminisme. **Andé, 04 mai 2018**

Déterminisme et indéterminisme multi-échelle, invariants et variance, des systèmes vivants.

Pierre BRICAGE
AFSCET, WOSC, IASCYS

pierre.bricage@univ-pau.fr

https://www.afscet.asso.fr/pagesperso/Bricage.html

Bricage P. (2018) ***Déterminisme et indéterminisme multi-échelle, invariants et variance des systèmes vivants. -présentation-.*** Journées annuelles de l'AFSCET à Andé, France, 05 mai 2018, 84 p., http://afscet.asso.fr/Ande18/pbricage_Ande2018_interactions-PowerLaws_presentation.pdf

Pierre BRICAGE

四川大学, 成都市, 中华人民共和国

long term guest Professor University of Sichuan, Chengdu, P.R. China

biologiste indépendant, enseignant-chercheur retraité

Faculté des Sciences et Techniques, **Université de Pau et des Pays de l'Adour**

UPPA, Pau, France, Europe http://web.univ-pau.fr/~bricage

Vice-Président **Association Française de Science des Systèmes**

AFSCET, Paris, France, Europe http://www.afscet.asso.fr

ex-Deputy Secretary General of **European Union for Systemics**

UES-EUS, Bruxelles, Belgique, Europe http://www.ues-eus.eu

Directorate **World Organisation of Systems and Cybernetics**

WOSC, London, UK http://www.wosc.co

Secretary General **International Academy for Systems and Cybernetic Sciences**

IASCYS, Wien, Österreich, Europa http://iascys.org

Président Association **ALBA**, Trésorier Association **PELLEAS**

Lasclaveries, France, Europe http://armsada.eu

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

Pau

ALBA · Association PELLEAS · SOME RIGHTS RESERVED creative commons · MCX 20 · AFSCET · ISSS · emcsr · UES - EUS · WOSC · IASCYS

SURVIVRE

1. La MOBILISATION de la MATIÈRE et de l'ÉNERGIE
2. La CROISSANCE en masse et en nombre
3. La RÉPONSE à des STIMULATIONS
4. L'ORGANISATION interne, dans l'espace et dans le temps
5. L'INTÉGRATION externe
6. Le MOUVEMENT

pour **SE SURVIVRE**

7. La REPRODUCTION

→ *" invariance de jauge des systèmes vivants "*

Bricage P. (1991)

pierre.bricage@univ-pau.fr http://www.afscet.asso.fr http://www.armsada.eu

BRICAGE Pierre (1991) Les caractéristiques des organismes vivants. 44 p.
Biologie, A.P.I.D.S., Fac. Sci. & Techniques, Univ. de Pau & Pays de l'Adour.

SURVIVRE

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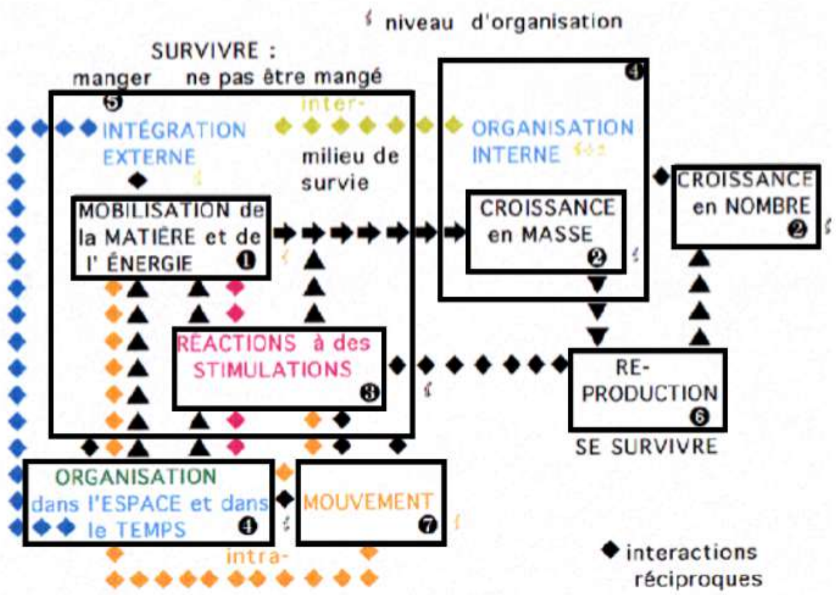
http://www.afscet.asso.fr/ergodiqW.pdf

p. 2/11

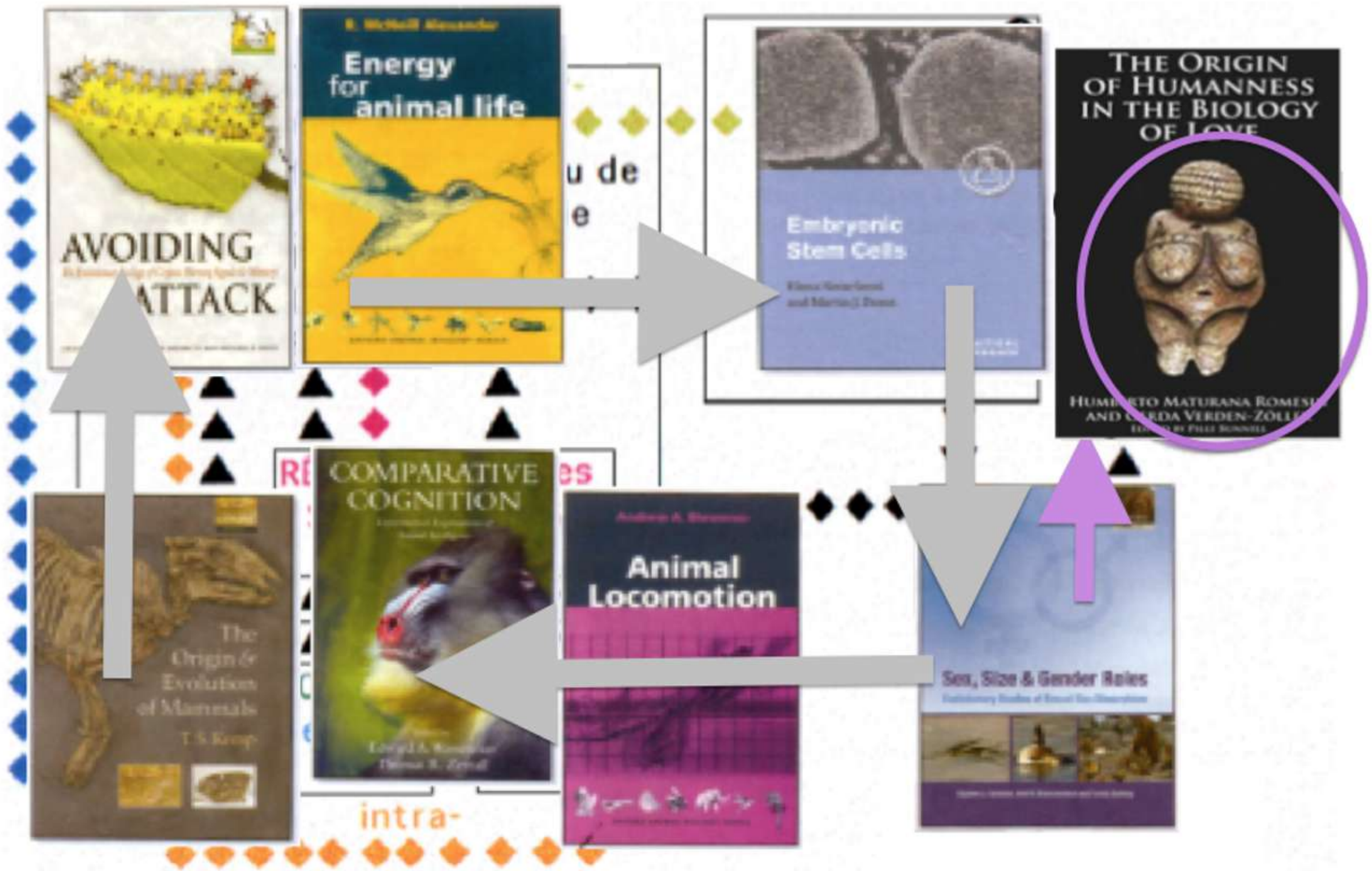
L'évolution, du vivant au social. 1er décembre 2001, **AFSCET**, I.I.A.P., Paris

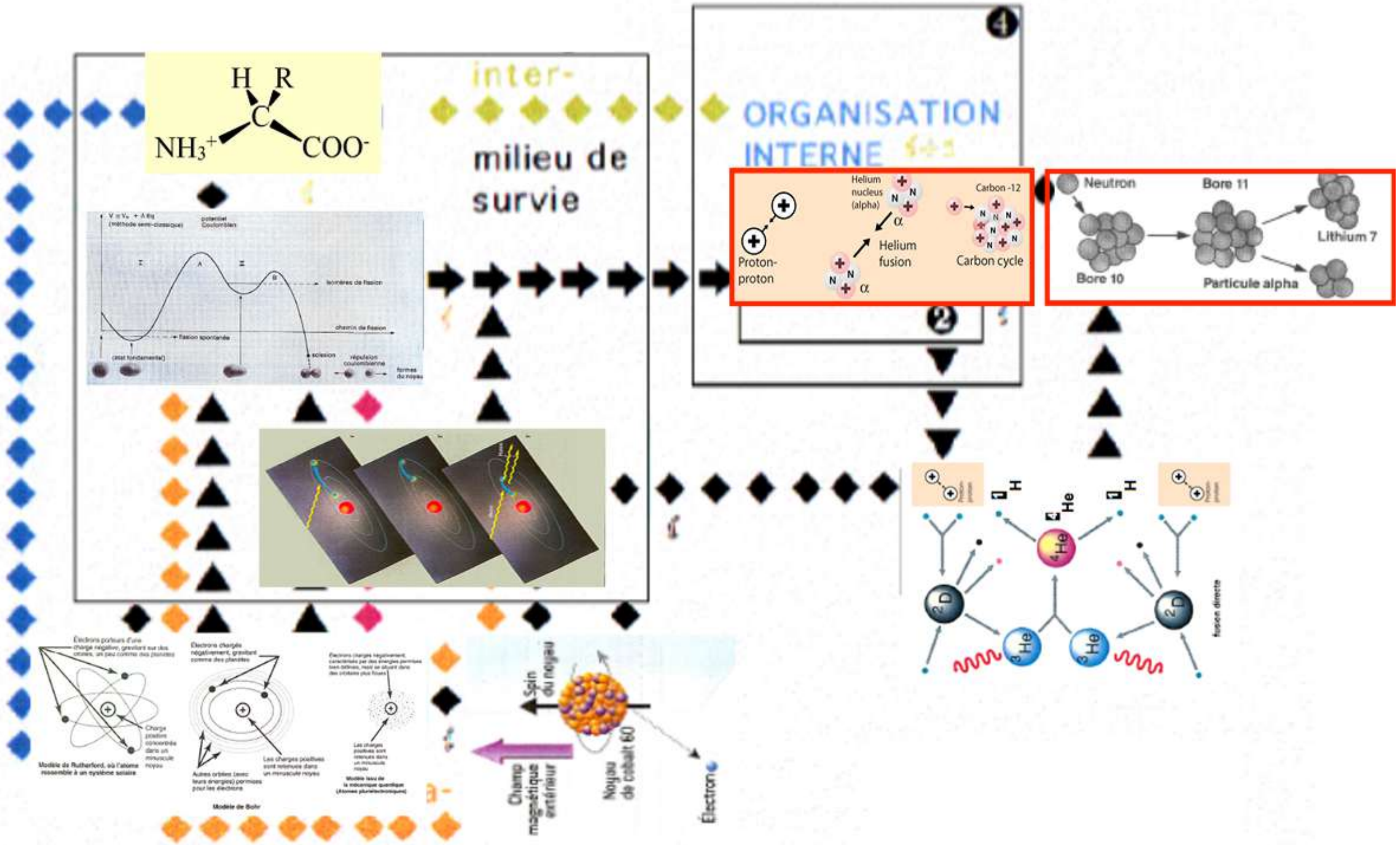
1· Les caractéristiques du vivant "vivant".



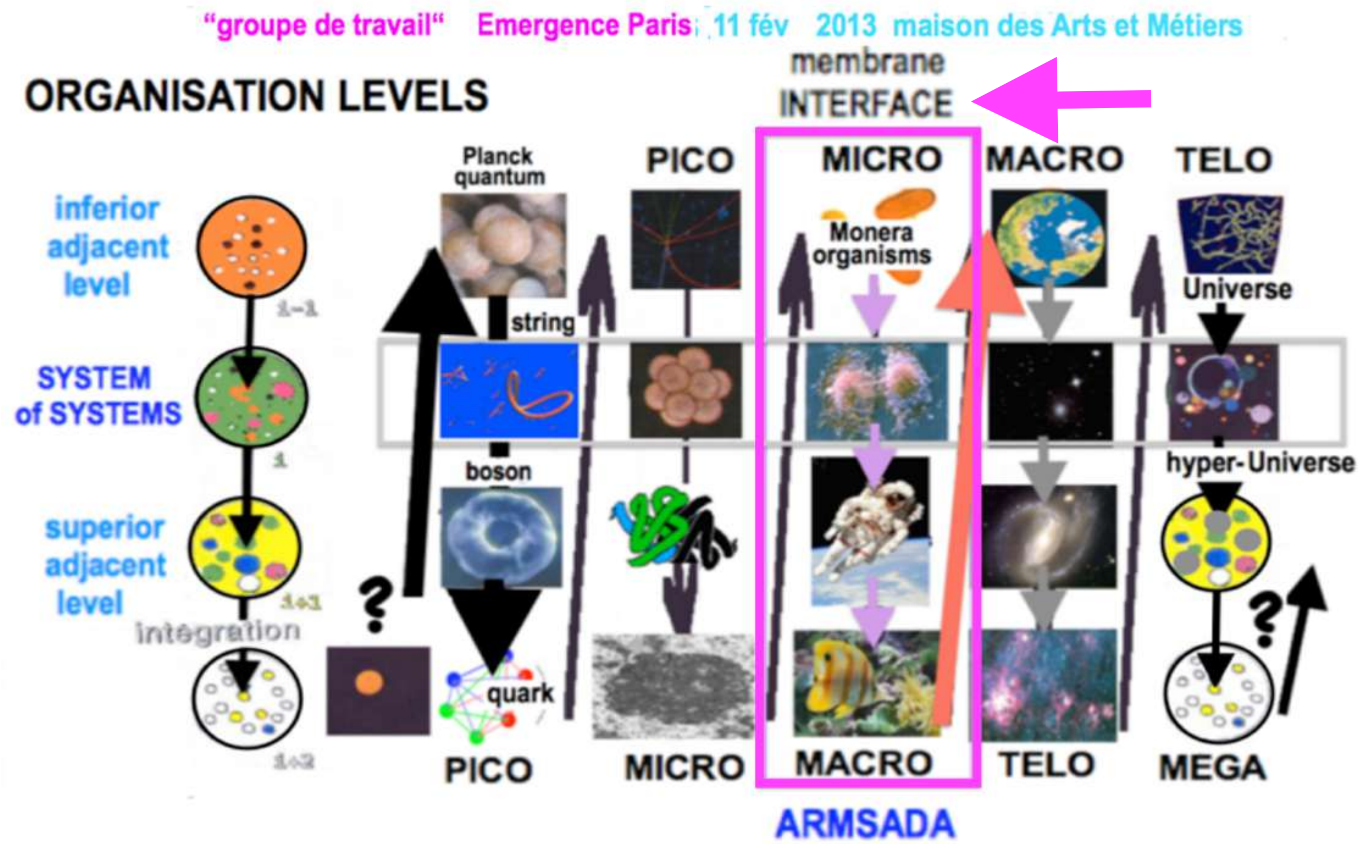
La survie des organismes vivants.
04 février 2000, Paris, 33 p.
http://www.afscet.asso.fr/SURVIVRE.pdf

les 7 degrés de liberté de la vie


AVOIDING
ATTACK
Energy for animal life
Embryonic Stem Cells
THE ORIGIN OF HUMANNESS IN THE BIOLOGY
COMPARATIVE COGNITION
The Origin & Evolution of Mammals
T. S. Kemp
Animal Locomotion
Sex, Size & Gender Roles
intra-



inter-
milieu de
survie
ORGANISATION
INTERNE
H R
C
NH_3^+
COO^-
Proton-
proton
Helium
nucleus
(alpha)
Helium
fusion
Carbon -12
Carbon cycle
Neutron
Bore 11
Lithium 7
Bore 10
Particule alpha
fusion directe
Spin du noyau
Champ magnétique extérieur
Noyau de cobalt 60
Électron
Modèle de Bohr


"groupe de travail" Emergence Paris 11 fév 2013 maison des Arts et Métiers
ORGANISATION LEVELS
membrane
INTERFACE
inferior adjacent level
SYSTEM of SYSTEMS
superior adjacent level
integration
Planck quantum
string
boson
quark
PICO
MICRO
MACRO
TELO
Monera organisms
Universe
hyper-Universe
PICO
MICRO
MACRO
TELO
MEGA
ARMSADA

intégration : écoexotope - endophysiotope **capacité d'accueil – capacité d'être accueilli**

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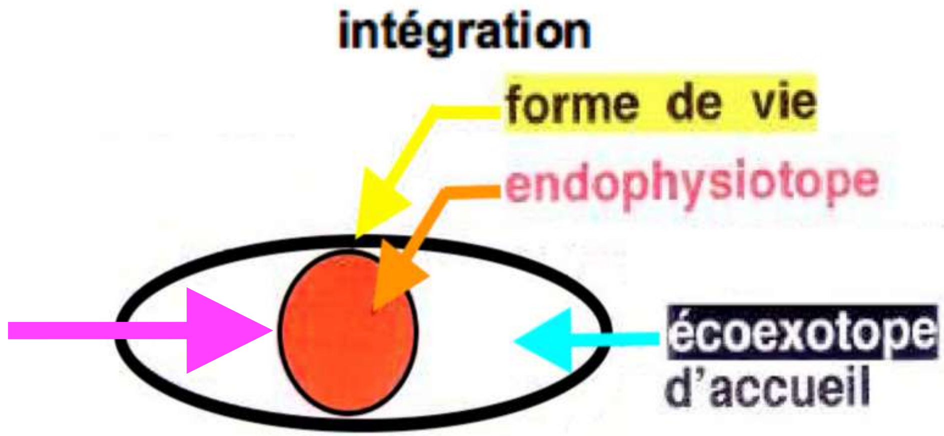
pour **SE SURVIVRE**

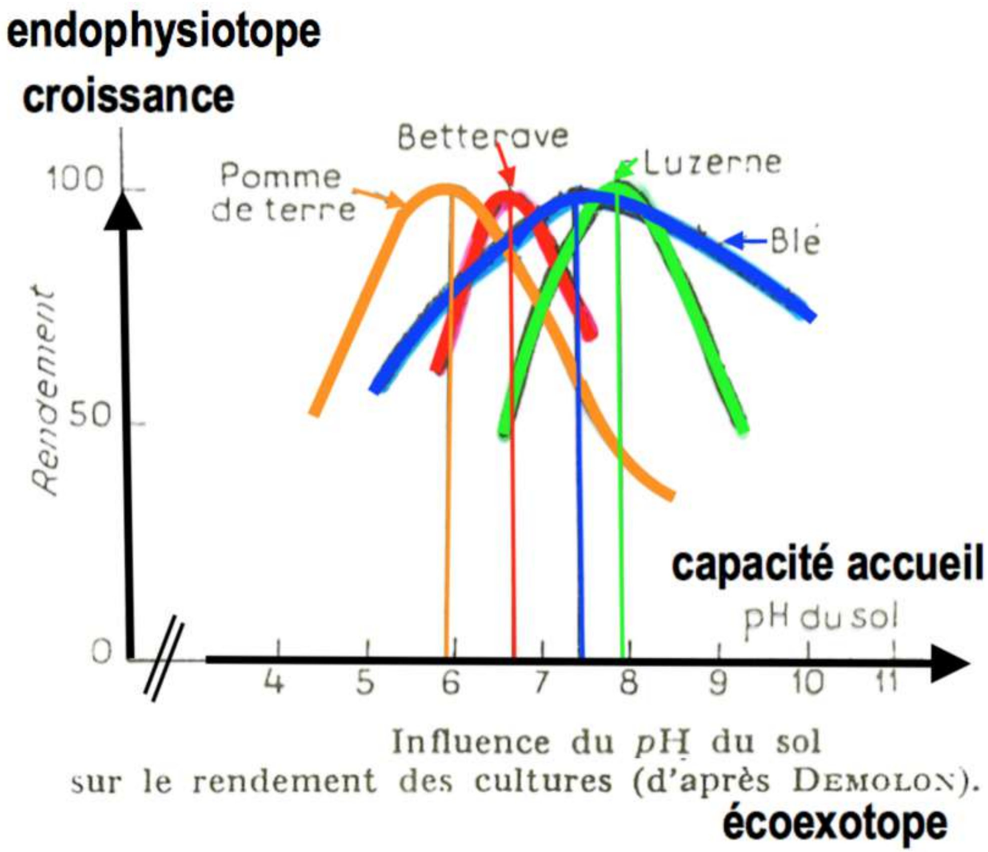
7. La REPRODUCTION



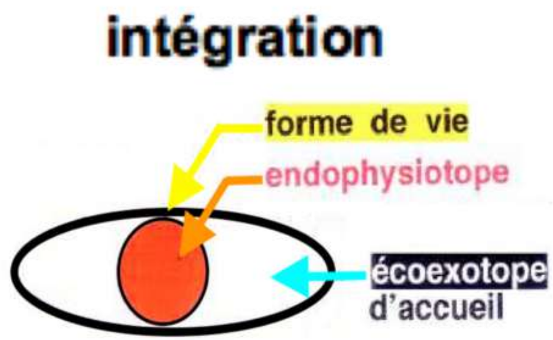
La nature de la décision dans la nature ?
19 mai 2001, Andé, 16 p.
http://www.afscet.asso.fr/Decision.pdf

pierre.bricage@univ-pau.fr

intégration : écoexotope - endophysiotope capacité d'accueil – capacité d'être accueilli

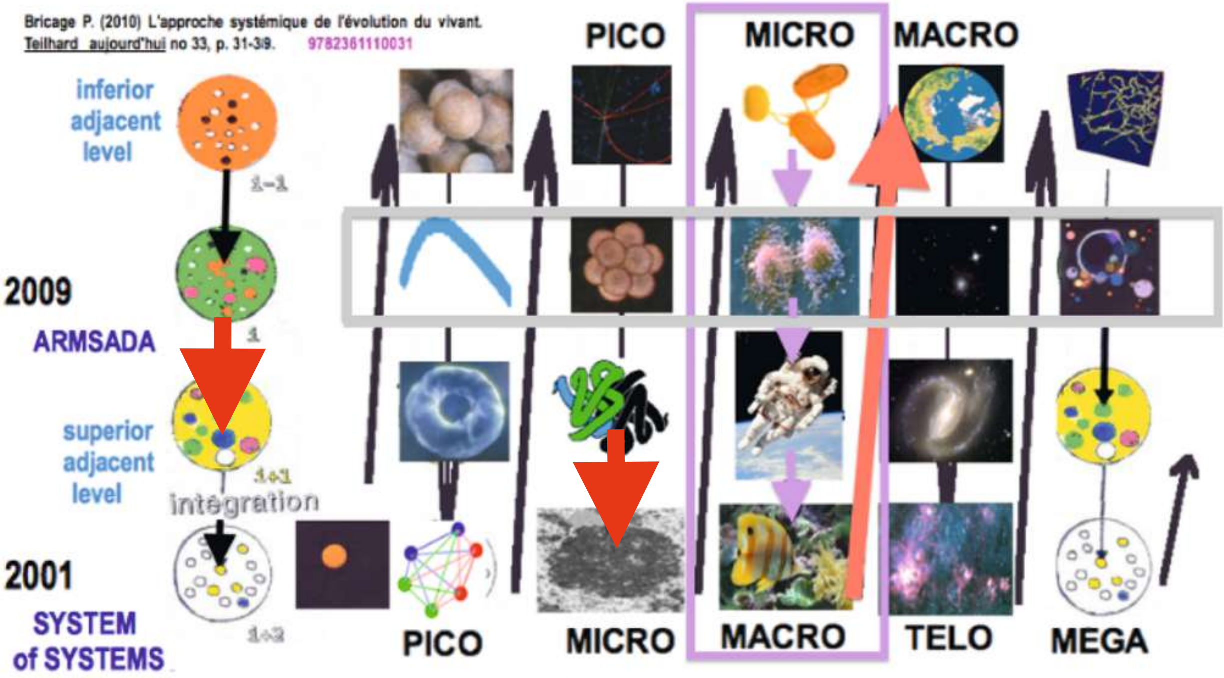


Influence du *pH* du sol sur le rendement des cultures (d'après DEMOLON).



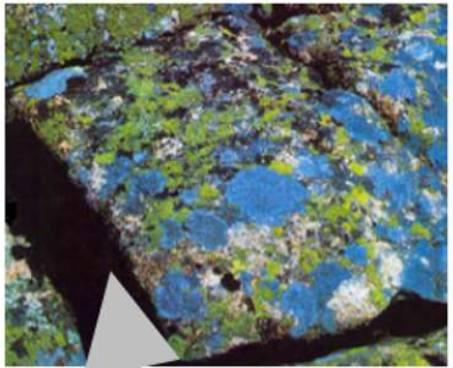
pierre.bricage@univ-pau.fr

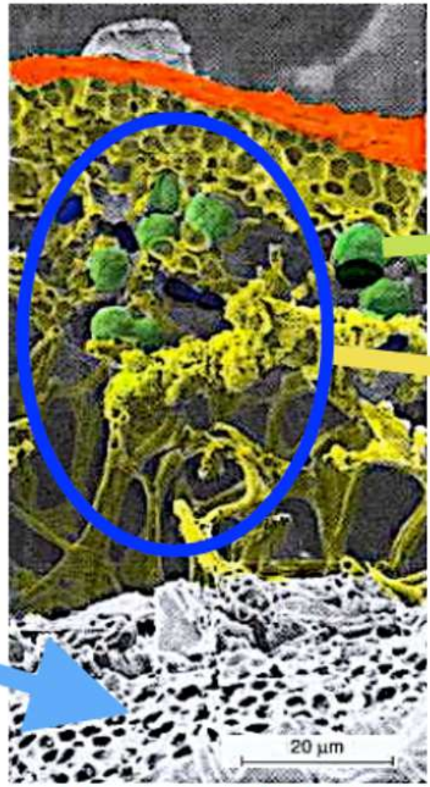
ORGANISATION LEVELS: PERIODIC CLASSIFICATION CHART

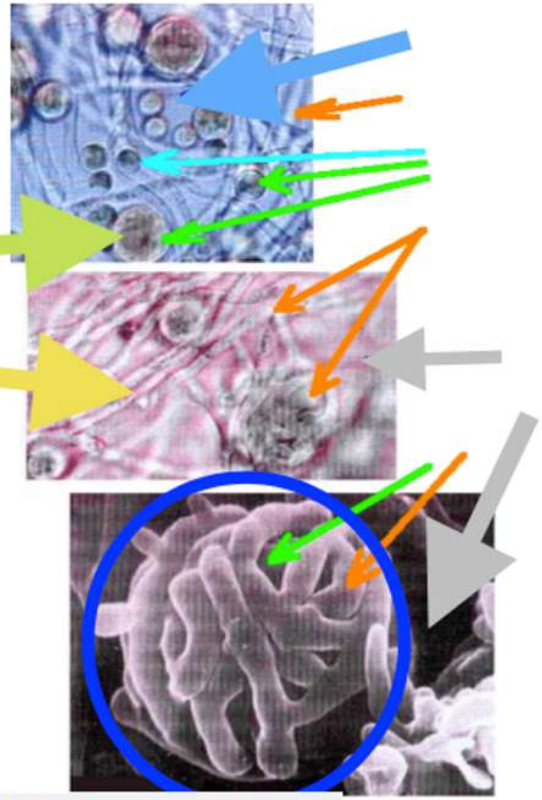


Todos los nuevos planes de organización de los seres vivos son construidos por la implementación de una ARMSADA

1.1. A LICHEN is NOT a WIN-WIN association BUT AN ARMSADA







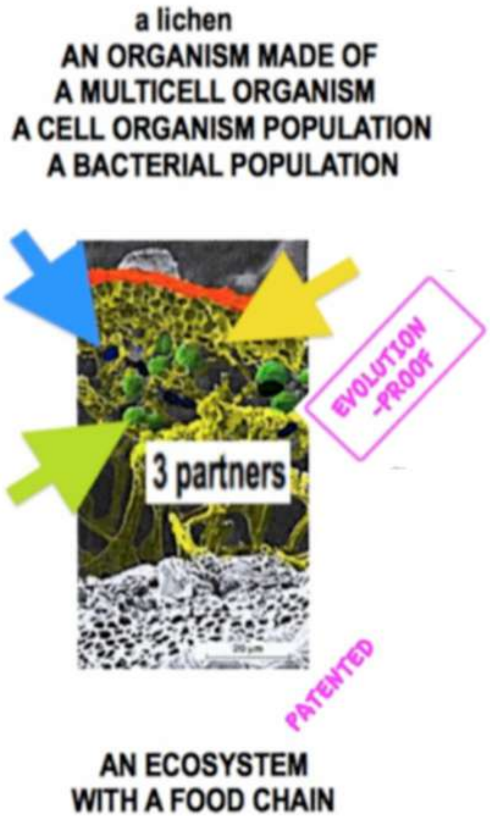
ECO-EXO-TOPE

ENDO-PHYSIO-TOPE

1998

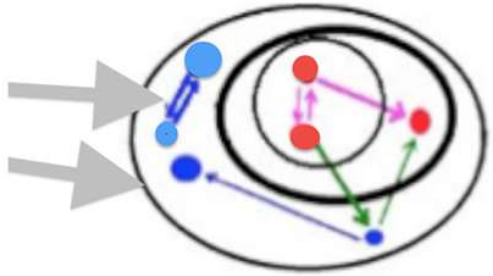
Bricage P. (1998) La Survie des Systèmes Vivants.
Atelier fondateur MCX20 "Prendre soin de l'homme"
Centre Hospitalier Général de Pau

El *"endophysiotope"* es a la vez el huésped (el invitado) y el rehén (el preso) de un ecoexotope para sobrevivir.



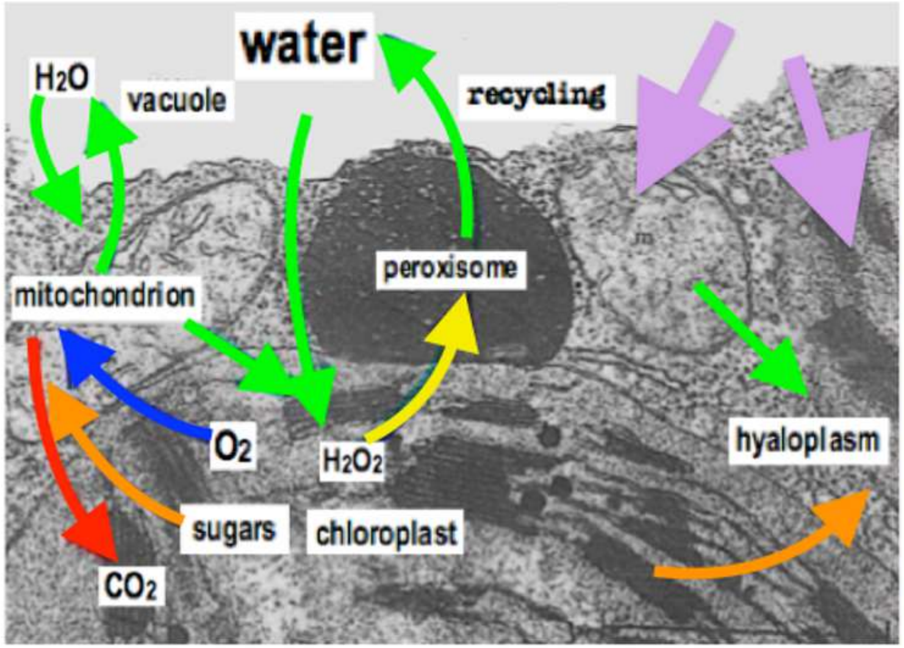
ARMSADA

Association for the Reciprocal and Mutual Sharing of Advantages and DisAdvantages



Associations for the Reciprocal and Mutual Sharing of Advantages and DisAvantages

A CELL IS AN ENDOSYNCENOSIS, AN ECOSYSTEM of ORGANISMS

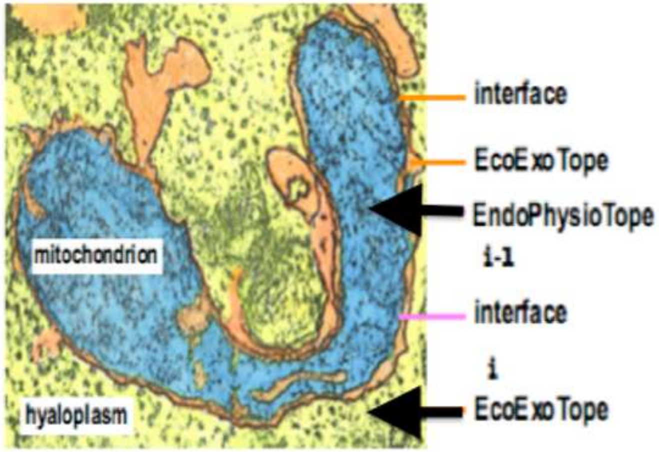


E PLURIBUS UNUM

UNUS PRO OMNIBUS OMNES PRO UNO

IN VARIETATE CONCORDIA

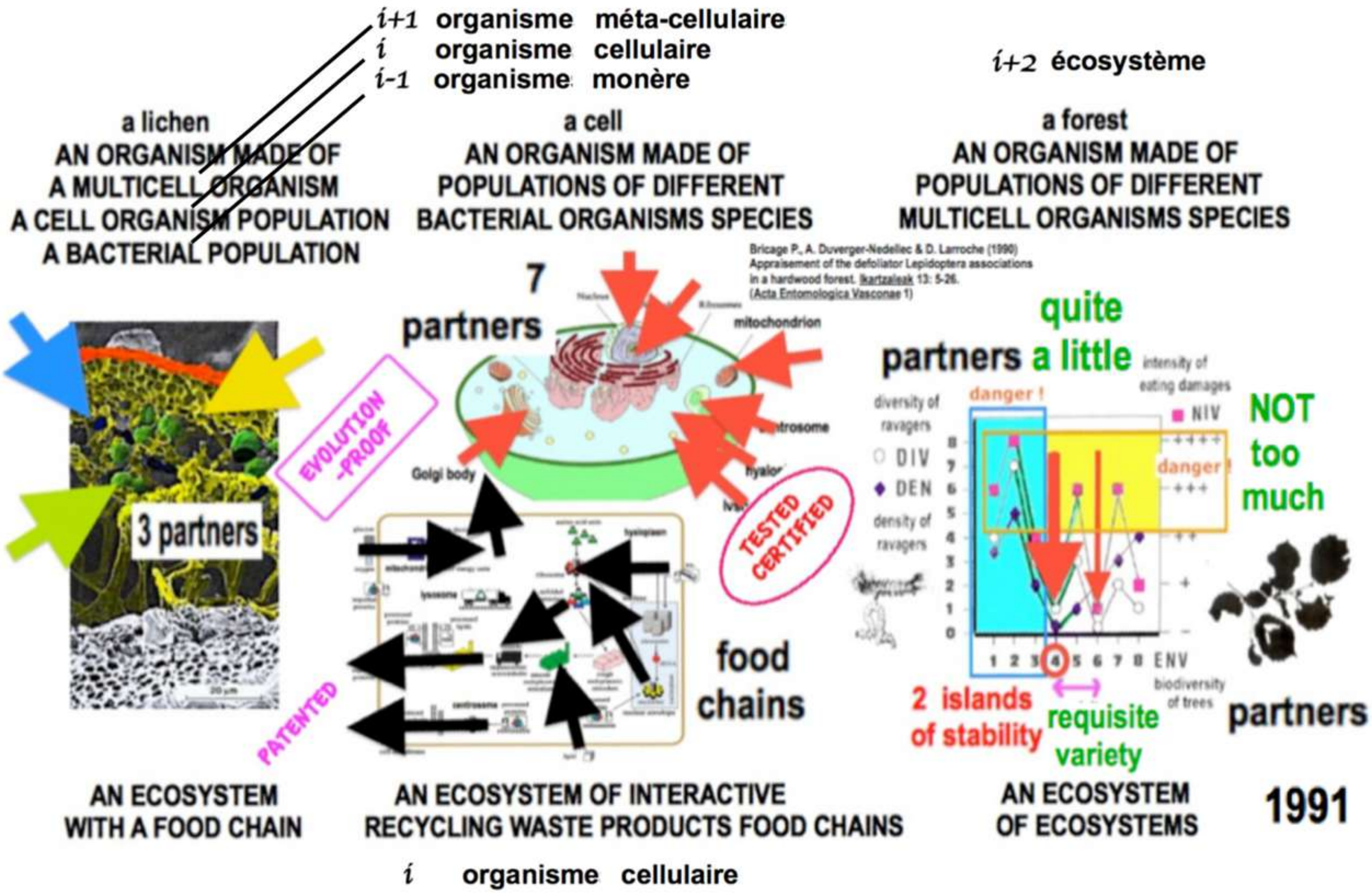
UN POUR TOUS TOUS POUR UN



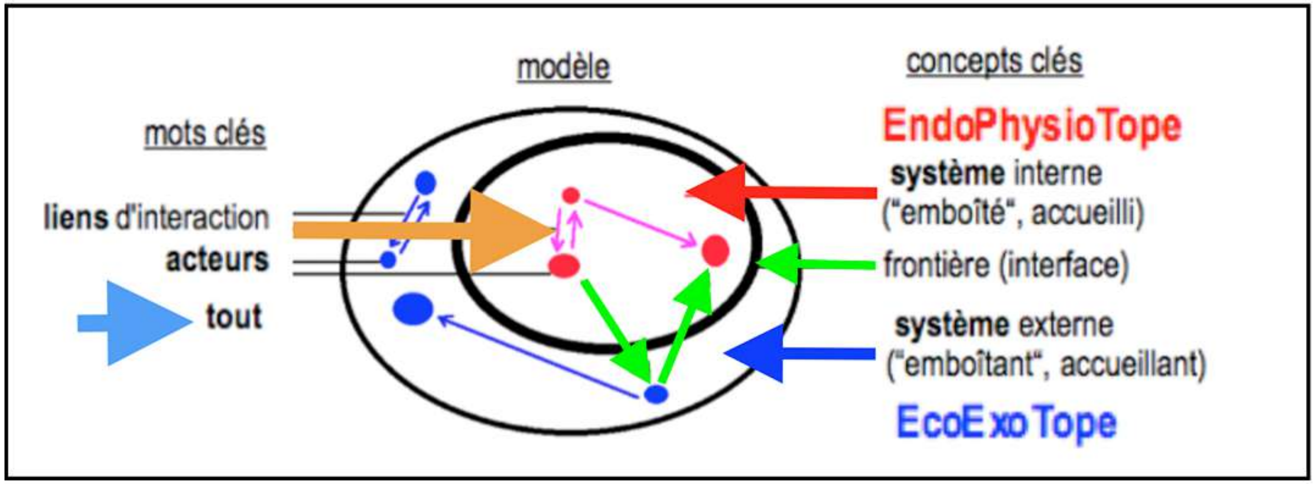
Bricage P. (1986) Isoperoxidases, markers of surrounding and physiological changes, in situ in leaves and in vitro in calli of *Pedilanthus tithymaloides L. variegatus*: cell compartmentation and polyfunctionality, control of activity by phenols, specific roles. p. 261-265. Molecular & Physiological Aspects of Plant Peroxidases, Univ. Genève, (ISBN 2-88164-001-X)

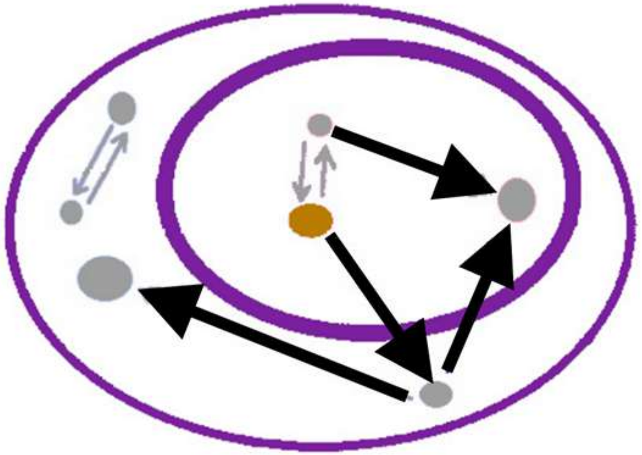
ISSS July 18-23, 2010, Wilfrid Laurier University, Waterloo, ON, Canada. Balancing Individualism and Collectivism: ARMSADA

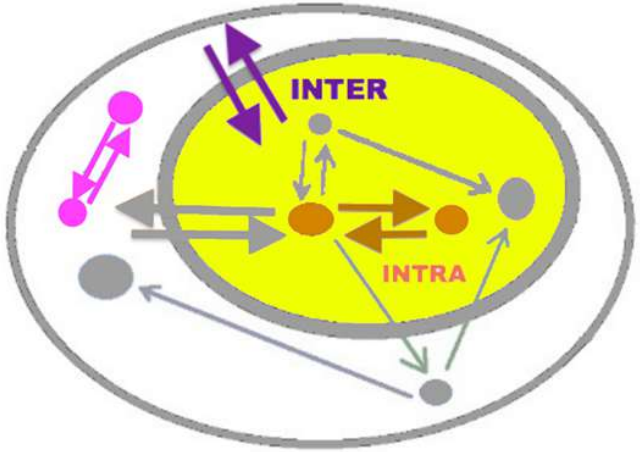
FOR THE ONE TO SURVIVE
THE OTHER ONE MUST SURVIVE FIRST
AND RECIPROCALLY 2000



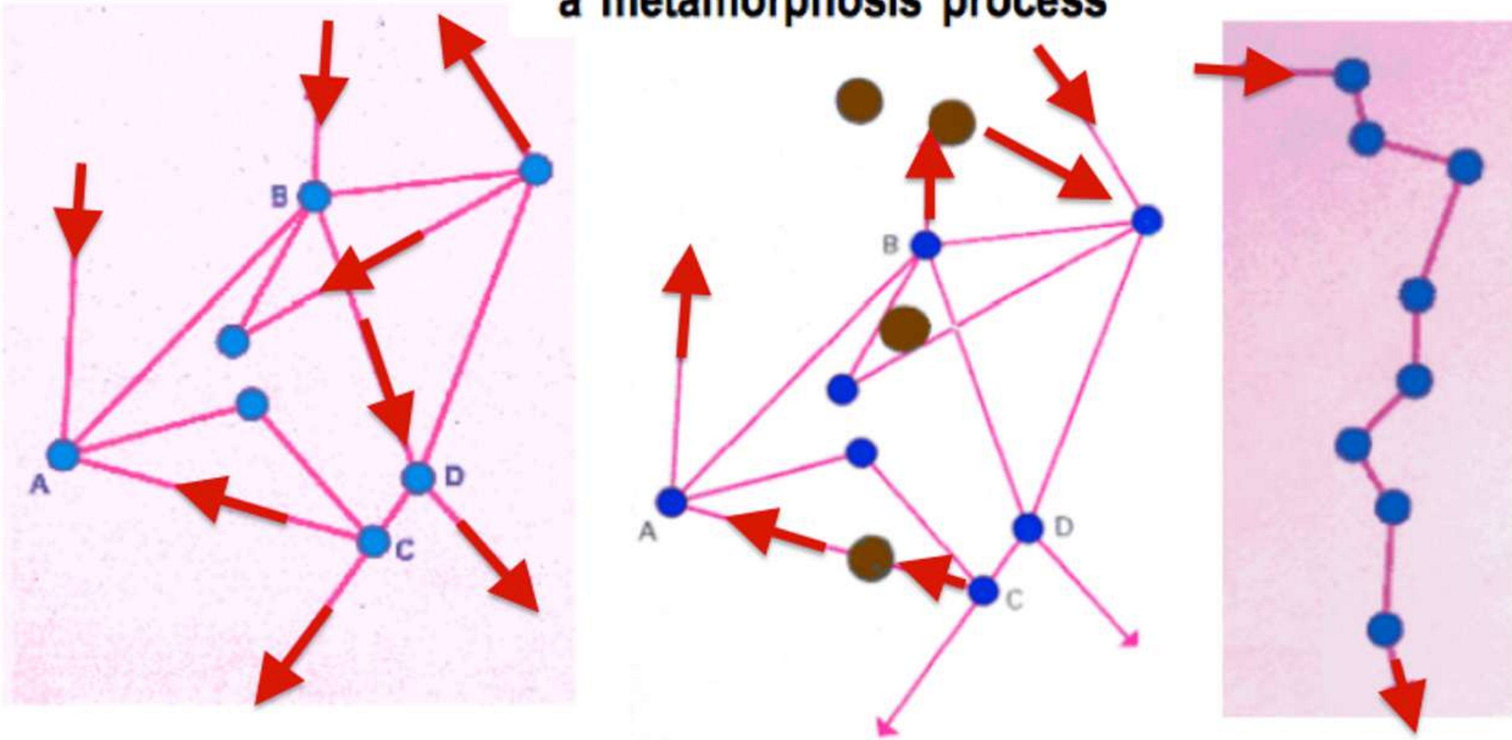
i+1 organisme méta-cellulaire
i organisme cellulaire
i-1 organisme monère
i+2 écosystème
a lichen
AN ORGANISM MADE OF
A MULTICELL ORGANISM
A CELL ORGANISM POPULATION
A BACTERIAL POPULATION
a cell
AN ORGANISM MADE OF
POPULATIONS OF DIFFERENT
BACTERIAL ORGANISMS SPECIES
a forest
AN ORGANISM MADE OF
POPULATIONS OF DIFFERENT
MULTICELL ORGANISMS SPECIES
Bricage P., A. Duverger-Nedellec & D. Larroche (1990)
Appraisement of the defoliator Lepidoptera associations
in a hardwood forest. Ikartzaleak 13: 5-26.
(Acta Entomologica Vasconae 1)
3 partners
7
partners
EVOLUTION -PROOF
mitochondrion
Golgi body
TESTED CERTIFIED
PATENTED
food
chains
partners
quite
a little
intensity of
eating damages
diversity of
ravagers
danger !
DIV
DEN
density of
ravagers
NIV
danger !
NOT
too
much
ENV
biodiversity
of trees
2 islands
of stability
requisite
variety
partners
AN ECOSYSTEM
WITH A FOOD CHAIN
AN ECOSYSTEM OF INTERACTIVE
RECYCLING WASTE PRODUCTS FOOD CHAINS
AN ECOSYSTEM
OF ECOSYSTEMS
1991
i organisme cellulaire


modèle
concepts clés
mots clés
EndoPhysioTope
système interne
("emboîté", accueilli)
liens d'interaction
acteurs
frontière (interface)
tout
système externe
("emboîtant", accueillant)
EcoExoTope



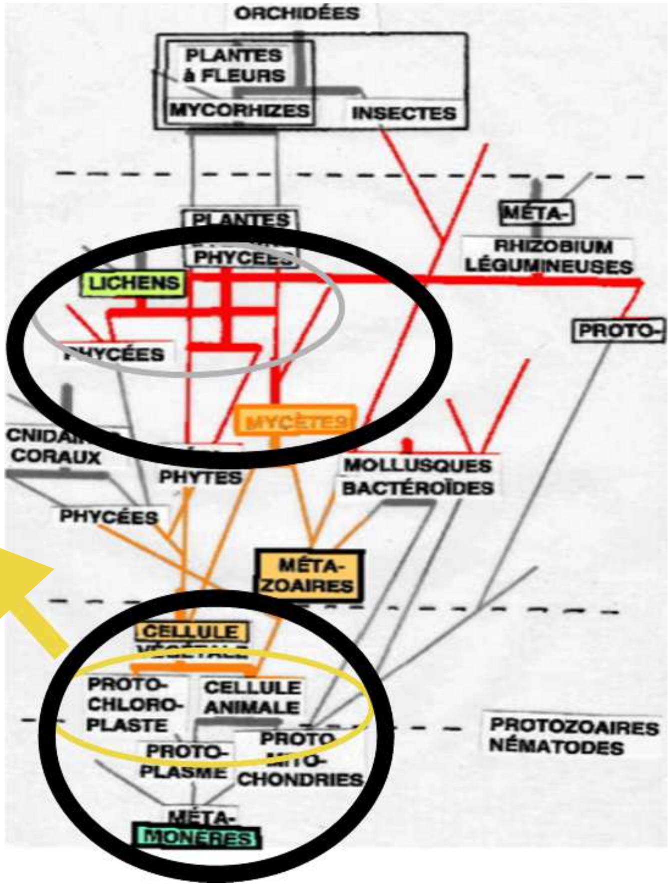

INTER
INTRA

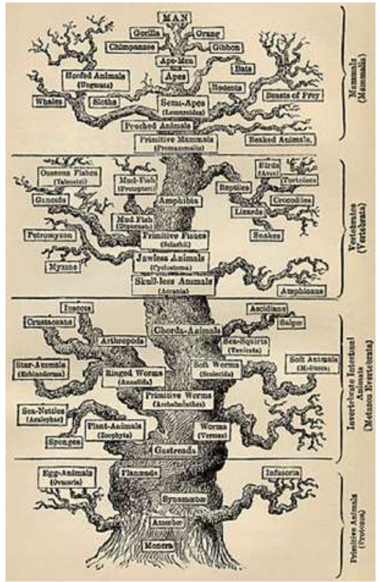
emergence of a new network
PERCOLATION
a metamorphosis process



before during after

II.C. *"Life is a coral not a tree"*





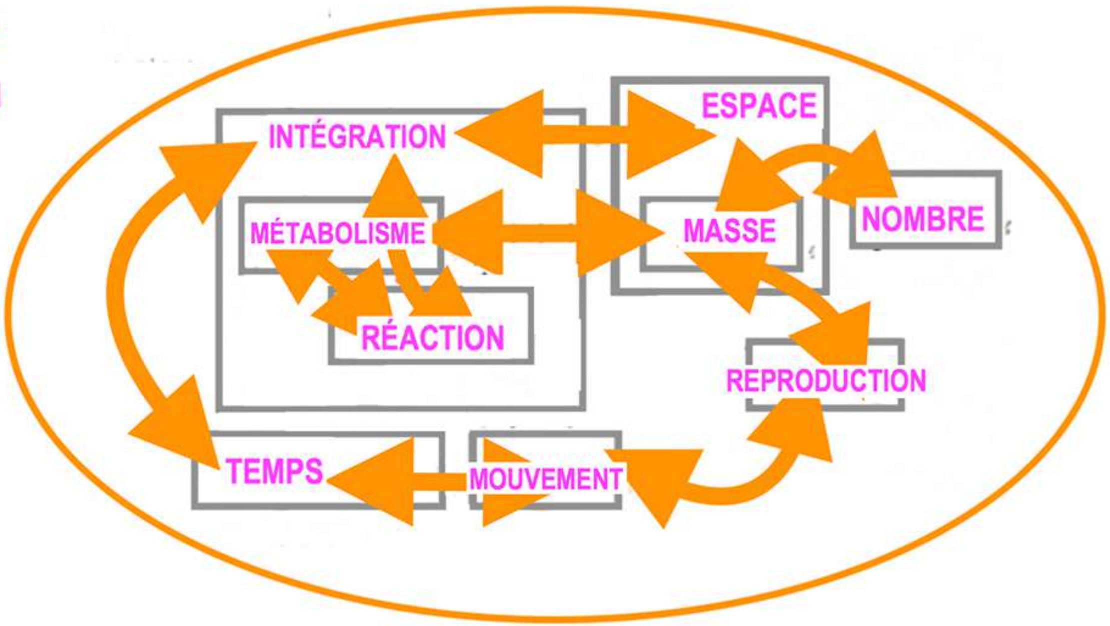
SURVIVRE

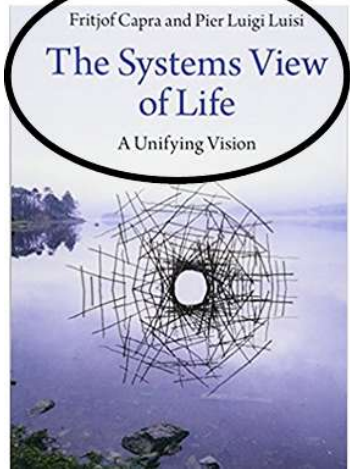
1. La MOBILISATION de la MATIÈRE et de l'ÉNERGIE MÉTABOLISME
2. La CROISSANCE en masse MASSE
2. La CROISSANCE en nombre NOMBRE
3. La RÉPONSE à des STIMULATIONS RÉACTION
4. L'ORGANISATION interne dans l'espace et dans le temps ESPACE TEMPS
5. L'INTÉGRATION externe
6. Le MOUVEMENT

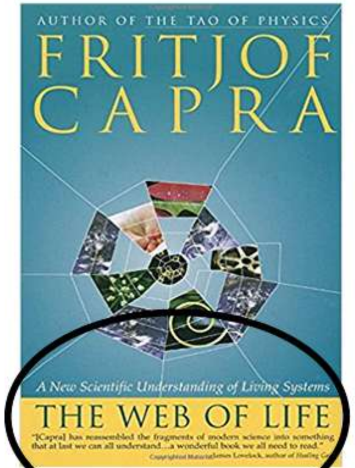
pour **SE SURVIVRE**

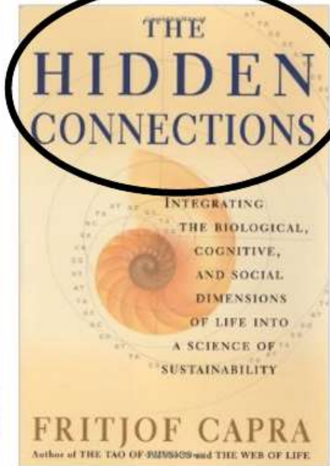
7. La REPRODUCTION

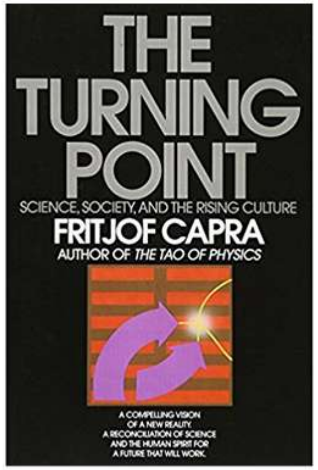
systémique

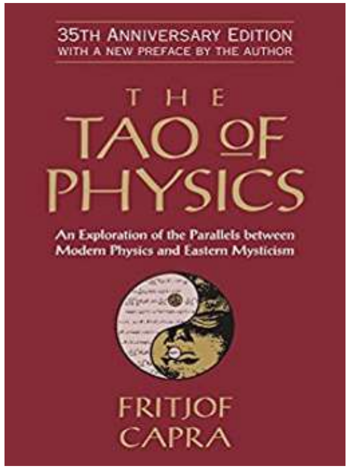


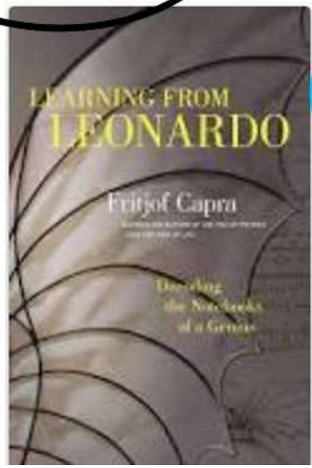

Fritjof Capra and Pier Luigi Luisi
The Systems View of Life
A Unifying Vision

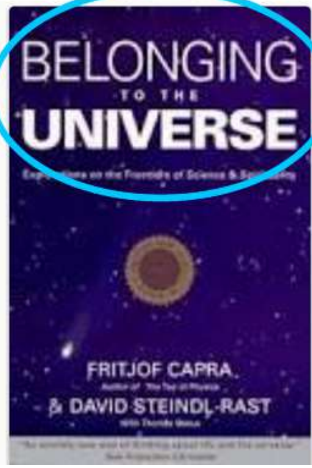

AUTHOR OF THE TAO OF PHYSICS
FRITJOF CAPRA
A New Scientific Understanding of Living Systems
THE WEB OF LIFE

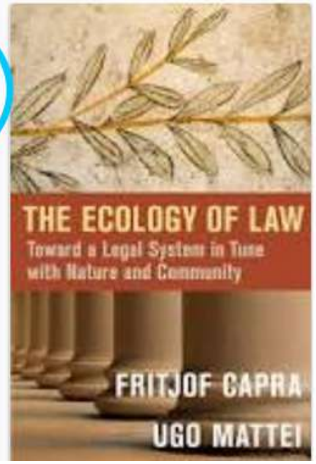

THE HIDDEN CONNECTIONS
INTEGRATING THE BIOLOGICAL, COGNITIVE, AND SOCIAL DIMENSIONS OF LIFE INTO A SCIENCE OF SUSTAINABILITY
FRITJOF CAPRA

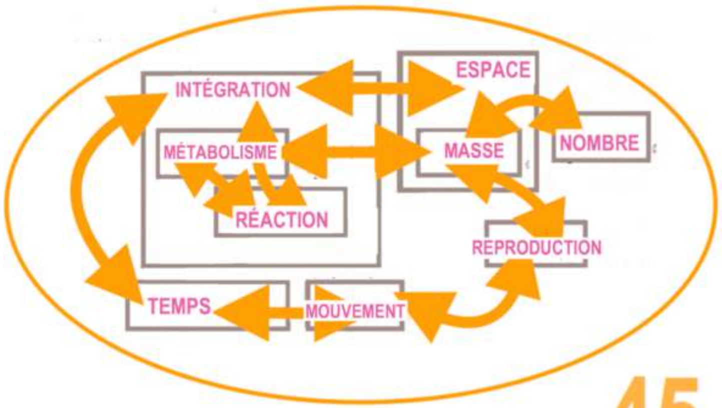

THE TURNING POINT
SCIENCE, SOCIETY, AND THE RISING CULTURE
FRITJOF CAPRA
AUTHOR OF THE TAO OF PHYSICS


35TH ANNIVERSARY EDITION
WITH A NEW PREFACE BY THE AUTHOR
THE TAO OF PHYSICS
An Exploration of the Parallels between Modern Physics and Eastern Mysticism
FRITJOF CAPRA


LEARNING FROM LEONARDO
Fritjof Capra


BELONGING TO THE UNIVERSE
FRITJOF CAPRA
& DAVID STEINDL-RAST

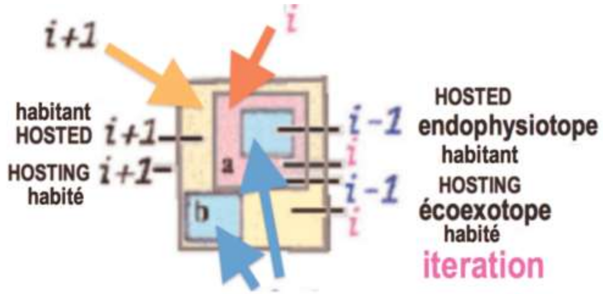

THE ECOLOGY OF LAW
Toward a Legal System in Tune with Nature and Community
FRITJOF CAPRA
UGO MATTEI



45 X

endophysiotope

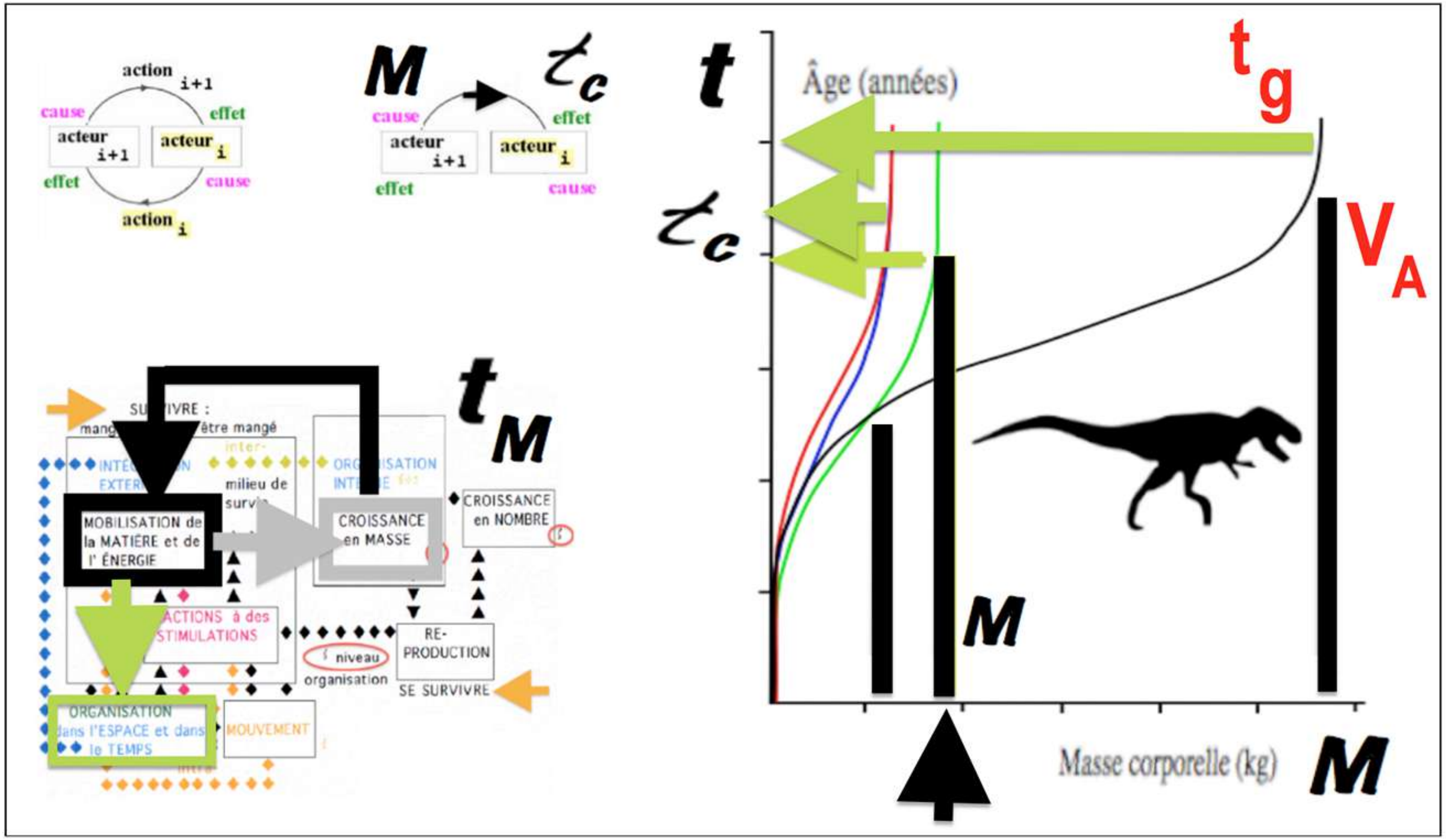
métabolisme	métabolisme
croissance en masse	croissance en masse
réponses aux stimulations	réponses aux stimulations
organisation spatiale	organisation spatiale
organisation temporelle	organisation temporelle
intégration	intégration
mouvement	mouvement
reproduction	reproduction
croissance en nombre	croissance en nombre



niveaux d'organisation

18 X

niveau	organisme
i-10	
i-9	Planck quantum
i-8	cordes
i-7	super-cordes
i-6	quarks
i-5	particules
i-4	atomes
i-3	molécules
i-2	amas de molécules
i-1	organismes monères
i	organismes cellulaires
i+1	organismes méta-cellulaires
i+2	écosystèmes
i+3	biosphères
i+4	systèmes stellaires
i+5	galaxies
i+6	amas de galaxies
i+7	univers
i+8	Hyper-univers
i+9	


action i+1
cause
effet
acteur i+1
acteur i
effet
cause
action i
M
τc
cause
effet
acteur i+1
acteur i
effet
cause
t
Âge (années)
tg
τc
VA
tM
M
Masse corporelle (kg)
M
SURVIVRE :
être mangé
MOBILISATION de la MATIÈRE et de l' ÉNERGIE
milieu de
CROISSANCE en MASSE
CROISSANCE en NOMBRE
STIMULATIONS
niveau
organisation
RE-PRODUCTION
SE SURVIVRE
ORGANISATION dans l'ESPACE et dans le TEMPS
MOUVEMENT

Sensibilité différentielle et Temps de RÉACTION

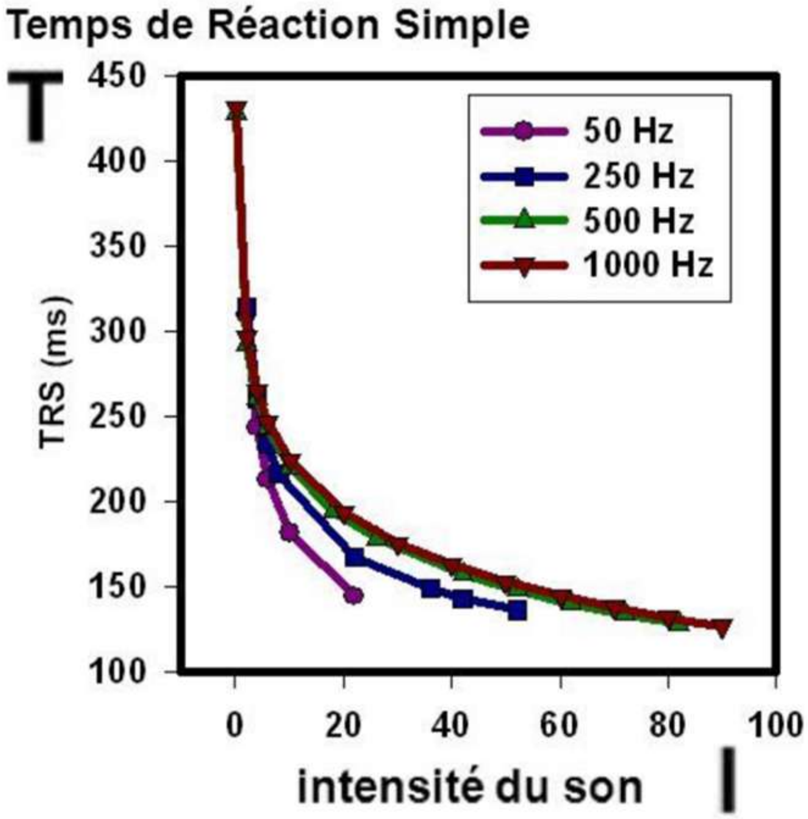
Le Temps de Réaction Simple diminue selon une fonction de puissance de l'intensité du son.

Fonction de Piéron :

$$T = (\beta\, I^{-\alpha}) + t_0$$

L'exposant de la fonction varie selon la fréquence du son.

La RÉPONSE à des STIMULATIONS



$$T = (\beta\, I^{-\alpha}) + t_0$$

exposant α

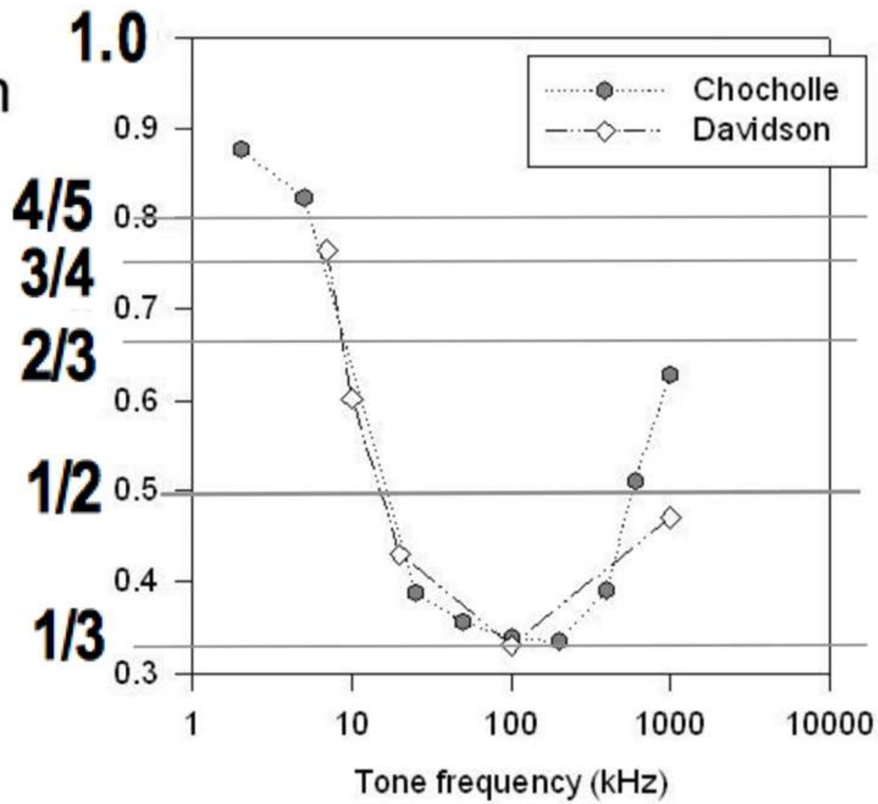
Loi de Piéron en audition

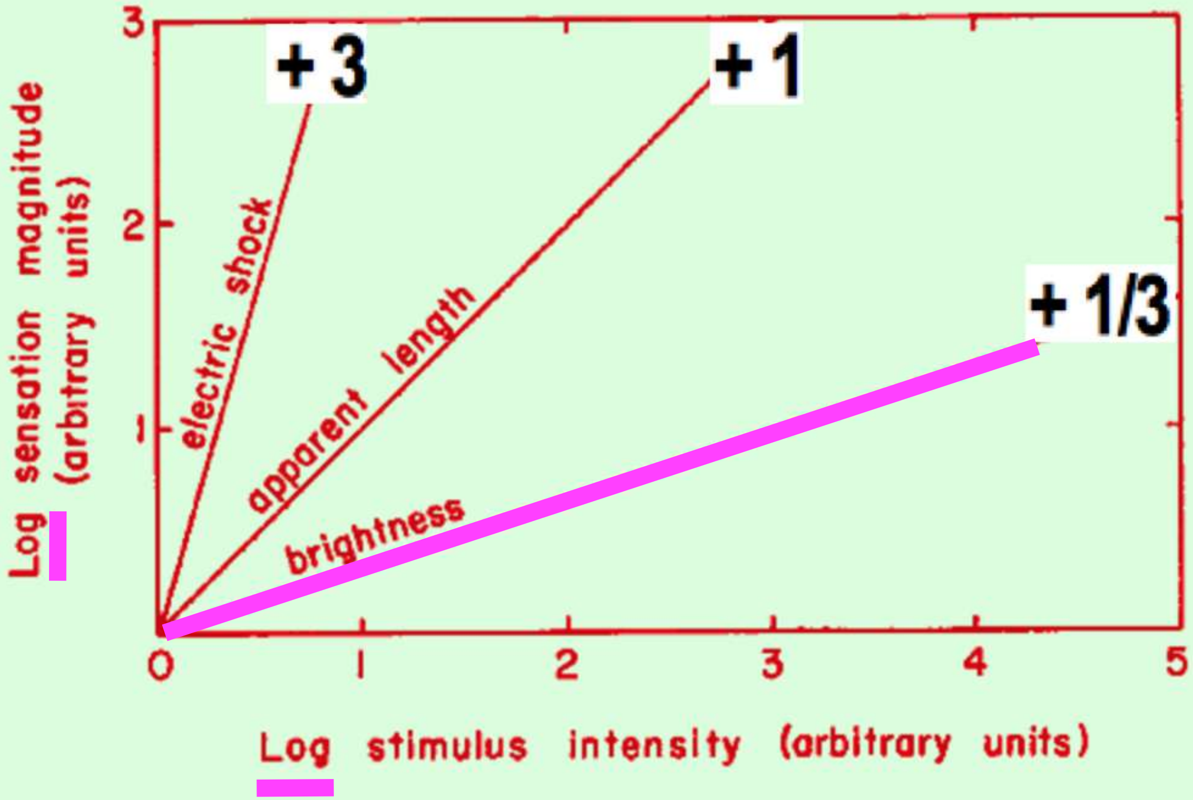
L'exposant varie curvilinéairement avec la fréquence du son avec un minimum dans la région 1000 – 2000 Hz

Chocholle 1940

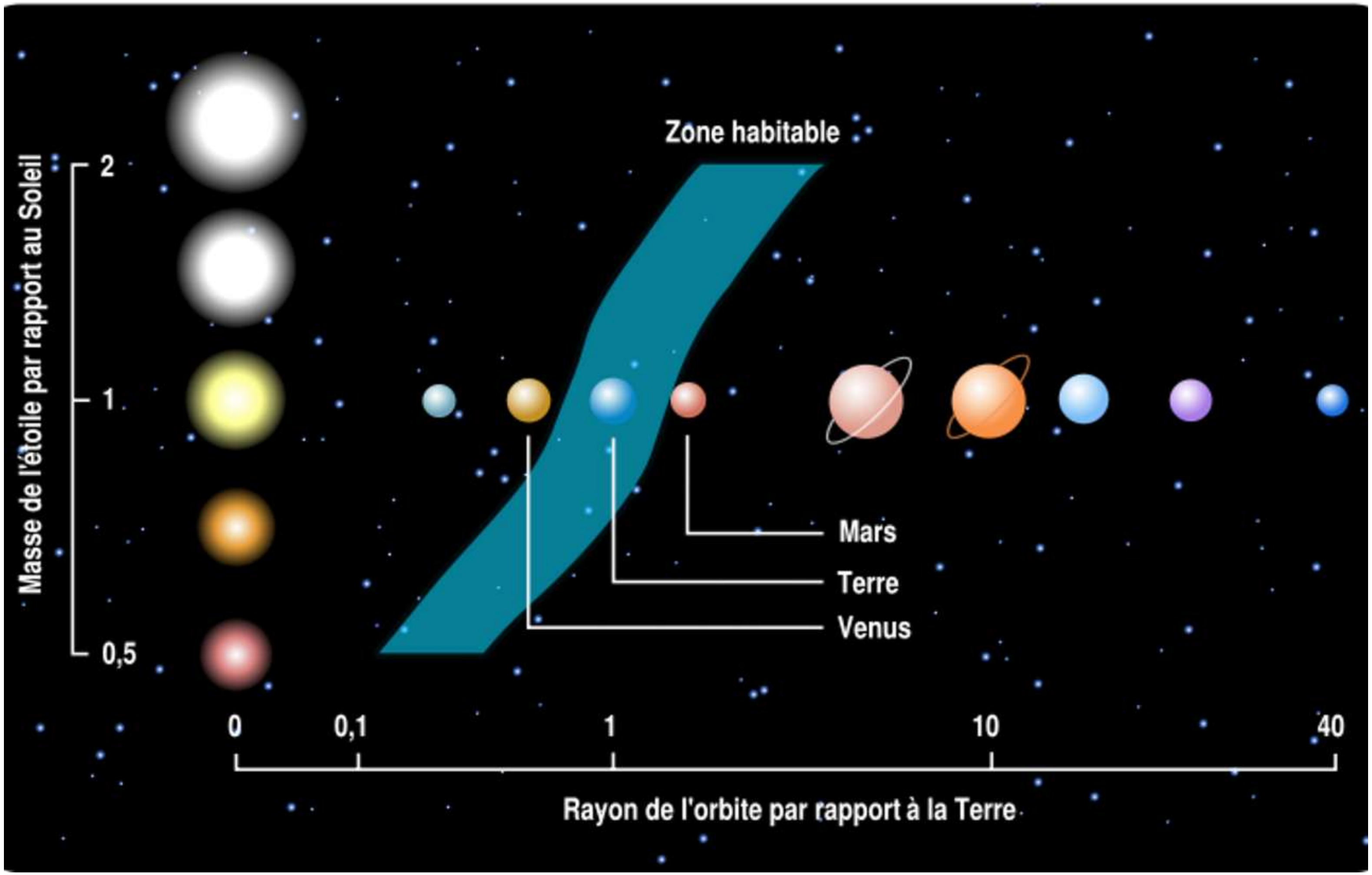
Davidson 1990

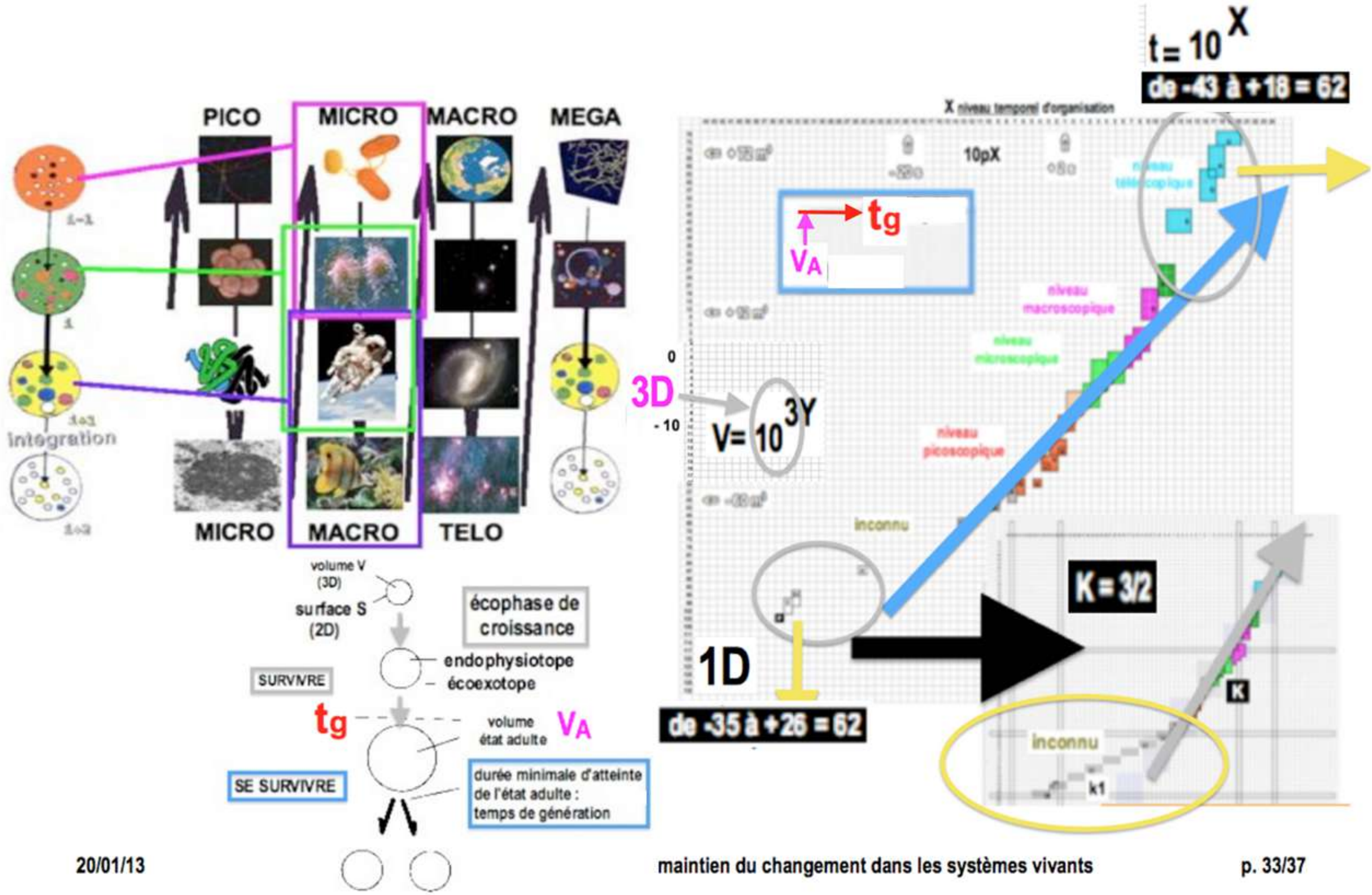
La courbe ressemble à celle des seuils de détection.

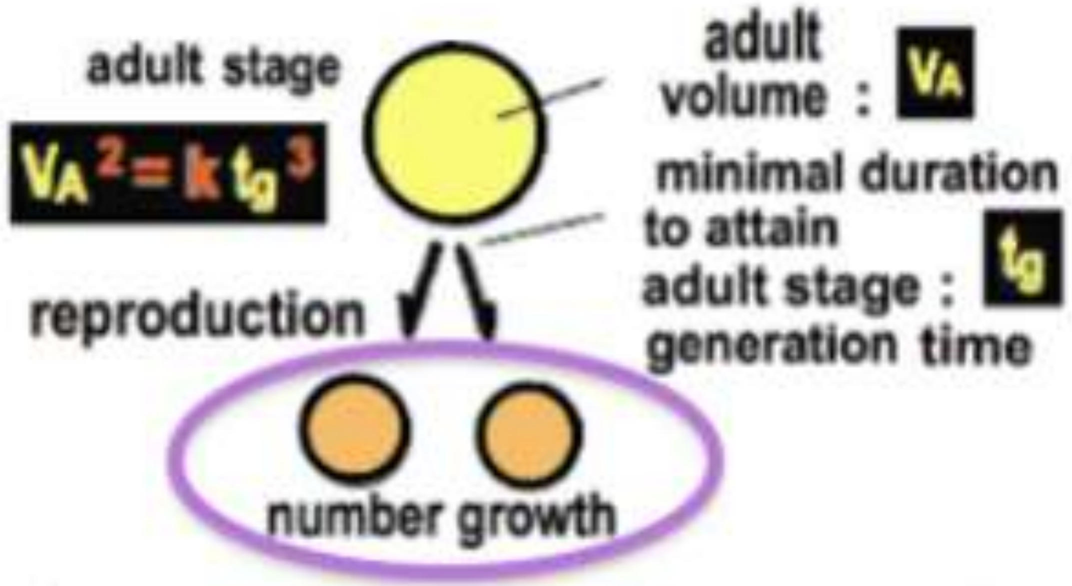




Psychophysical magnitude functions for three perceptual continua. The linearity of the functions on double logarithmic coordinates indicates that sensation magnitude is a power function of stimulus intensity. The slope of the line corresponds to the exponent of the power function.


Zone habitable
Masse de l'étoile par rapport au Soleil
2
1
0,5
Mars
Terre
Venus
0
0,1
1
10
40
Rayon de l'orbite par rapport à la Terre

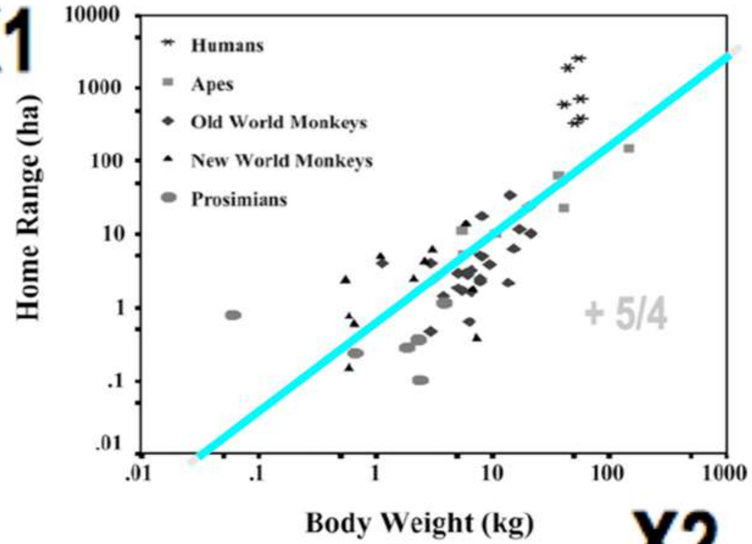

PICO
MICRO
MACRO
MEGA
integration
MICRO
MACRO
TELO
volume V
(3D)
surface S
(2D)
écophase de
croissance
endophysiotope
écoexotope
SURVIVRE
tg
volume
état adulte
VA
SE SURVIVRE
durée minimale d'atteinte
de l'état adulte :
temps de génération
t= 10 X
de -43 à +18 = 62
X niveau temporel d'organisation
10pX
tg
VA
3D
V= 10 3Y
0
- 10
niveau
télescopique
niveau
macroscopique
niveau
microscopique
niveau
picoscopique
inconnu
1D
de -35 à +26 = 62
K= 3/2
K
inconnu
k1


adult stage
$V_A{}^2 = k\, t_g{}^3$
reproduction
adult
volume : V_A
minimal duration
to attain
adult stage :
generation time
t_g
number growth

L'INTÉGRATION externe

EcoExoTope

X1

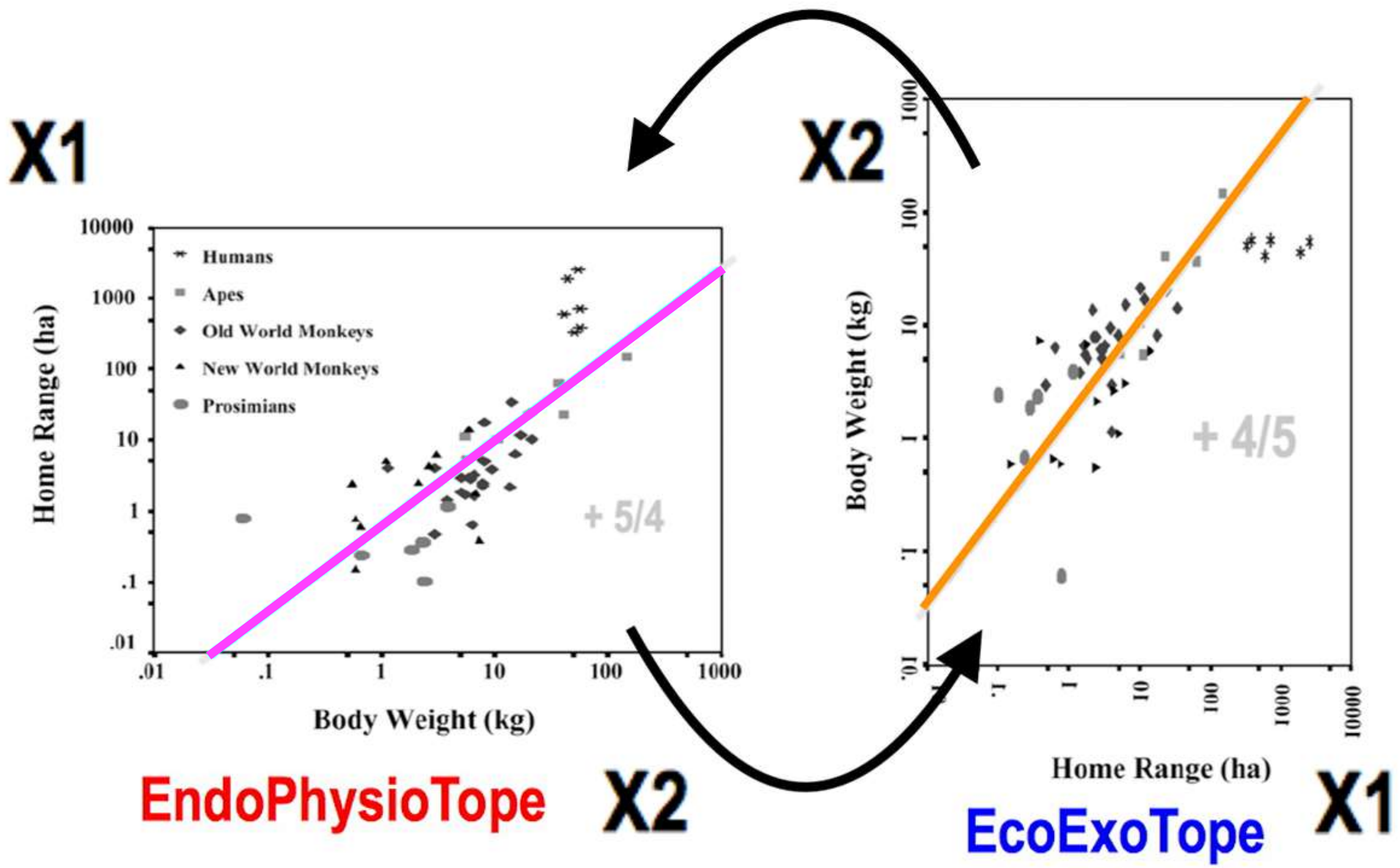


X2

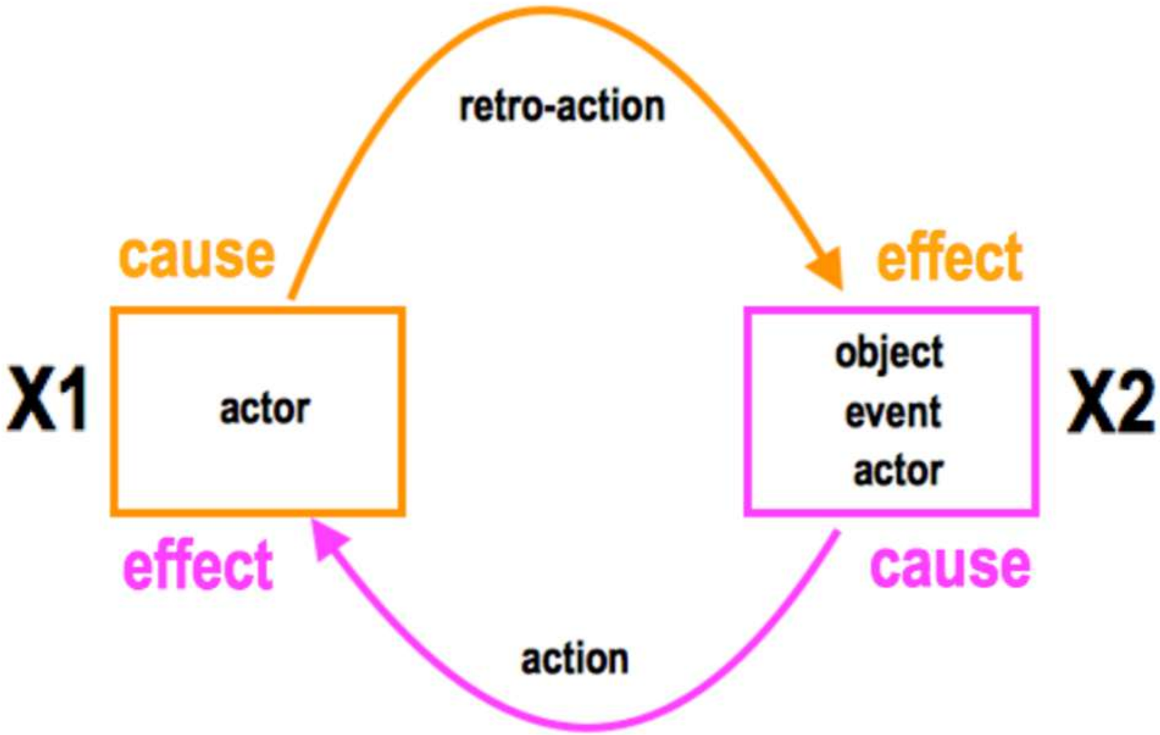
La CROISSANCE
en masse

MASSE

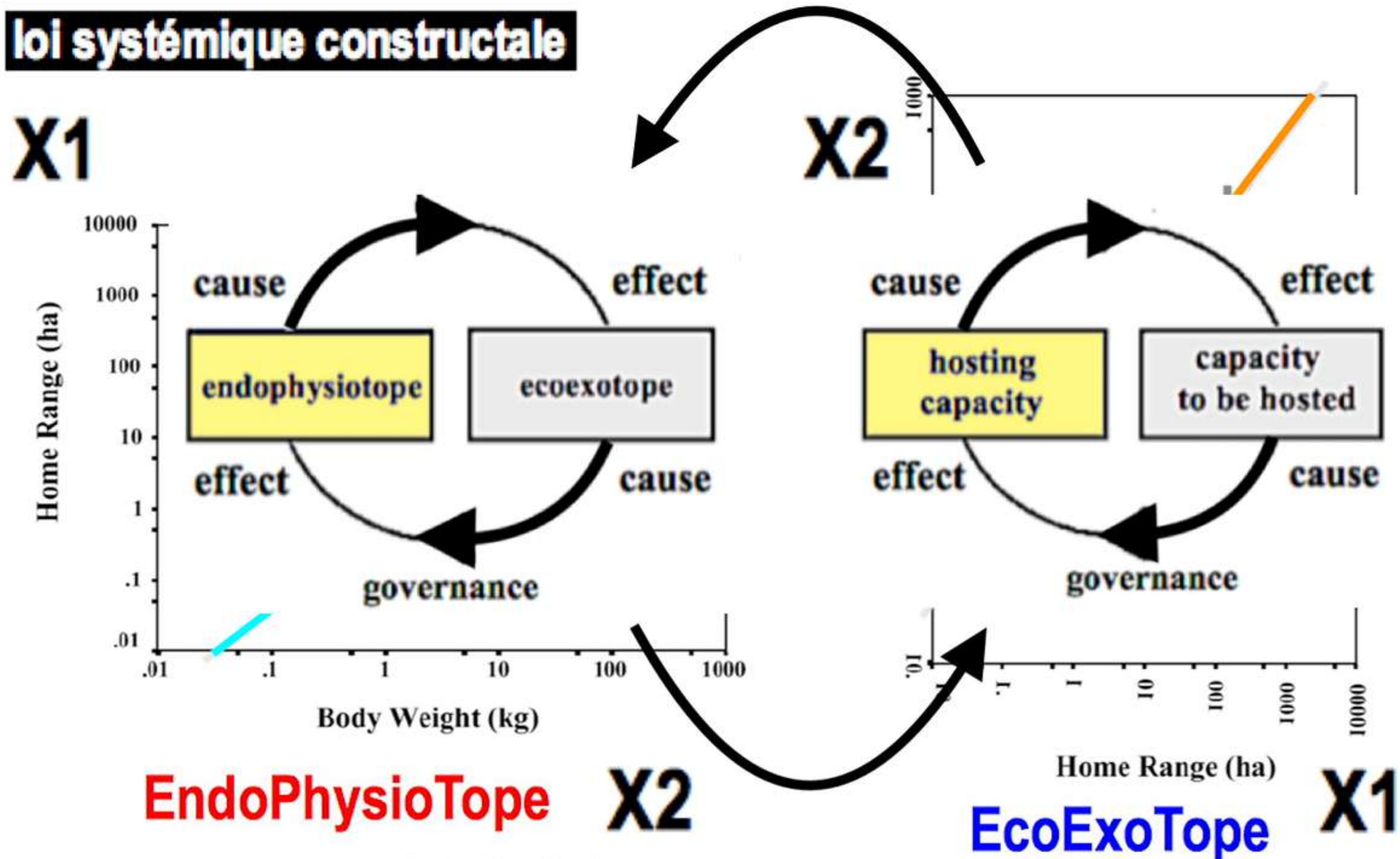
EndoPhysioTope



X1
X2
10000
1000
100
10
1
.1
.01
Humans
Apes
Old World Monkeys
New World Monkeys
Prosimians
Home Range (ha)
+ 5/4
.01
.1
1
10
100
1000
Body Weight (kg)
EndoPhysioTope
X2
1000
100
10
Body Weight (kg)
+ 4/5
Home Range (ha)
EcoExoTope
X1


retro-action
cause
effect
X1
actor
object
event
actor
X2
effect
cause
action

loi systémique constructale



La cause conduit à l'effet (dépendance)
et l'effet retourne à la cause (rétroaction).
La fin est le commencement et
le commencement est la fin ("palindrome").

$$V_A^2 = C.t_g^3$$

$$t_g = K.V_A^{2/3}$$

larval stage

duration in s

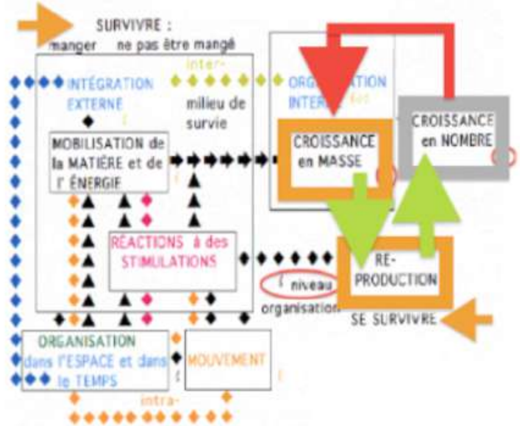
'generation time'

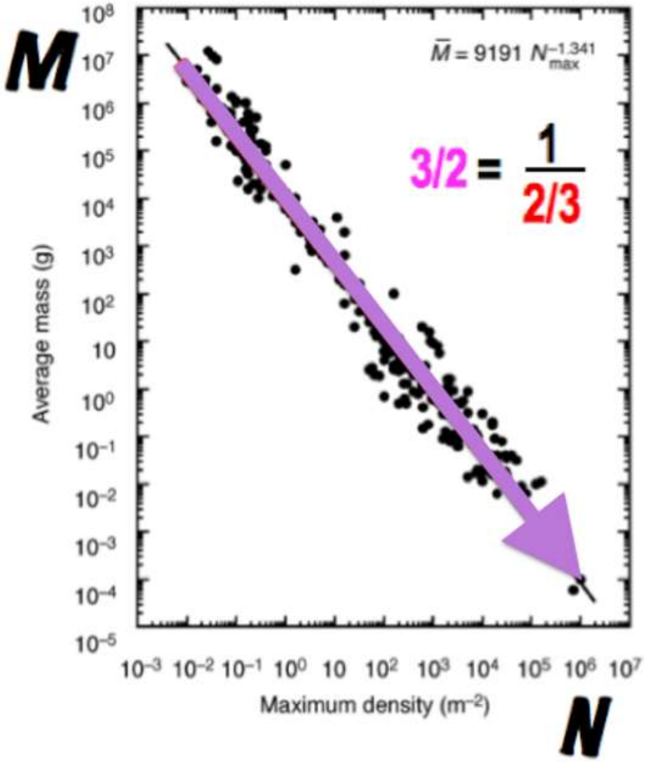
$$V_A = C.t_g^{3/2}$$

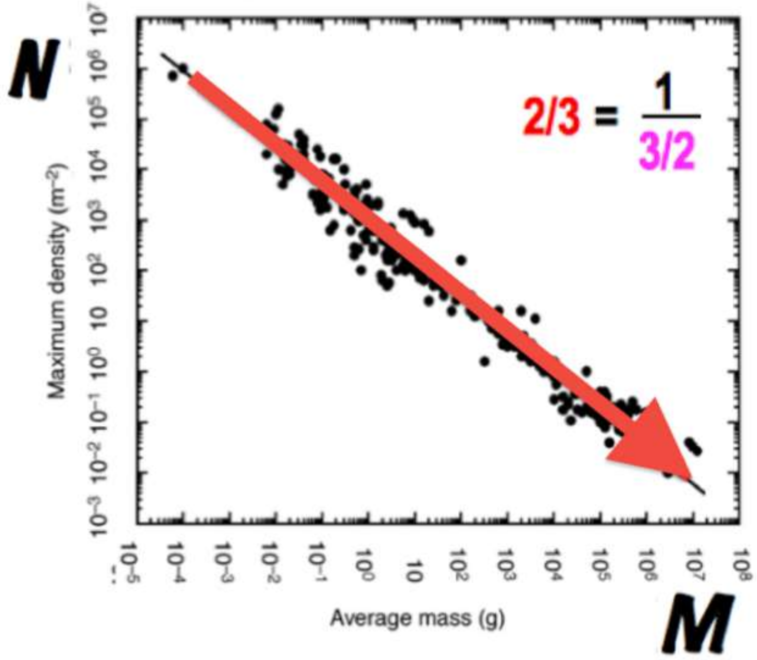
reproductive Adult

volume in m^3

Allometric scaling of plant energetics and population density







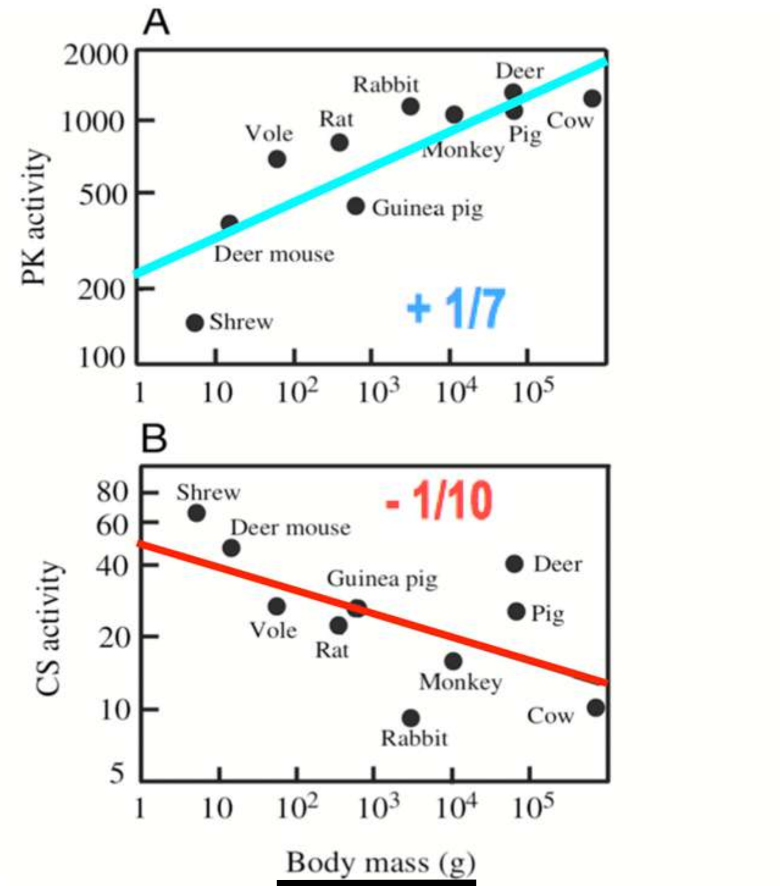


Fig. 1. Mitochondrial and glycolytic enzyme activities in muscles of mammals (adapted from Emmett and Hochachka, 1981). PK, pyruvate kinase (U g^{-1}); CS, citrate synthase (U g^{-1}); body mass (g).

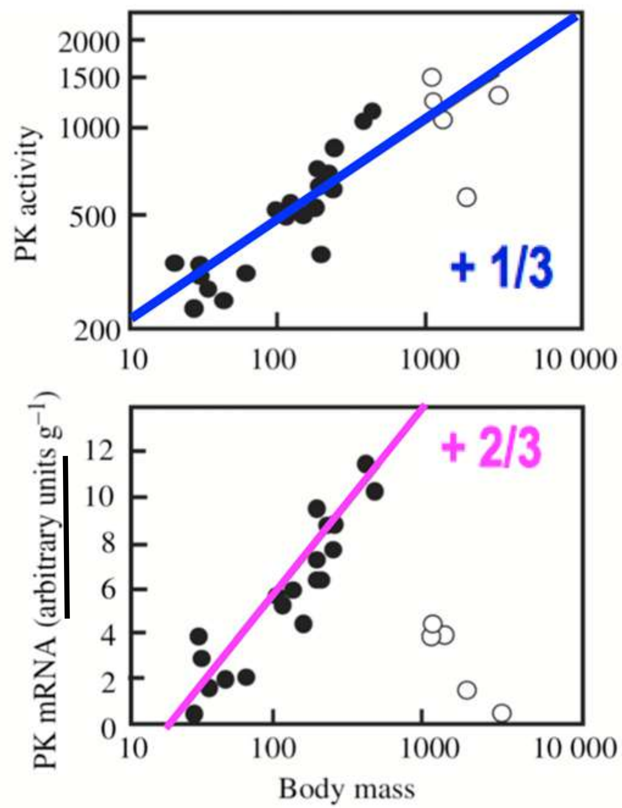
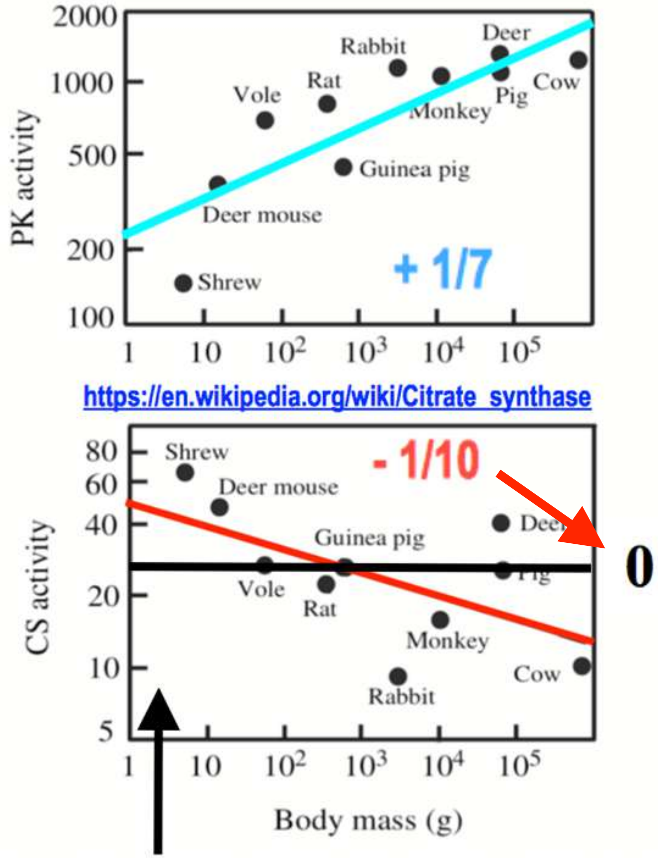


Fig. 2. Relationship between pyruvate kinase activity and mRNA. PK shows positive allometric scaling (b=0.2). Larger fish (open circles) are able to produce more protein from a lower amount of mRNA (adapted from Burness et al., 1999). PK, pyruvate kinase (U g^{-1}); body mass (g)

muscle bioenergetic gene expression: allometric scaling relationships of glycolytic and oxidative enzymes



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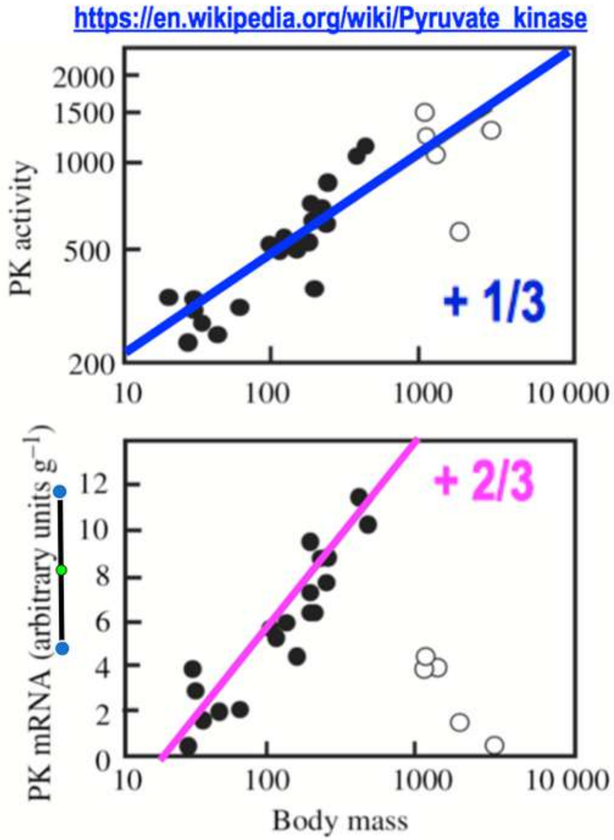

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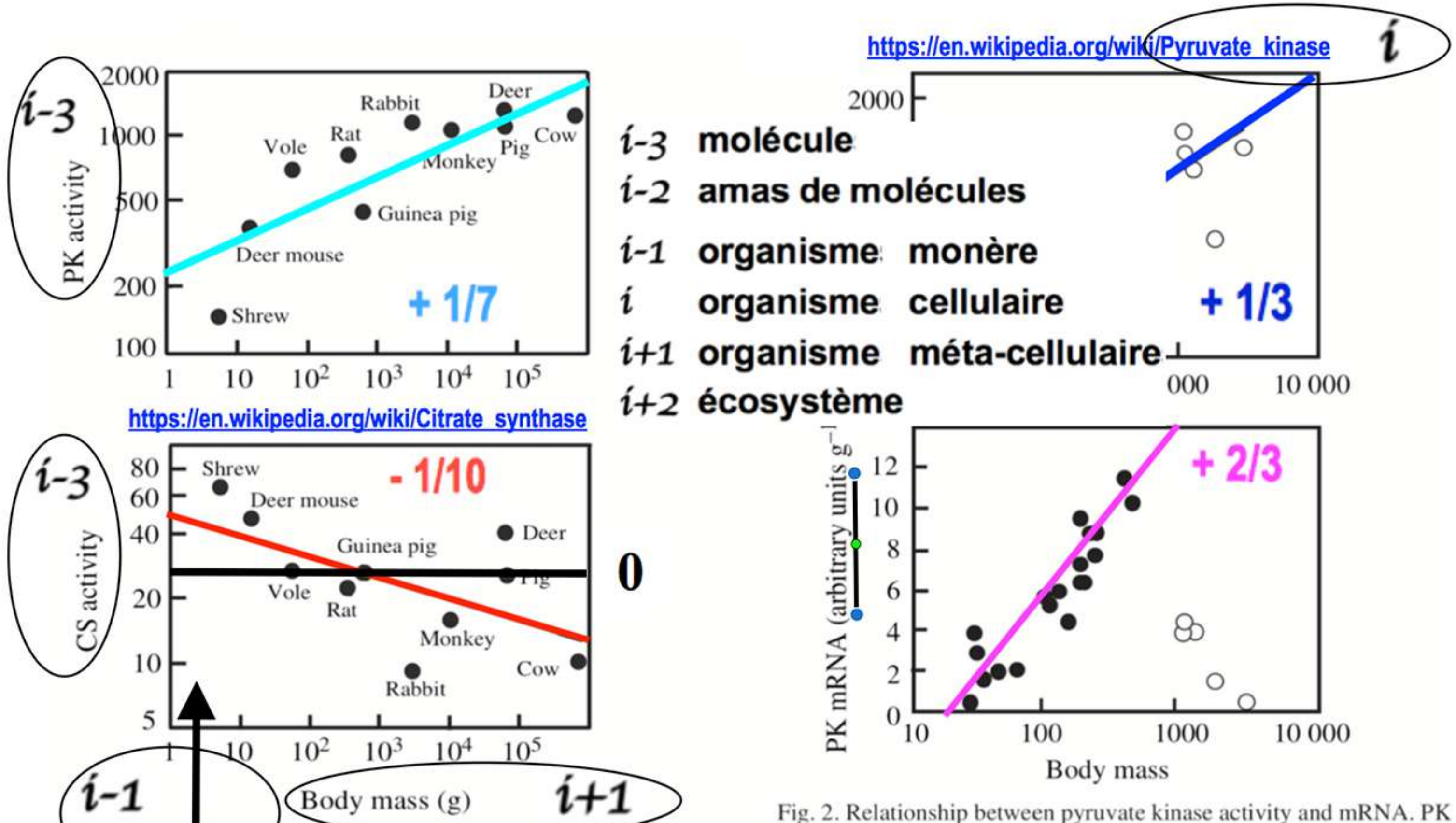

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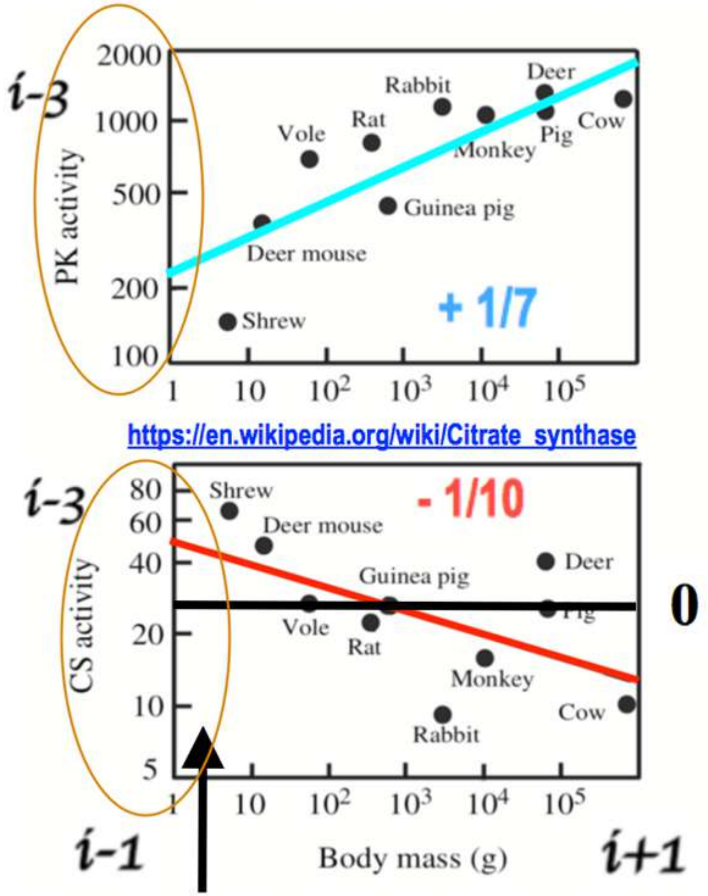

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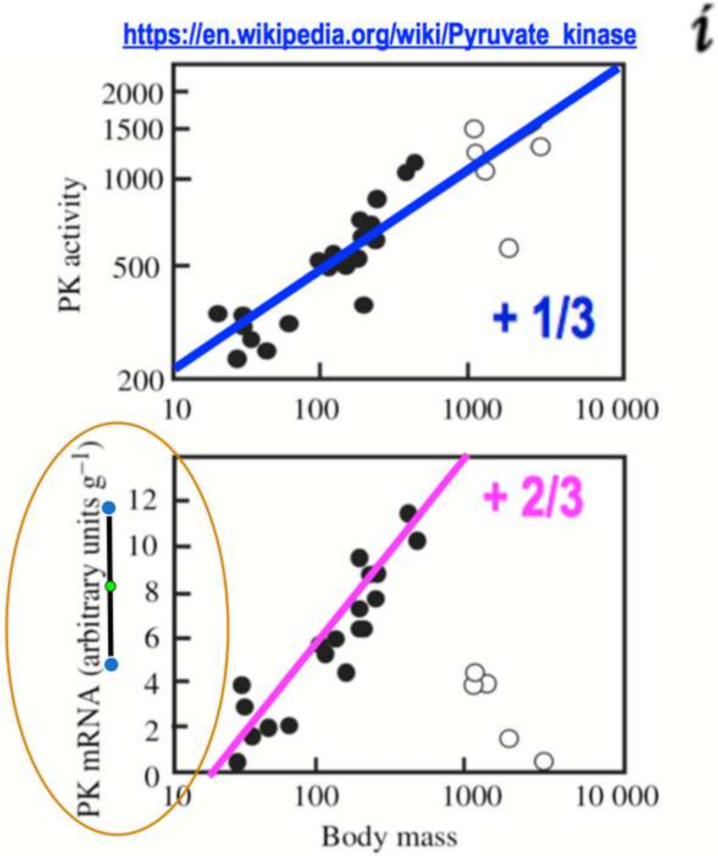

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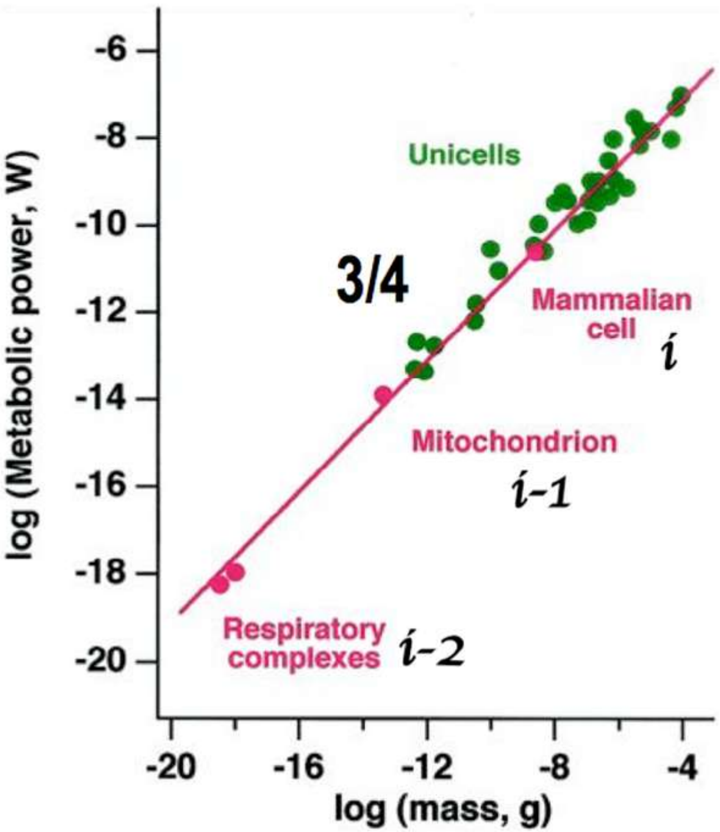
muscle bioenergetic gene expression: allometric scaling relationships of glycolytic and oxidative enzymes



$i-9$ **Planck quantum**
$i-8$ **cordes**
$i-7$ **super-cordes**
$i-6$ **quarks**
$i-5$ **particules**
$i-4$ **atomes**
$i-3$ **molécules**
$i-2$ **amas de molécules**
$i-1$ **organismes monères**
i **organismes cellulaires**
$i+1$ **organismes méta-cellulaires**
$i+2$ **écosystèmes**
$i+3$ **biosphères**
$i+4$ **systèmes stellaires**
$i+5$ **galaxies**
$i+6$ **amas de galaxies**
$i+7$ **univers**
$i+8$ **Hyper-univers**

Review

The origin of allometric scaling laws in biology from genomes to ecosystems: towards a quantitative unifying theory of biological structure and organization

Geoffrey B. West[1,2,*] and James H. Brown[1,3]

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The Journal of Experimental Biology 208, 1575-1592
Published by The Company of Biologists 2005
doi:10.1242/jeb.01589

Summary

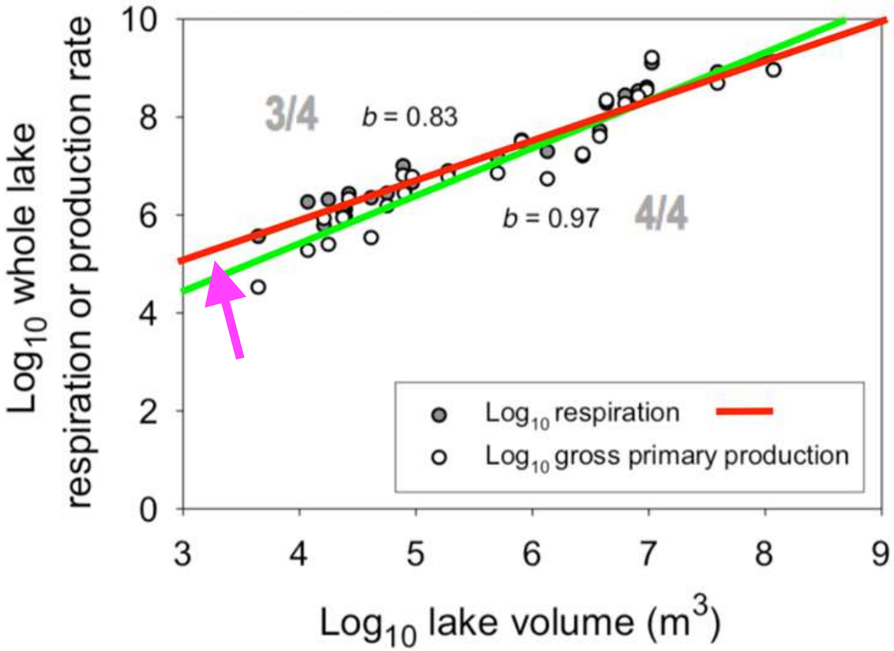
Life is the most complex physical phenomenon in the Universe, manifesting an extraordinary diversity of form and function over an enormous scale from the largest animals and plants to the smallest microbes and subcellular units. Despite this many of its most fundamental and complex phenomena scale with size in a surprisingly simple fashion. For example, metabolic rate scales as the 3/4-power of mass over 27 orders of magnitude, from molecular and intracellular levels up to the largest organisms. Similarly, time-scales (such as lifespans and growth rates) and sizes (such as bacterial genome lengths, tree heights and mitochondrial densities) scale with exponents that are typically simple powers of 1/4. The universality and simplicity of these relationships suggest that fundamental universal principles underly much of the coarse-grained generic structure and organisation of living systems. We have proposed a set of principles based on the observation that almost all life is sustained by hierarchical branching networks, which we assume have invariant terminal units, are space-filling and are optimised by the process of natural selection. We show how these general constraints explain quarter power scaling and lead to a quantitative, predictive theory that captures many of the essential features of diverse biological systems. Examples considered include animal circulatory systems, plant vascular systems, growth, mitochondrial densities, and the concept of a universal molecular clock. Temperature considerations, dimensionality and the role of invariants are discussed. Criticisms and controversies associated with this approach are also addressed.

Key words: allometry, quarter-power scaling, laws of life, circulatory system, ontogenetic growth.

Scaling of total community respiration (R, mmol·O_2·d^{-1}) and gross primary production (GPP, mmol·O_2·d^{-1}) with total water volume (V, m^3) above the thermocline in 25 lakes from Wisconsin and Michigan (data from [319]). R and GPP were estimated by multiplying measured rates per m^3 times V. The b values are scaling exponents (log-log slopes); and the lines refer to least squares regression equations (solid line: $\log_{10}R = 2.529$ (±0.568 95% CI) + logV(0.833 (±0.99)), $r = 0.964$, $p < 0.00001$; dashed line: $\log_{10}GPP = 1.553$ (±0.778) + logV(0.966 (±0.136)), $r = 0.951$, $p < 0.00001$).

$\log a^n = n. \log a$

$\log a + \log b = \log a.b$

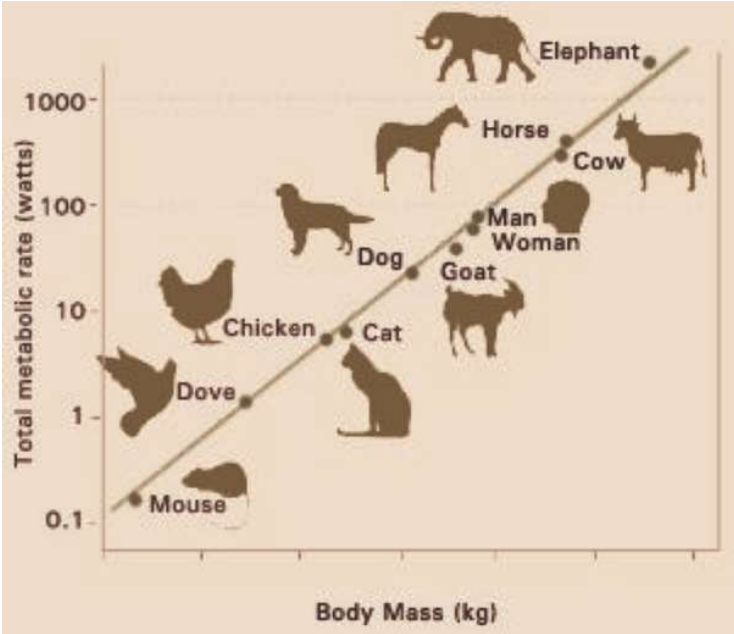


production - consommation

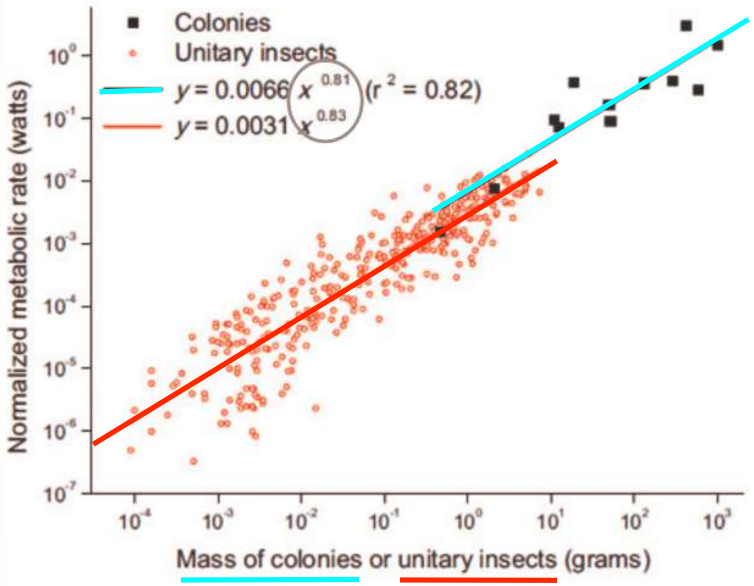
= énergie disponible

= masse $^{1/4}$

3/4



Elephant
Horse
Cow
Man
Woman
Dog
Goat
Chicken
Cat
Dove
Mouse
1000
100
10
1
0.1
Total metabolic rate (watts)
Body Mass (kg)



Colonies
Unitary insects
y = 0.0066 x 0.81 (r 2 = 0.82)
y = 0.0031 x 0.83
Normalized metabolic rate (watts)
Mass of colonies or unitary insects (grams)

production < consommation

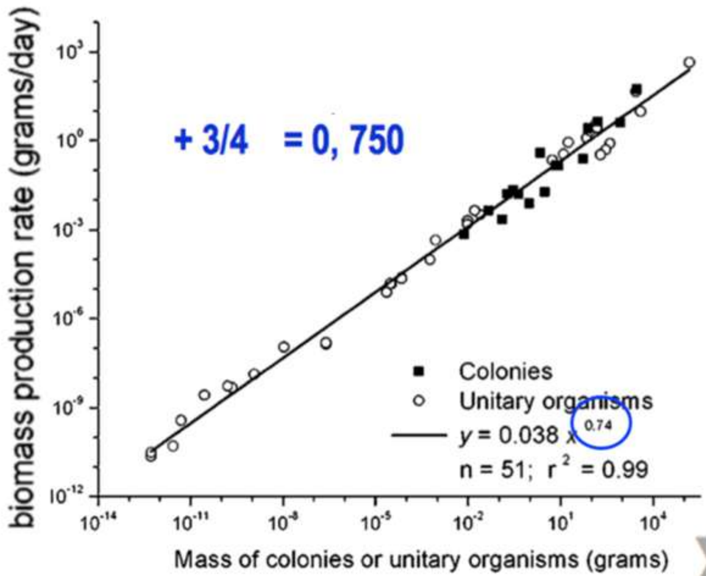
production = masse$^{+0,75}$

X1 = +0,75 X2

consommation = masse$^{+0,82}$

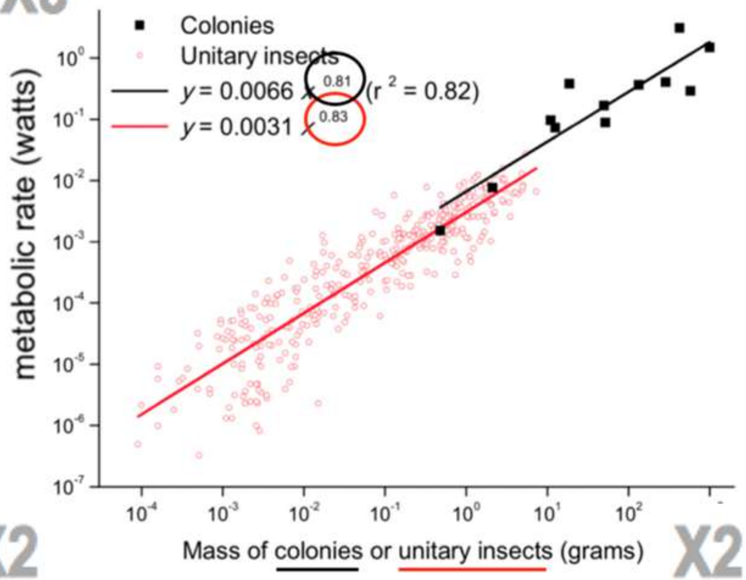
X3 = + 0,82 X2

X1



X2

X3



X2

+ 3/4 = 0, 750
+ 4/5 = 0, 800
+ 5/6 = 0, 833

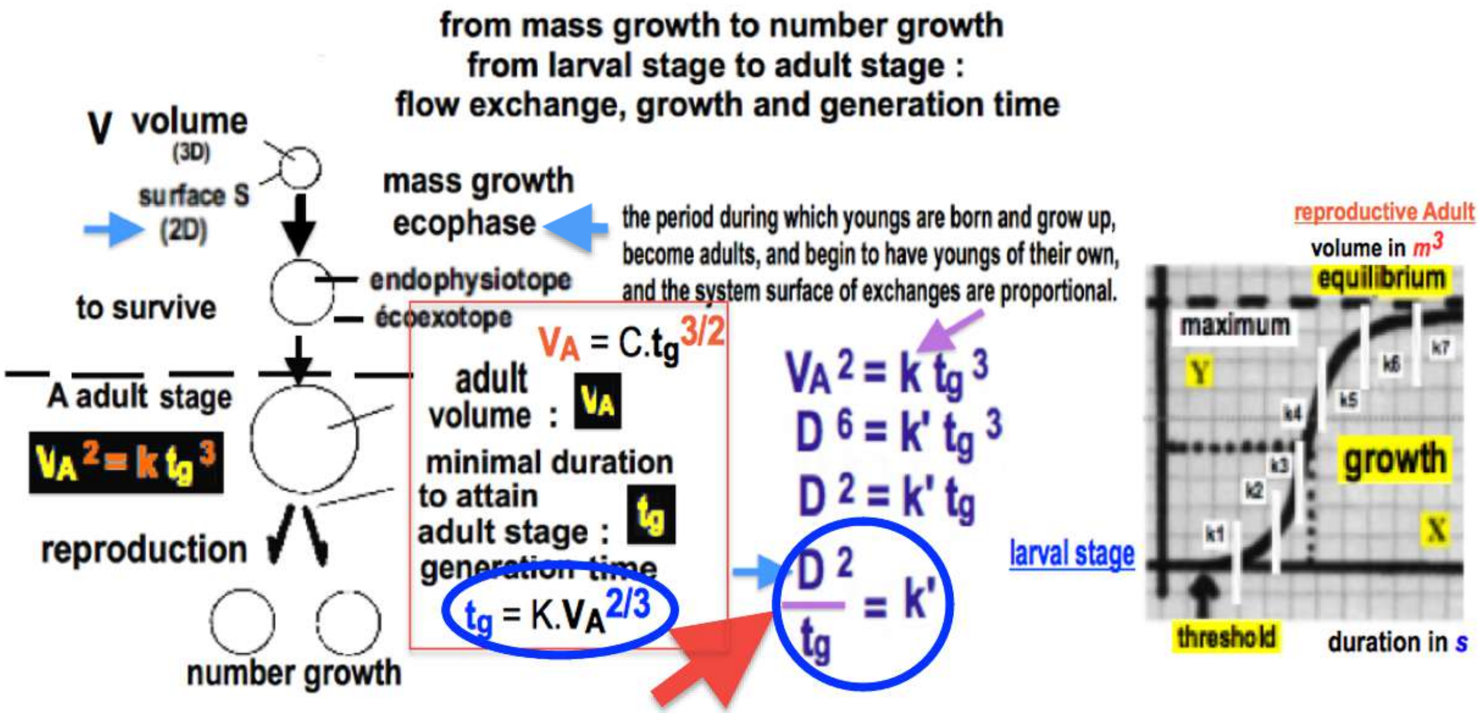
+0,75 < + 0,82

Apparently, the mysterious "3/4 law of metabolism" -- proposed by Max Kleiber in 1932, printed in biology textbooks for decades, explained theoretically in *Science* in 1997 and described in a 2000 essay in *Nature* as "extended to all life forms" from bacteria to whales -- is just plain wrong.

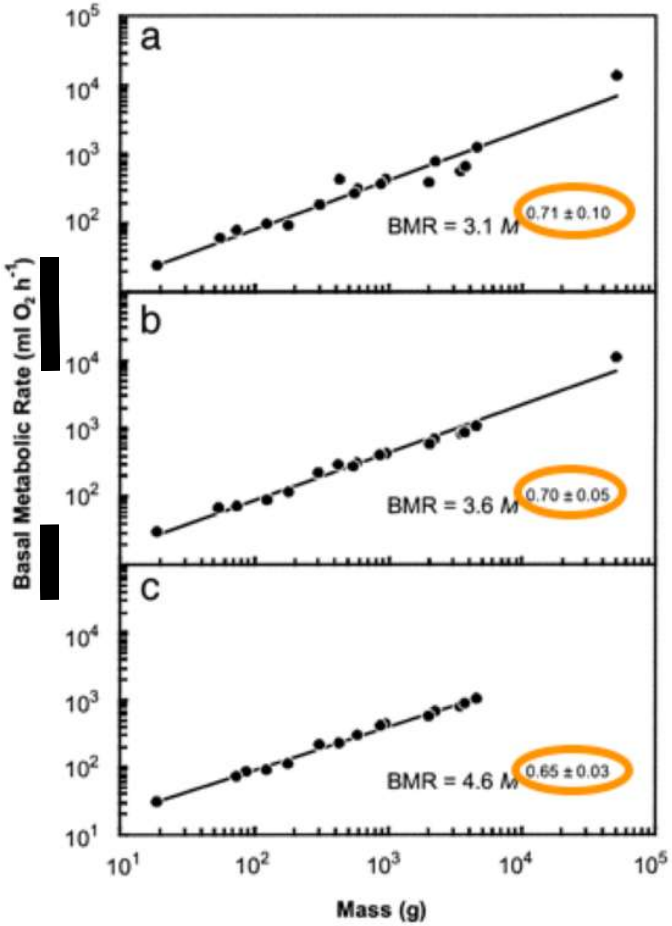
"Actually, it's two-thirds," says University of Vermont mathematician Peter Dodds. His paper in the January 29 edition of *Physical Review Letters* helps overturn almost eighty years of near-mystical belief in a 3/4 exponent used to describe the relationship between the size of animals and their resting metabolism.

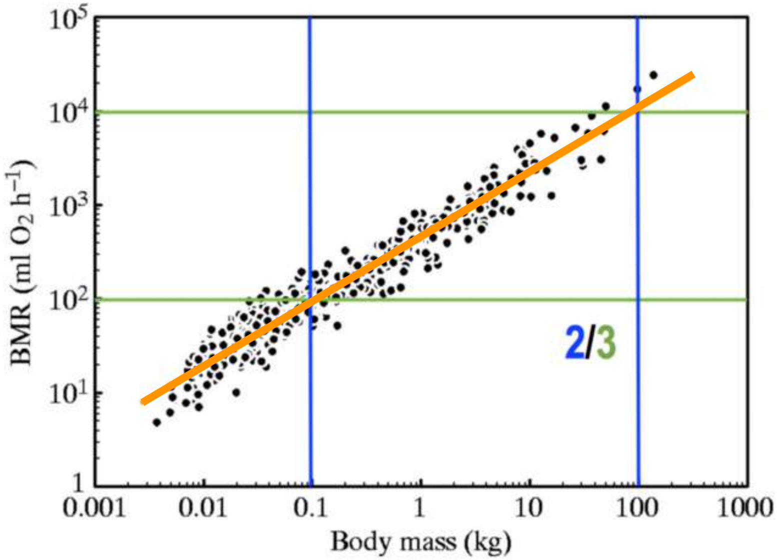
Two-thirds or three-quarters?

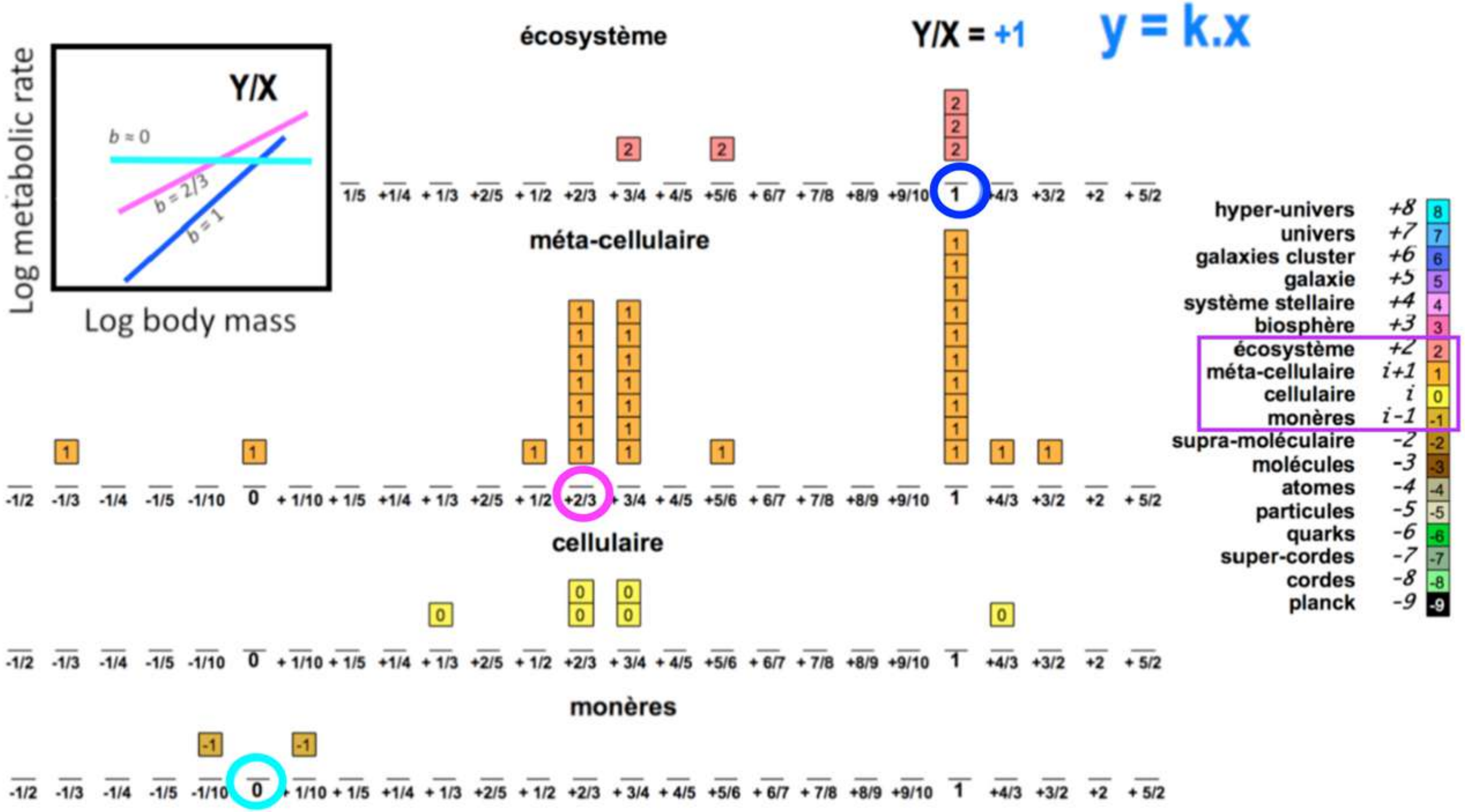
To understand the debate between 2/3 and 3/4, assume a spherical cow. "That's what a physicist would do," Dodds says, laughing. Basic geometry shows that the surface area of this difficult-to-milk creature would increase as the square of its radius while the volume would increase as the cube of the radius. In other words, the exponent that describes the ratio of surface area to volume is 2/3.

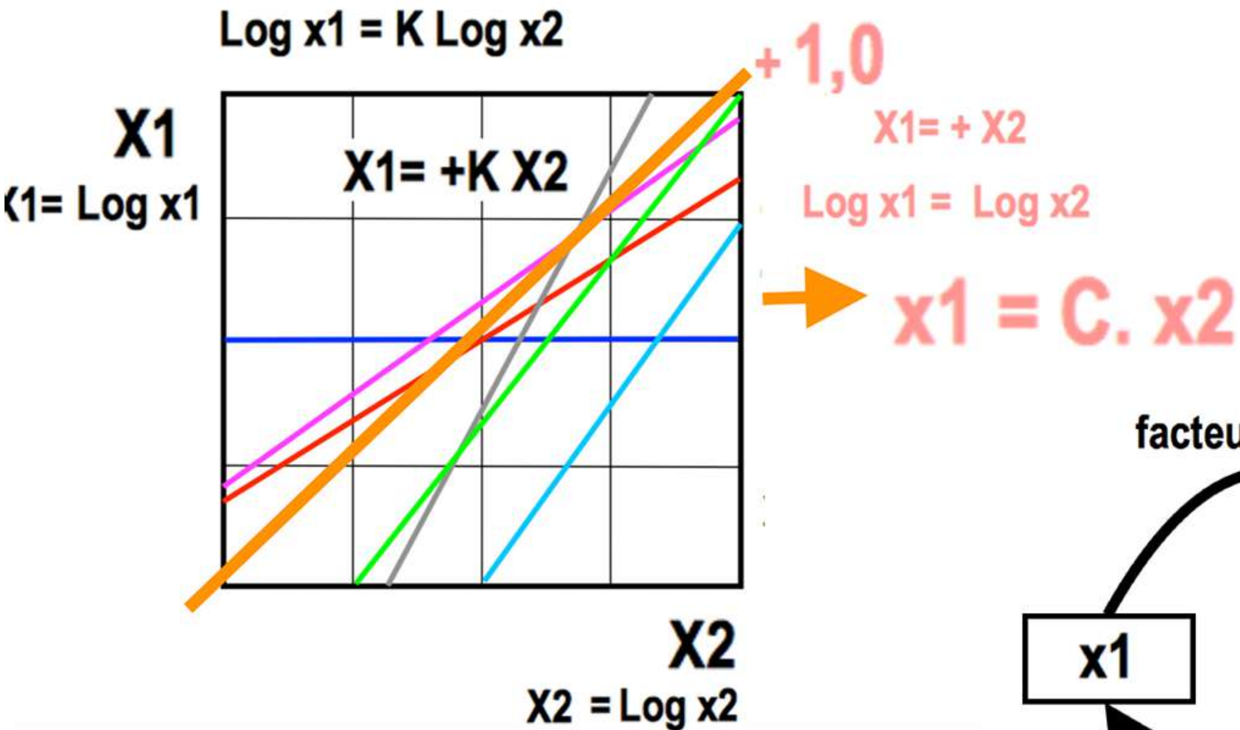


« La complexification ne peut se poursuivre indéfiniment, car c'est par la surface que se réalisent les échanges.» (Laborit, 1985).

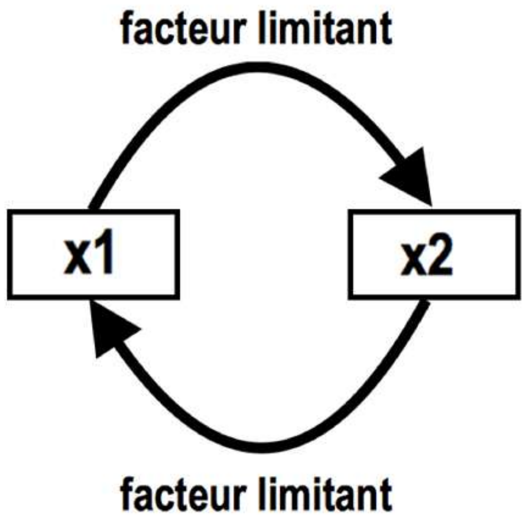

a
BMR = 3.1 M 0.71 ± 0.10
b
BMR = 3.6 M 0.70 ± 0.05
c
BMR = 4.6 M 0.65 ± 0.03
Basal Metabolic Rate (ml O_2 h^{-1})
[redacted]
Mass (g)


2/3
BMR (ml O_2 h^{-1})
Body mass (kg)


écosystème
Y/X = +1
y = k.x
Y/X
Log metabolic rate
Log body mass
b ≈ 0
b = 2/3
b = 1
méta-cellulaire
cellulaire
monères
-1/2 -1/3 -1/4 -1/5 -1/10 0 + 1/10 + 1/5 +1/4 + 1/3 +2/5 + 1/2 +2/3 + 3/4 + 4/5 +5/6 + 6/7 + 7/8 +8/9 +9/10 1 +4/3 +3/2 +2 + 5/2
hyper-univers +8
univers +7
galaxies cluster +6
galaxie +5
système stellaire +4
biosphère +3
écosystème +2
méta-cellulaire i+1
cellulaire i
monères i-1
supra-moléculaire -2
molécules -3
atomes -4
particules -5
quarks -6
super-cordes -7
cordes -8
planck -9



Log x1 = K Log x2
X1
1= Log x1
X1= +K X2
+ 1,0
X1= + X2
Log x1 = Log x2
x1 = C. x2
X2
X2 = Log x2



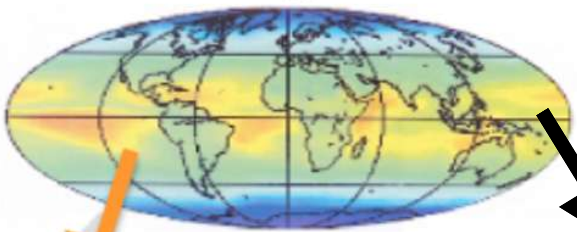
facteur limitant
x1
x2
facteur limitant

EcoExoTope & EndoPhysioTope

Limitations

all the water of the earth

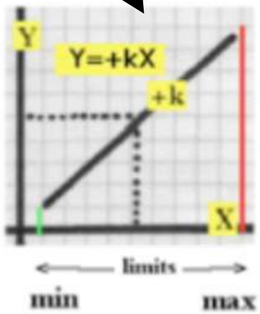
1x



10x

solar energy

hosting capacity



capacity to be hosted

endophysiotope

SURVIVRE

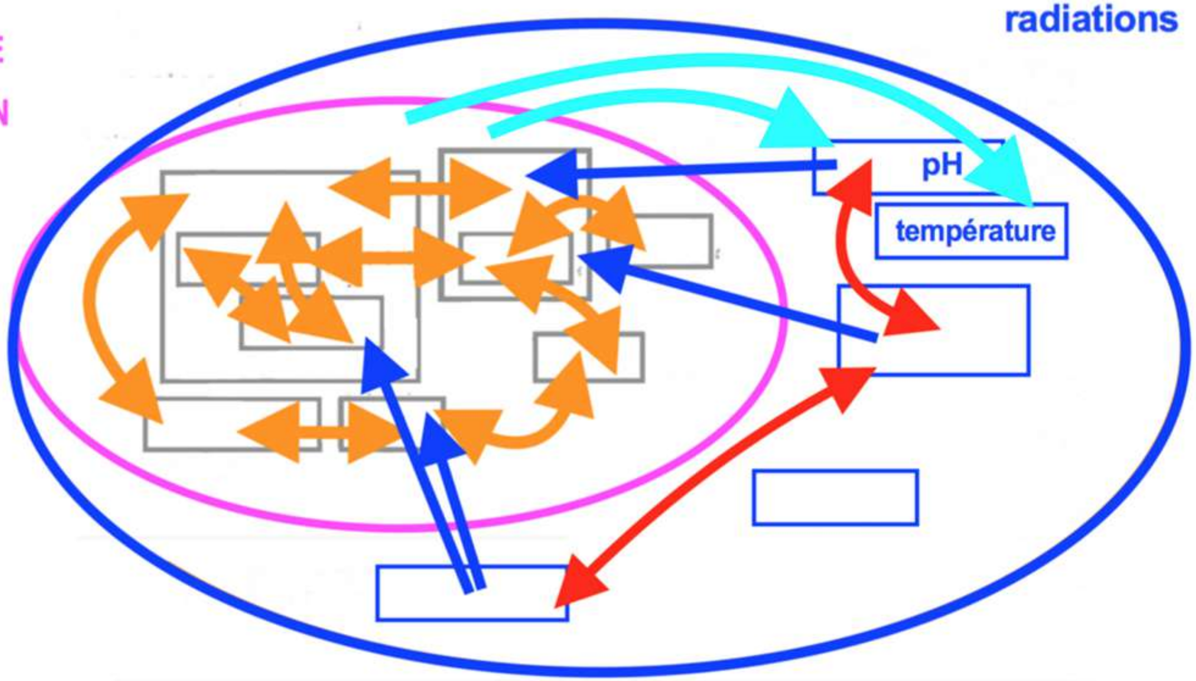
1. La MOBILISATION MÉTABOLISME
   de la MATIÈRE et de l'ÉNERGIE
2. La CROISSANCE MASSE
   en masse
2. La CROISSANCE NOMBRE
   en nombre
3. La RÉPONSE à RÉACTION
   des STIMULATIONS
4. L'ORGANISATION interne
   dans l'espace ESPACE
   et dans le temps TEMPS
5. L'INTÉGRATION exteme
6. Le MOUVEMENT

pour **SE SURVIVRE**

7. La REPRODUCTION

écoexotope

pH
température
radiations



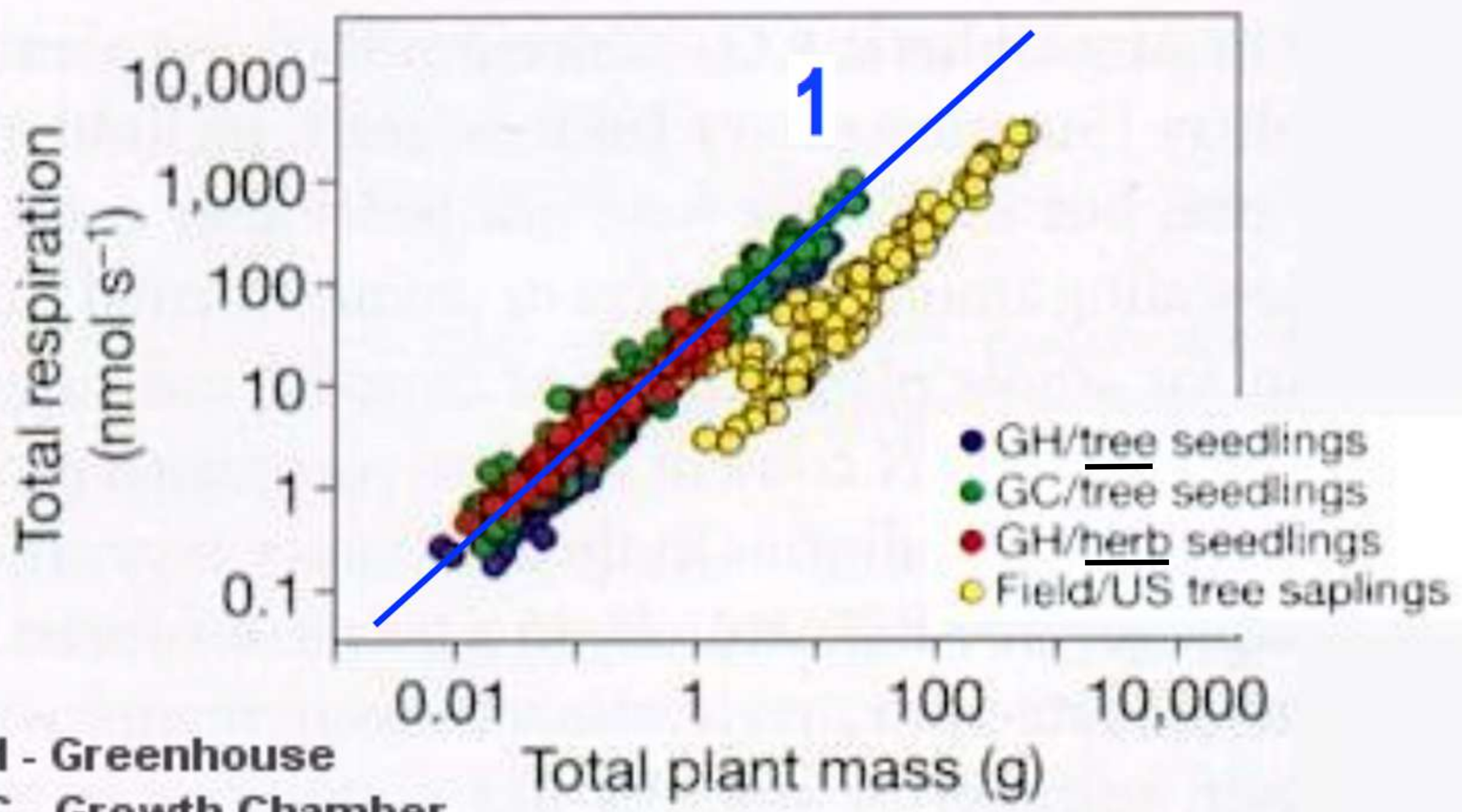
Scaling relationships for angiosperms of leaf nitrogen concentration N_L and leaf phosphorus concentration P_L in relation to SLA for all data pooled, for plants grouped by life form and for three biomes. (All relations were significant ($p < 0.0001$). All equations were fit using the log–log version of the equation: $Y = \beta X^{\alpha}$. Reduced major axis slopes (exponents) are shown, as well as the lower and upper 95% CI of the exponent, and r^2. n, number of observations. Significant differences ($p < 0.05$) in exponents among groups (for appropriate contrasts separated by blank lines) are shown by the lack of shared letters.)

		N_L			P_L		
plant group	n	exponent	low CI, high CI	r^2	exponent	low CI, high CI	r^2
all	1819	3/4	0.73, 0.79	0.54	1,14	1.08, 1.12	0.45
angiosperm **endophysiotope**							
graminoid	34	0.59 a	0.41, 0.85	0.52	1.17 a	0.81, 1.69	0.51
forb	22	0.72 a	0.33, 1.56	0.34	1.01		ns
shrub	535	0.83 a	0.76, 0.89	0.55	1.19 a	1.08, 1.31	0.45
trees	1112	0.75 a	0.70, 0.80	0.45	1.17 a	1.09, 1.26	0.39
biomes **écoexotope**							
temperate	449	0.67 a	0.59, 0.76	0.35	0.95 a	0.80, 1.12	0.24
Mediterranean	321	0.93 b	0.83, 1.03	0.54	1.41 b	1.26, 1.58	0.49
moist tropical	950	0.78 a	0.71, 0.85	0.34	1.21 ab	1.08, 1.35	0.24

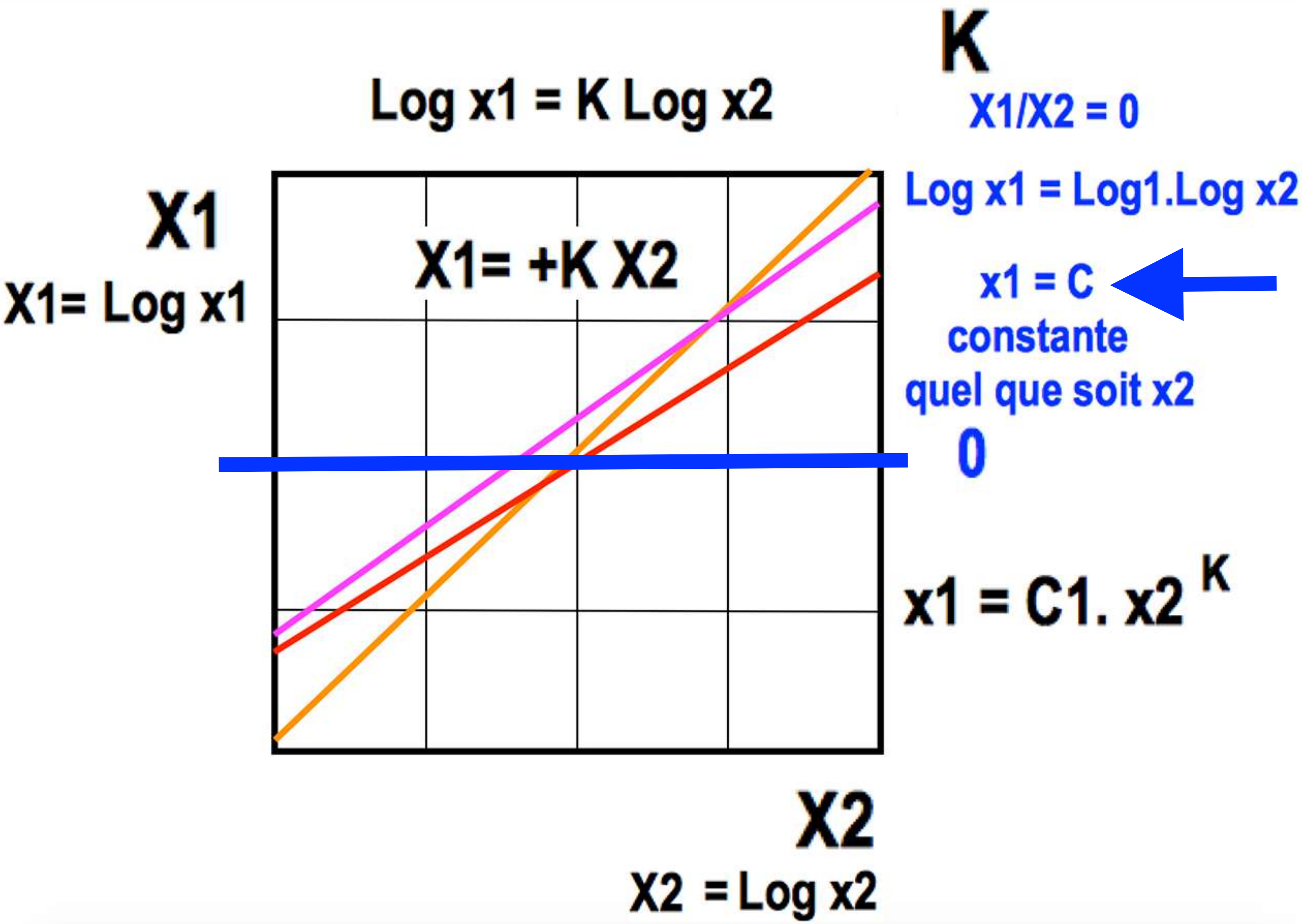
2/3 **3/2**

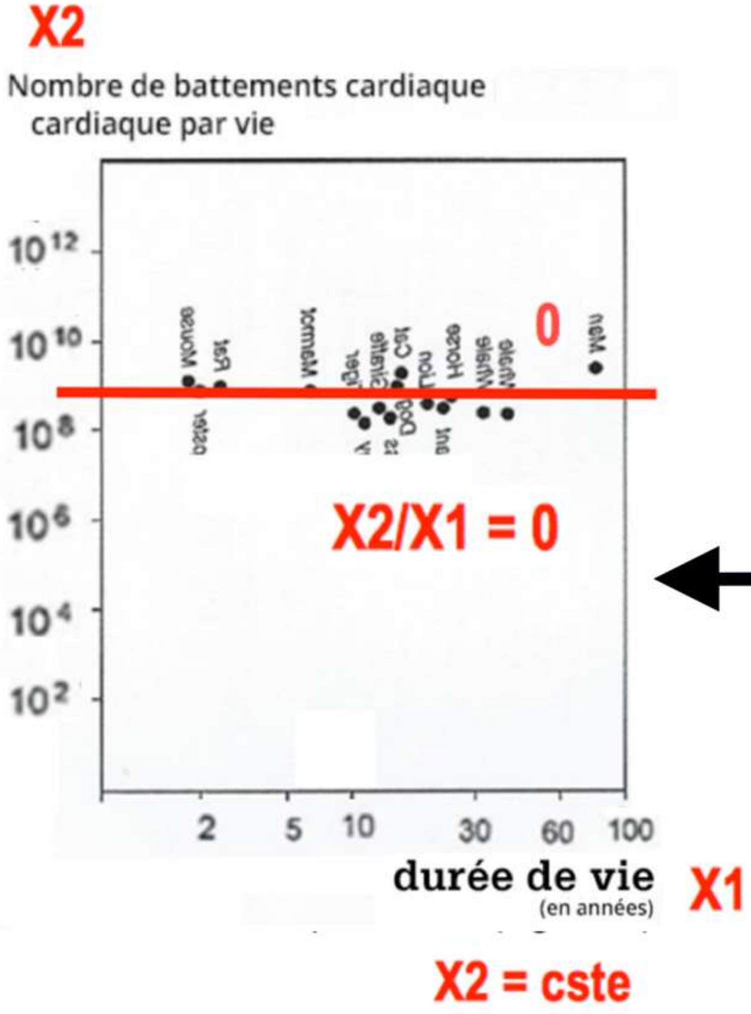
1

3/4

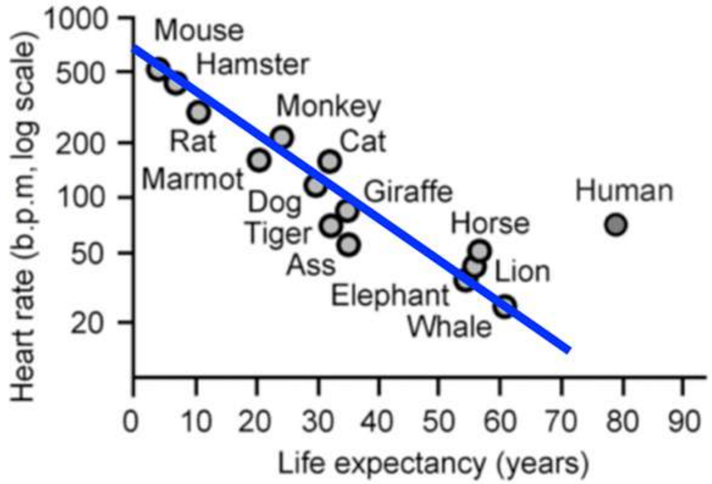


GH - Greenhouse
GC - Growth Chamber

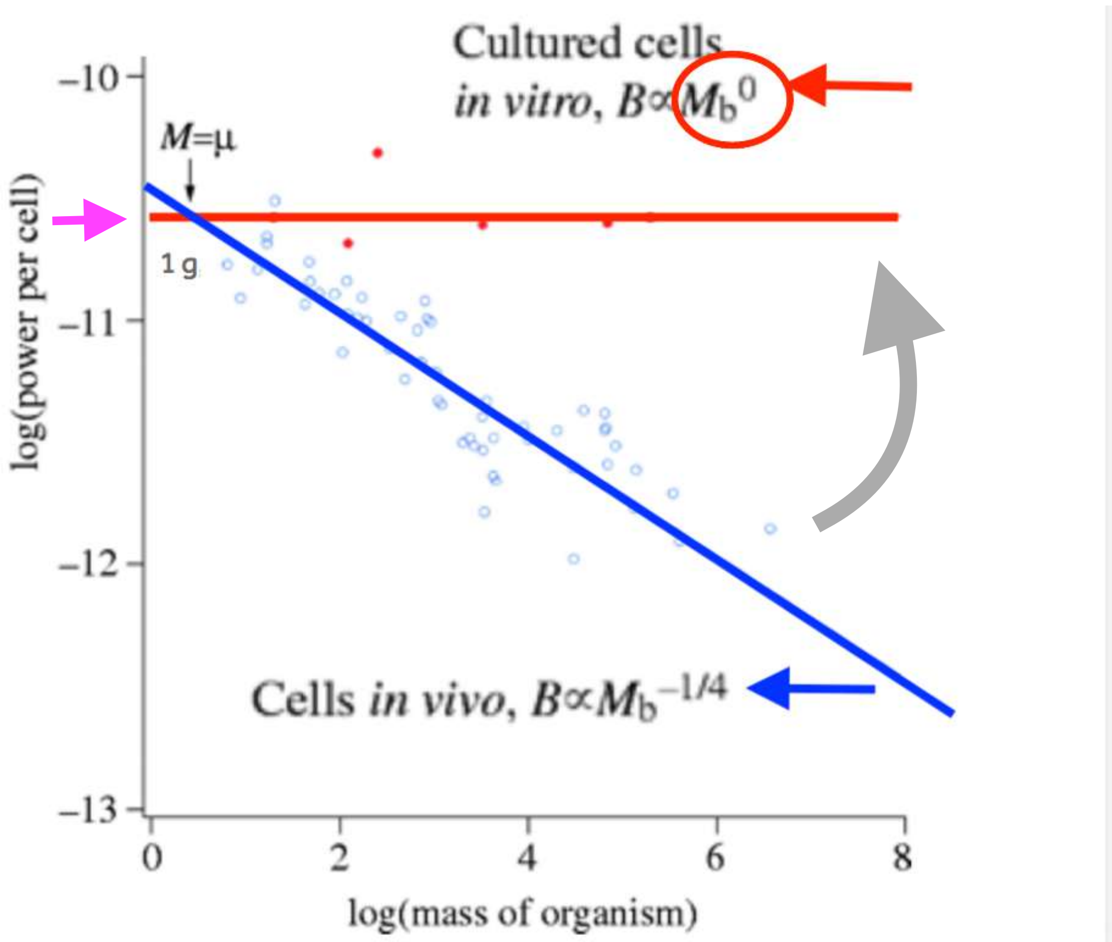

K
Log x1 = K Log x2
X1/X2 = 0
Log x1 = Log1.Log x2
X1
X1= Log x1
X1= +K X2
x1 = C
constante
quel que soit x2
0
x1 = C1. x2 K
X2
X2 =Log x2



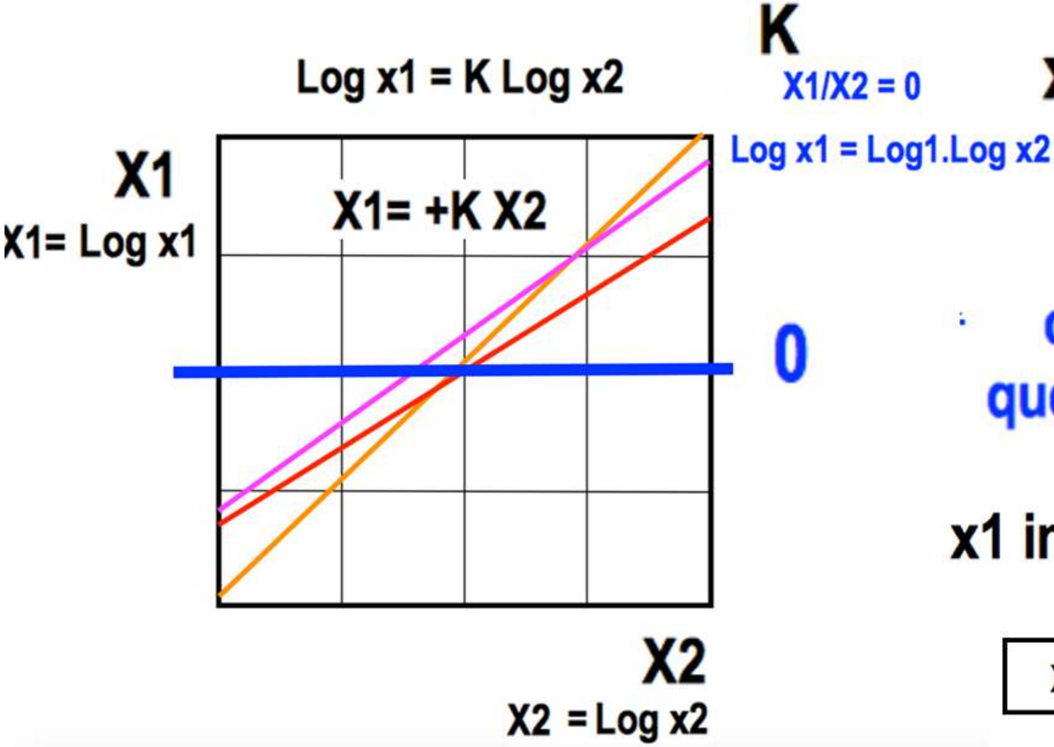
X2
Nombre de battements cardiaque
cardiaque par vie
10^{12}
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}
0
X2/X1 = 0
2
5
10
30
60
100
durée de vie
(en années)
X1
X2 = cste



Heart rate (b.p.m, log scale)
1000
500
200
100
50
20
Mouse
Hamster
Rat
Monkey
Cat
Marmot
Dog
Giraffe
Tiger
Ass
Human
Horse
Lion
Elephant
Whale
0
10
20
30
40
50
60
70
80
90
Life expectancy (years)



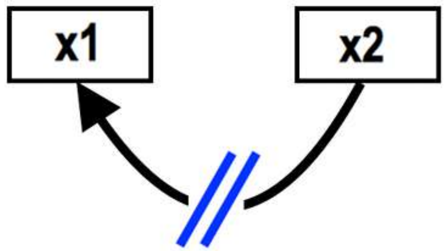
Metabolic rates (in W) of mammalian cells *in vivo* (blue line) and cultured *in vitro* (red line) plotted as a function of organism mass (M_b in g) on a log-log scale. While still in the body and constrained by vascular supply networks cellular metabolic rates scale as $M_b^{-1/4}$. When cells are removed from the body and cultured *in vitro*, their metabolic rates converge to a constant value predicted by theory (**West et al., 2002b**). The two lines meet at the mass of the smallest mammal

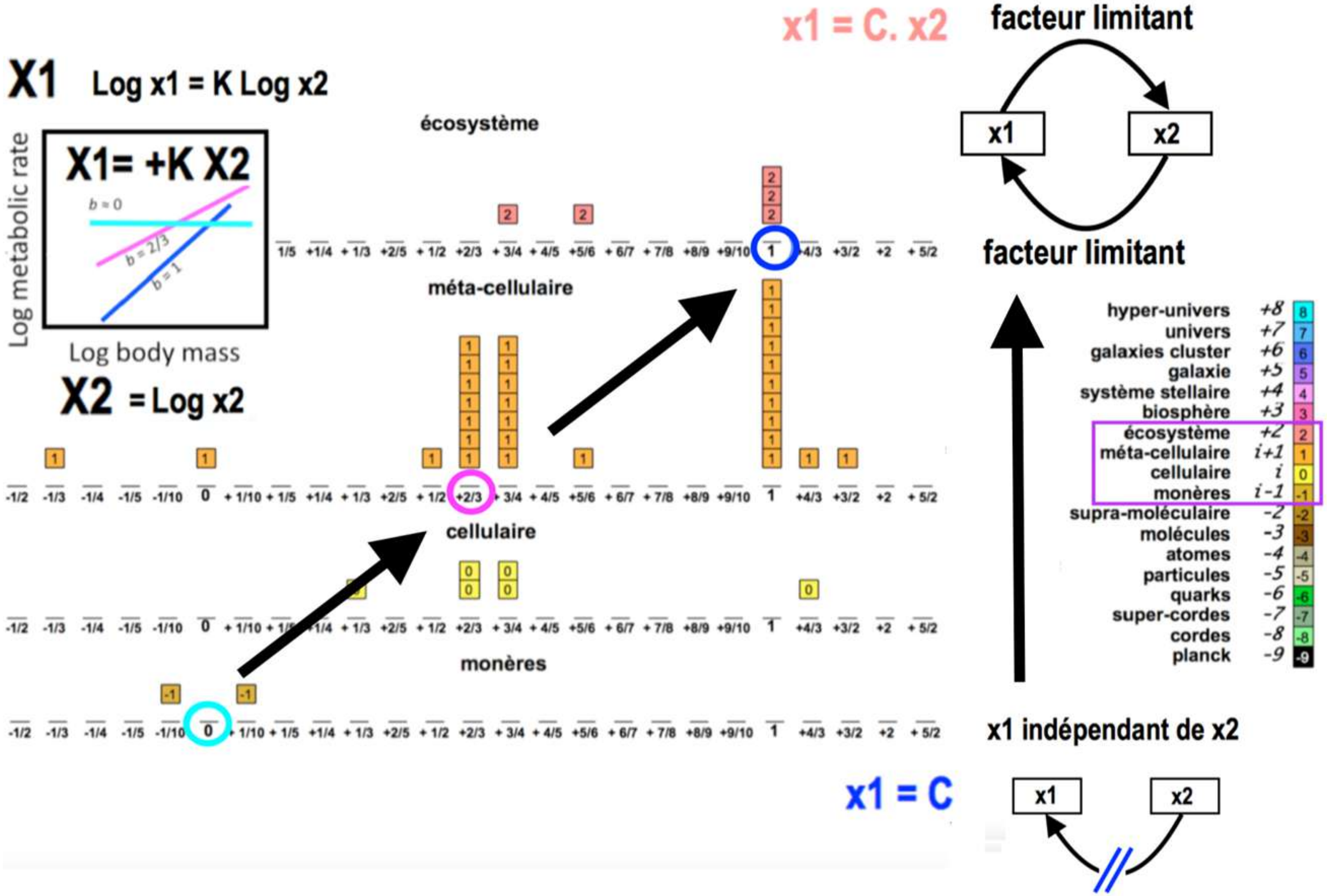


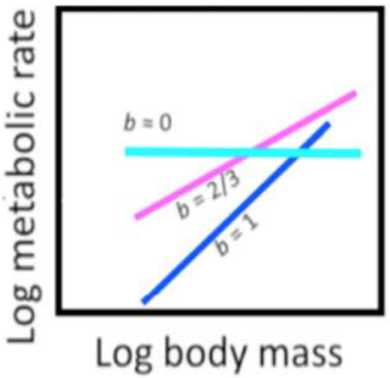
$$x1 = C1.\ x2^{0}$$

x1 = C
constante
quel que soit x2

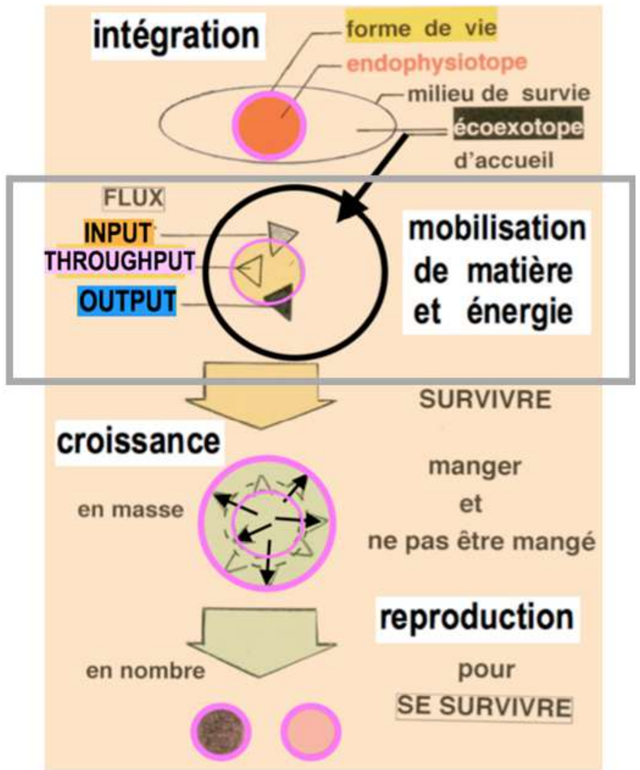
x1 indépendant de x2

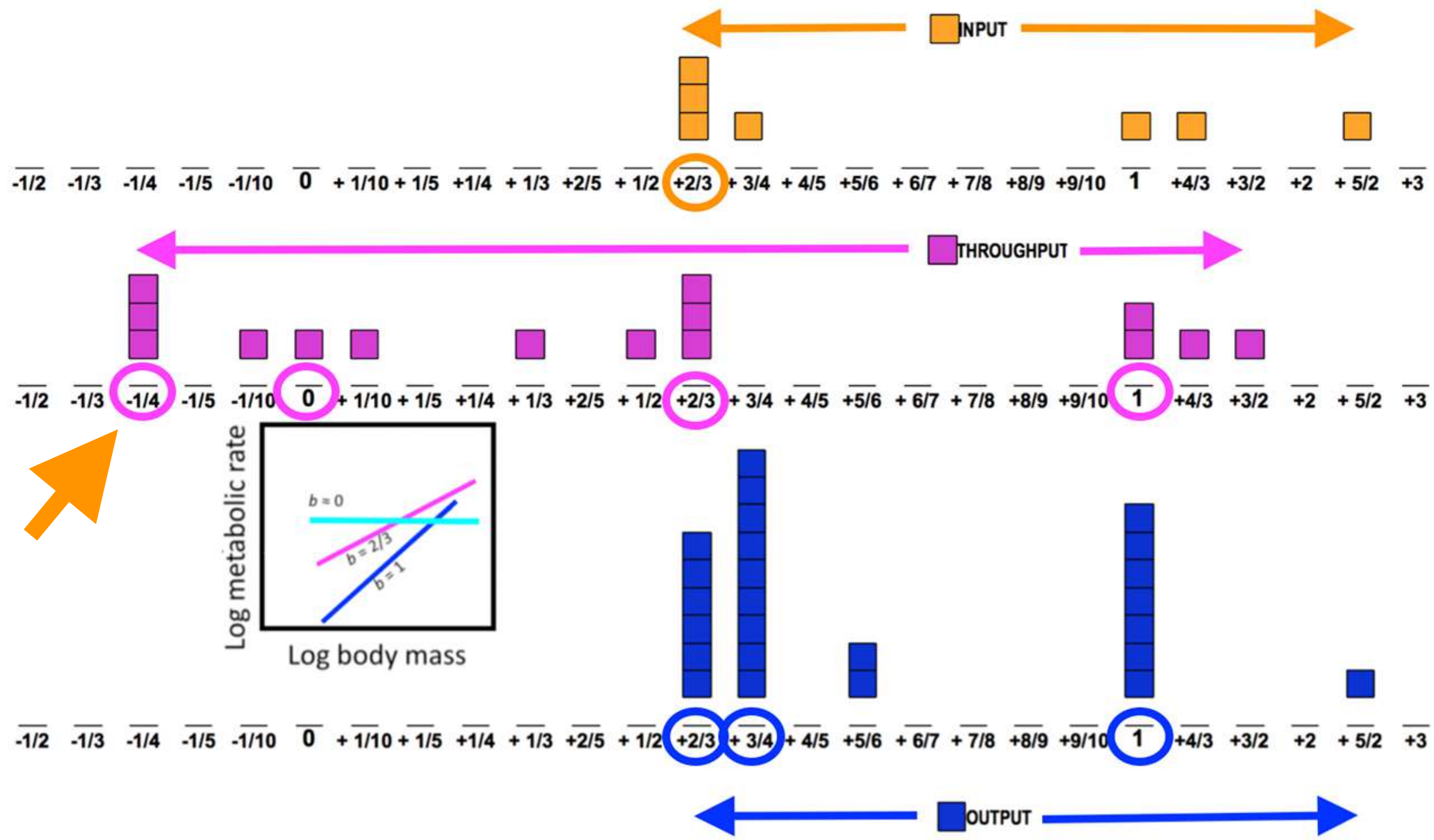



X1 Log x1 = K Log x2
X1= +K X2
Log metabolic rate
Log body mass
X2 = Log x2
écosystème
méta-cellulaire
cellulaire
monères
x1 = C. x2
facteur limitant
x1
x2
facteur limitant
hyper-univers +8
univers +7
galaxies cluster +6
galaxie +5
système stellaire +4
biosphère +3
écosystème +2
méta-cellulaire i+1
cellulaire i
monères i-1
supra-moléculaire -2
molécules -3
atomes -4
particules -5
quarks -6
super-cordes -7
cordes -8
planck -9
x1 indépendant de x2
x1 = C

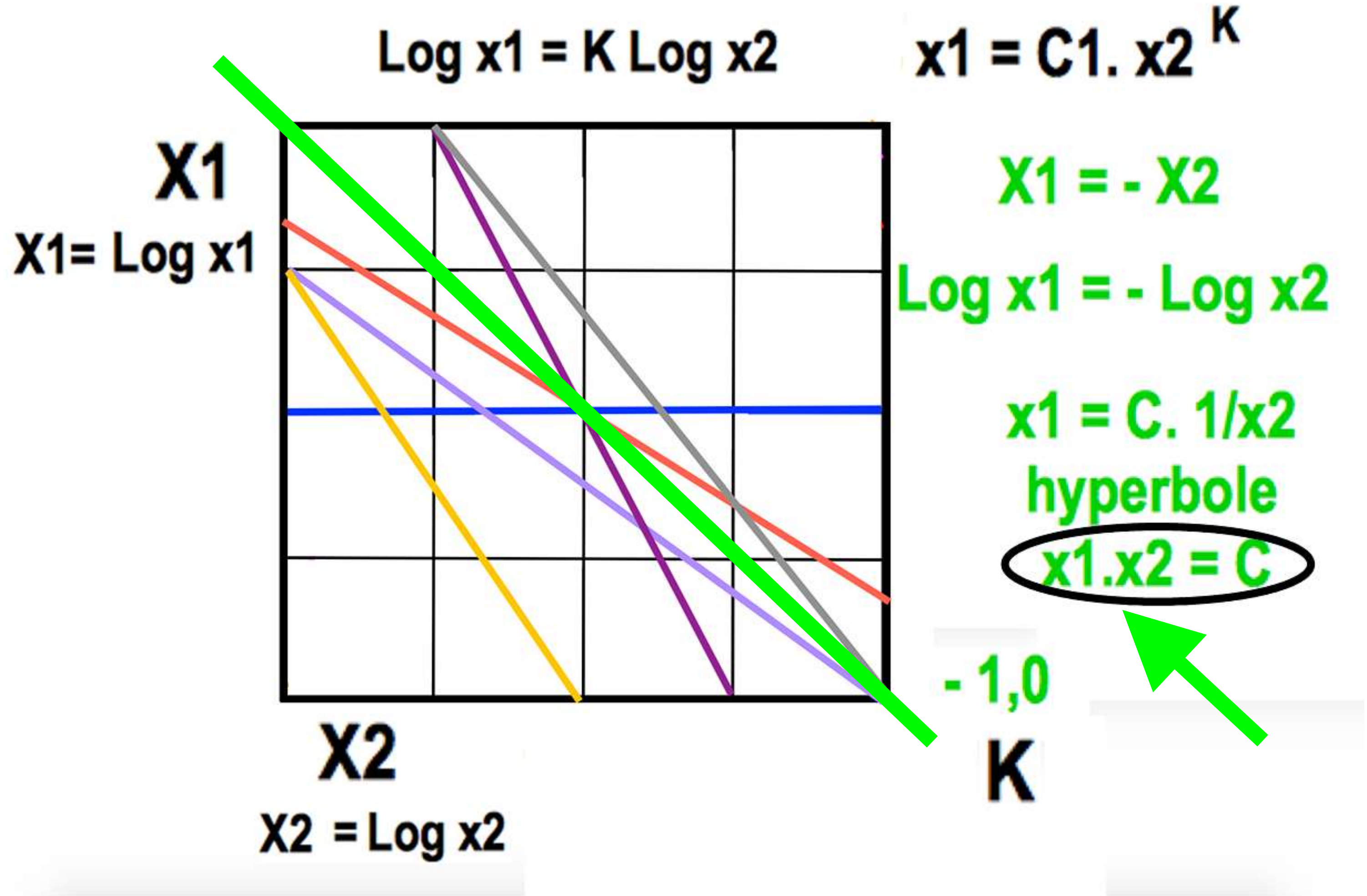


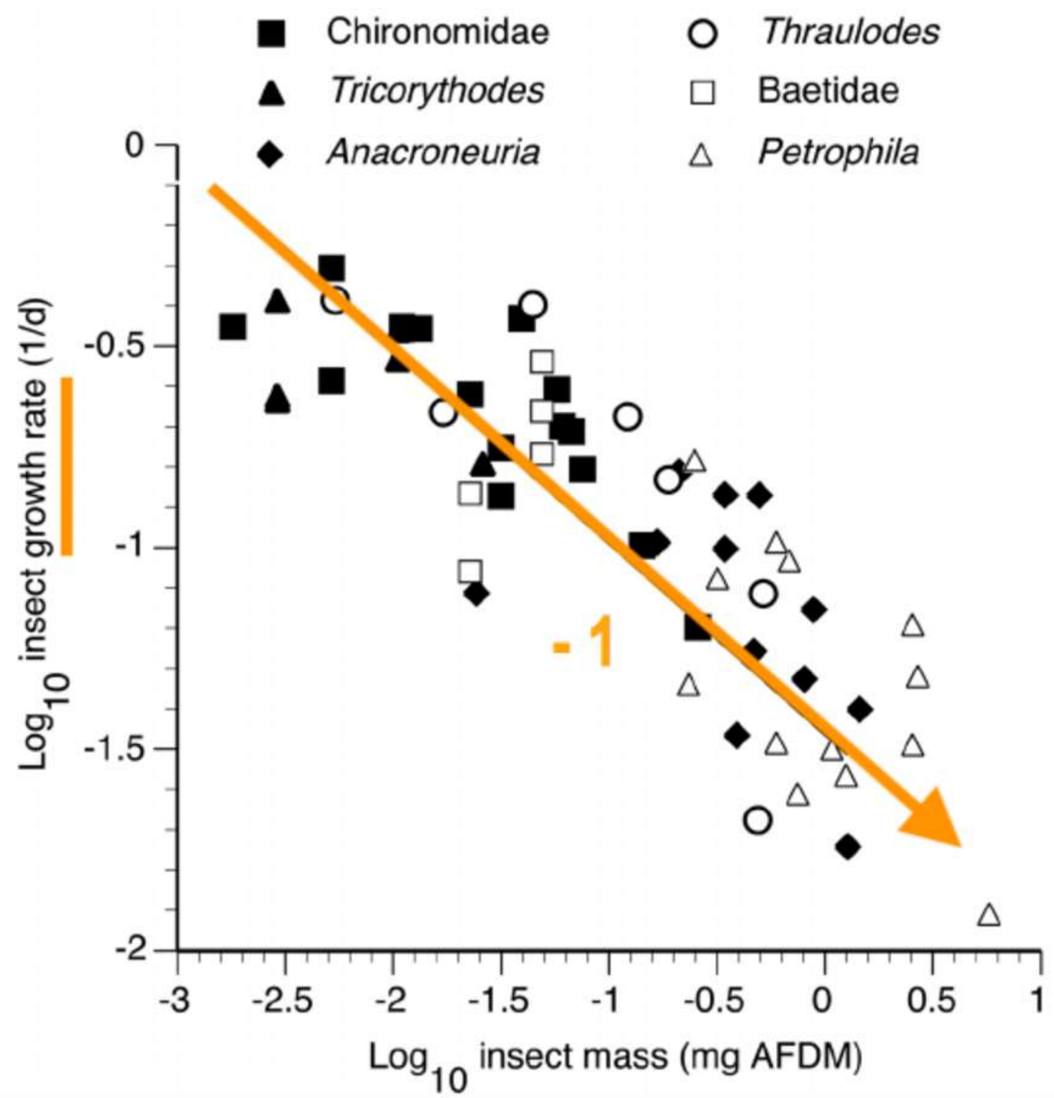
$i-9$ Planck quantum
$i-8$ cordes
$i-7$ super-cordes
$i-6$ quarks
$i-5$ particules
$i-4$ atomes
$i-3$ molécules
$i-2$ amas de molécules
$i-1$ organismes monères
i organismes cellulaires
$i+1$ organismes méta-cellulaires
$i+2$ écosystèmes
$i+3$ biosphères
$i+4$ systèmes stellaires
$i+5$ galaxies
$i+6$ amas de galaxies
$i+7$ univers
$i+8$ Hyper-univers



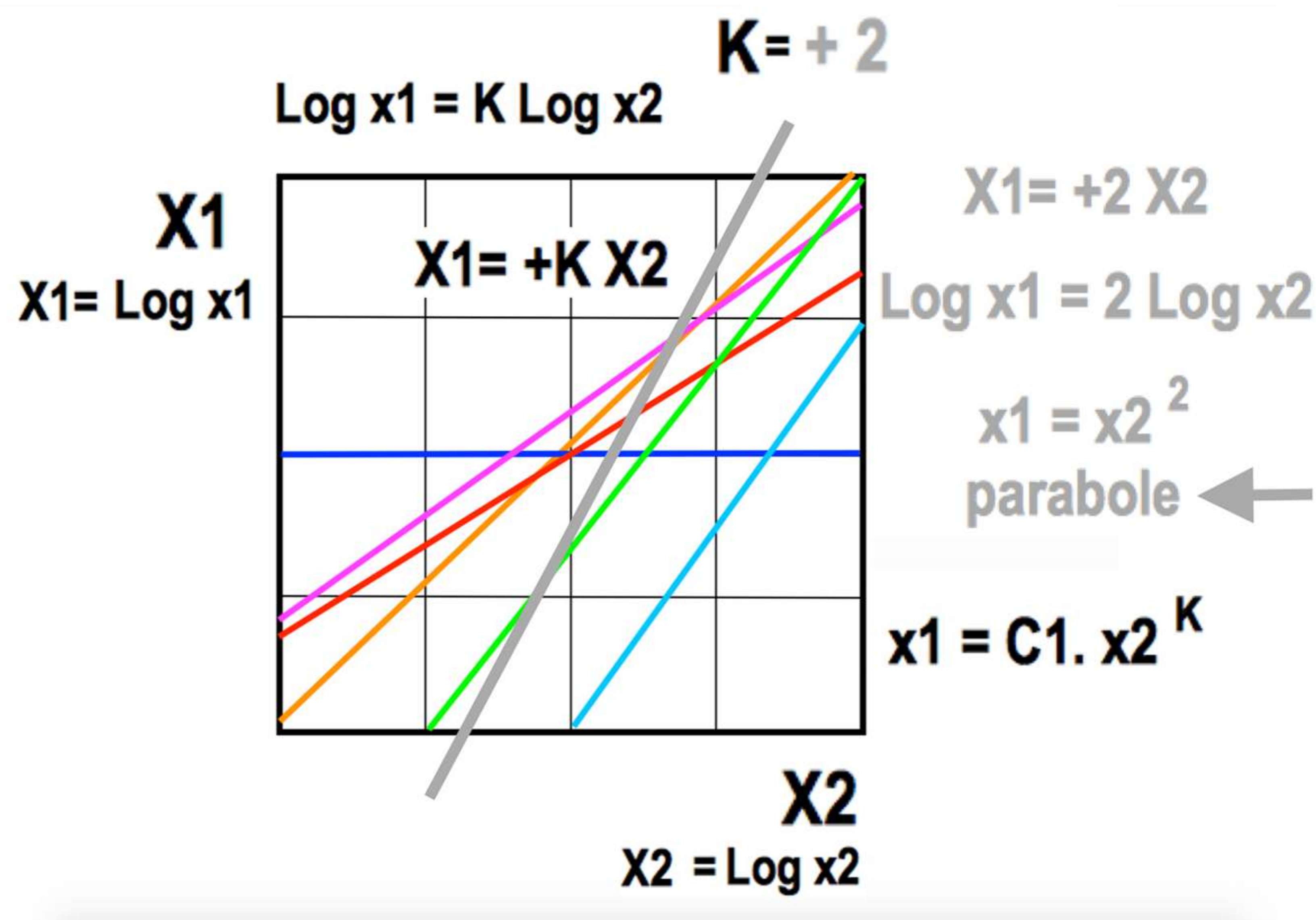


INPUT
-1/2 -1/3 -1/4 -1/5 -1/10 0 + 1/10 + 1/5 +1/4 + 1/3 +2/5 + 1/2 +2/3 + 3/4 + 4/5 +5/6 + 6/7 + 7/8 +8/9 +9/10 1 +4/3 +3/2 +2 + 5/2 +3
THROUGHPUT
-1/2 -1/3 -1/4 -1/5 -1/10 0 + 1/10 + 1/5 +1/4 + 1/3 +2/5 + 1/2 +2/3 + 3/4 + 4/5 +5/6 + 6/7 + 7/8 +8/9 +9/10 1 +4/3 +3/2 +2 + 5/2 +3
Log metabolic rate
Log body mass
b = 0
b = 2/3
b = 1
-1/2 -1/3 -1/4 -1/5 -1/10 0 + 1/10 + 1/5 +1/4 + 1/3 +2/5 + 1/2 +2/3 + 3/4 + 4/5 +5/6 + 6/7 + 7/8 +8/9 +9/10 1 +4/3 +3/2 +2 + 5/2 +3
OUTPUT


Log x1 = K Log x2
x1 = C1. x2 K
X1
X1= Log x1
X1 = - X2
Log x1 = - Log x2
x1 = C. 1/x2
hyperbole
x1.x2 = C
- 1,0
K
X2
X2 = Log x2



Chironomidae
Tricorythodes
Anacroneuria
Thraulodes
Baetidae
Petrophila
0
-0.5
-1
-1.5
-2
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
-1
Log10 insect growth rate (1/d)
Log10 insect mass (mg AFDM)

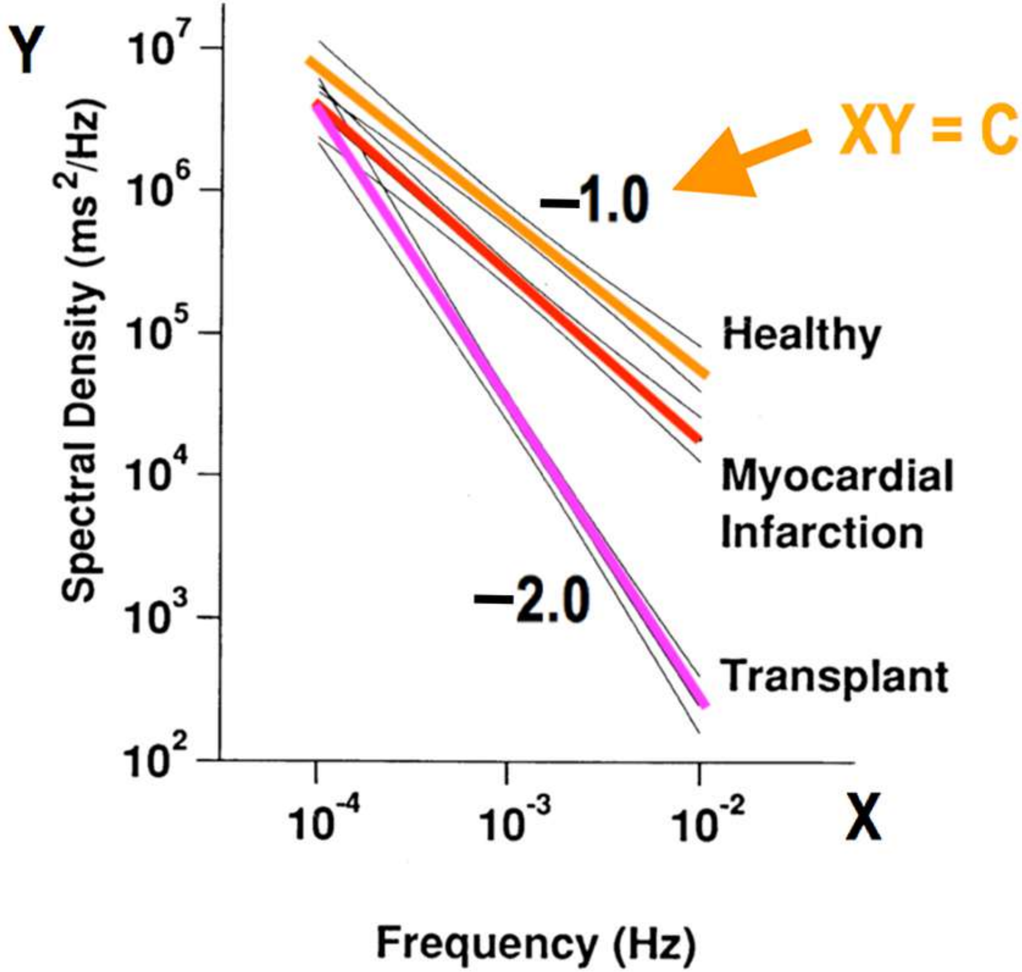


K= + 2
Log x1 = K Log x2
X1
X1= Log x1
X1= +K X2
X1= +2 X2
Log x1 = 2 Log x2
x1 = x2 2
parabole
x1 = C1. x2 K
X2
X2 = Log x2

$Y/X = -1$	$\mathrm{Log}(y) = -1\ \mathrm{Log}(x)$	$y = 1/x$	hyperbole	$xy = k$
$Y/X = +1$	$\mathrm{Log}(y) = +1\ \mathrm{Log}(x)$	$y = x$	droite	$y = k.x$
$Y/X = 2$	$\mathrm{Log}(y) = 2\ \mathrm{Log}(x)$	$y = x^2$	parabole	

Regression of log(power) on log(frequency) for healthy subjects (n=274), myocardial infarction patients (n=715), and heart transplant patients (n=19)

Bigger J et al. Circulation 1996;93:2142-2151



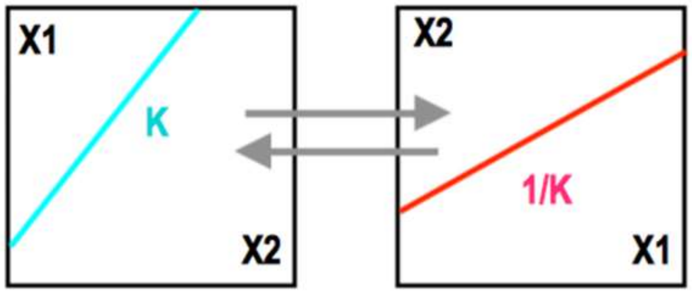
American Heart Association

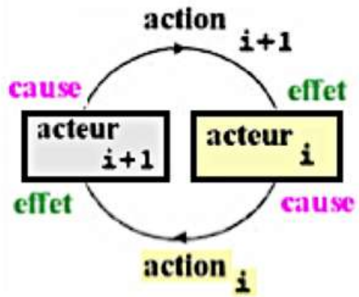
on ne peut pas privilégier,
comme cause ou effet,
un facteur plutôt qu'un autre

$X1 = K\,X2$ équivaut à $X2 = 1/K\,X1$

$\text{Log } x1 = K \text{ Log } x2$ $\qquad$ $\text{Log } x2 = 1/K \text{ Log } x1$

$x1 = x2^{K}$ ou $x2 = x1^{1/K}$





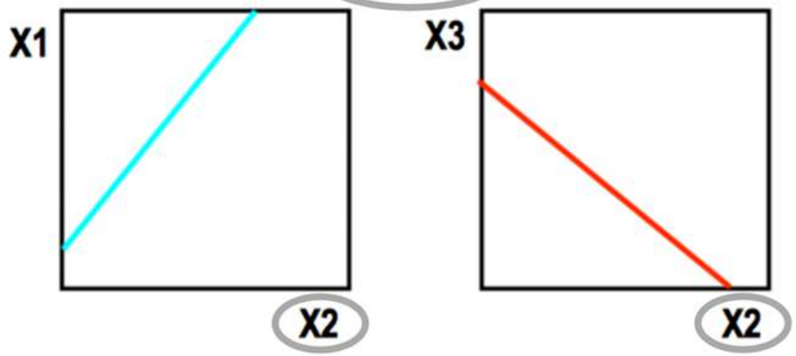
des interactions antagonistes
permettent la mise en place
d'un processus de rétroaction négative

$X1 = +K\,X2$ $\qquad$ $X3 = -K\,X2$

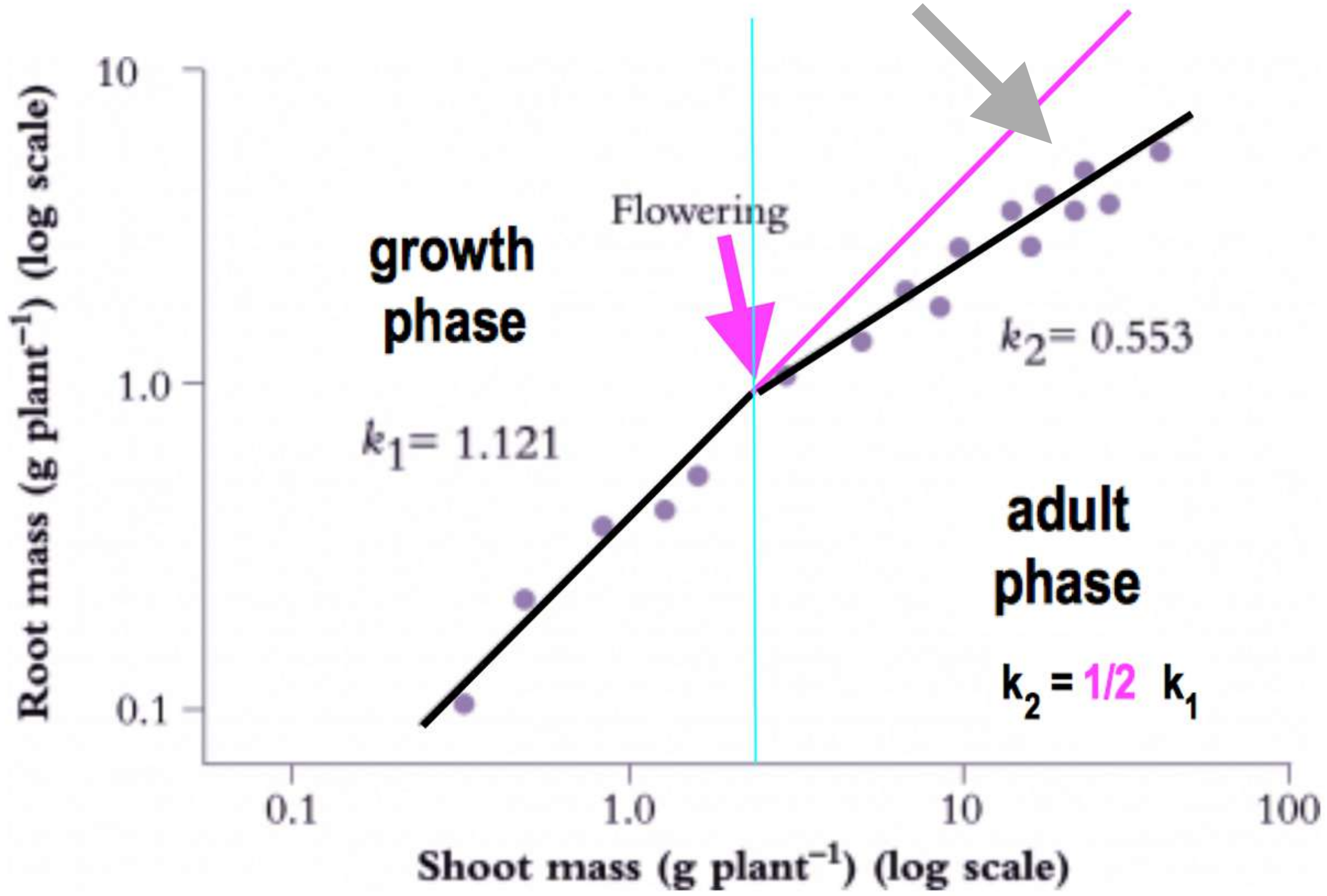
$\text{Log } x1 = K \text{ Log } x2$ $\qquad$ $\text{Log } x3 = -K \text{ Log } x2$

$x1 = C1.\,x2^{K}$ $\qquad$ $x3 = C3.\,x2^{-K}$

$x1.\,x3 = C$



quand l'un croît,
l'autre décroît



Flowering
growth phase
k_1= 1.121
k_2= 0.553
adult phase
k_2 = 1/2 k_1
10
1.0
0.1
0.1
1.0
10
100
Root mass (g plant^{-1}) (log scale)
Shoot mass (g plant^{-1}) (log scale)

Two-Third power law for curved movements provides a strict constraint on optimal control models

Dongsung B Huh (huh@salk.edu), Terrence J Sejnowski (terry@salk.edu)

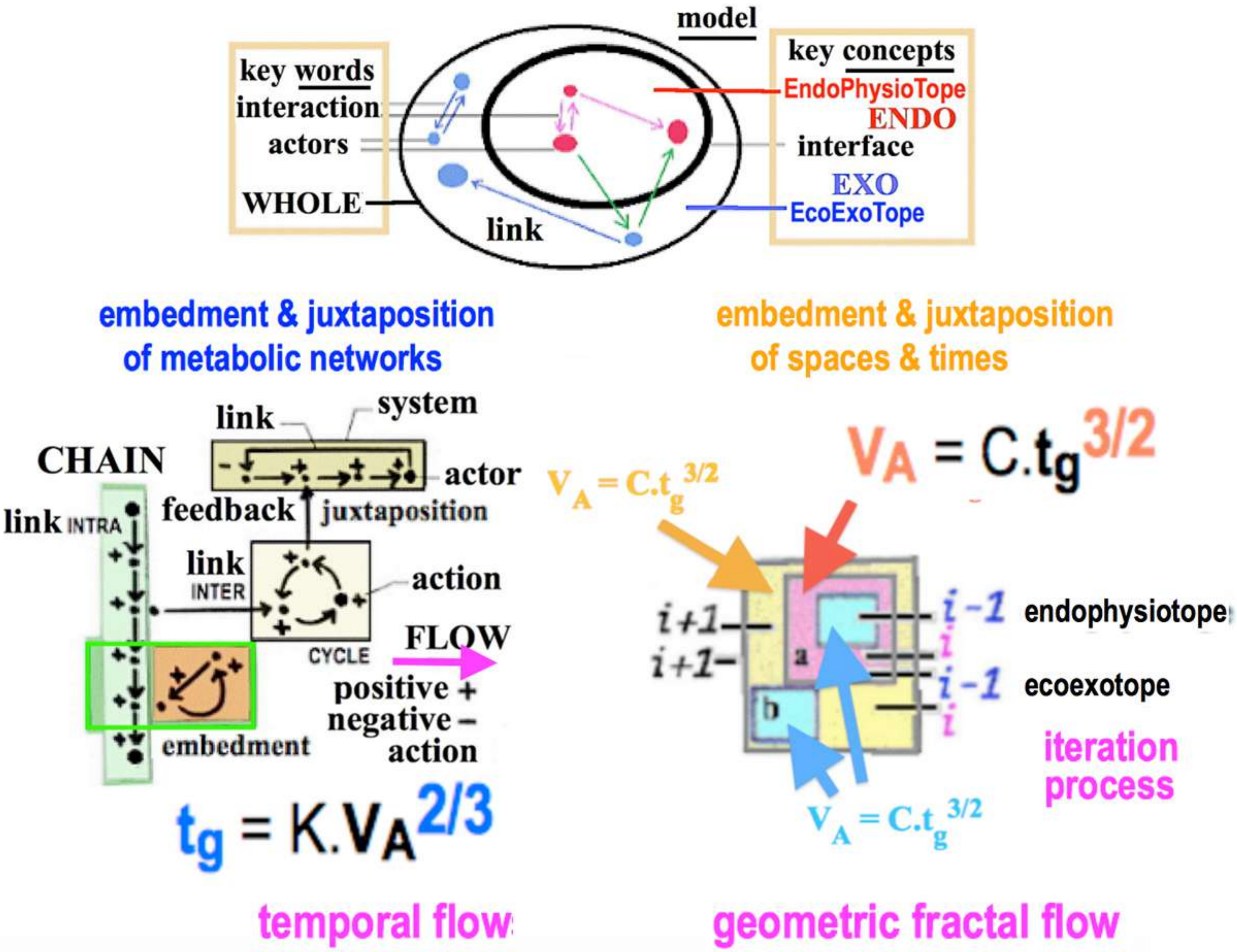
One of the interesting properties of curved hand movements is that the speed v is related to the curvature k through a power law: $v(t) \propto k(t)^{-1/3}$, called the ⅔ power law (because the angular speed is proportional to $k^{2/3}$).

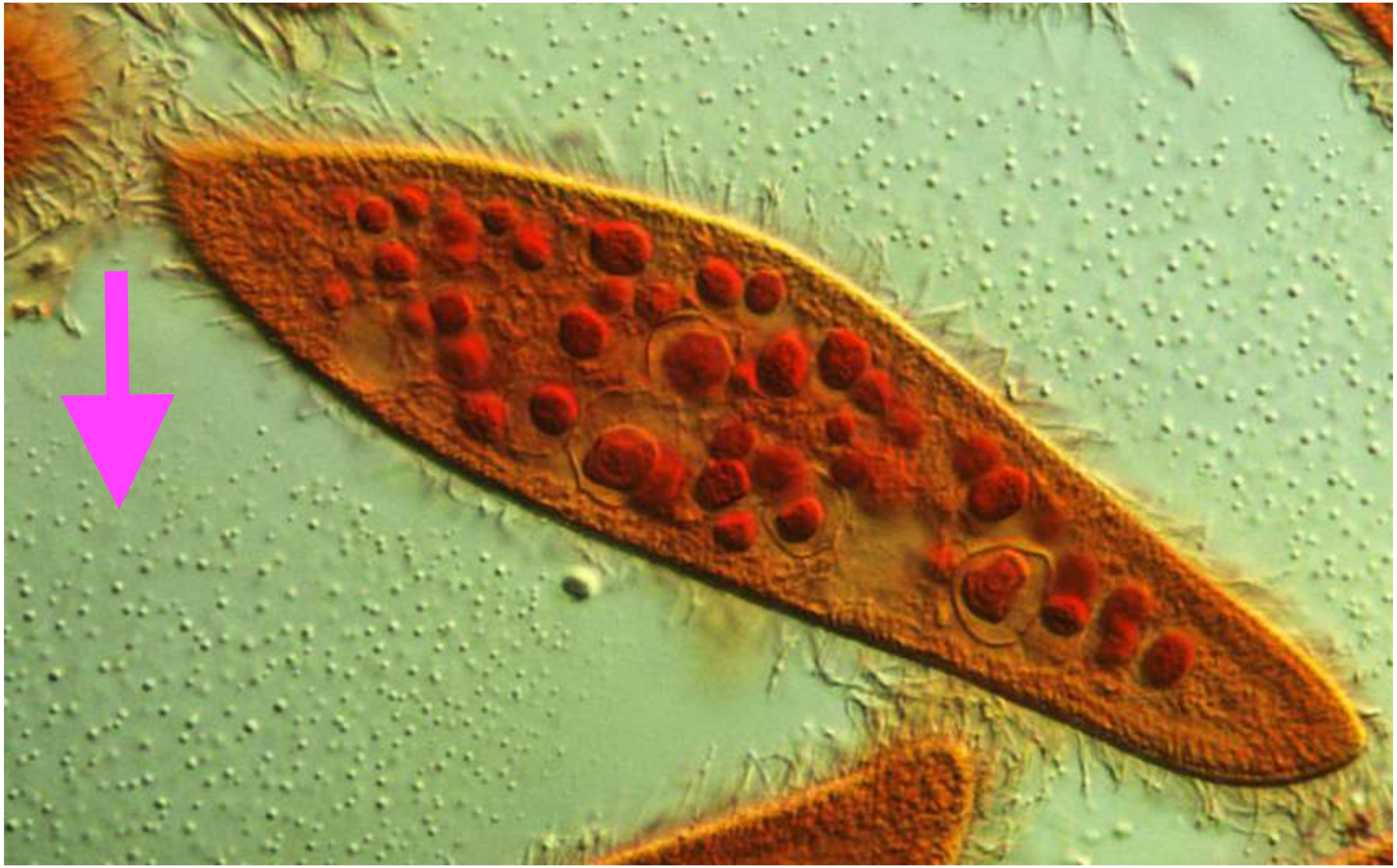
Several models have been proposed to explain the origin of the ⅔ power law from optimality principle: the minimum jerk models (Richardson and Flash 2002; Todorov and Jordan 1998; Viviani and Flash 1995; Wann et al. 1988), and the minimum-variance model (Harris and Wolpert 1998), to name a few. It seemed the ⅔ power law was an easily explainable phenomenon.

In further analyzing these models, however, we found their predictions to hold only for movement paths that have rather quickly changing curvature (such as ellipses, cloverleaf shapes and figure eights). For paths with slowly changing curvature, such as spirals, the power law is no longer ⅔.

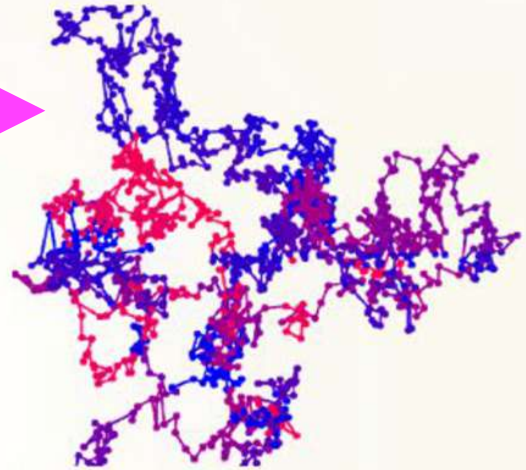
This failure can be analytically proved for the minimum jerk model. We show that the minimum jerk model in fact predicts a ⅓ power law ($v(t) \propto k(t)^{-2/3}$) for paths with slowly changing curvature, and that the power law approaches ⅔ for paths with fast changing curvature.

Our analysis shows that predicting the ⅔ power law for a wide range of paths is a very strict criterion that narrows down the appropriate cost function. We are currently investigating a family of cost functions that satisfy this criterion.


model
key words
interaction
actors
WHOLE
link
key concepts
EndoPhysioTope
ENDO
interface
EXO
EcoExoTope
embedment & juxtaposition
of metabolic networks
embedment & juxtaposition
of spaces & times
link
system
CHAIN
actor
link INTRA
feedback
juxtaposition
link
INTER
action
FLOW
CYCLE
positive +
negative –
action
embedment
$t_g = K.V_A^{2/3}$
$V_A = C.t_g^{3/2}$
$V_A = C.t_g^{3/2}$
i+1
i+1
i-1
endophysiotope
i
i-1
ecoexotope
i
a
b
iteration
process
$V_A = C.t_g^{3/2}$
temporal flow
geometric fractal flow



- **Random Walk**



  - **a particle repeatedly moves in all directions**
- **Brownian motion**
  - **continuous irregular motion of individual pollen particles**
    - **Robert Brown(1828)**

On note $E_x(f(B_s))$ l'espérance de $f(B_s)$
quand B est un Brownien issu de x. Cette quantité est égale à

$$E(f(x+B_s)) = \frac{1}{\sqrt{2\pi t}} \int_{\mathbb{R}} f(x+y) \exp\left(-\frac{y^2}{2t}\right) dy$$

où B est un Brownien issu de 0.

Soit B un mouvement Brownien, b et σ deux constantes.
Le processus ***Brownien géométrique***.

$$X_t = X_0 \exp\{(b - \frac{1}{2}\sigma^2)t + \sigma B_t\}$$

est aussi appellé processus "log-normal".

Temps d'atteinte *T_a est un temps d'arrêt fini*

$E(\exp - \lambda T_a) = \exp(-|a|\sqrt{2\lambda})$.

Par inversion de la transformée de Laplace,
on obtient la densité de T_a qui est, pour $a > 0$

$$\frac{a}{\sqrt{2\pi t^3}} \exp\left(-\frac{a^2}{2t}\right)$$

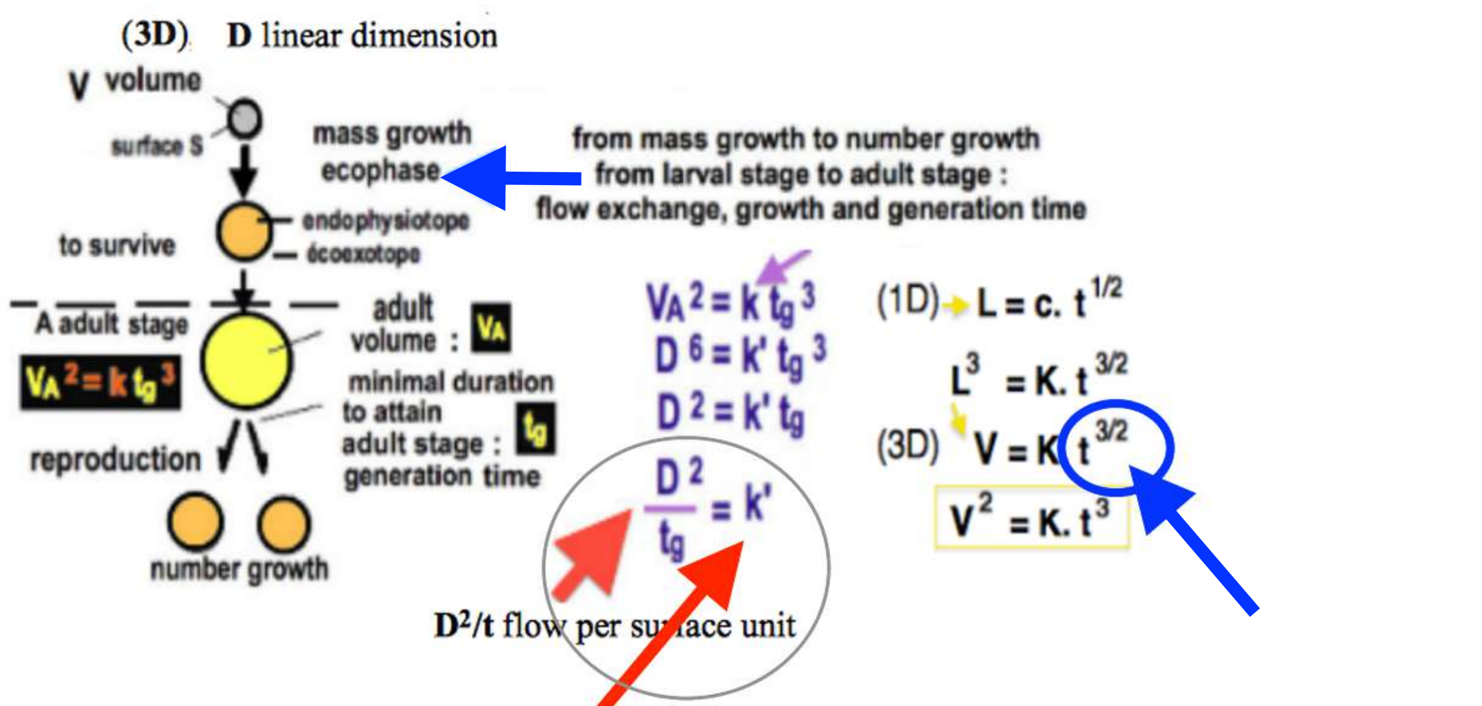


Fig. 9a Exchanges at a constant rate
t time, **V** volume (**3D**), **A** adult phase
D linear dimension, :
a constant exchange rate **k'**
To survive with **mass growth** is the prerequisite for a life form to itself survive with **number growth**.
Just-in-time exchanges: the exchanges flow rate at the surface of exchange is a constant.

Fig. 9b Brownian motion
The length of the linear movement (1D), **L**, is proportional to the square root of the duration of observation -time **t**- (Perrin 1908): **1/2** power-law.
This is the same as: **V** obeys a **3/2** power-law of **t**,
or $V_A{}^2 = K t_g{}^3$
and **3/2** is just the true exponent that describes ***"the ratio of volume to surface area in a sphere"***.

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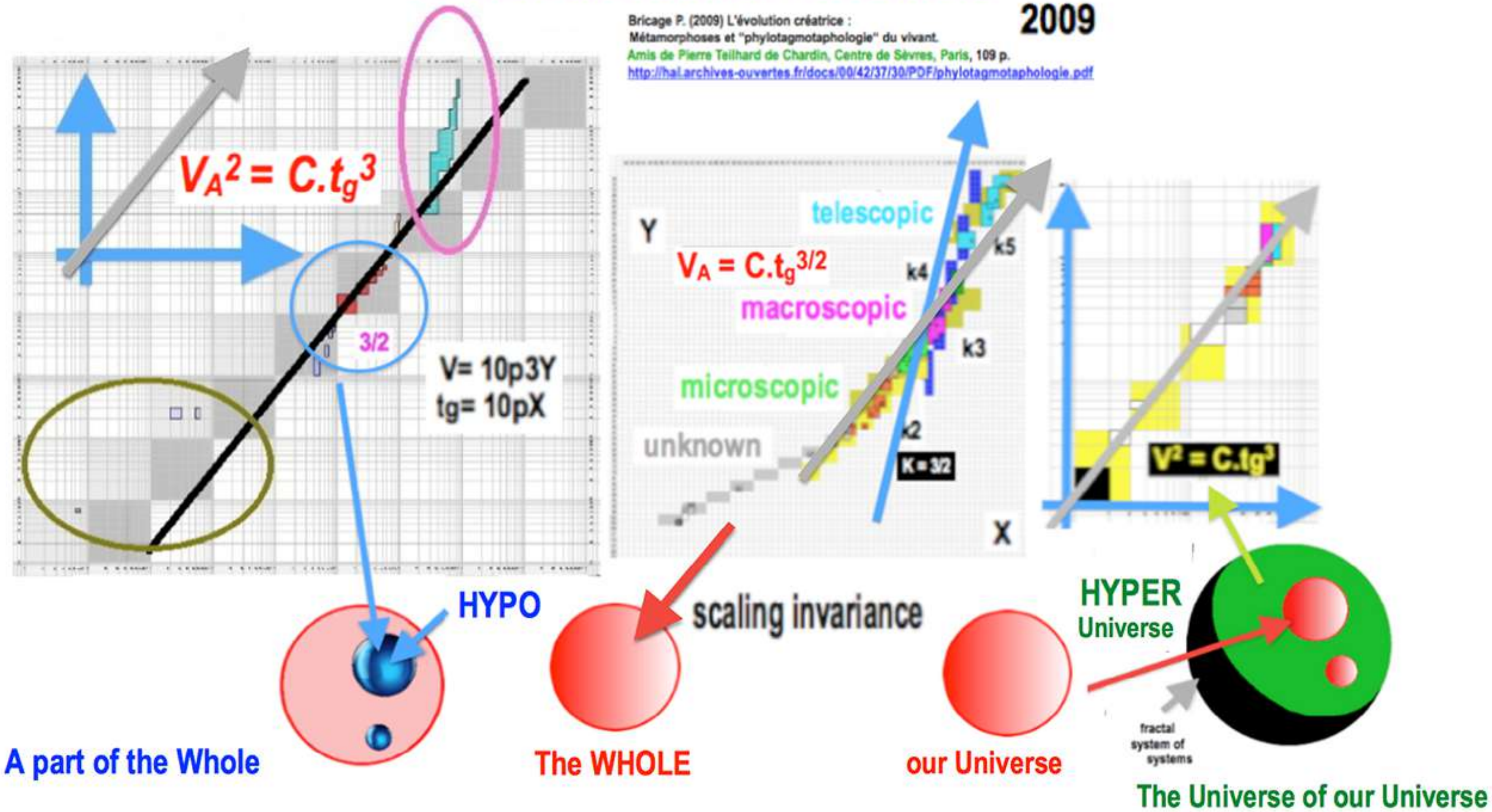
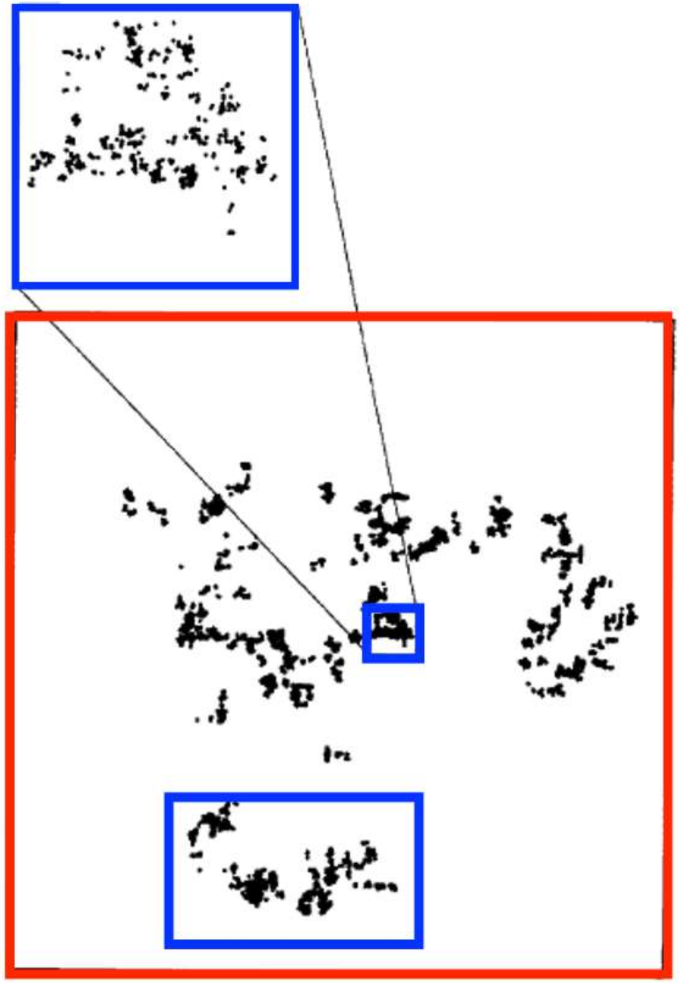
ASSOCIATIONS à AVANTAGES et INCONVÉNIENTS RÉCIPROQUES et PARTAGÉS

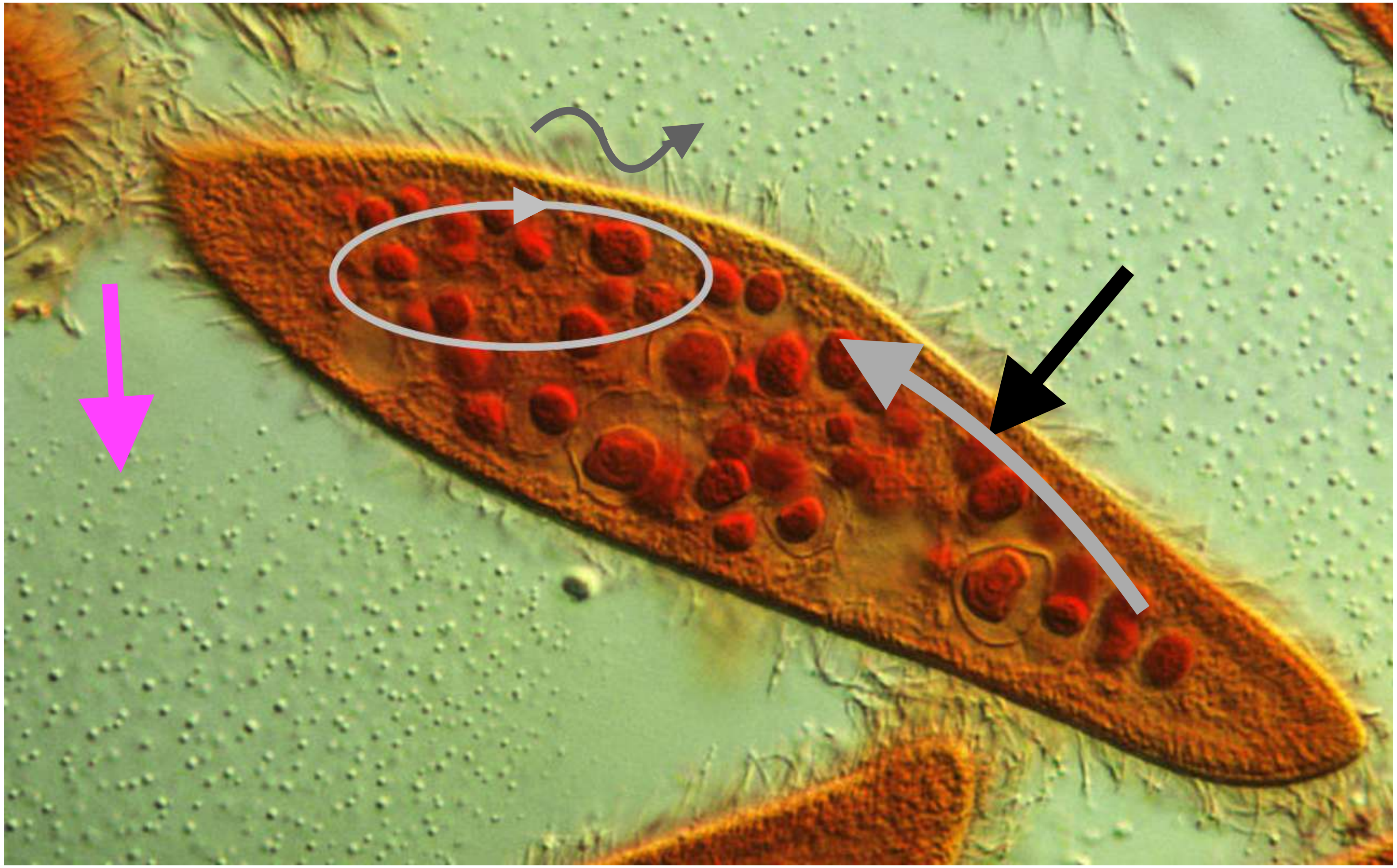
L'INVARIANCE FRACTALE du VIVANT



ASSOCIATIONS for the RECIPROCAL and MUTUAL SHARING of ADVANTAGES and DISADVANTAGES



The first 10^4 points visited by a two-dimensional random walk generated by a power-law jump distribution with exponent g = 1.5, starting at the center of the main frame. The amplification illustrates the self-similar properties of this process.



La conception traditionnelle chinoise de l'éthique

Du rapport entre l'homme et la nature et de leurs expériences agricoles, les ancêtres chinois ont tiré deux idées fondamentales : "L'harmonie et l'ordre".

Il faut maintenir l'harmonie entre l'homme et la nature et *les hommes doivent respecter les lois de la nature*. L'harmonie est la pièce maîtresse de cette éthique.

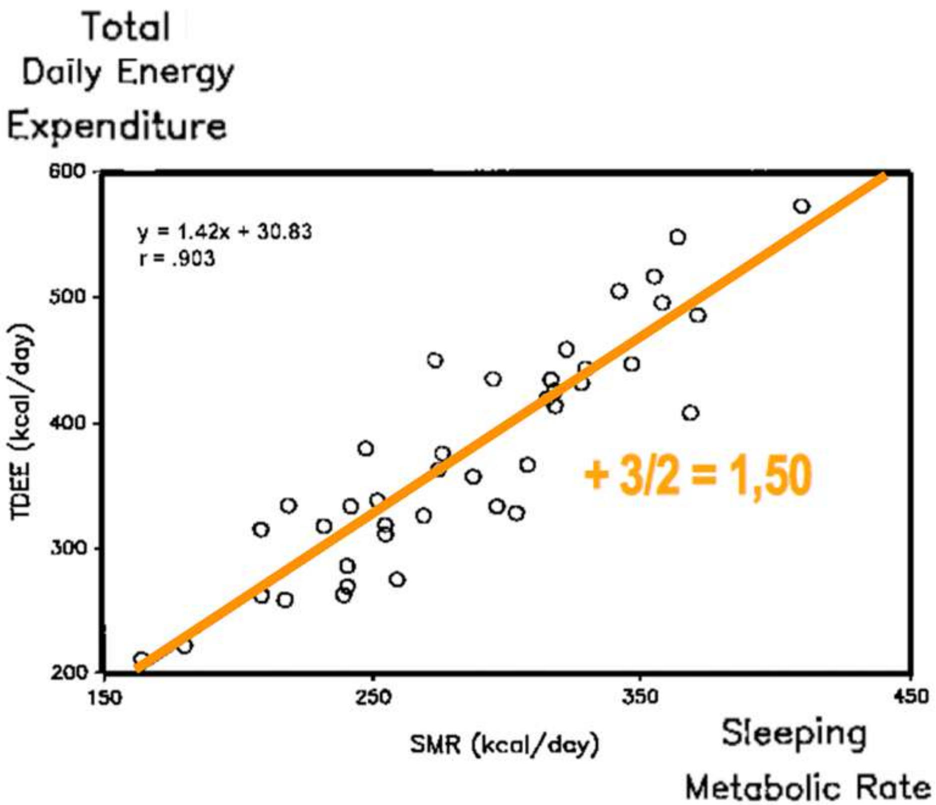
Le confucianisme et **le taoïsme** sont les deux grands ***courants ago-antagonistes*** qui ont animé l'histoire chinoise avec **le bouddhisme** arrivé en Chine à l'époque des Han (vers le IIIème siècle), probablement par des commerçants indiens, via la Route de la Soie.

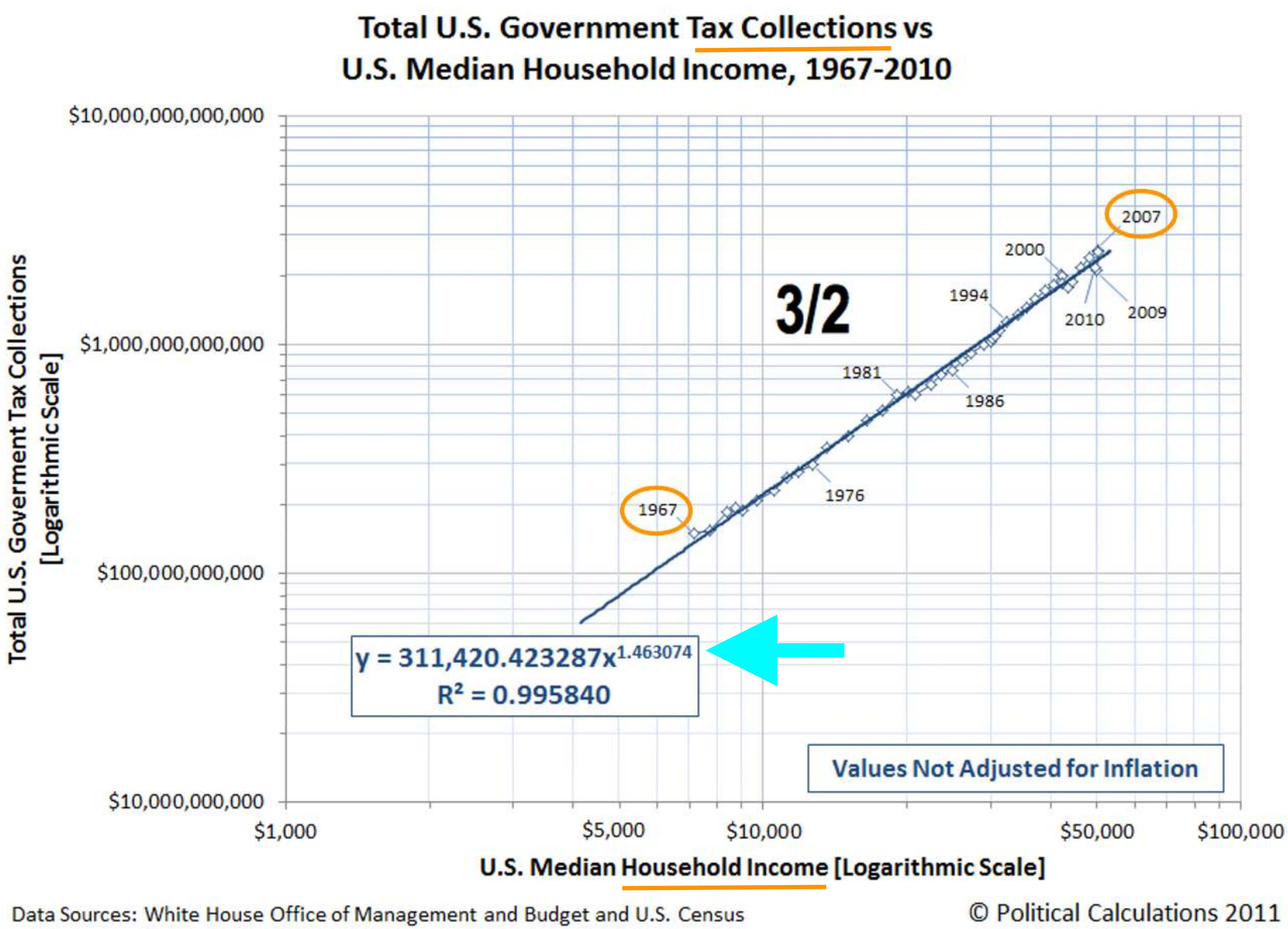
Confucius a dit : *"L'harmonie prime en tout"*.

Le taoïsme est considéré par certains comme étant la seule "vraie" **religion chinoise**. C'est un mélange du culte des esprits, de la nature et des ancêtres, ***une quête mystique des lois qui gouvernent notre vie***, en quelque sorte une quête de l'immortalité.

Les valeurs confucéennes se retrouvent dans toutes les sociétés qui ont adopté l'écriture chinoise. Le respect des enfants envers leurs parents, l'épouse envers son mari, conduisant à l'obéissance des travailleurs à leurs chefs, explique la discipline qui règne dans les entreprises chinoises.

Le maintien de l'harmonie se fait à l'aide de la loi et de l'ordre, une société doit être régie par l'ordre, ***ce qui lui permet d'établir une hiérarchie, un système, des lois, des relations humaines et des règles morales.***

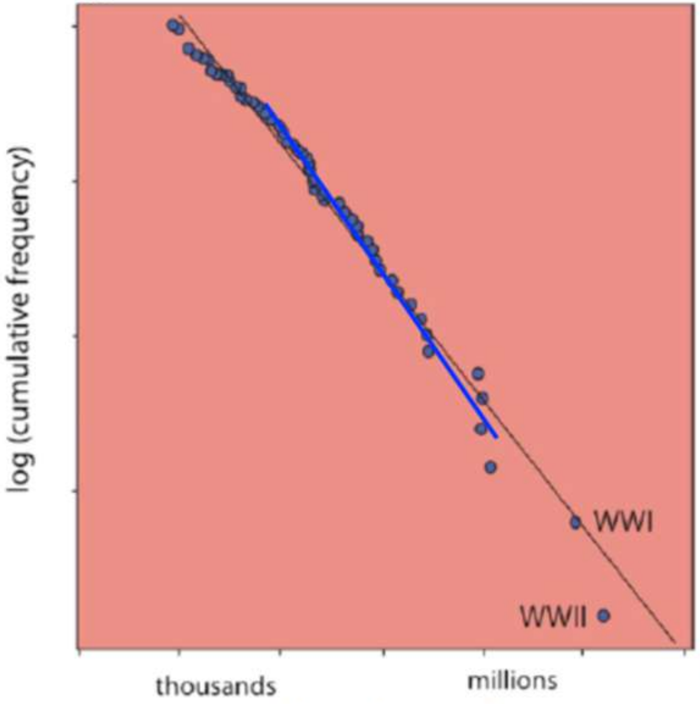

Total
Daily Energy
Expenditure
y = 1.42x + 30.83
r = .903
+ 3/2 = 1,50
TDEE (kcal/day)
SMR (kcal/day)
Sleeping
Metabolic Rate
600
500
400
300
200
150
250
350
450



Total U.S. Government Tax Collections vs
U.S. Median Household Income, 1967-2010
$10,000,000,000,000
$1,000,000,000,000
$100,000,000,000
$10,000,000,000
Total U.S. Goverment Tax Collections [Logarithmic Scale]
2007
2000
1994
2010
2009
3/2
1981
1986
1976
1967
y = 311,420.423287x^1.463074
R² = 0.995840
Values Not Adjusted for Inflation
$1,000
$5,000
$10,000
$50,000
$100,000
U.S. Median Household Income [Logarithmic Scale]
Data Sources: White House Office of Management and Budget and U.S. Census
© Political Calculations 2011

$X1 = \text{Log } x1$

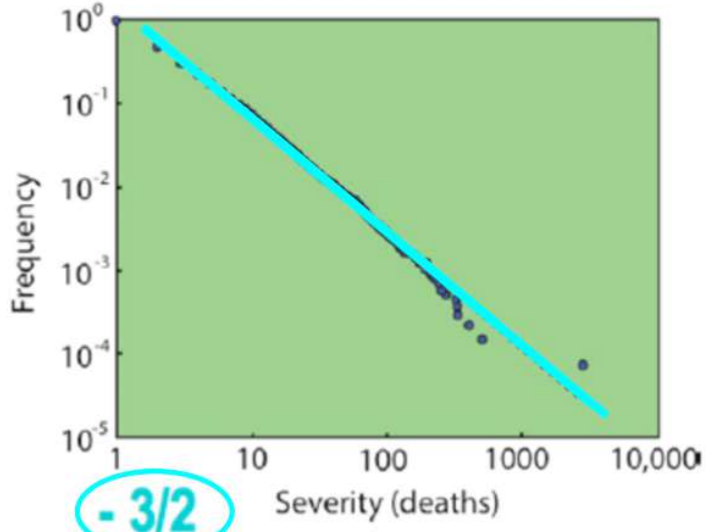
-1



$X2 = \text{Log } x2$

How the number of deaths in a war between states (from 1820 to 1997) varies with the frequency (equivalently, the probability) of such a conflict. The relationship is a mathematically simple one, called a power law. The last two data points are, respectively, World Wars I and II.

$$x1 \,.\, x2 = C$$



$-3/2$

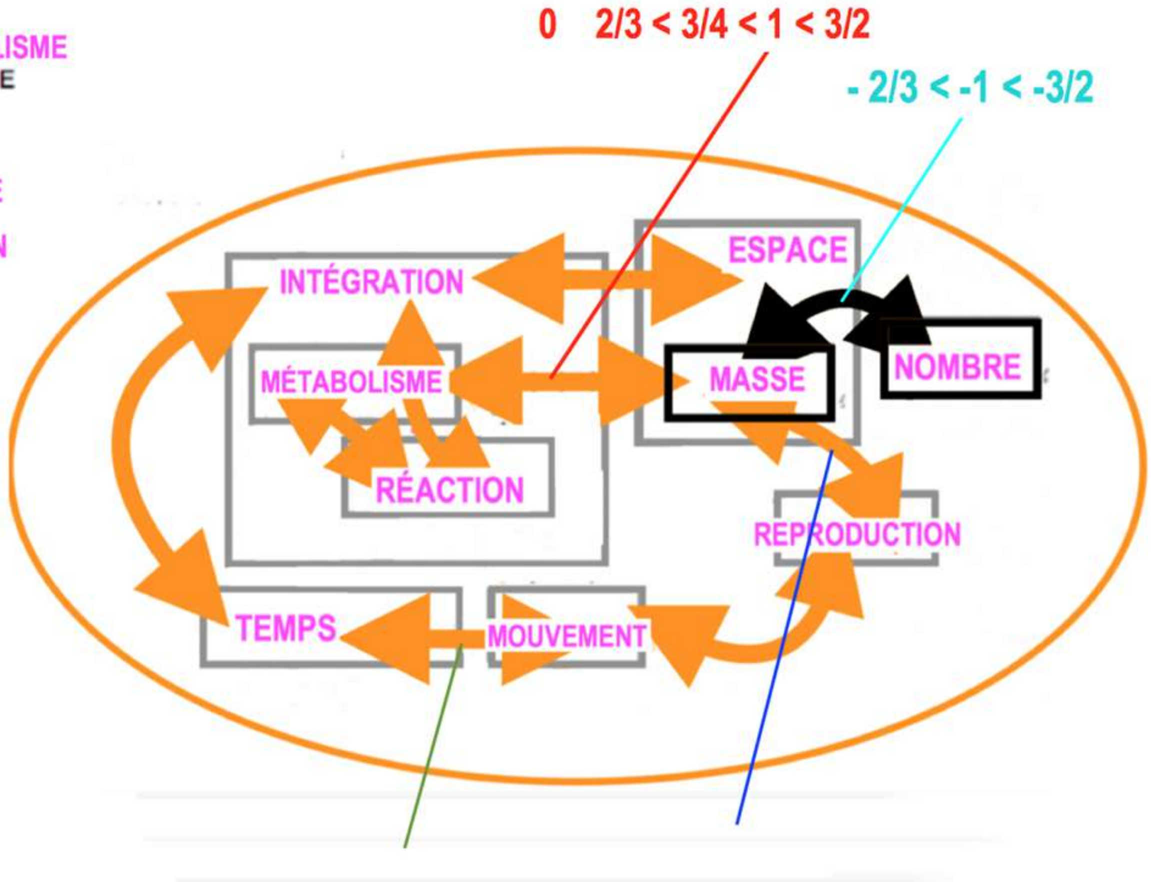
How the number of deaths in a terrorist attack (between 1968 and 2008) varies with the frequency of such an attack. The relationship is another power law, but with a different exponent from that of inter-state wars.

SURVIVRE

1. La MOBILISATION MÉTABOLISME de la MATIÈRE et de l'ÉNERGIE
2. La CROISSANCE en masse MASSE
2. La CROISSANCE en nombre NOMBRE
3. La RÉPONSE à des STIMULATIONS RÉACTION
4. L'ORGANISATION interne dans l'espace et dans le temps ESPACE TEMPS
5. L'INTÉGRATION externe
6. Le MOUVEMENT

pour **SE SURVIVRE**

7. La REPRODUCTION

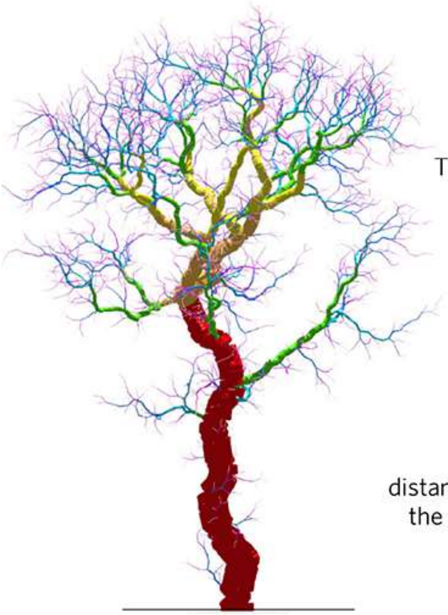


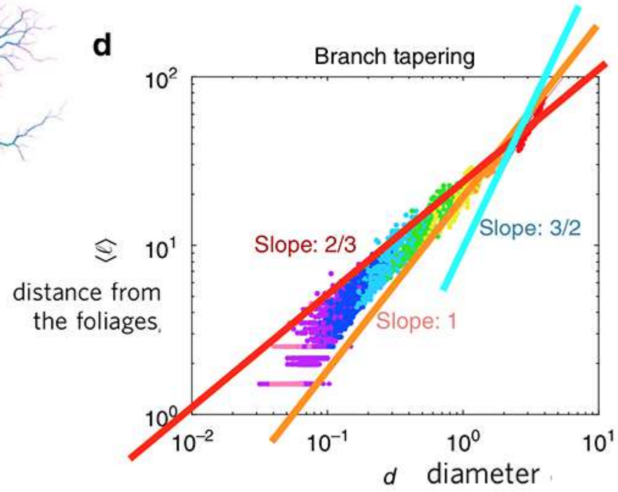
systémique

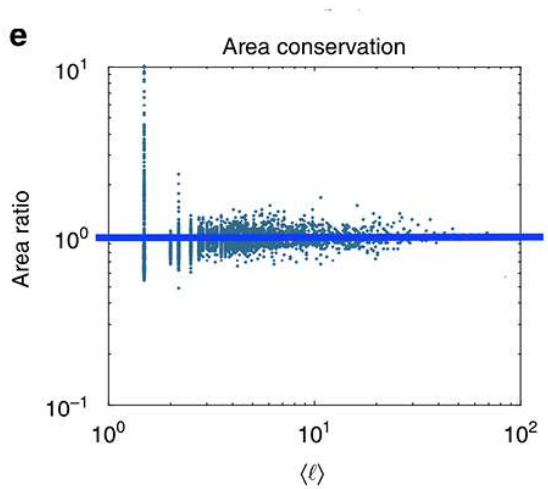
Self-similarity.

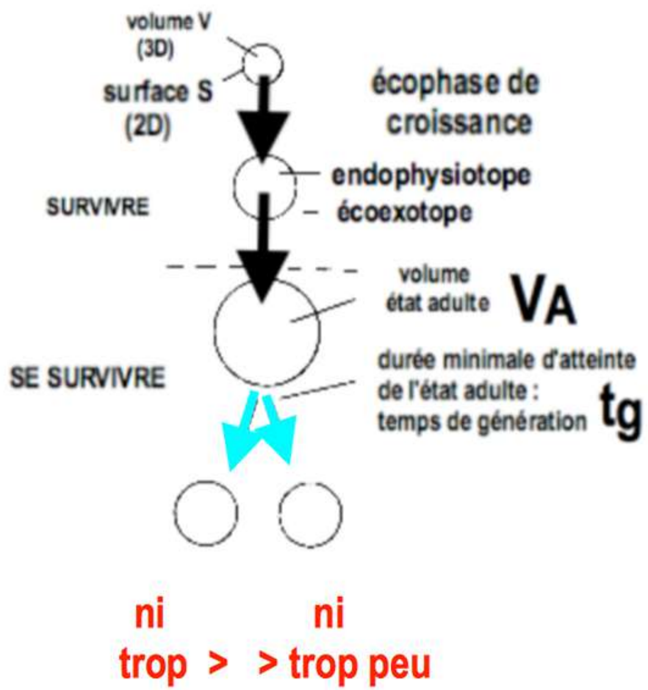
length (unit L), area (unit L^2) and diameter (unit L)

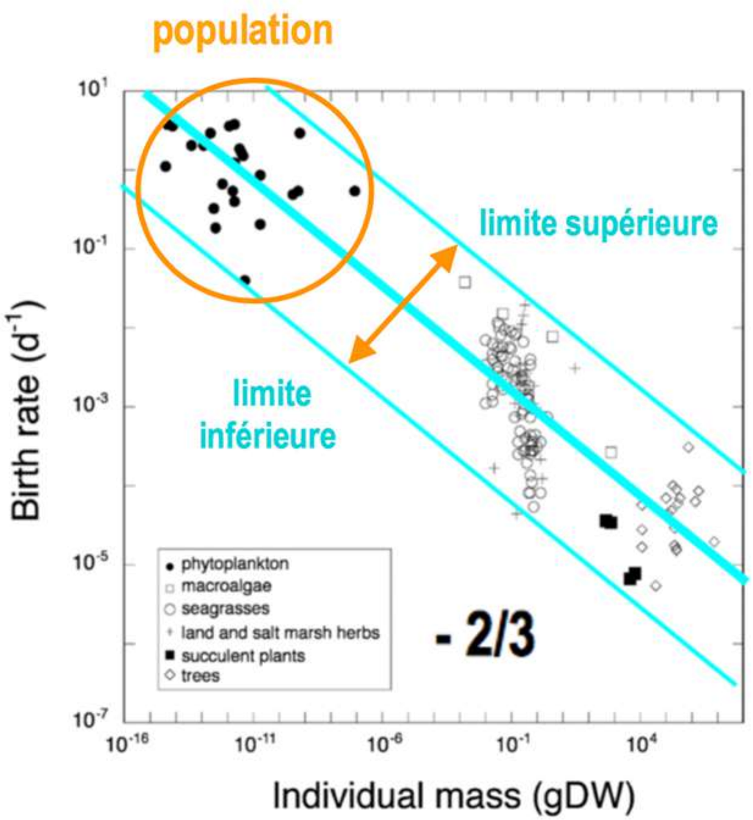
The Strahler order of each segment is represented with the same colour








volume V
(3D)
surface S
(2D)
écophase de
croissance
endophysiotope
SURVIVRE
écoexotope
volume
état adulte
V_A
SE SURVIVRE
durée minimale d'atteinte
de l'état adulte :
temps de génération
tg
ni
trop >
ni
> trop peu


population
limite supérieure
limite
inférieure
Birth rate (d^{-1})
Individual mass (gDW)
phytoplankton
macroalgae
seagrasses
land and salt marsh herbs
succulent plants
trees
- 2/3
10^{1}
10^{-1}
10^{-3}
10^{-5}
10^{-7}
10^{-16}
10^{-11}
10^{-6}
10^{-1}
10^{4}

CyberSystemics

How to capture the comprehensive nature of complex systems and processes as a whole?

CyberSystemics abounds of celebrities ...

If you know these authors or these words (concepts), you have made already cybersystemics without knowing it!

R. ASHBY (**requisite variety**), Gregory BATESON (**inter-personal communication**), Henri BERGSON (**creative changing & evolution**), Claude BERNARD (**homeostasis**), Elie BERNARD-WEIL (**agoantagonism, paradoxical strategies**), BERTIN (diagrams, networks, maps: **graphic semiology**), BOLTZMANN (**behavior statistical laws**), BOOLE (**algebra**), BOULDING (**economic typology of systems**), BUNGE (**general typology of systems**), CANNON, Noam CHOMSKY (**language syntax**), L. COUFFIGNAL, Michel CROZIER (**multiple agents decision making systems**), Joël DE ROSNAY (*the macro-scope*), DE SAUSSURE (**linguistic structuralism**), Gérard DONNADIEU & Michel KARSKY (**systemic approach**), J.W. FORRESTER (**systems dynamics**), Michel FOUCAULT (**analogy**), Arthur KOESTLER (**wholeness**), LAVOISIER (**isomorphism**), Jean-Louis LE MOIGNE, LEIBNIIZ, J. LESOURNE (**fate systems**), Claude LEVY-STRAUSS (**anthropologic structuralism**), Edward LORENZ (**butterfly effect**), James LOVELOCK (**Gaïa system**), MAC CULLOCH (**biomimicry**), Benoît MANDELBROT (**fractals, systems scaling invariance**, **theory of catastrophes**), Edgar MORIN (*the method*), Blaise PASCAL (**the Whole and the parts**), Louis PASTEUR, Jean PIAGET (**psychological structuralism**), PRIGOGINE (**autonomy & auto-organization, dissipation structures**), PYTHAGORE, Michel SERRES (**communication interference**), Claude SHANNON (**communication, quantitative theory of information**), SKINNER (**behavior**), Herbert SPENCER (**progress**), TARSKY (**theory of models**), Pierre TEILHARD DE CHARDIN (**man cosmic system**), Paul VALERY (**models & modeling**), Ludwig VON BERTALANFFY (**general system theory**), VON FOERSTER, (**information**), VON NEUMANN & MORGENSTERN (**games theory**), Norbert WIENER (**cybernetics**).

Les échelles des systèmes vivants :

- **espace** http://www.afscet.asso.fr/Ande10/pbETAvivant10.pdf
- **temps** http://www.afscet.asso.fr/Ande12/pbAnde2012.pdf
- **espace-temps** http://www.armsada.eu/pb/bernardins/phylotagmotaphologie.pdf

LES LOIS SYSTÉMIQUES de l'ÉVOLUTION du VIVANT

- LOI SYSTÉMIQUE D'INVARIANCE DE JAUGE :
écoexotope et endophysiotope, les 7 caractéristiques fonctionnelles du vivant "vivant".

- LOI SYSTÉMIQUE ERGODIQUE D'ÉMERGENCE CONSTITUTIVE :
niveaux d'organisation et échelles d'emboîtements hiérarchiques, règles d'émergence, ARMSADA et confinement.

- LOI SYSTÉMIQUE ERGODIQUE D'INDIVIDUATION ET D'ÉLAN VITAL :
hypothèse de linéarité et principe de moindre action, loi puissance $V_A^2 = k.t_g^3$, non-linéarité.

- LOI SYSTÉMIQUE CONSTRUCTALE :
global et local, capacité d'accueil et capacité d'être accueilli, action et rétroaction.

- LOI SYSTÉMIQUE ERGODIQUE DE CAUSALITÉ ONTOGÉNIQUE :
tableau de la classification périodique du vivant.

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Online reference to cite this work:

Bricage P. (2018) Déterminisme et indéterminisme multi-échelle, invariants et variance des systèmes vivants. -présentation- Journées annuelles de l'AFSCET à Andé, France, 05 mai 2018, 84 p. **http://afscet.asso.fr/Ande18/pbricage_Ande2018_interactions-PowerLaws_presentation.pdf**