

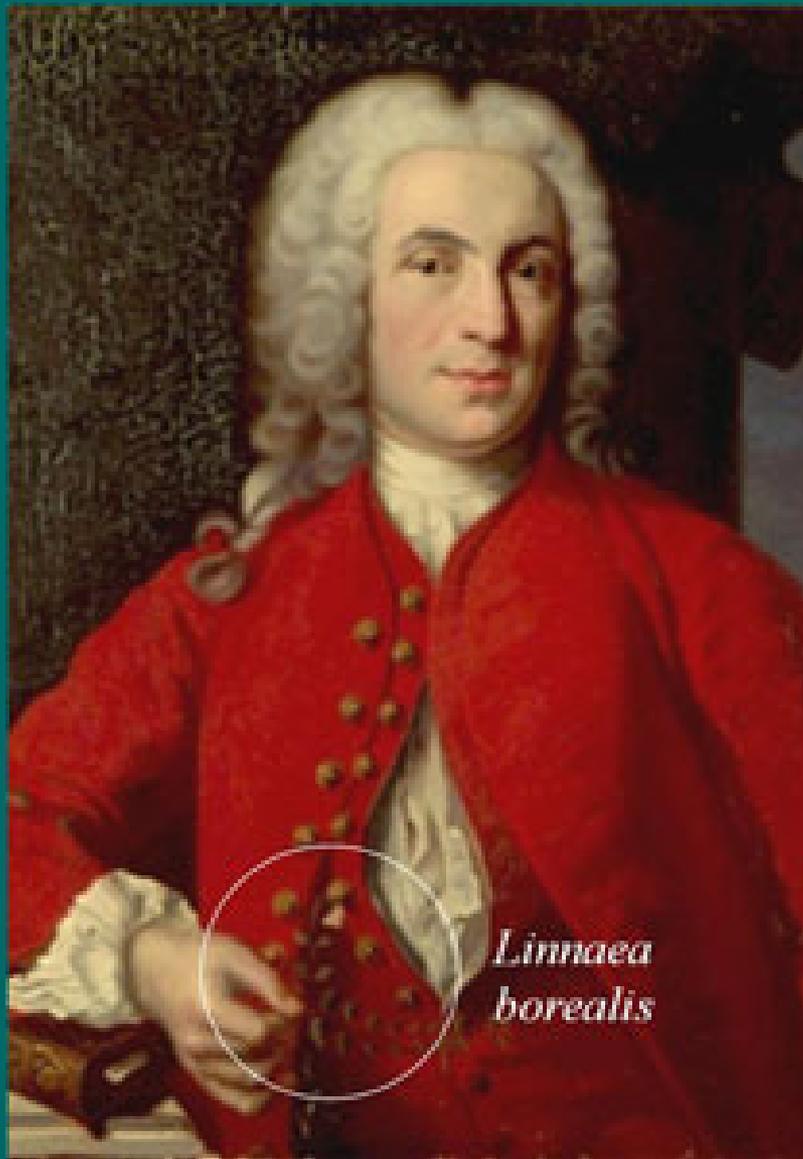


La

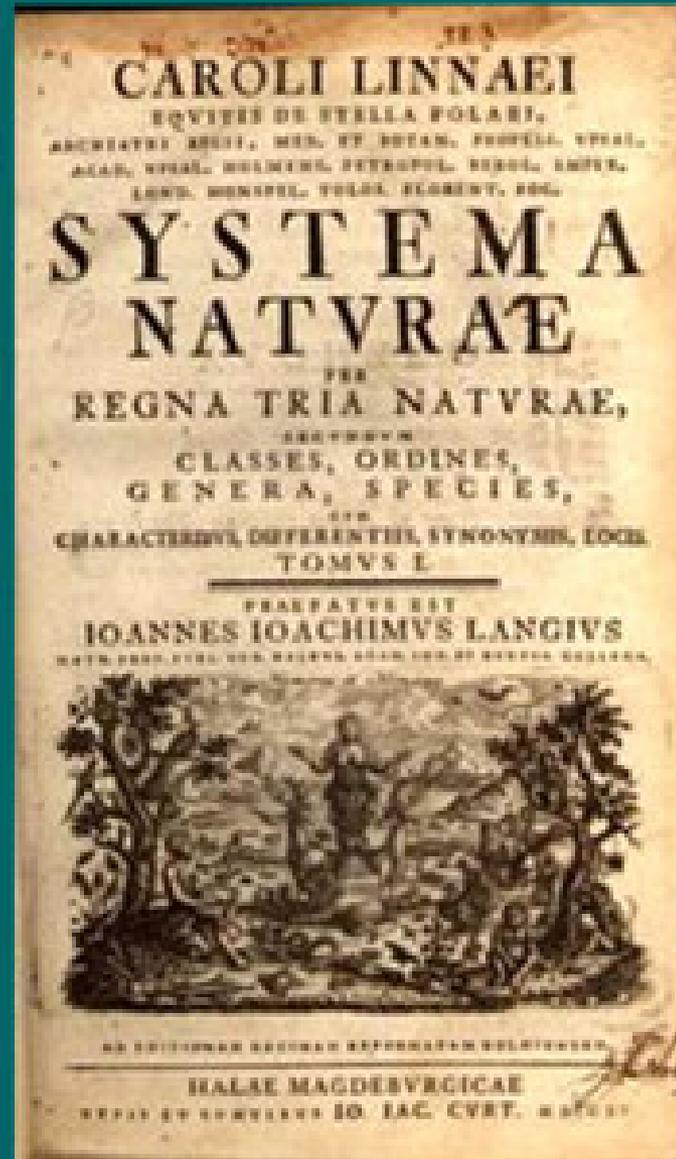
Biodiversité ?



La Biodiversité ?



*Linnaea
borealis*



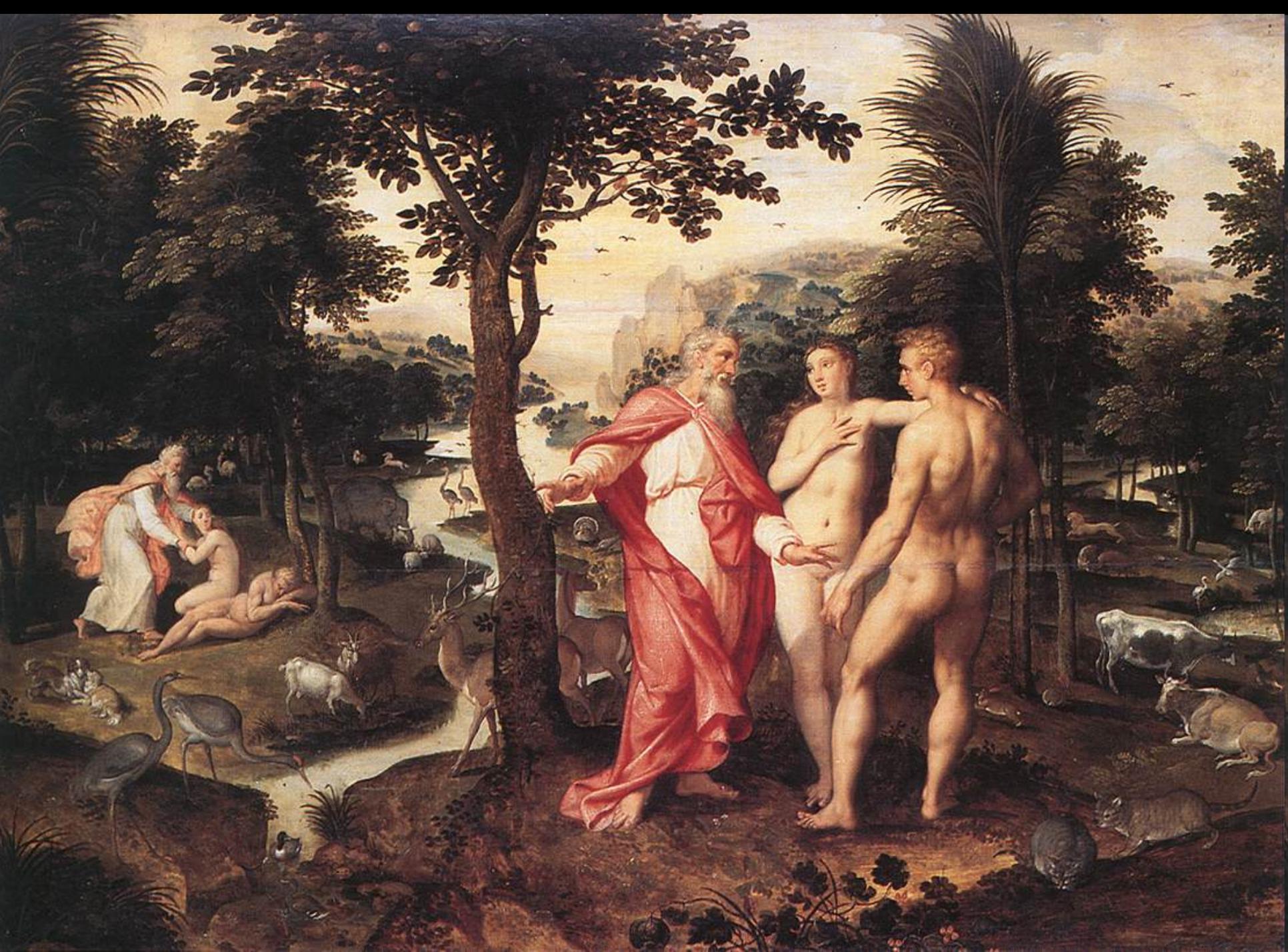
General

Classes
Orders
Genera
Species

Particular

Systema Naturae, 1735

« Toutes les espèces tiennent leur origine de leur souche, en première instance, de la main même du Créateur Tout-Puissant, car l'Auteur de la Nature, en créant les espèces, imposa à ses créatures une loi éternelle de reproduction et de multiplication dans les limites de leurs propres types. »







Darwin

La sélection naturelle

- Reproduction
- Variation
- Tri

Processus répété
de nombreuses fois
!!!

ON
THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE
PRESERVATION OF FAVOURED RACES IN THE STRUGGLE
FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE
ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

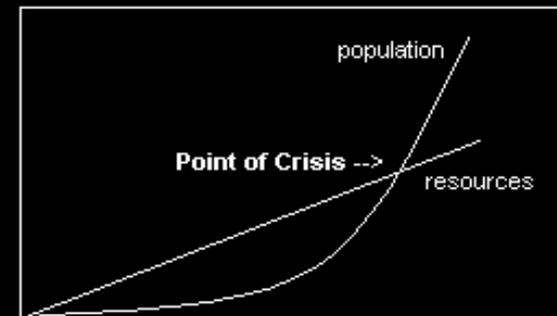
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Thomas Malthus
1766-1834

Within 50 years, world's population growth would outstrip food supply

"The power of population is so superior to the power of the Earth to produce subsistence for man, that premature death must in some shape or other visit the human race." —Thomas Malthus, 1798



Malthus' Basic Theory

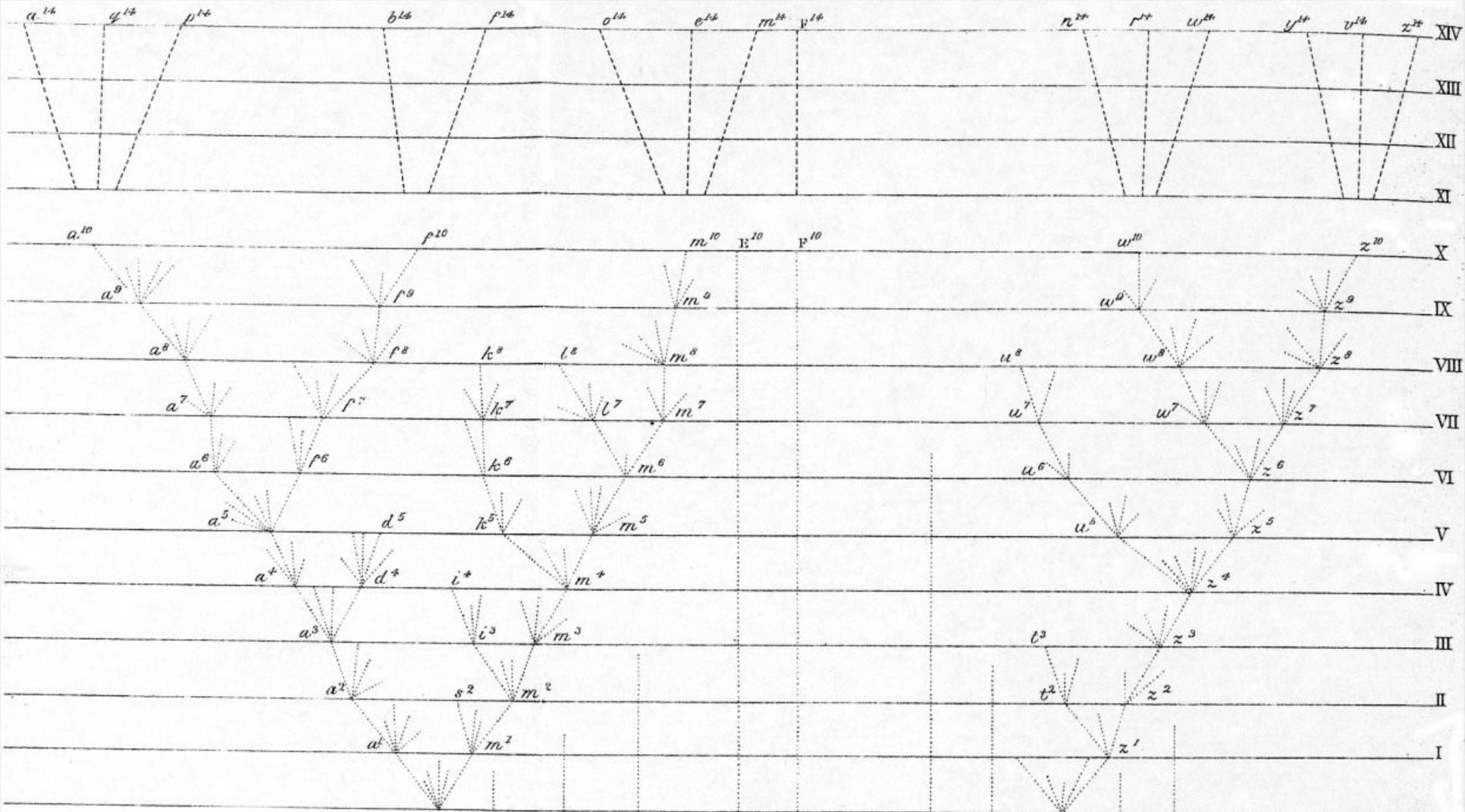


CHAPTER III.

STRUGGLE FOR EXISTENCE.

Bears on natural selection—The term used in a wide sense—Geometrical powers of increase — Rapid increase of naturalised animals and plants—Nature of the checks to increase—Competition universal — Effects of climate — Protection from the number of individuals—Complex relations of all animals and plants throughout nature—Struggle for life most severe between individuals and varieties of the same species ; often severe between species of the same genus—The relation of organism to organism the most important of all relations.

Every being, which during its natural lifetime produces several eggs or seeds, must suffer destruction during some period of its life, and during some season or occasional year, otherwise, on the principle of geometrical increase, its numbers would quickly become so inordinately great that no country could support the product. Hence, as more individuals are produced than can possibly survive, there must in every case be a struggle for existence, either one individual with another of the same species, or with the individuals of distinct species, or with the physical conditions of life. It is the doctrine of Malthus applied with manifold force to the whole animal and vegetable kingdoms; for in this case there can be no artificial increase of food, and no prudential restraint from marriage.



The writings of Charles Darwin on the web

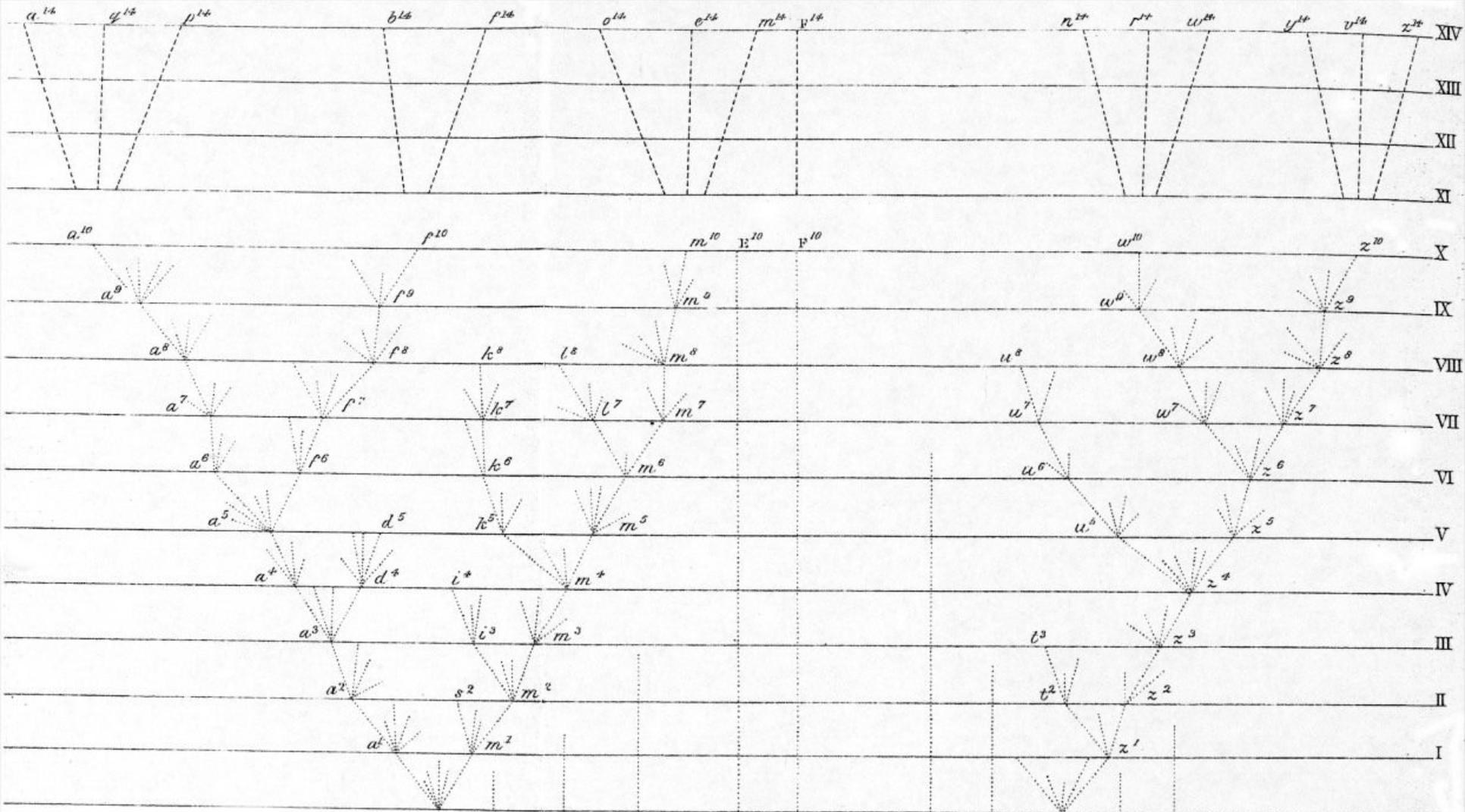
A B C D E F G H I K L

W. West Irish Hutton Garden.

Darwin : « Jusqu'à présent, on n'a pas pu tracer une ligne de démarcation entre les **espèces et les sous-espèces**, [...] ; on n'a pas réussi davantage à tracer une ligne de démarcation entre les **sous-espèces et les variétés** fortement accusées ou entre les **variétés** à peine sensibles et les **différences individuelles**. Ces différences se fondent l'une dans l'autre, par des degrés insensibles, en une véritable série »

I am often in despair in making the generality of naturalists even comprehend me. Intelligent men who are not naturalists and have not a bigoted idea of the term species, show more clearness of mind.

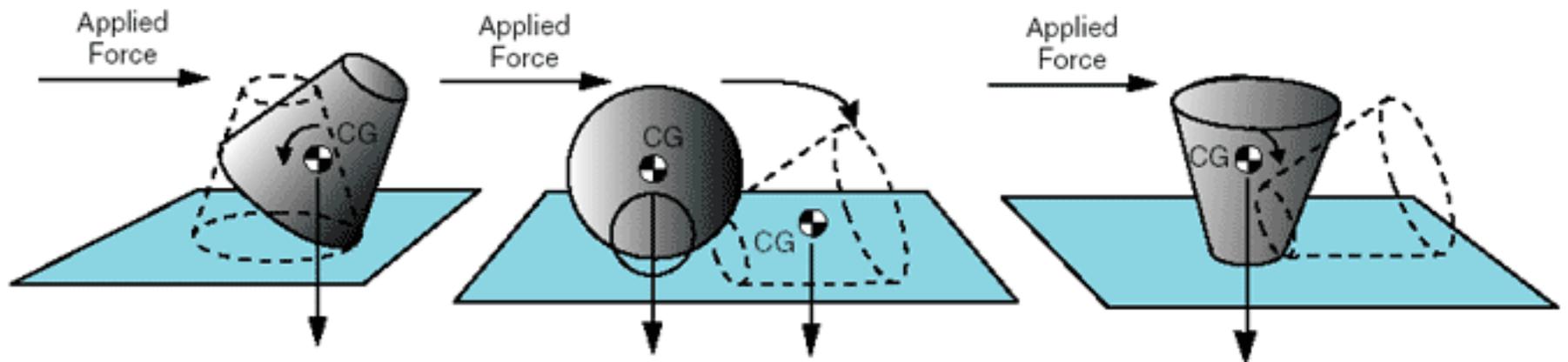




The writings of Charles Darwin on the web

A B C D E F G H I K L

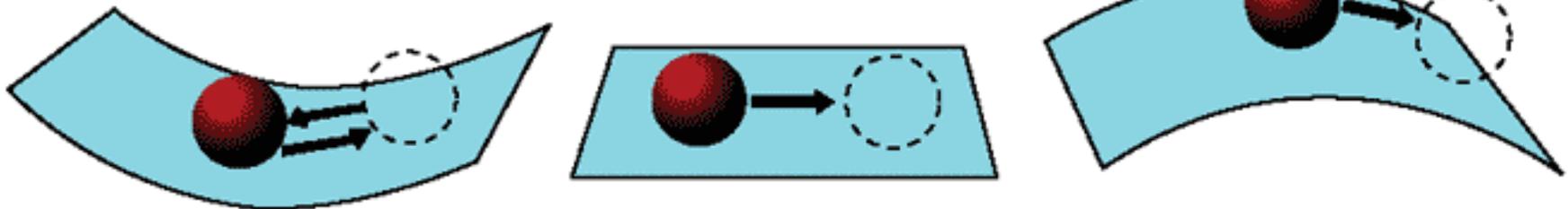
W. West Irish, Hutton, Garden.



POSITIVE
STATIC STABILITY

NEUTRAL
STATIC STABILITY

NEGATIVE
STATIC STABILITY



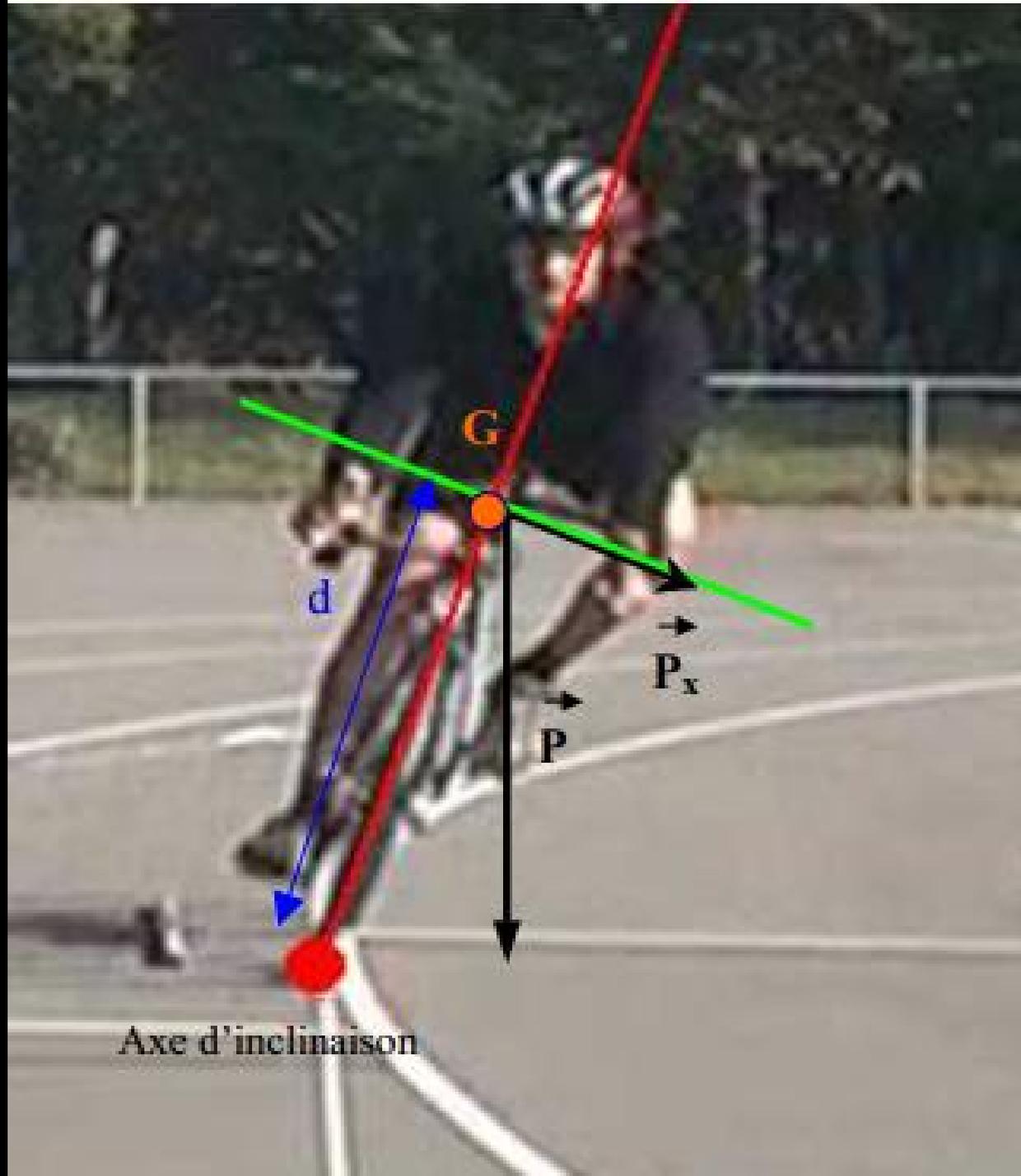


12:00:12

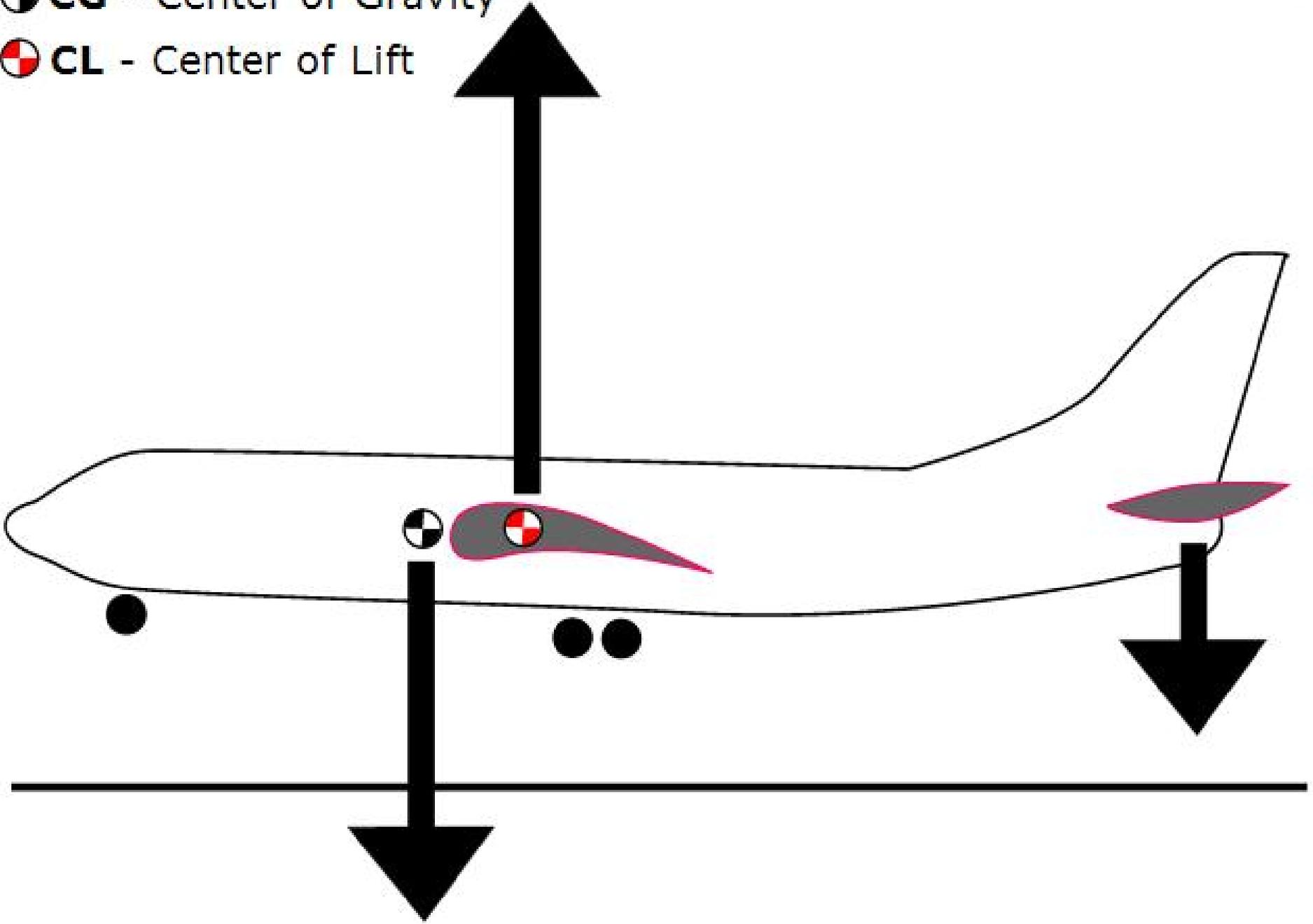
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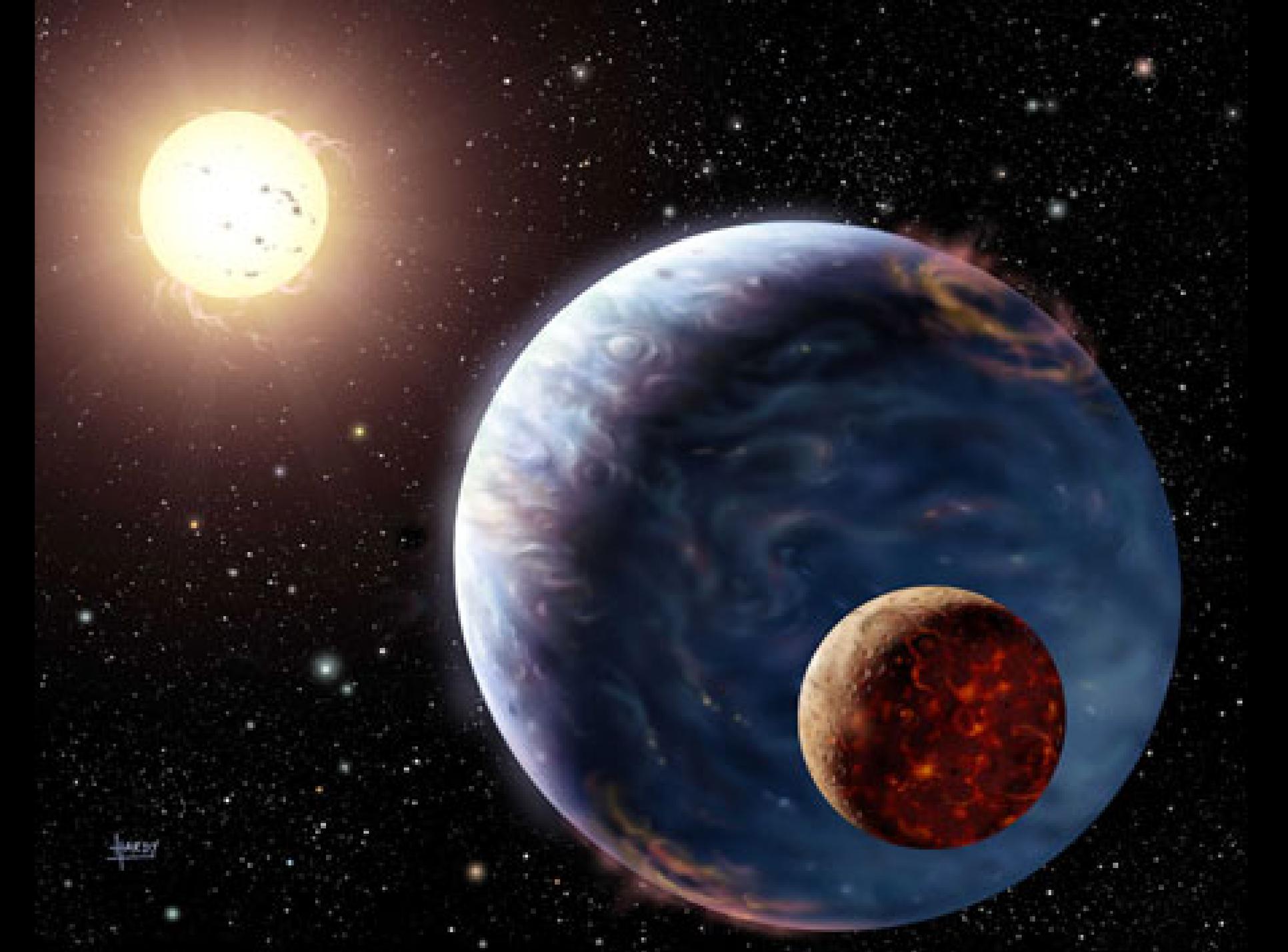






● CG - Center of Gravity
● CL - Center of Lift









12:00:13 PM

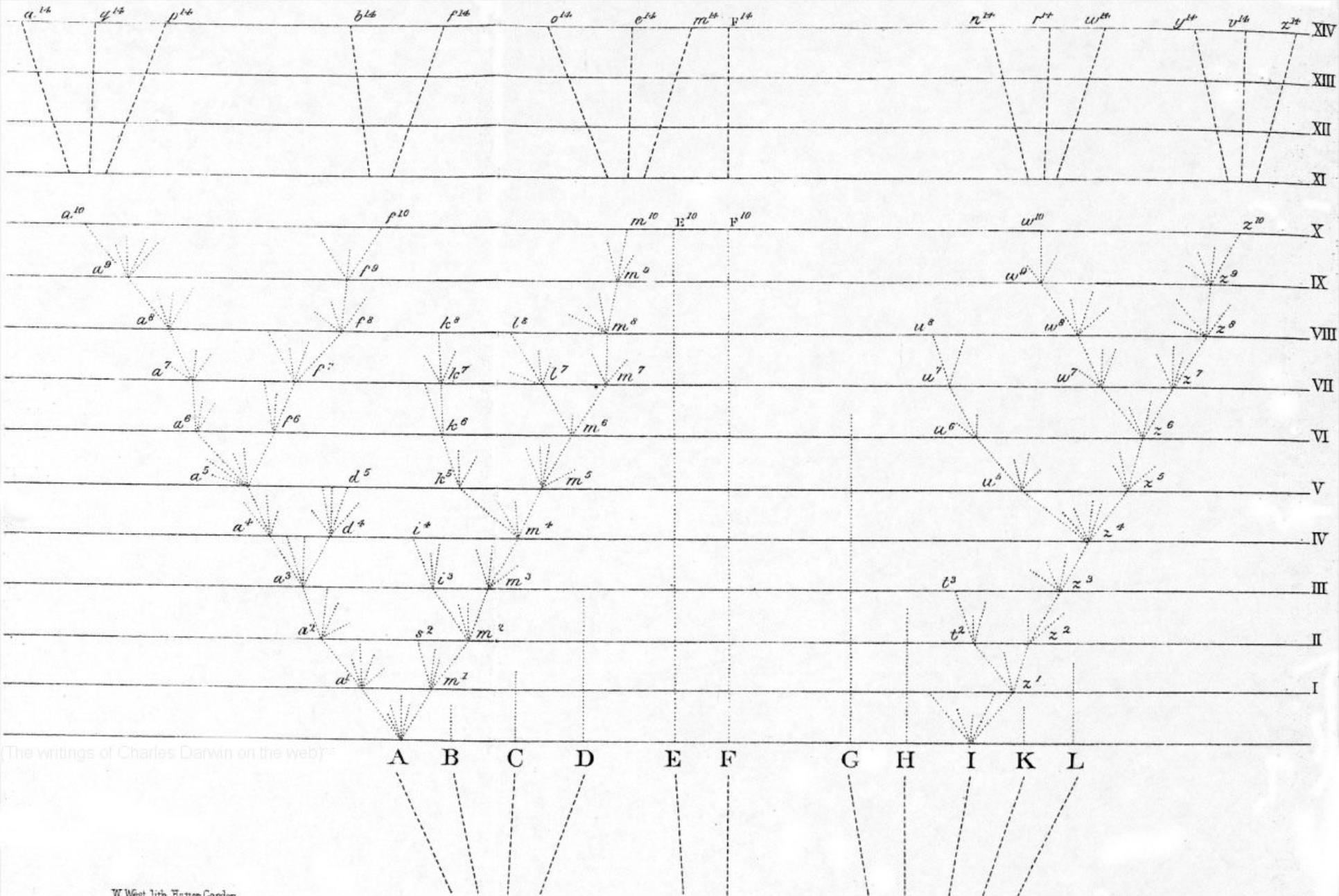
27



« La vie, c'est comme une bicyclette, il faut avancer pour ne pas perdre l'équilibre. »

Albert Einstein

cartree.fr



The writings of Charles Darwin on the web

W. West Irish, Hutton, Garden.

Competition



$$\frac{dN}{dt} = rN \frac{(K - N)}{K}$$

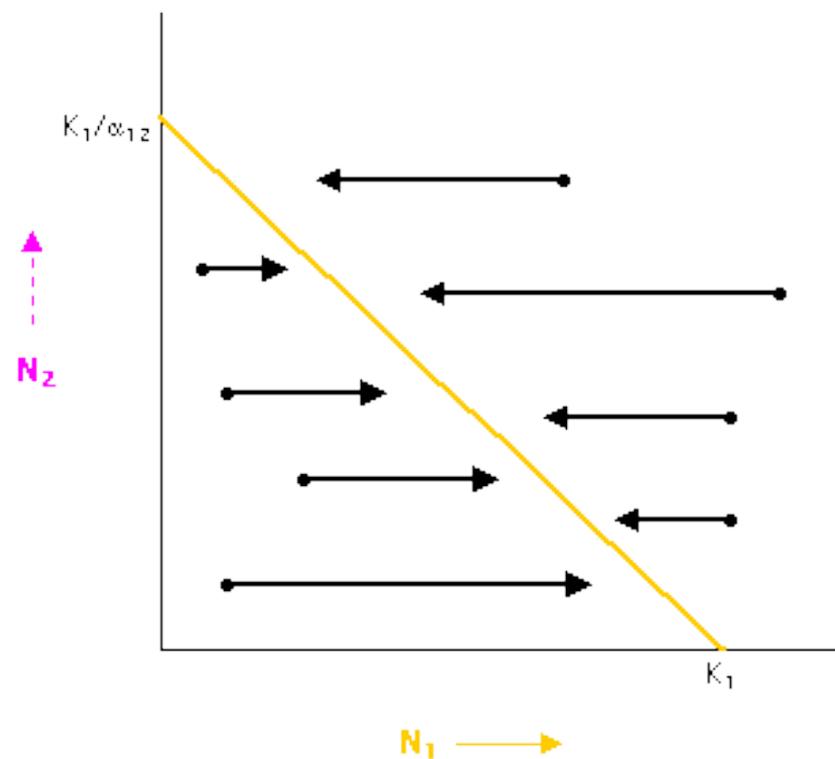
$$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 + \alpha_{12} N_2}{K_1} \right)$$

$$\frac{dN_2}{dt} = r_2 N_2 \left(\frac{K_2 - N_2 + \alpha_{21} N_1}{K_2} \right)$$

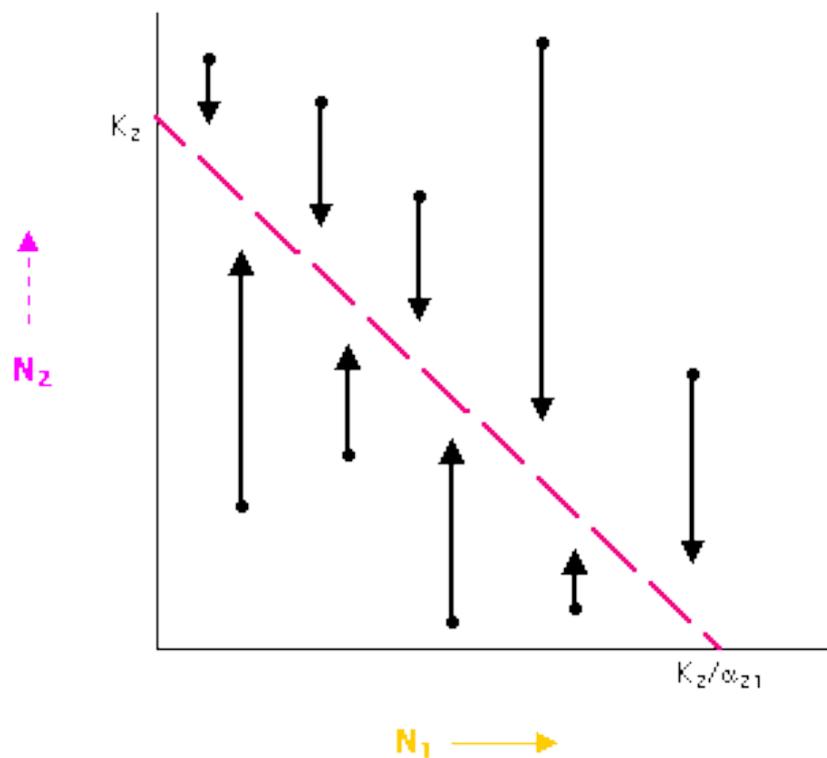
$$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 + \alpha_{12} N_2}{K_1} \right)$$

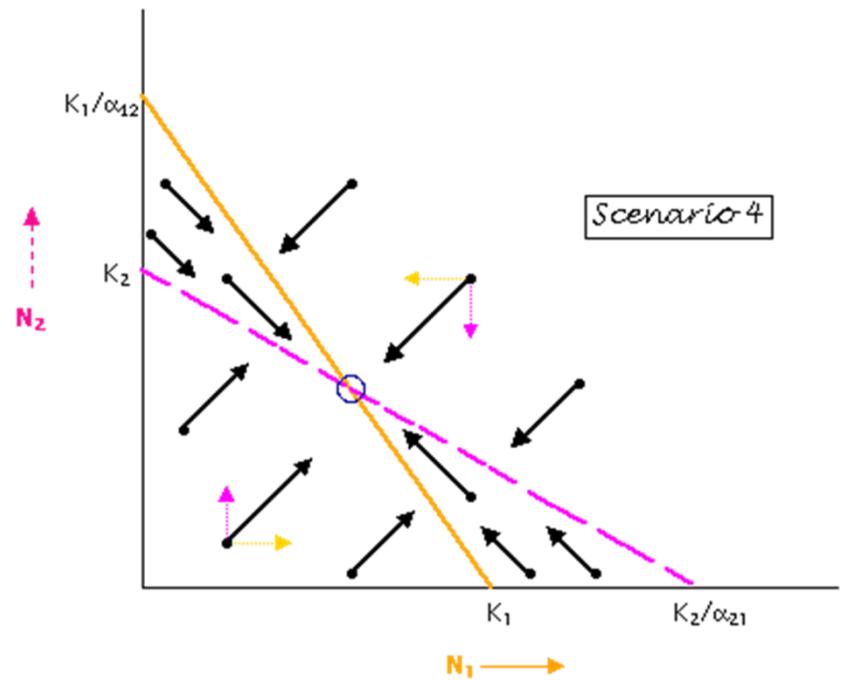
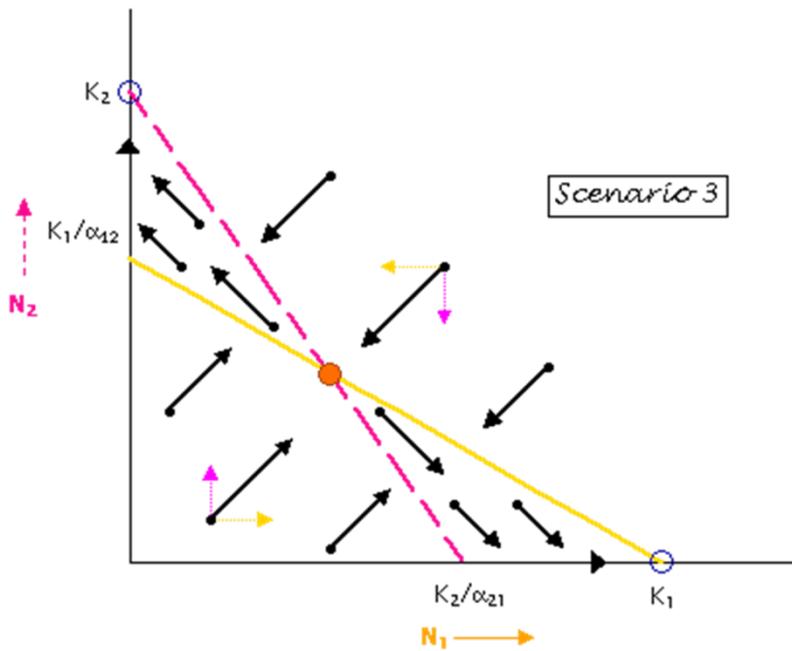
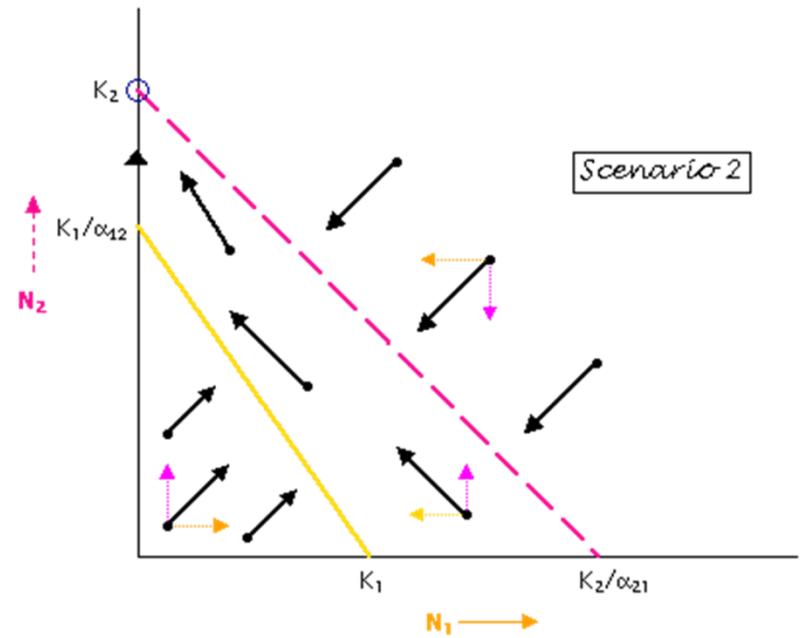
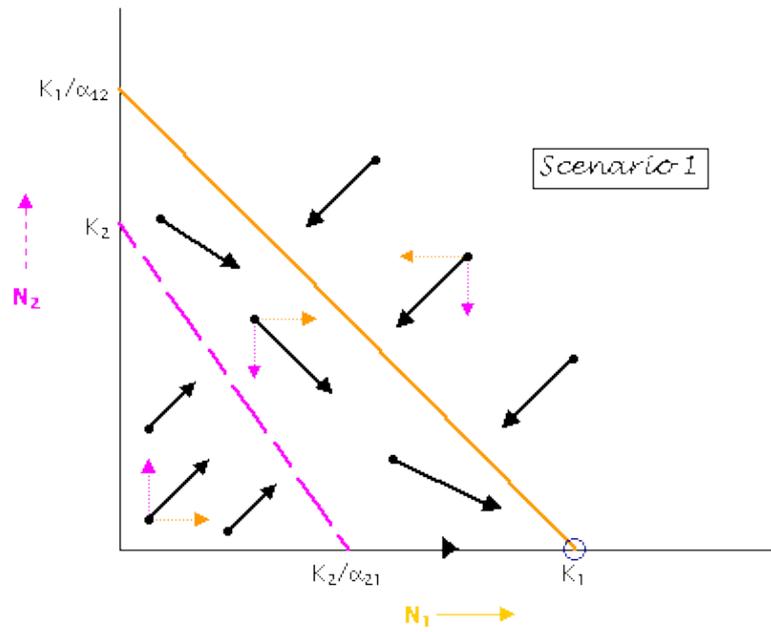
$$\frac{dN_2}{dt} = r_2 N_2 \left(\frac{K_2 - N_2 + \alpha_{21} N_1}{K_2} \right)$$

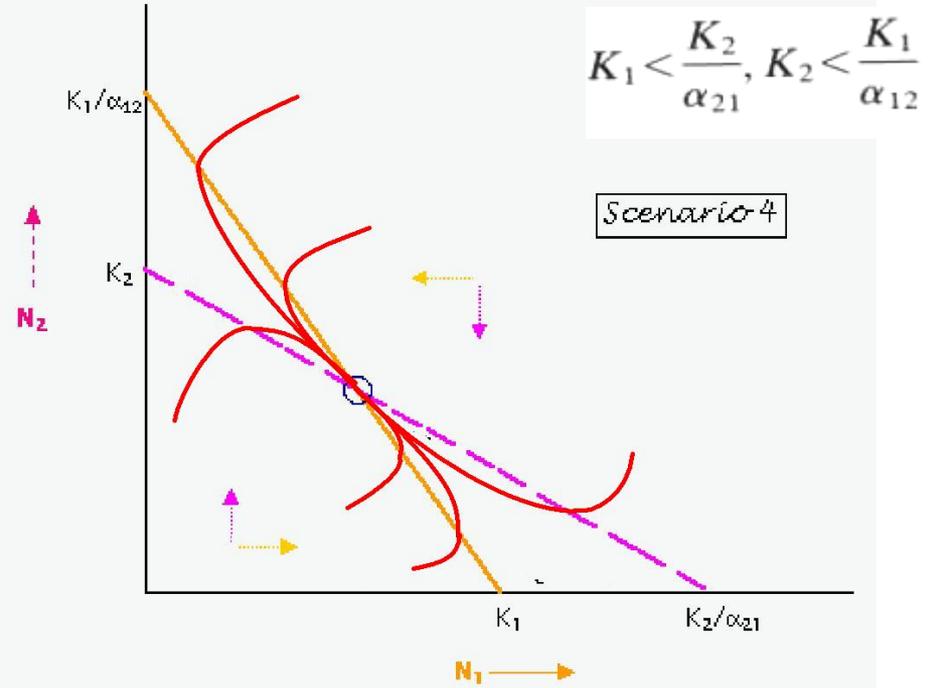
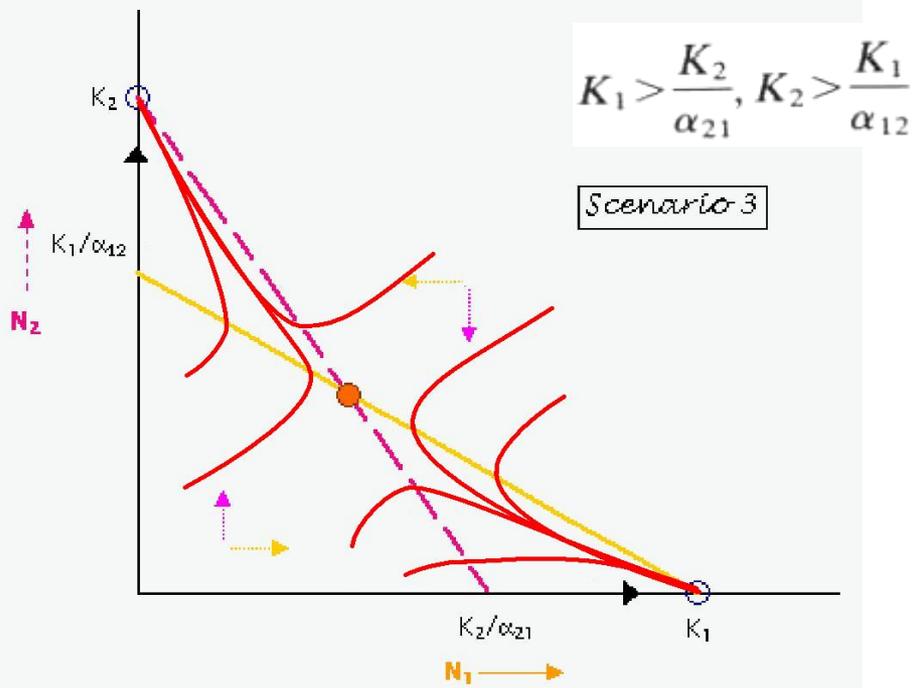
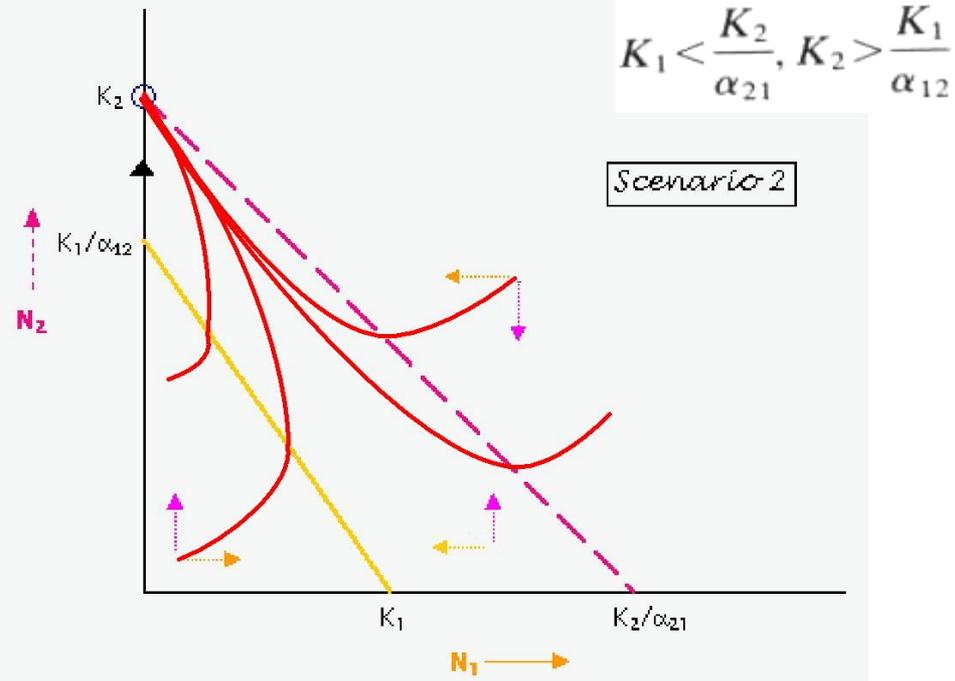
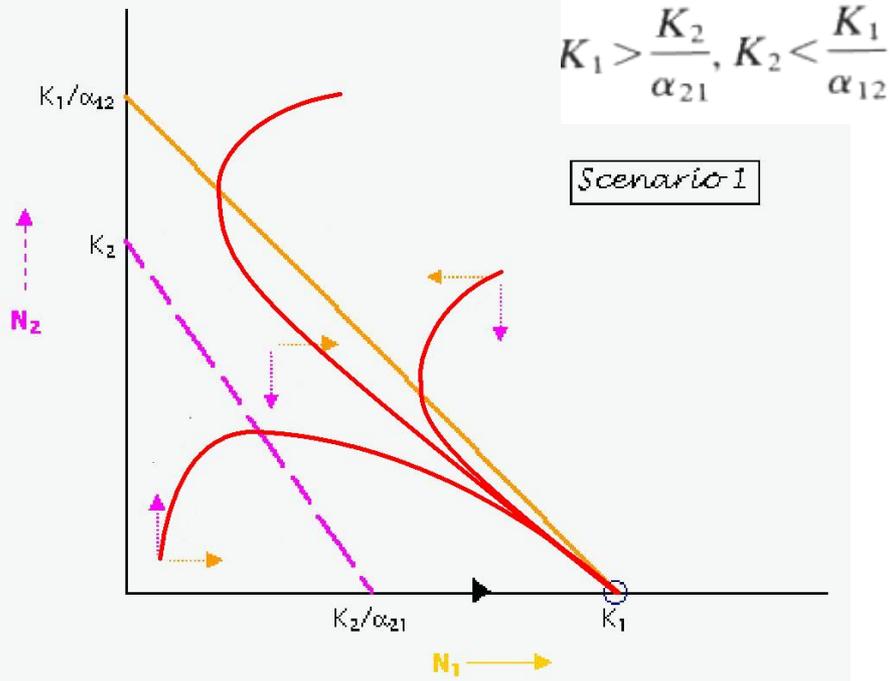
Zero Isocline for N_1

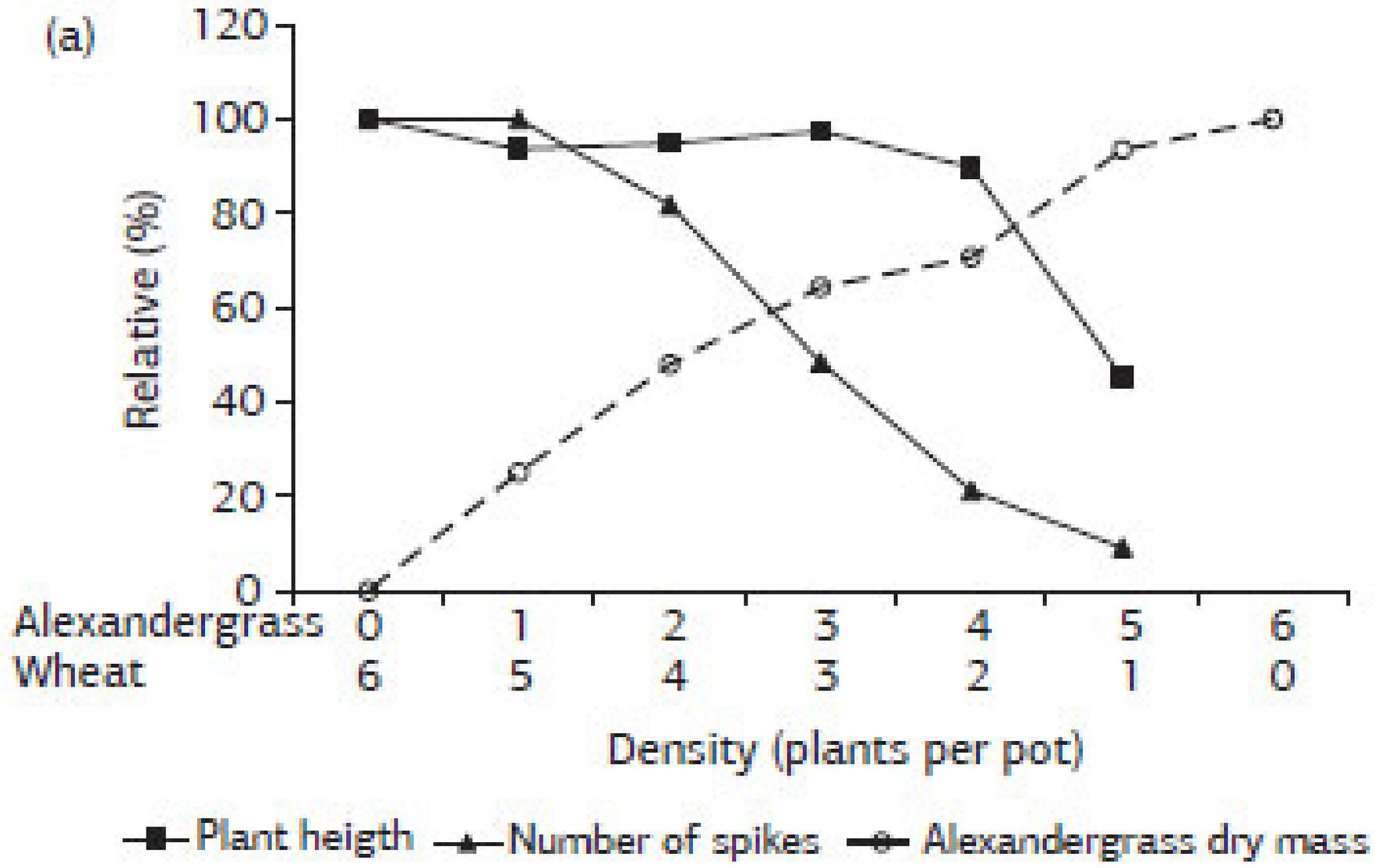


Zero Isocline for N_2









Predation



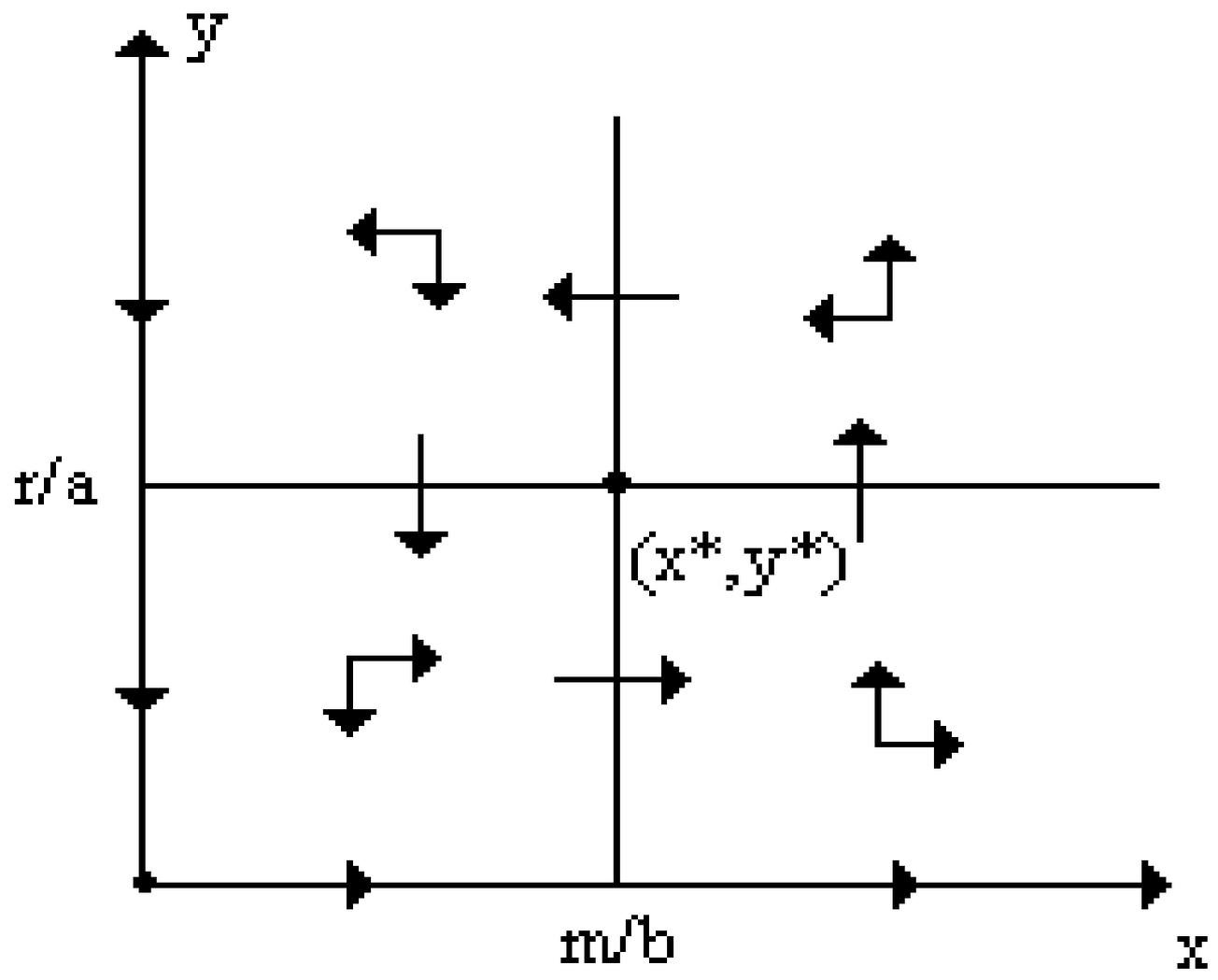
Prey (Victim)

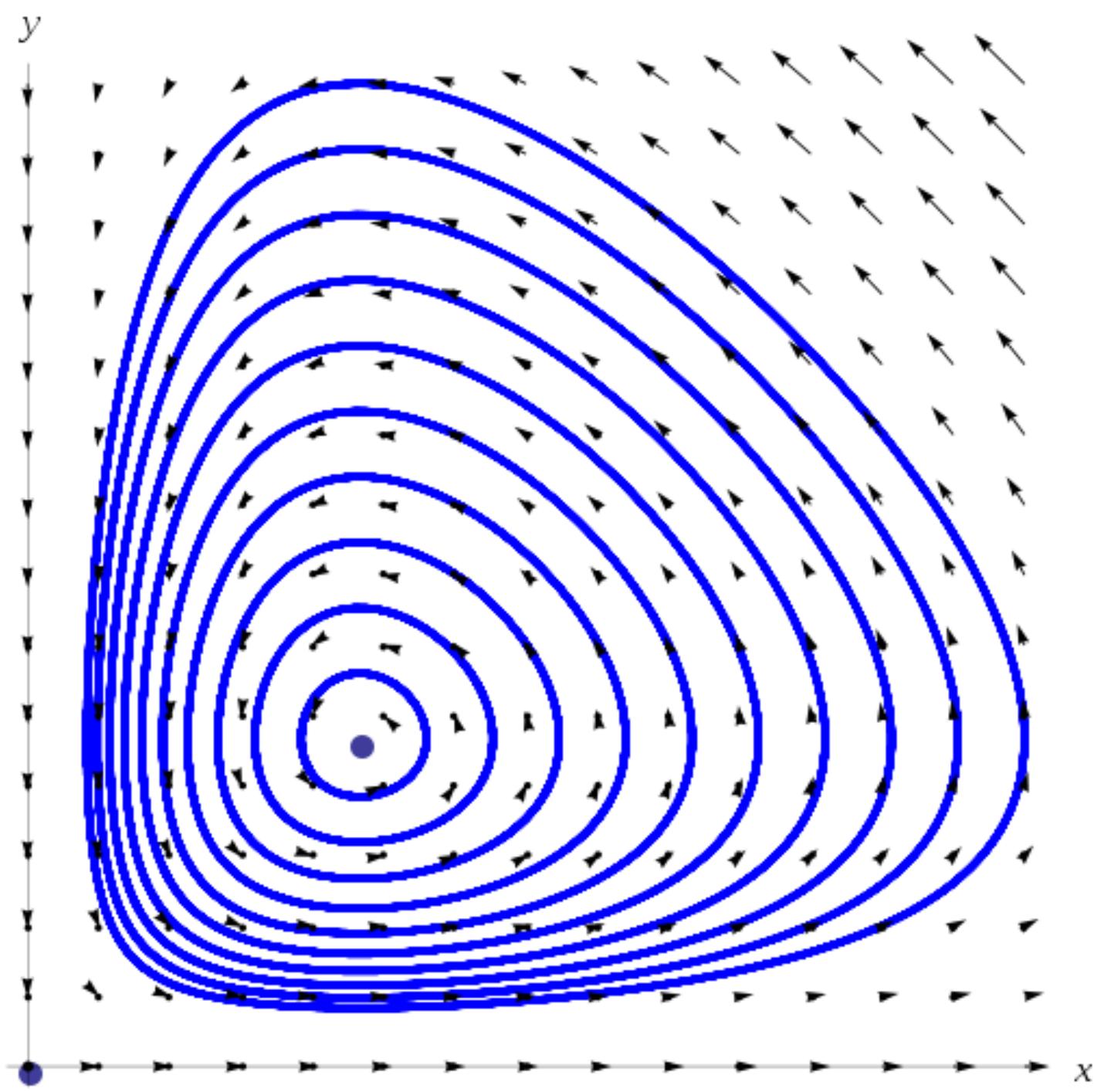
$$\frac{dV}{dt} = r V - a P V$$

Predator

$$\frac{dP}{dt} = abVP - d P$$





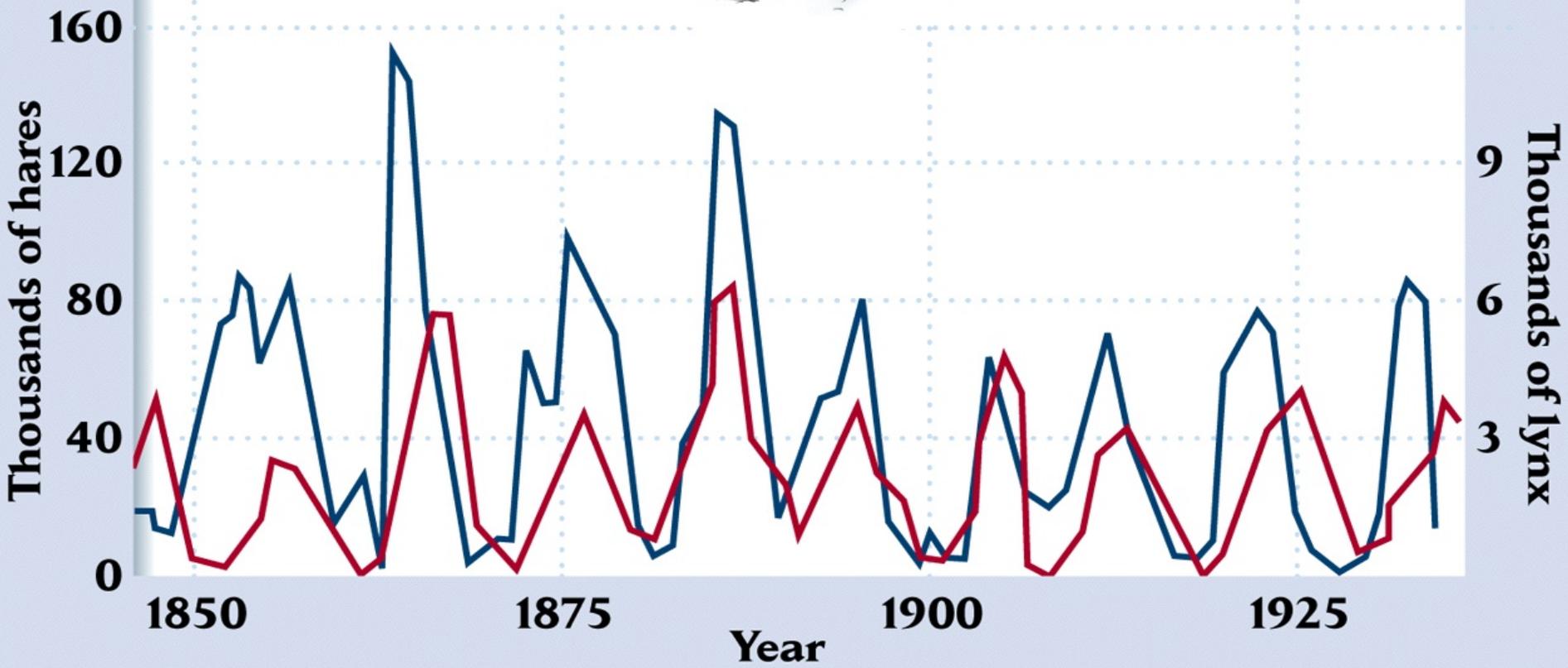


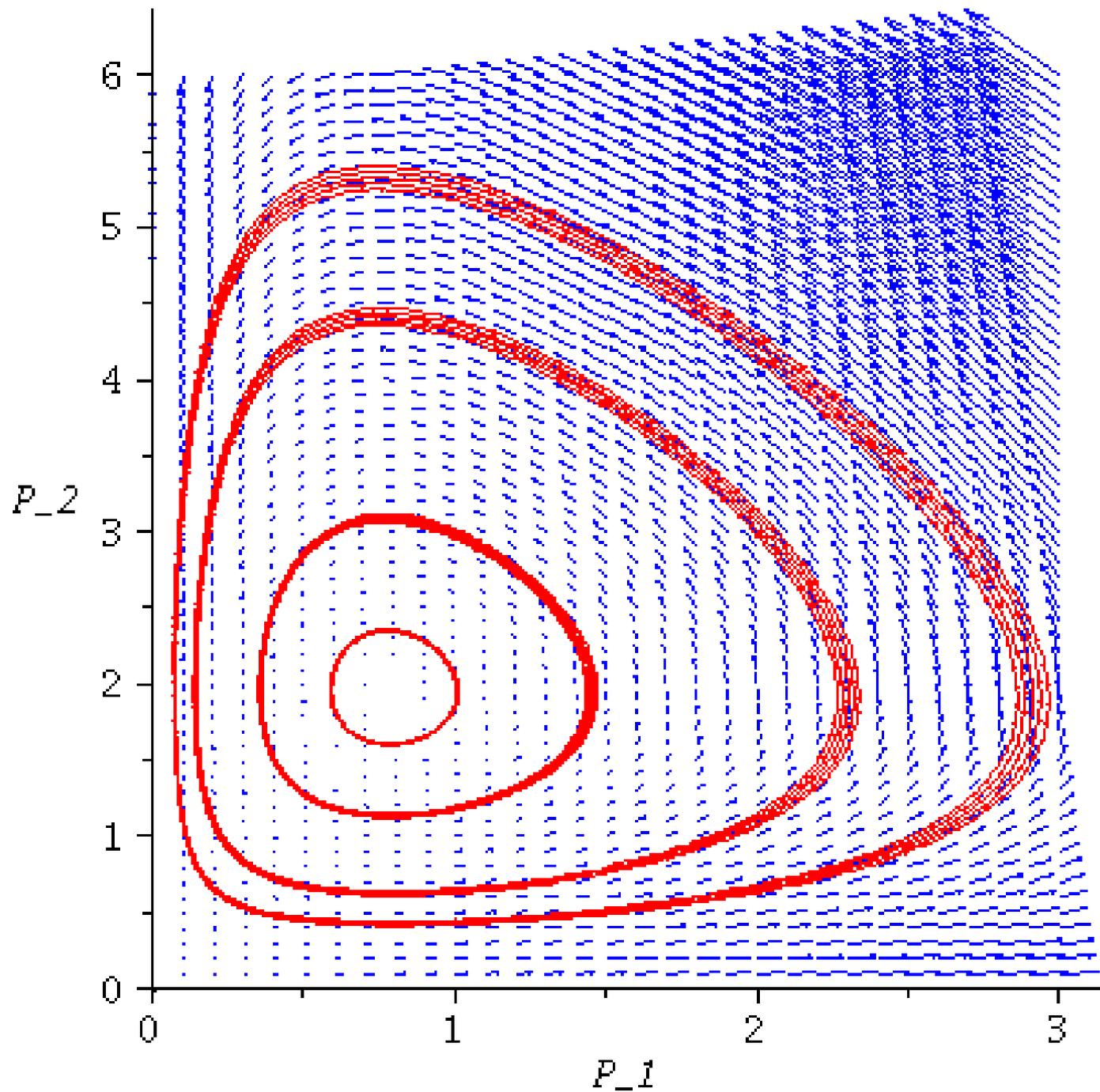


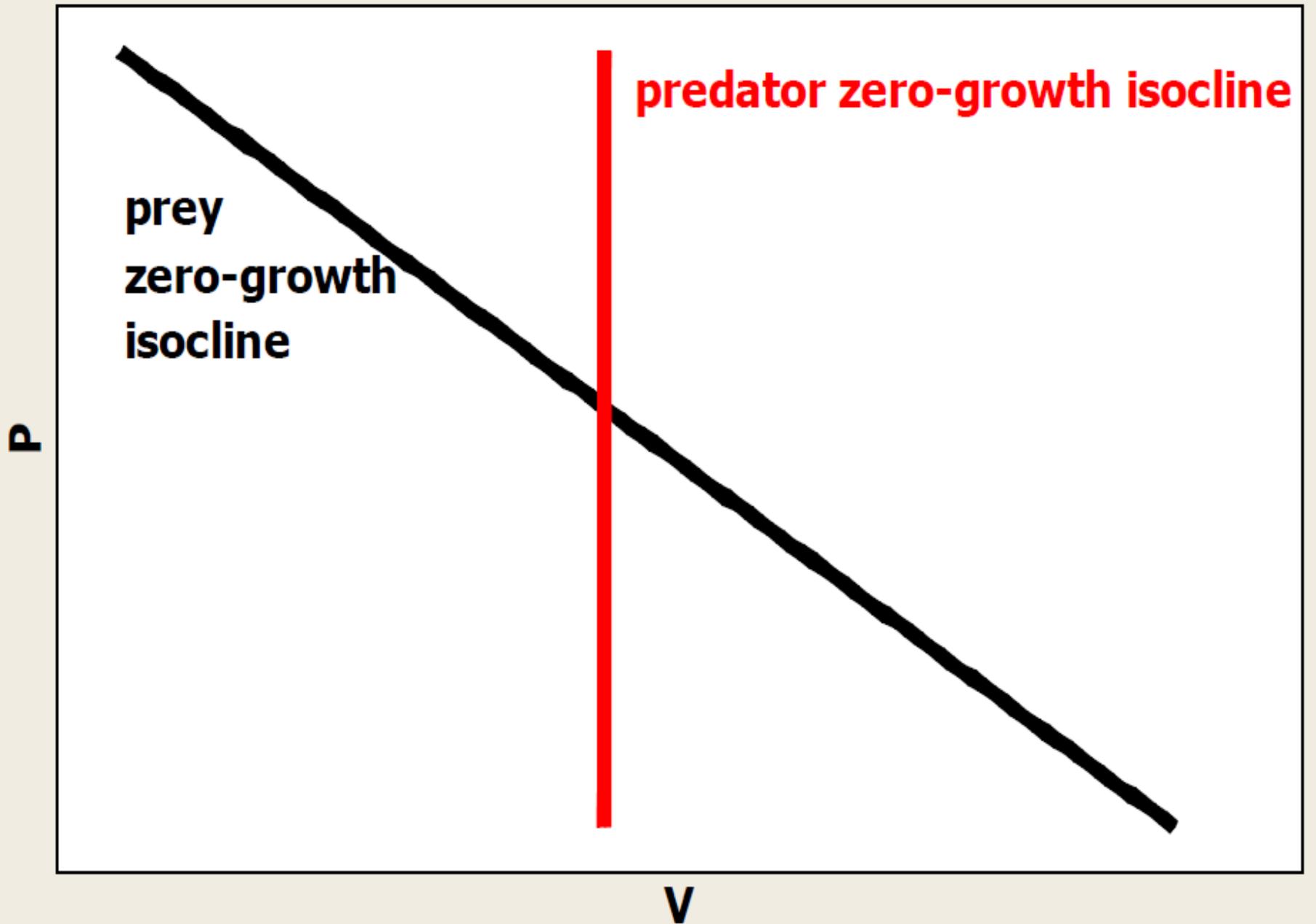


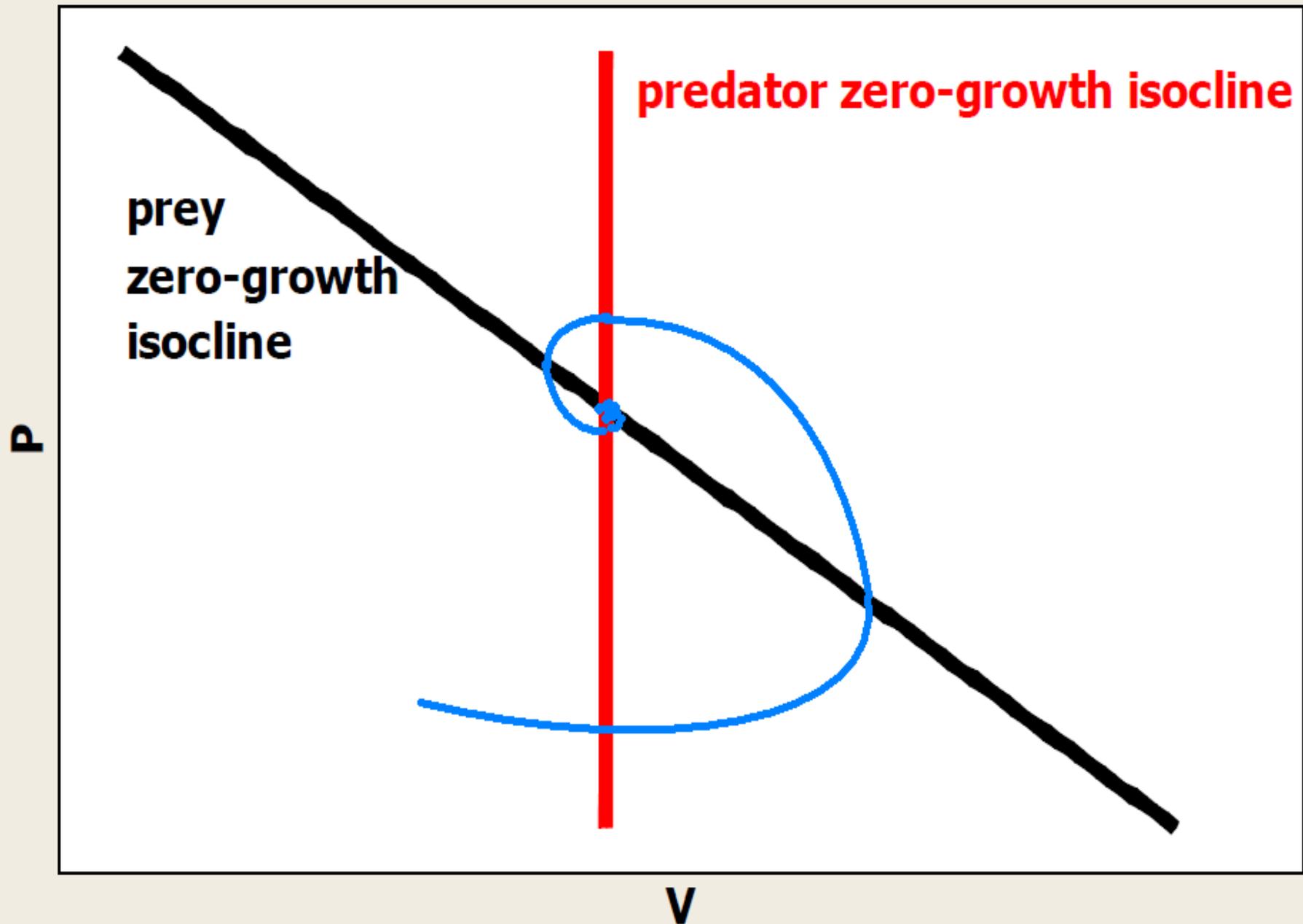
KEY

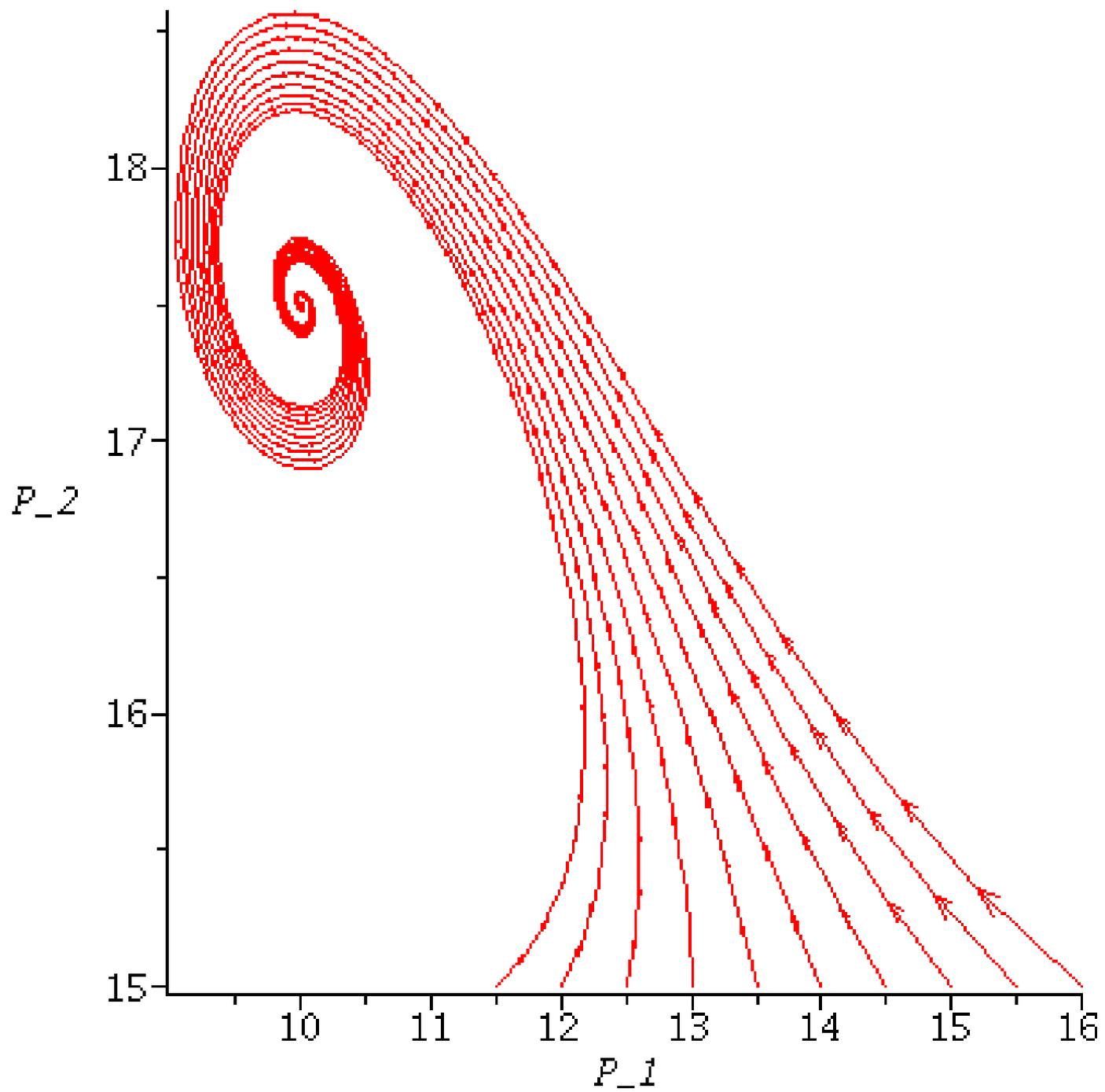
-  **Snowshoe hare**
-  **Lynx**

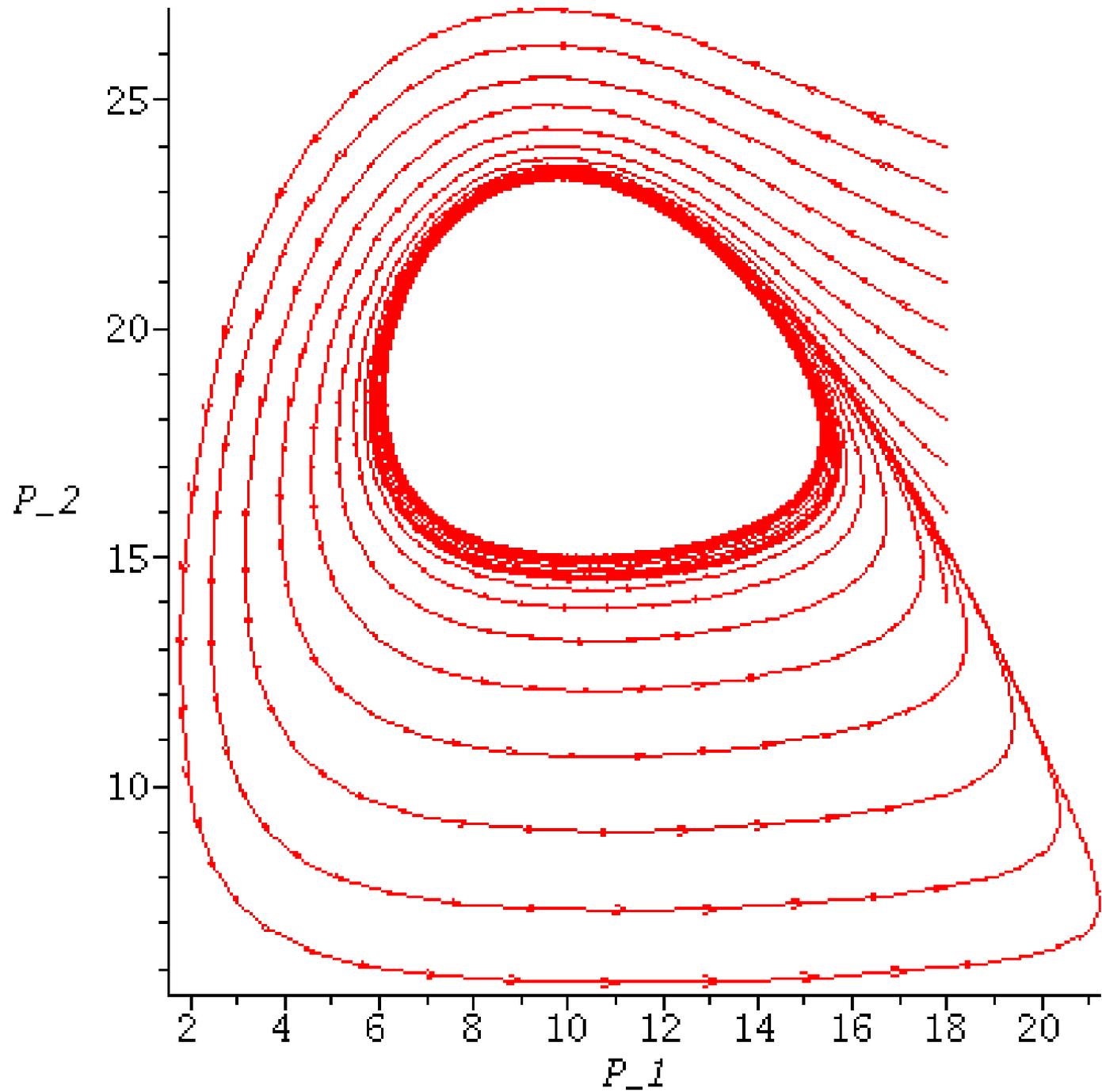


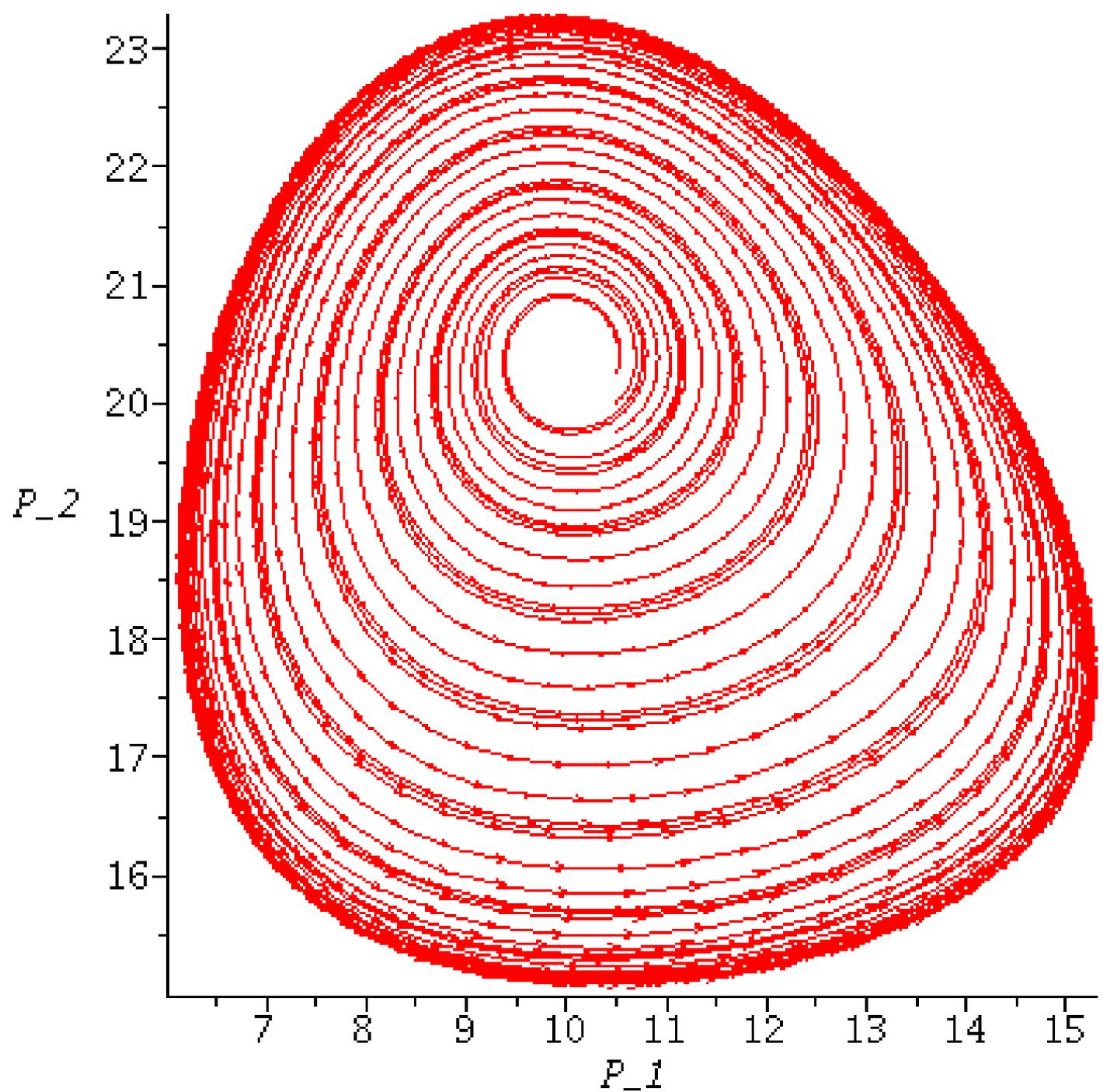


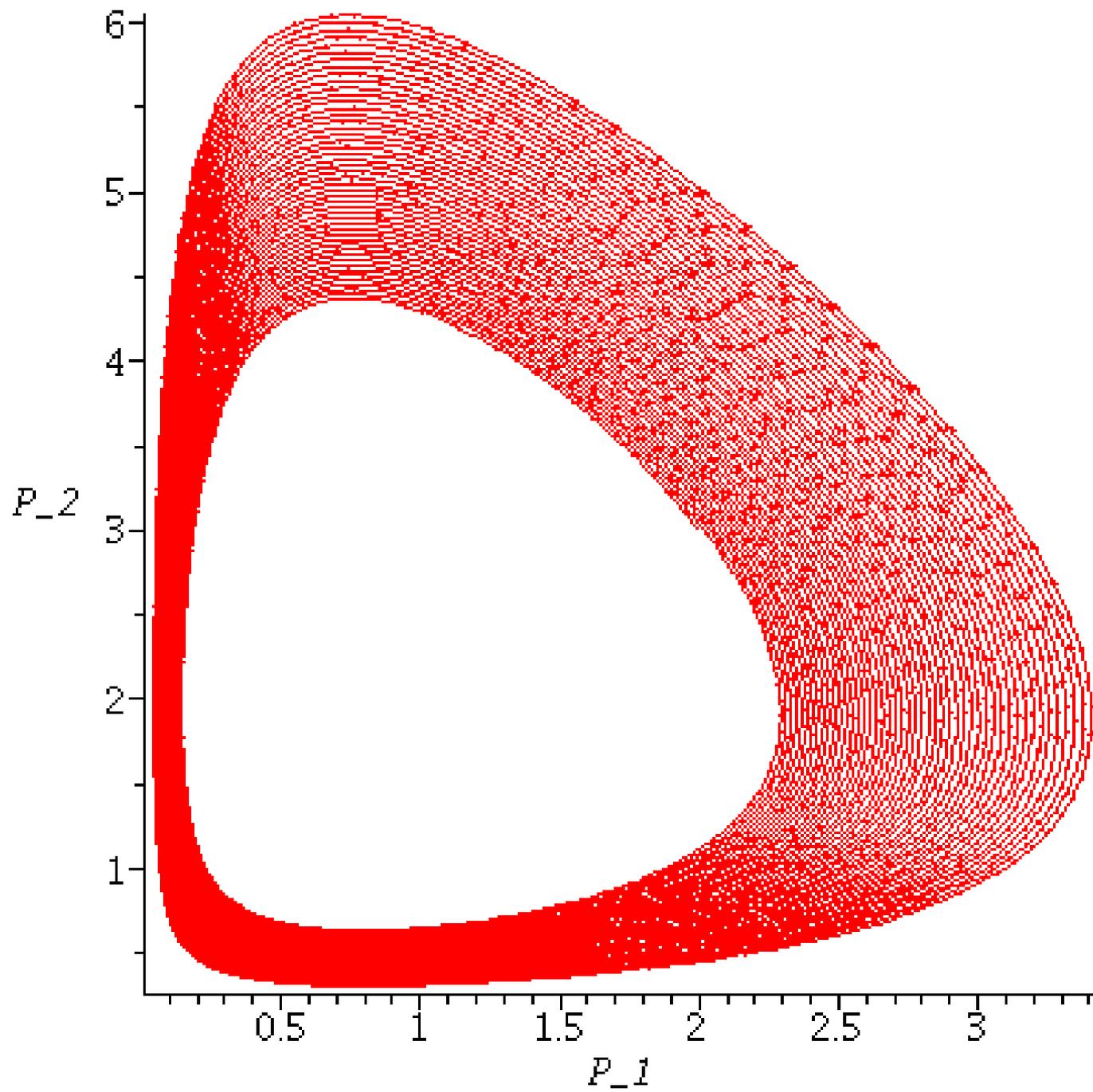


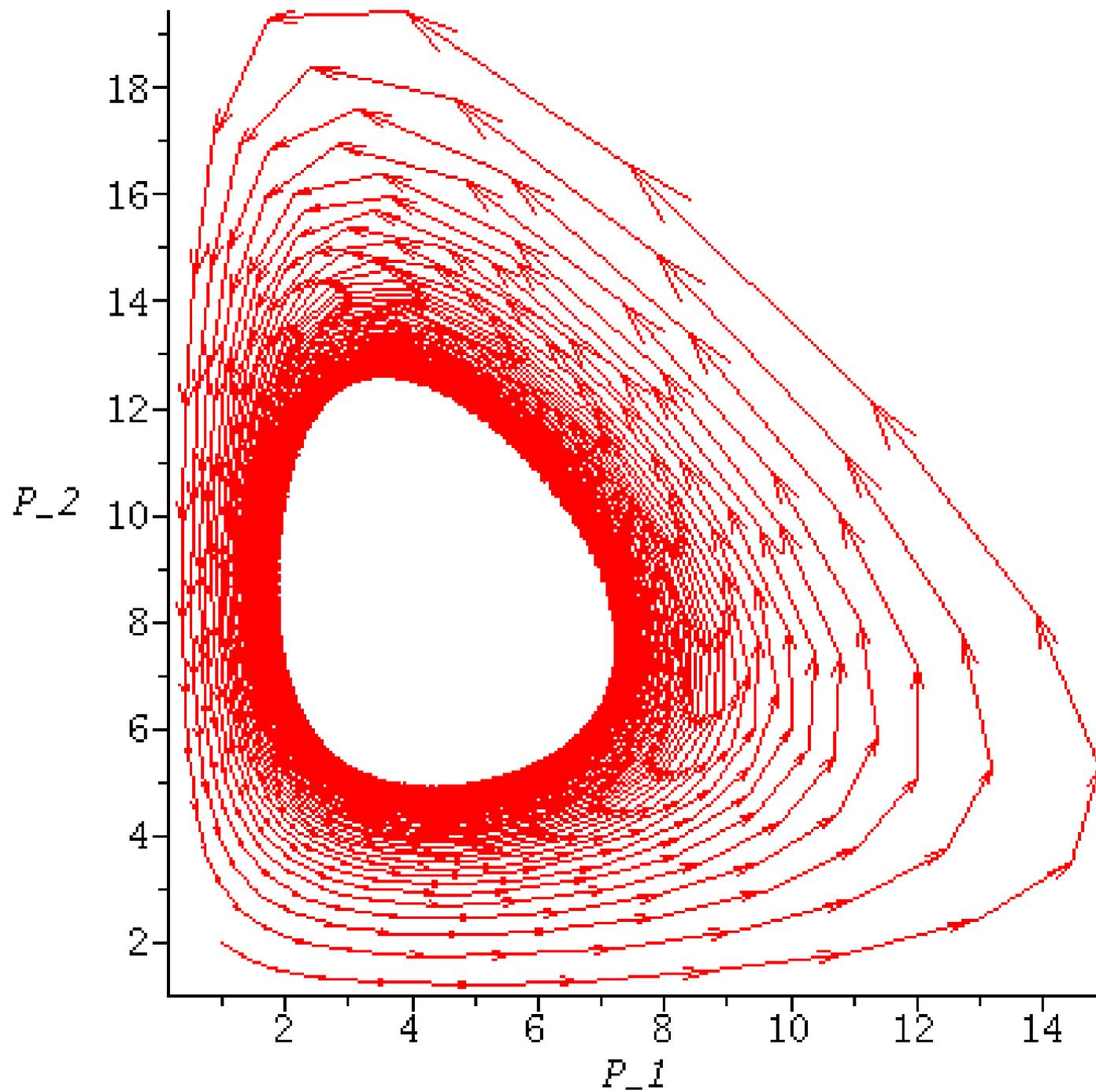


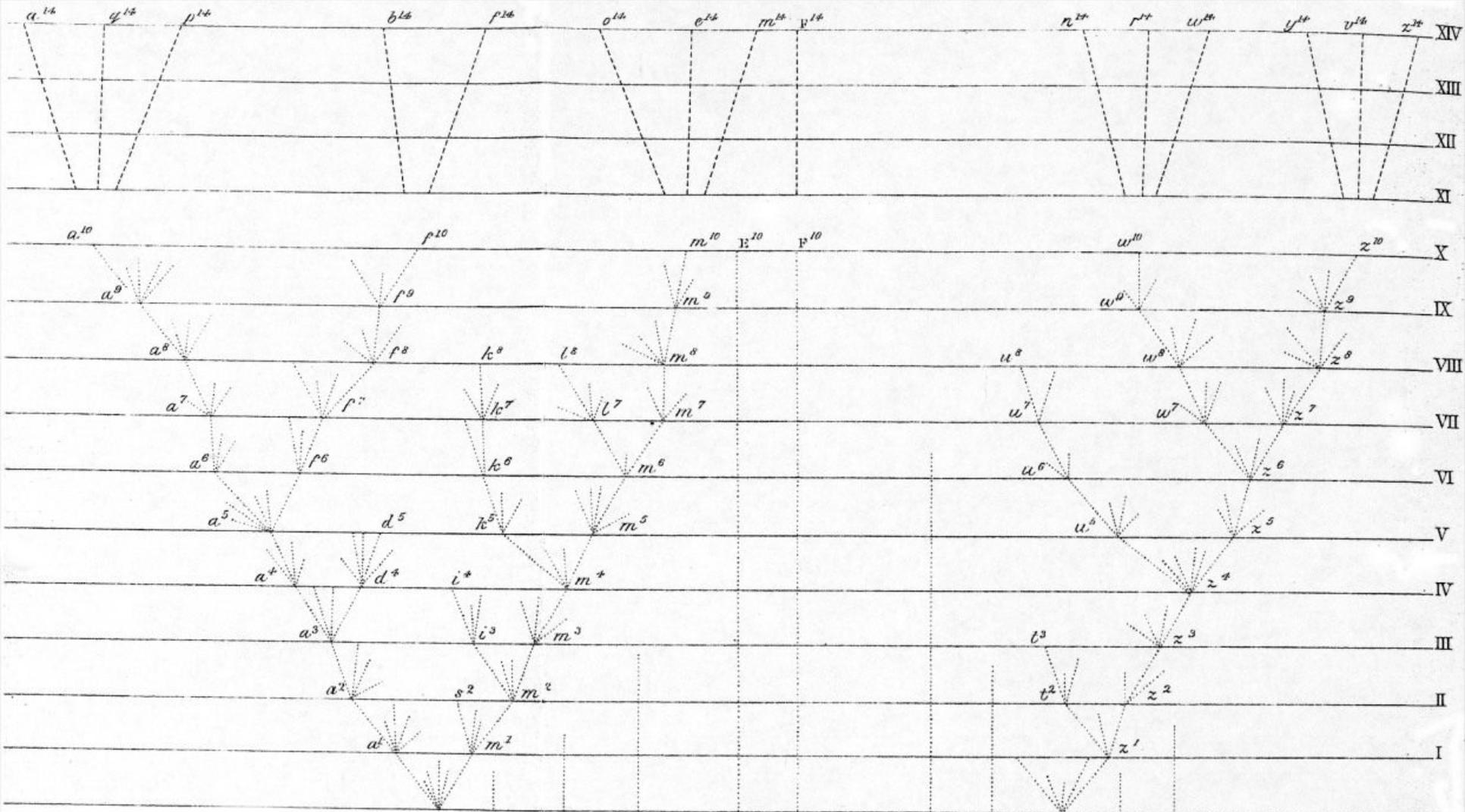










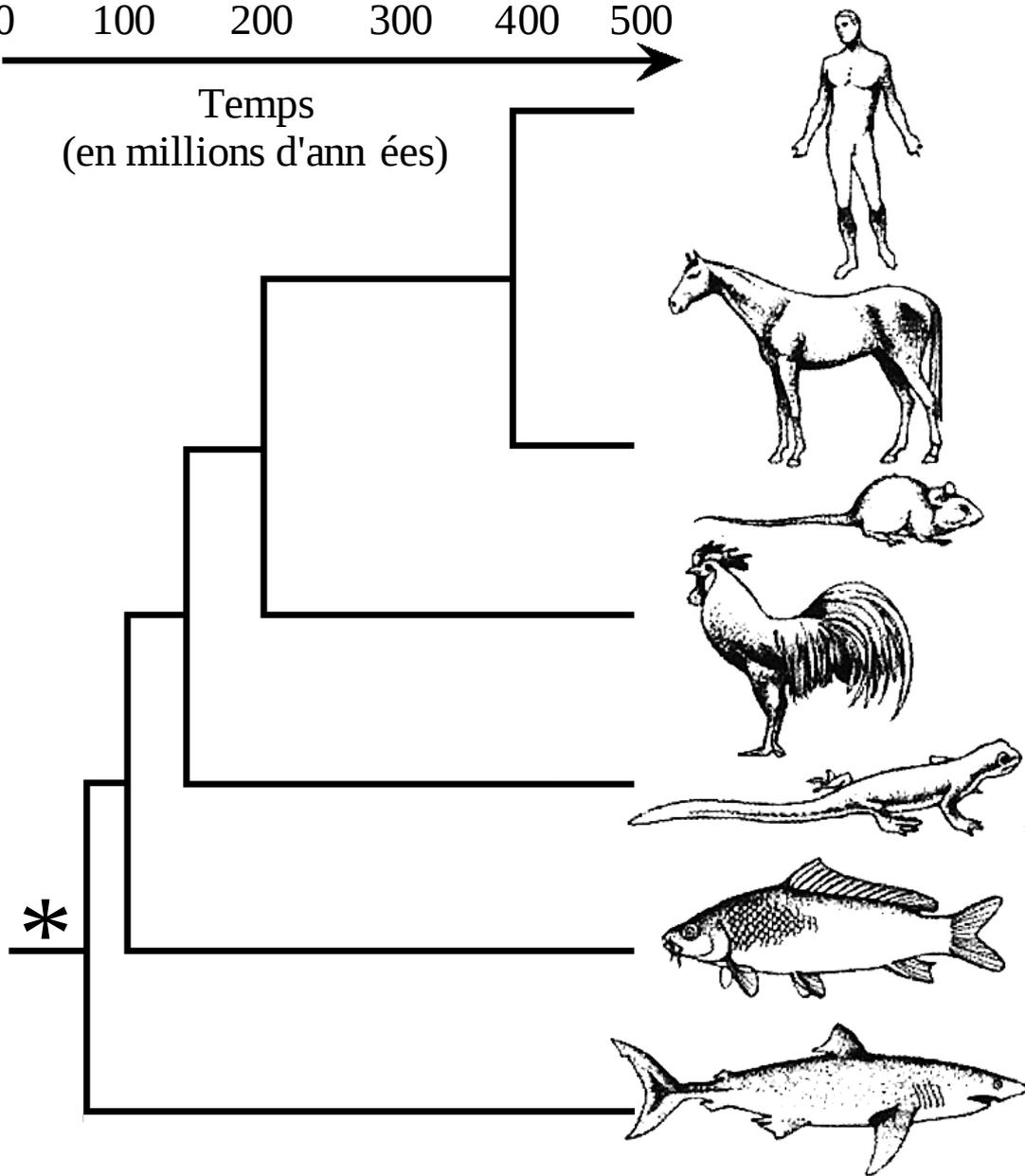


The writings of Charles Darwin on the web

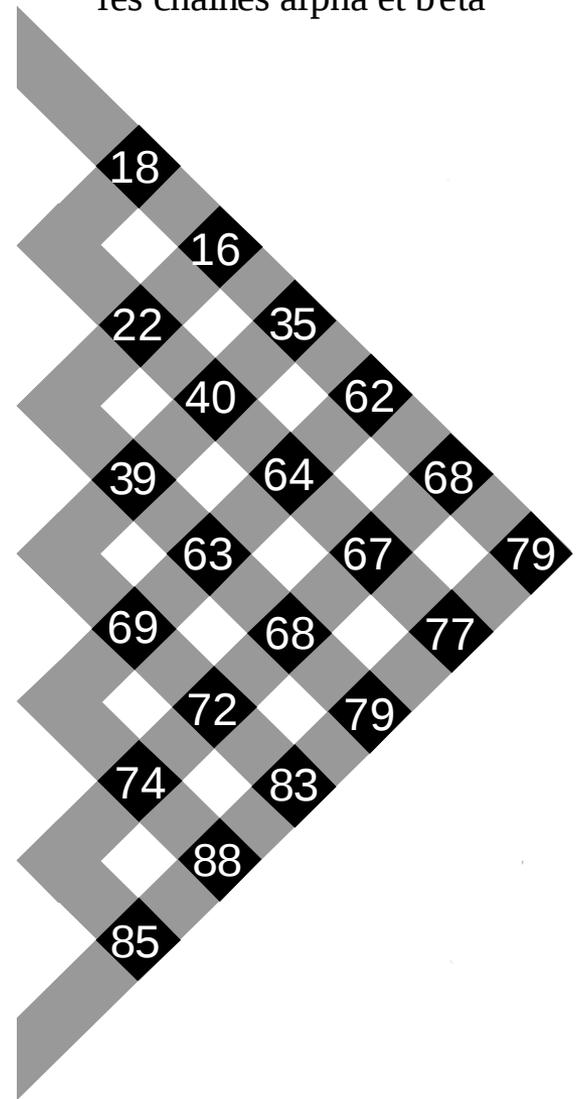
W. West Irish, Hutton, Garden.

0 100 200 300 400 500

Temps
(en millions d'ann ées)



* Duplication d'un g ène
promordial pour constituer
les chaînes alpha et bêta

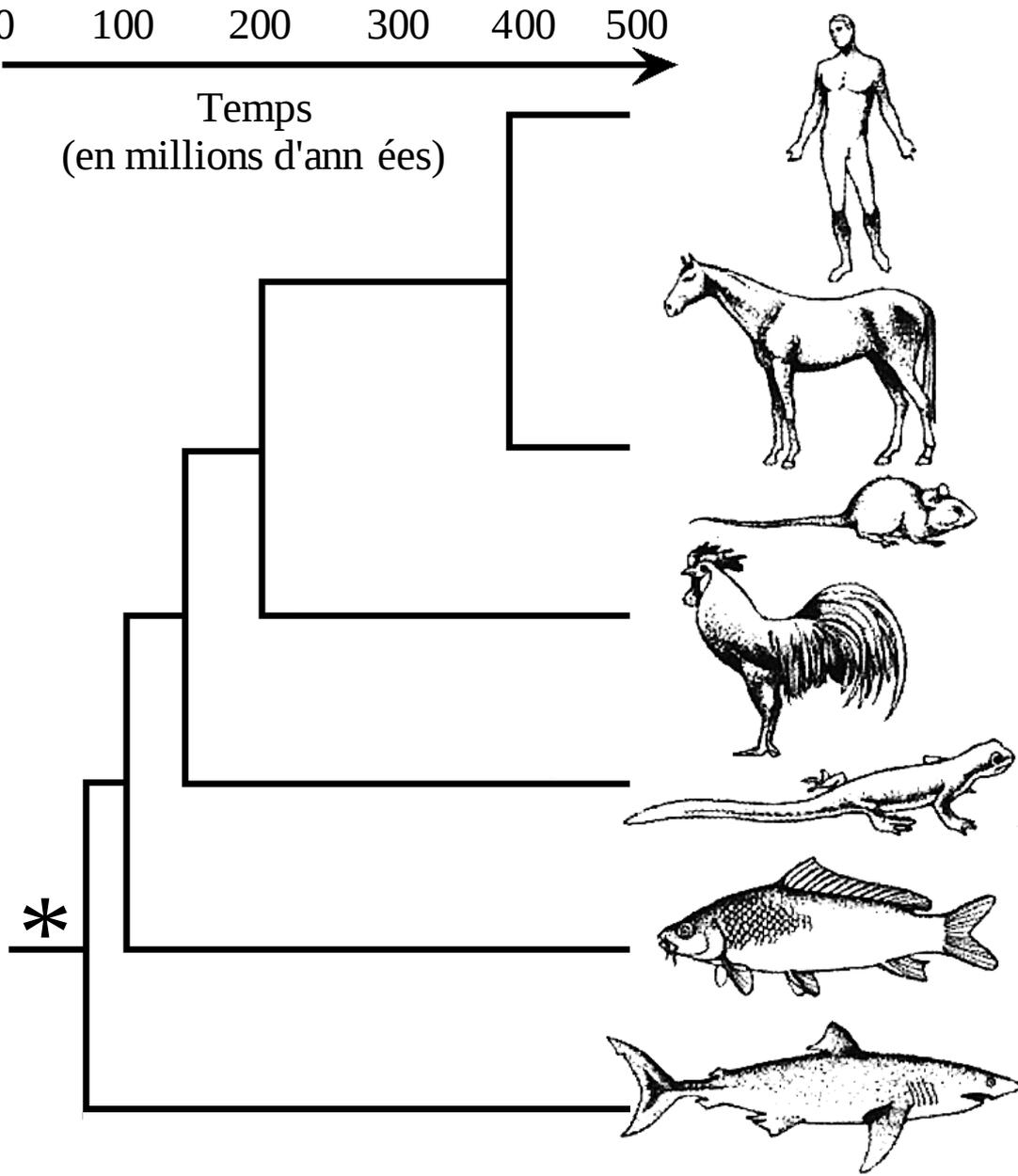


Qu'est-ce qui est
conservé au
cours de
l'évolution?
(sur quoi la sélection
agit-elle?)

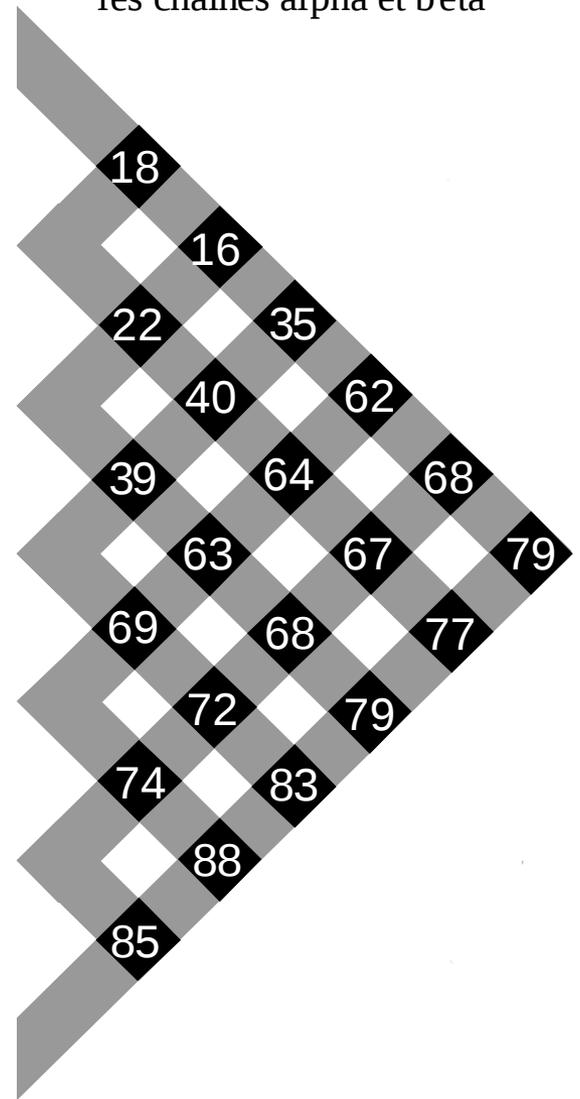
Les individus sont
des artifices
inventés par les
gènes pour se
reproduire

0 100 200 300 400 500

Temps
(en millions d'ann ées)



* Duplication d'un g ène
promordial pour constituer
les chaînes alpha et bêta



Information

Short sequence

Gene

Genome

”

Avatar

Nucleotides

Nucleic Acid

Chromosome

Cell

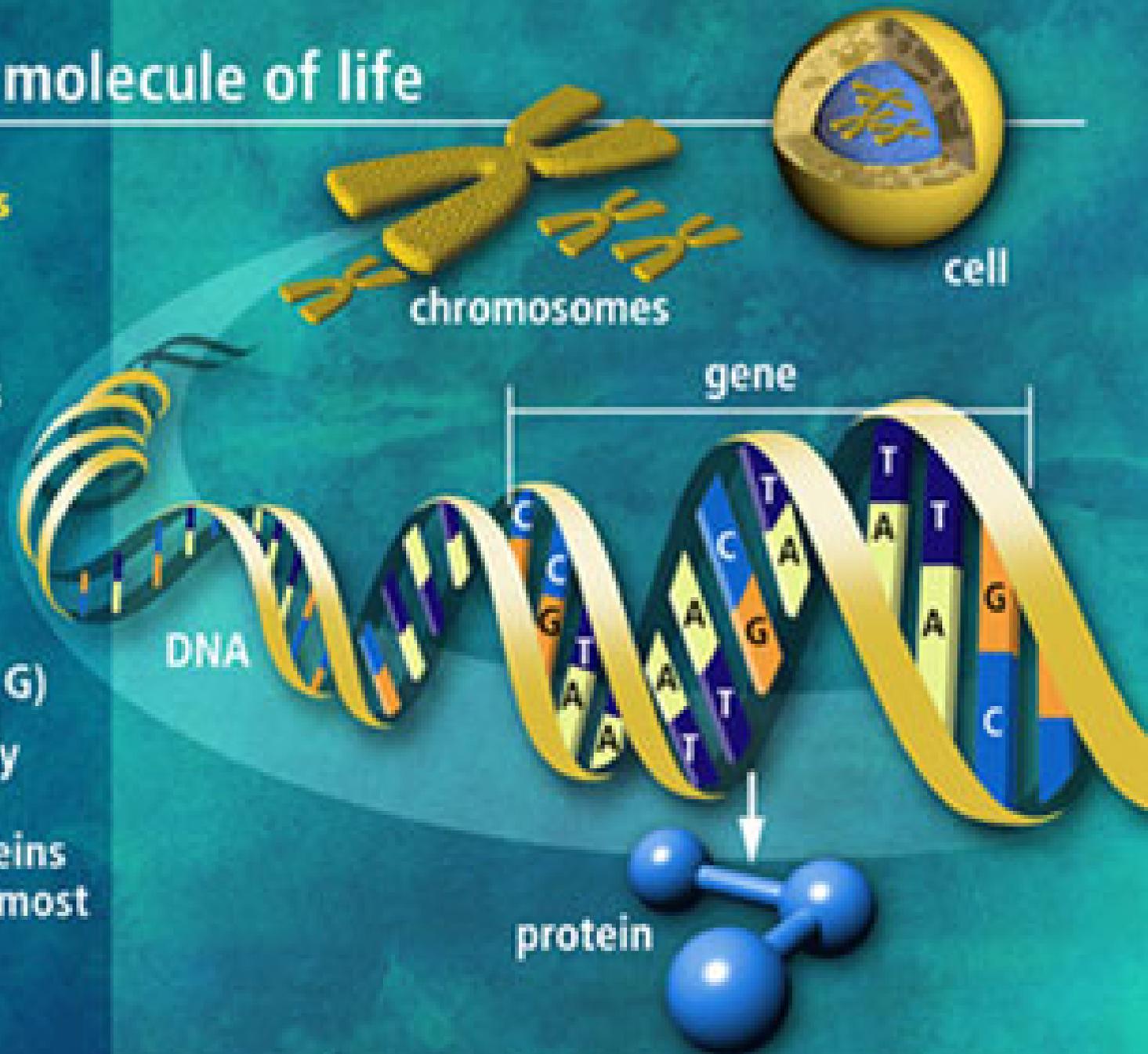
Individual

DNA the molecule of life

Trillions of cells

Each cell:

- 46 human chromosomes
- 2 meters of DNA
- 3 billion DNA subunits (the bases: A, T, C, G)
- Approximately 30,000 genes code for proteins that perform most life functions



Matière / Information

- Physiologie : flux de matière & énergie

**Vivant = matière, flux, organes,
structures transitoires**

- Génétique : flux d'information

**Vivant = produit de la sélection
sur l'information**

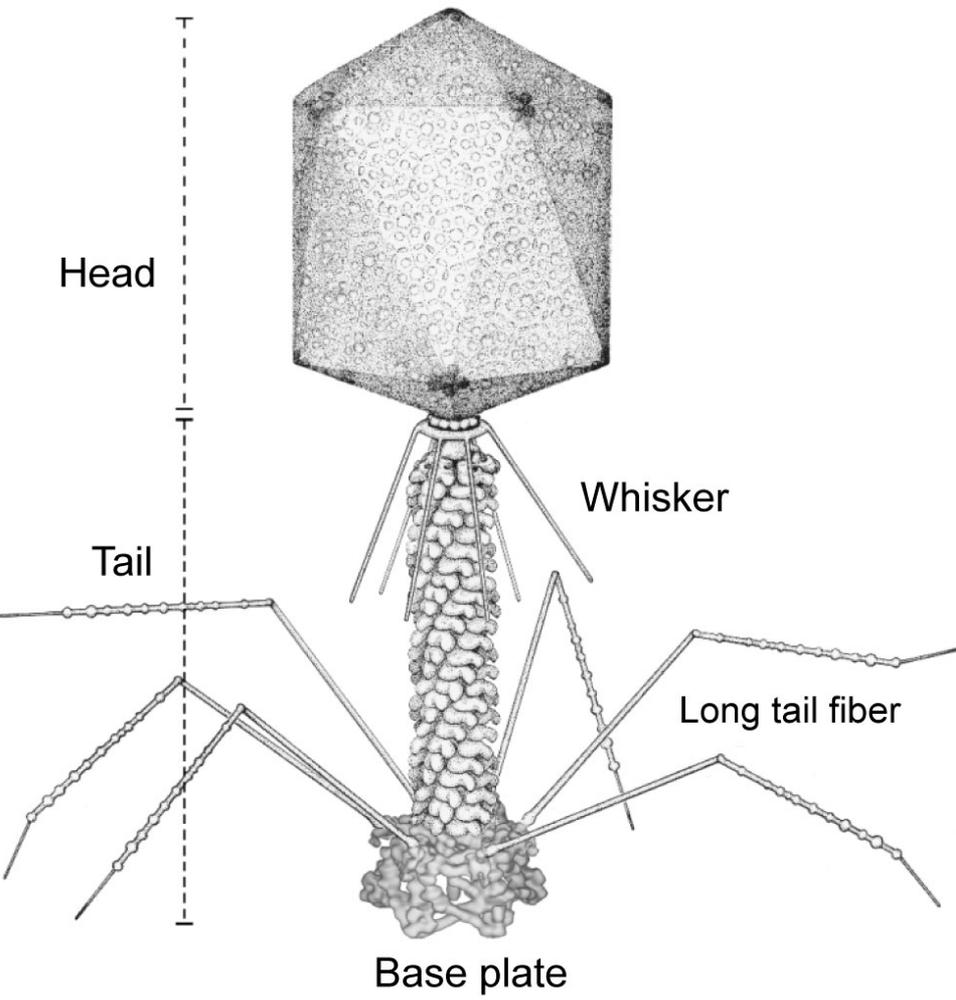
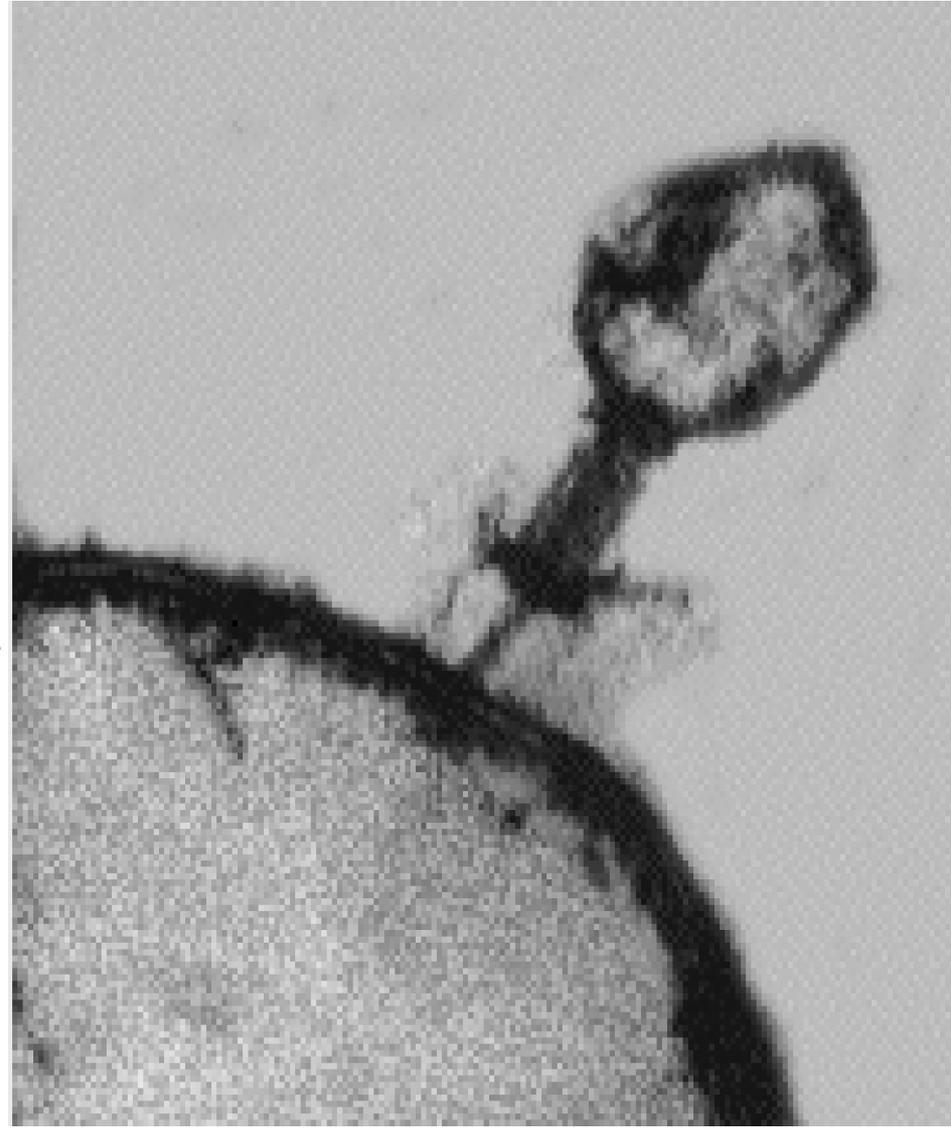


Fig.1-1 Structure of T4 phage (Eiserling, 1983)



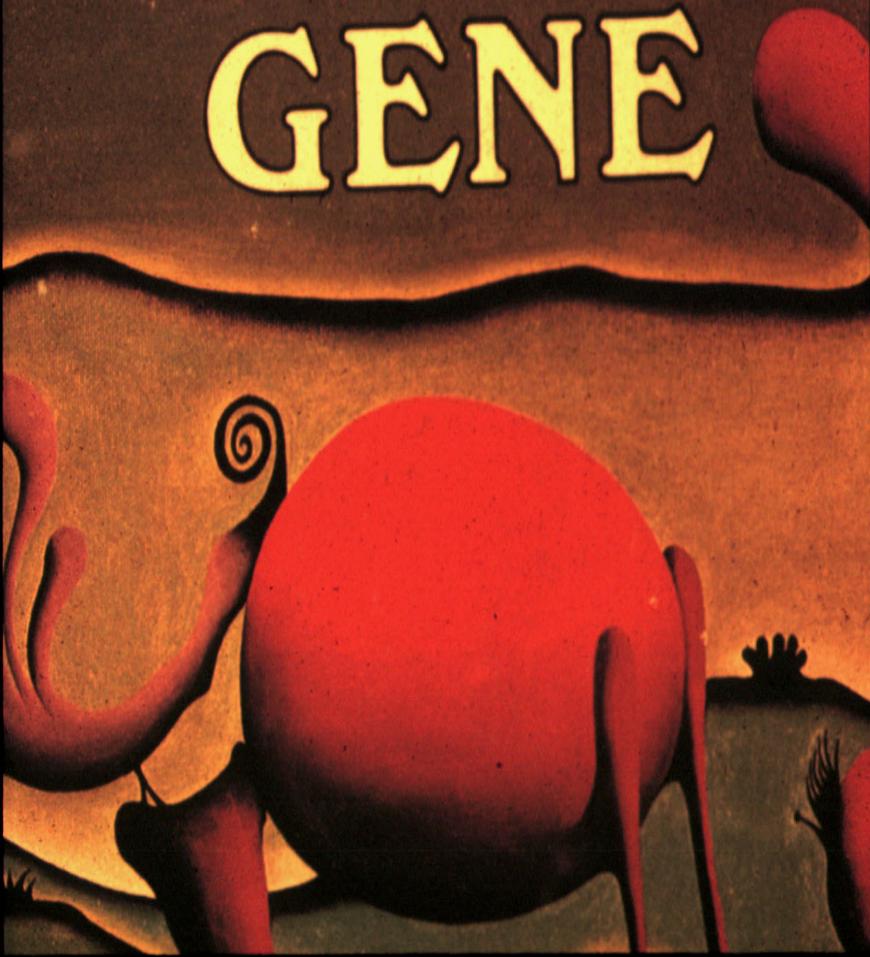




isole

Richard Dawkins
selection and/or development?

THE SELFISH GENE



The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme

STEPHEN JAY GOULD AND RICHARD C. LEWONTIN

Spandrels of San Marco and the Panglossian Paradigm

253



Figure 1. One of the four spandrels of St Mark's; seated evangelist above, personification of river below.

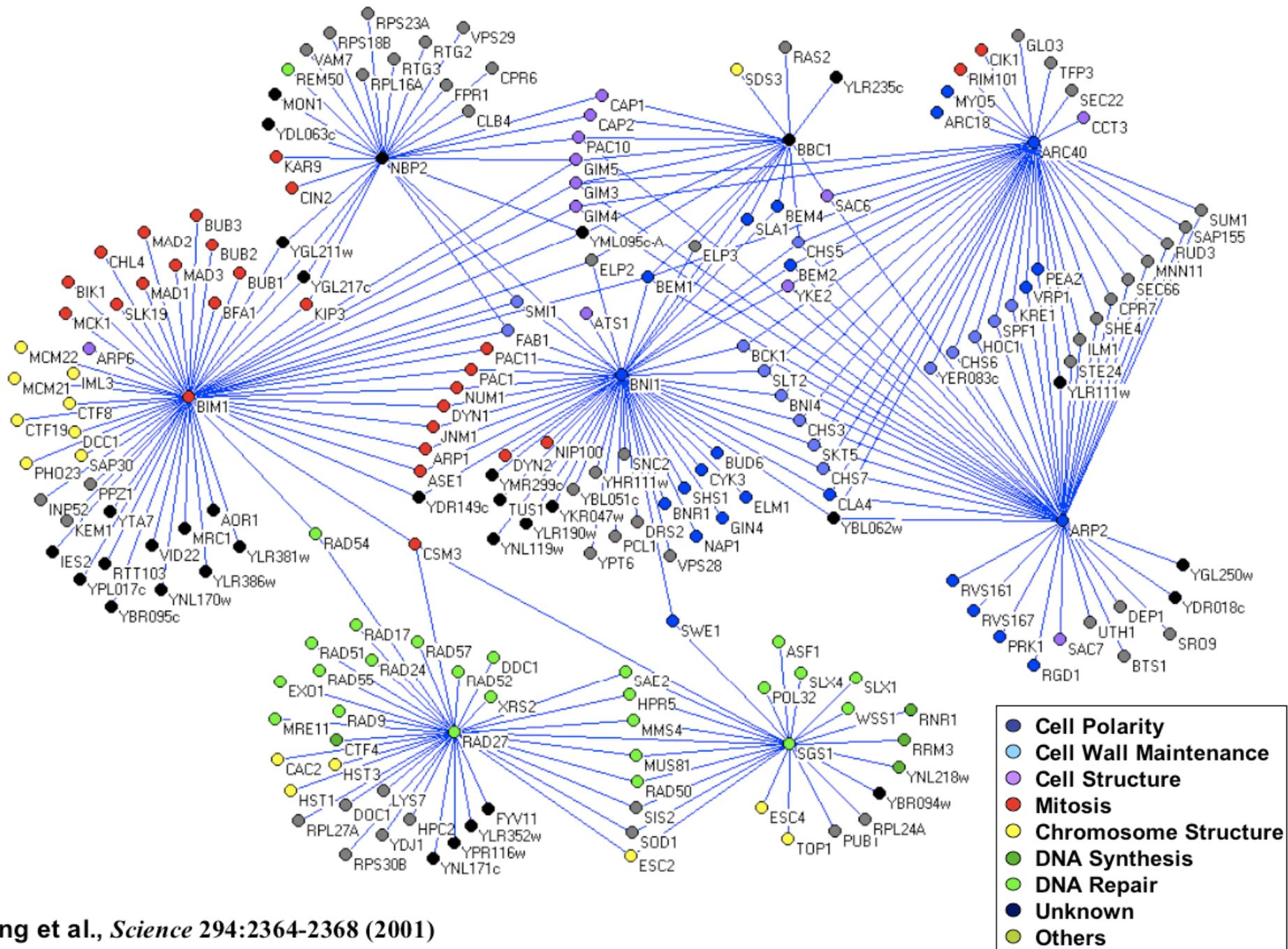


Information

Avatar

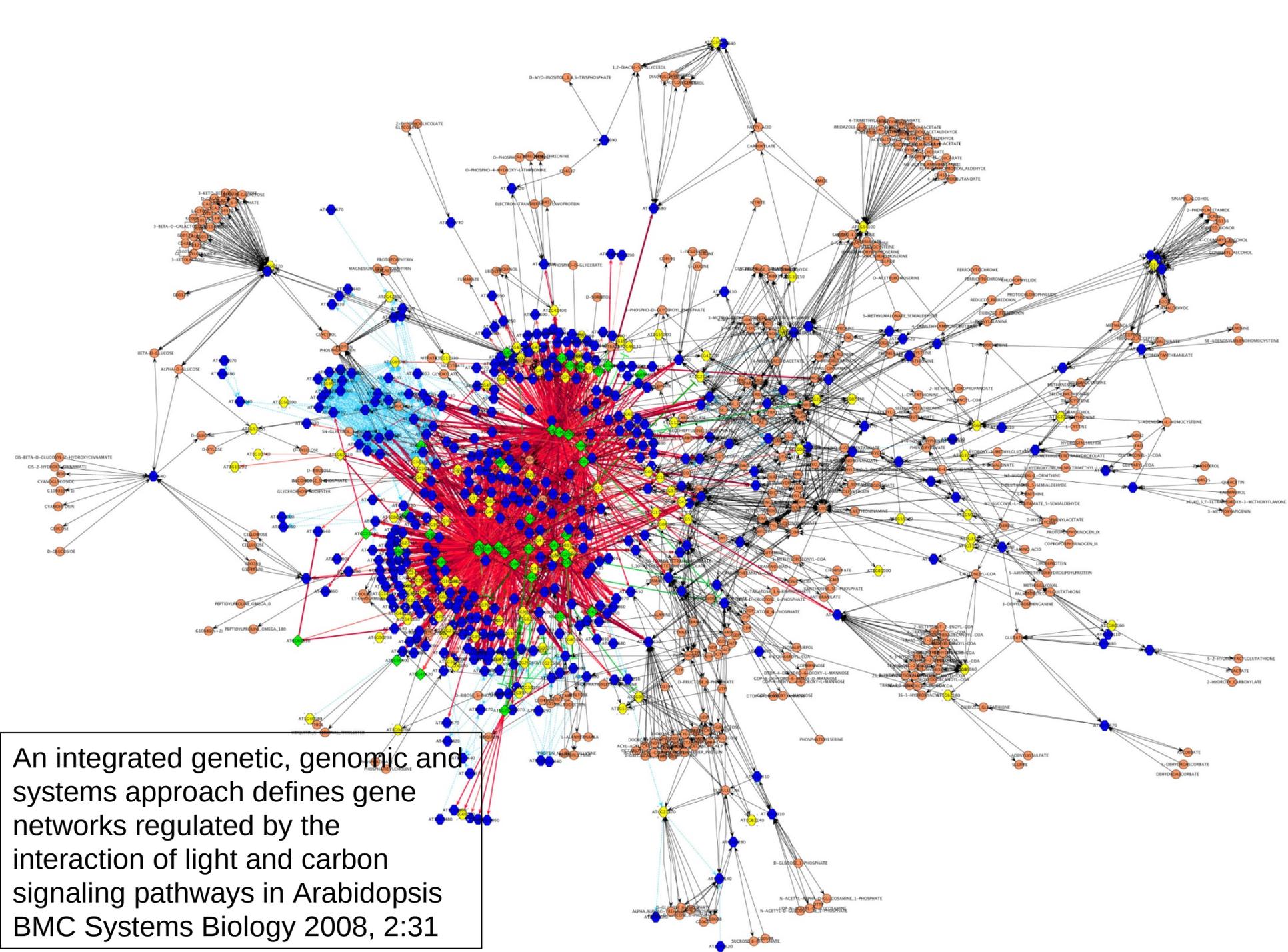
Genome

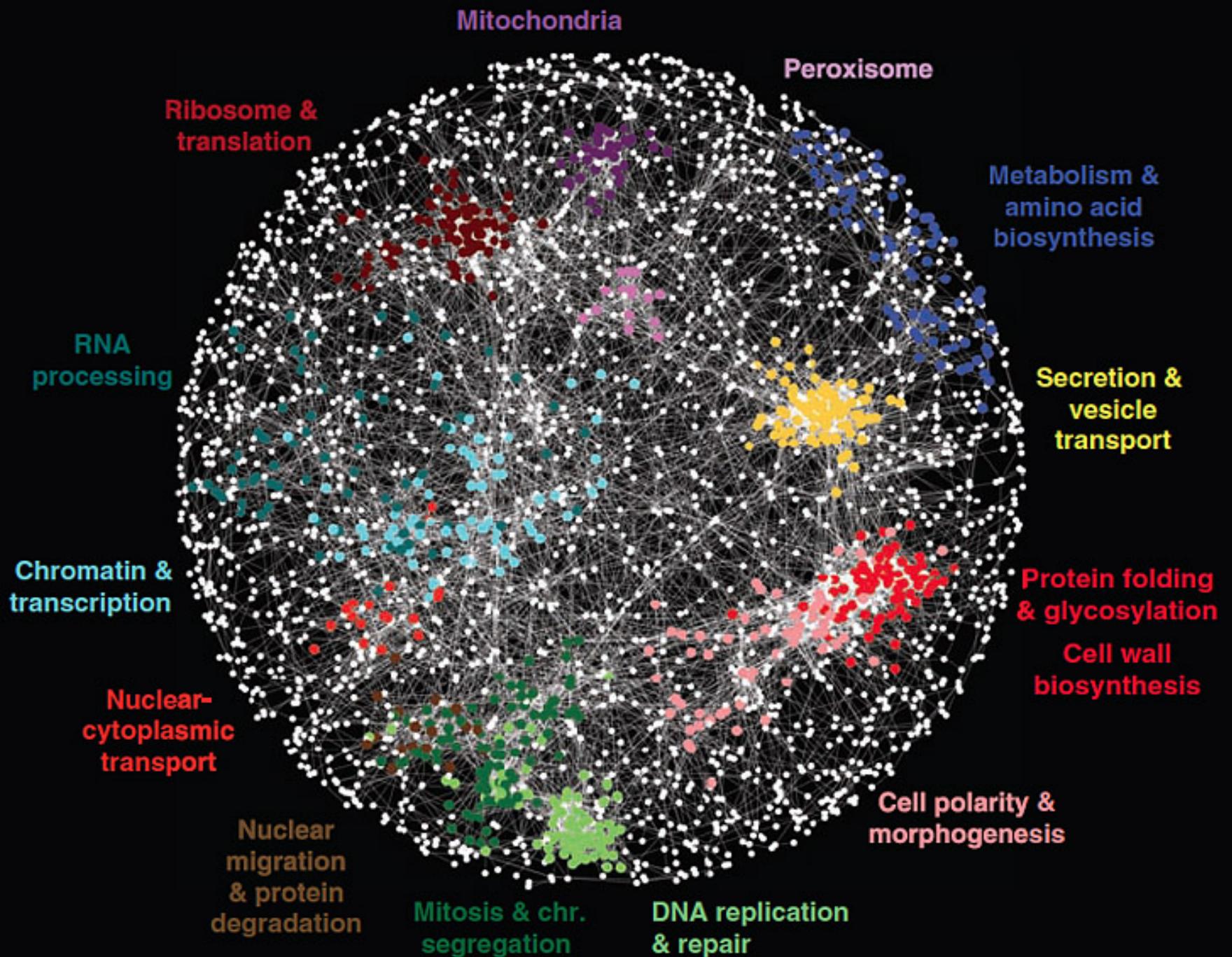
Individual

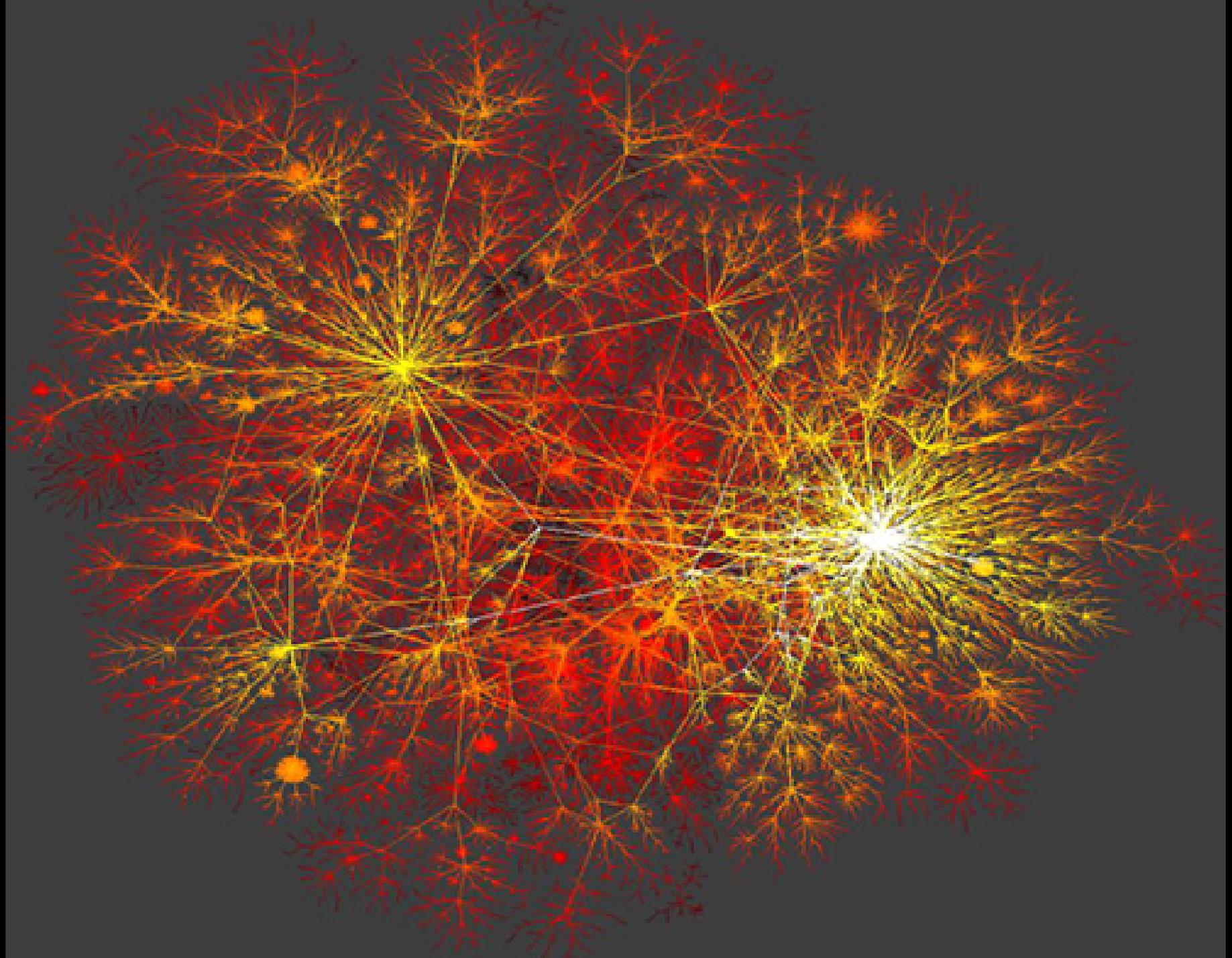


Tong et al., *Science* 294:2364-2368 (2001)

An integrated genetic, genomic and systems approach defines gene networks regulated by the interaction of light and carbon signaling pathways in Arabidopsis
BMC Systems Biology 2008, 2:31

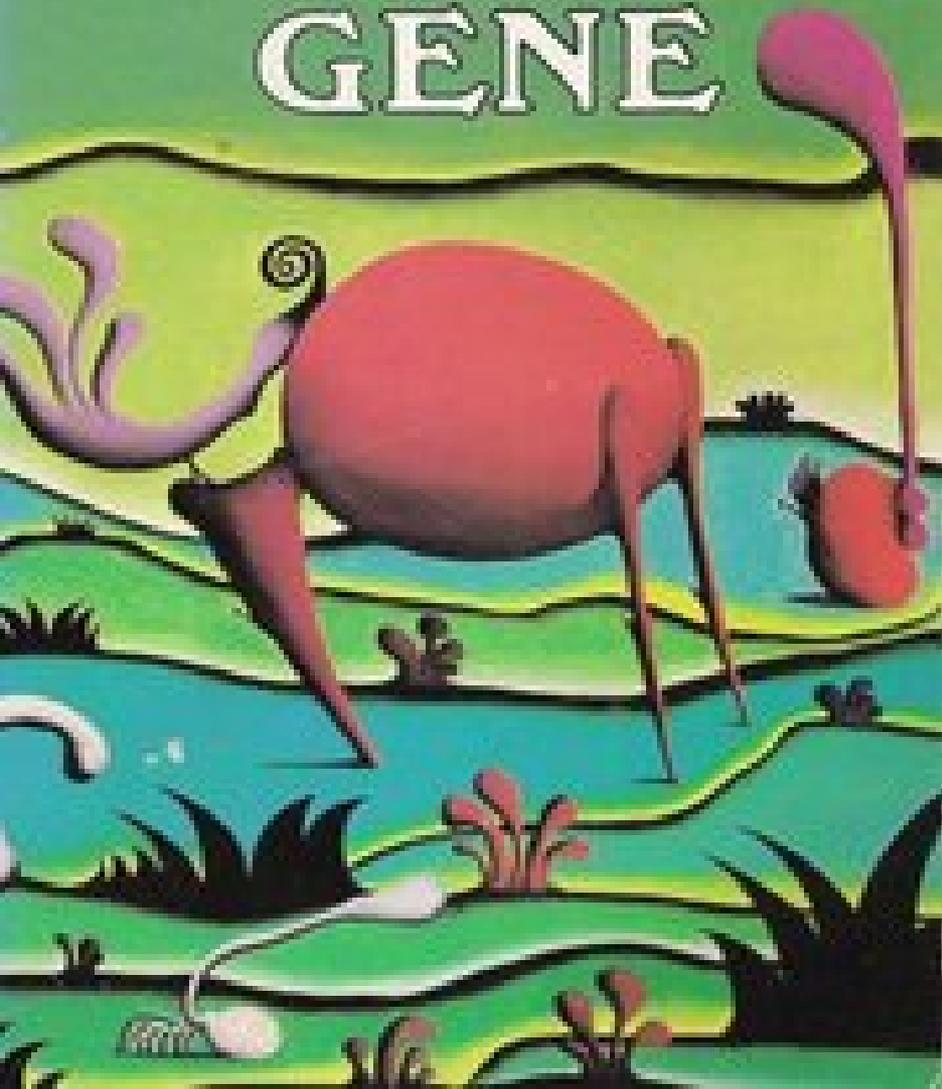






Richard Dawkins

THE SELFISH GENE



nature



SELFISH
DNA

Pangloss enseignait la métaphysico-théologo-cosmolo-nigologie. Il prouvait admirablement qu'il n'y a point d'effet sans cause, et que, dans ce meilleur des mondes possibles, le château de monseigneur le baron était le plus beau des châteaux et madame la meilleure des baronnes possibles. « Il est démontré, disait-il, que les choses ne peuvent être autrement : car, tout étant fait pour une fin, tout est nécessairement pour la meilleure fin. Remarquez bien que les nez ont été faits pour porter des lunettes, aussi avons-nous des lunettes. Les jambes sont visiblement instituées pour être chaussées, et nous avons des chausses. Les pierres ont été formées pour être taillées, et pour en faire des châteaux, aussi monseigneur a un très beau château ; le plus grand baron de la province doit être le mieux logé ; et, les cochons étant faits pour être mangés, nous mangeons du porc toute l'année : par conséquent, ceux qui ont avancé que tout est bien ont dit une sottise ; il fallait dire que tout est au mieux. »

Information

Short sequence

Gene

Genome

„

Gene Pool

Avatar

Nucleotides

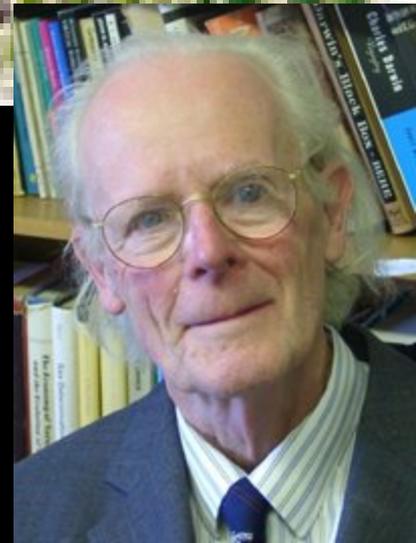
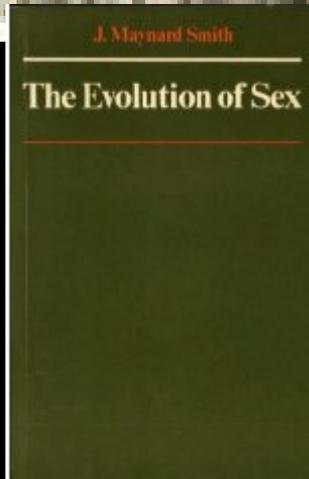
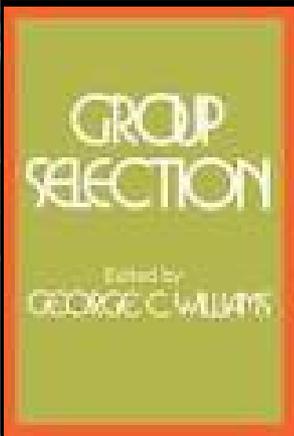
Nucleic Acid

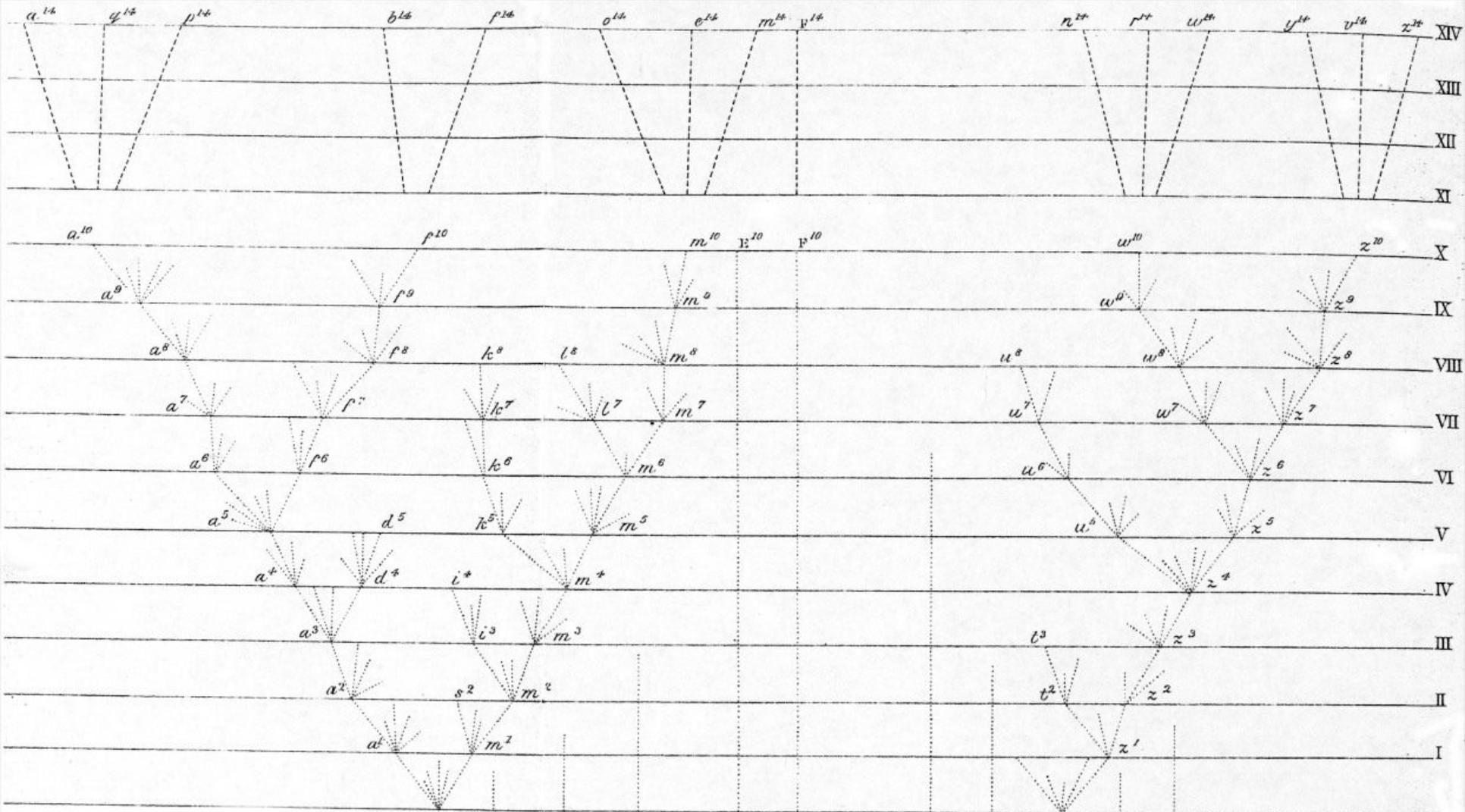
Chromosome

Cell

Individual

Population ?





The writings of Charles Darwin on the web

A B C D E F G H I K L

W. West Irish Hutton Garden.

Social Organisms

Multicellular Organisms

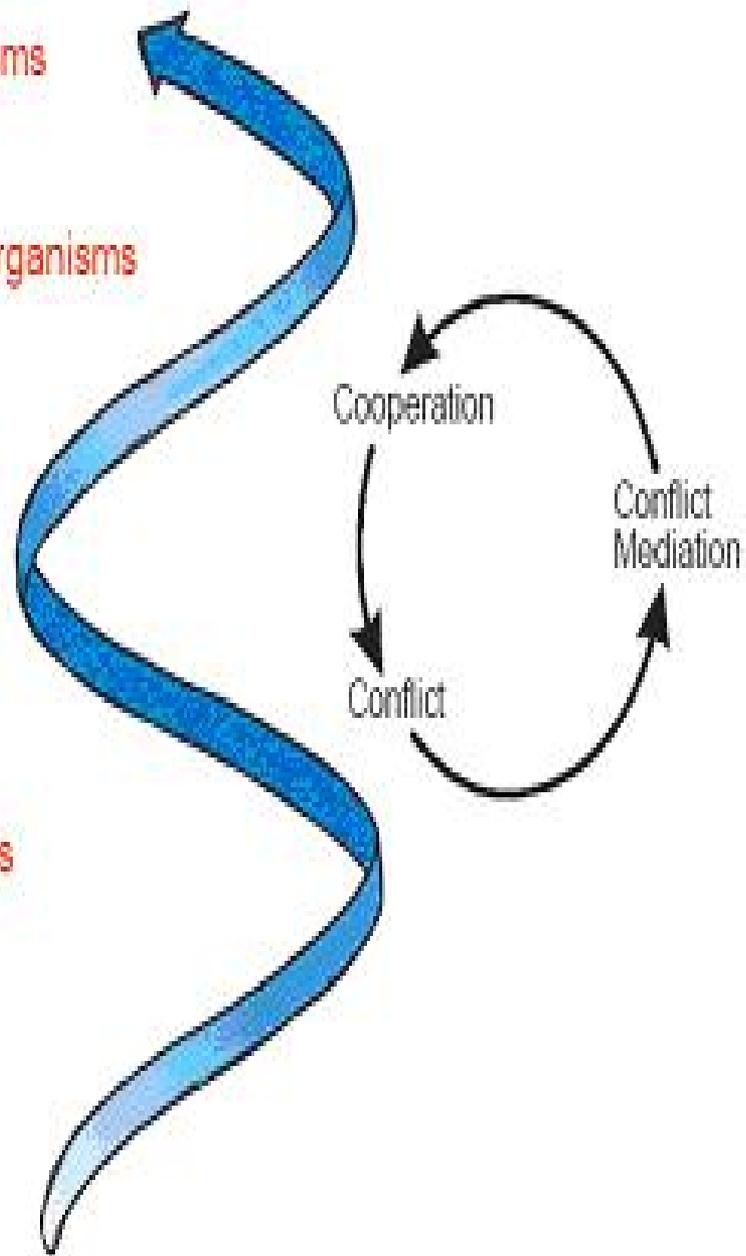
Cells in cells

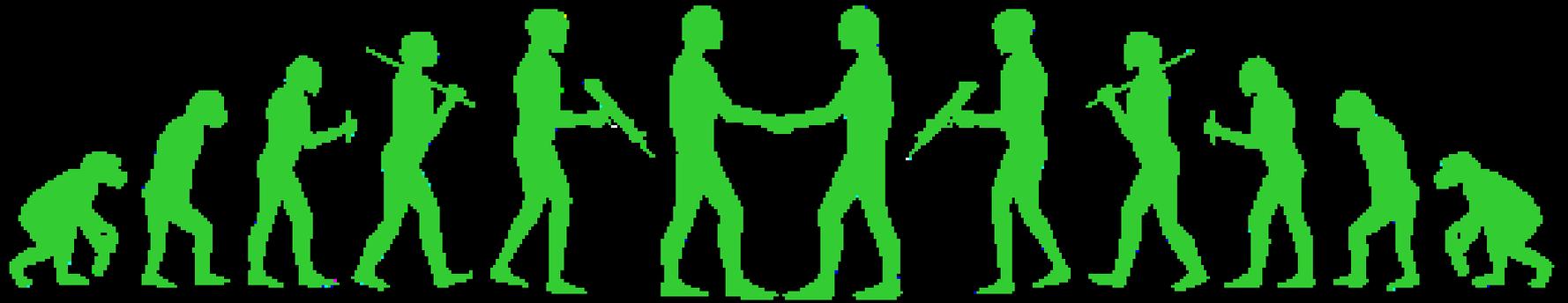
Cells

Gene Networks

Genes

Molecules





Conflicts, Coopération & Diversité







L'altruisme



L'altruisme



L'altruisme

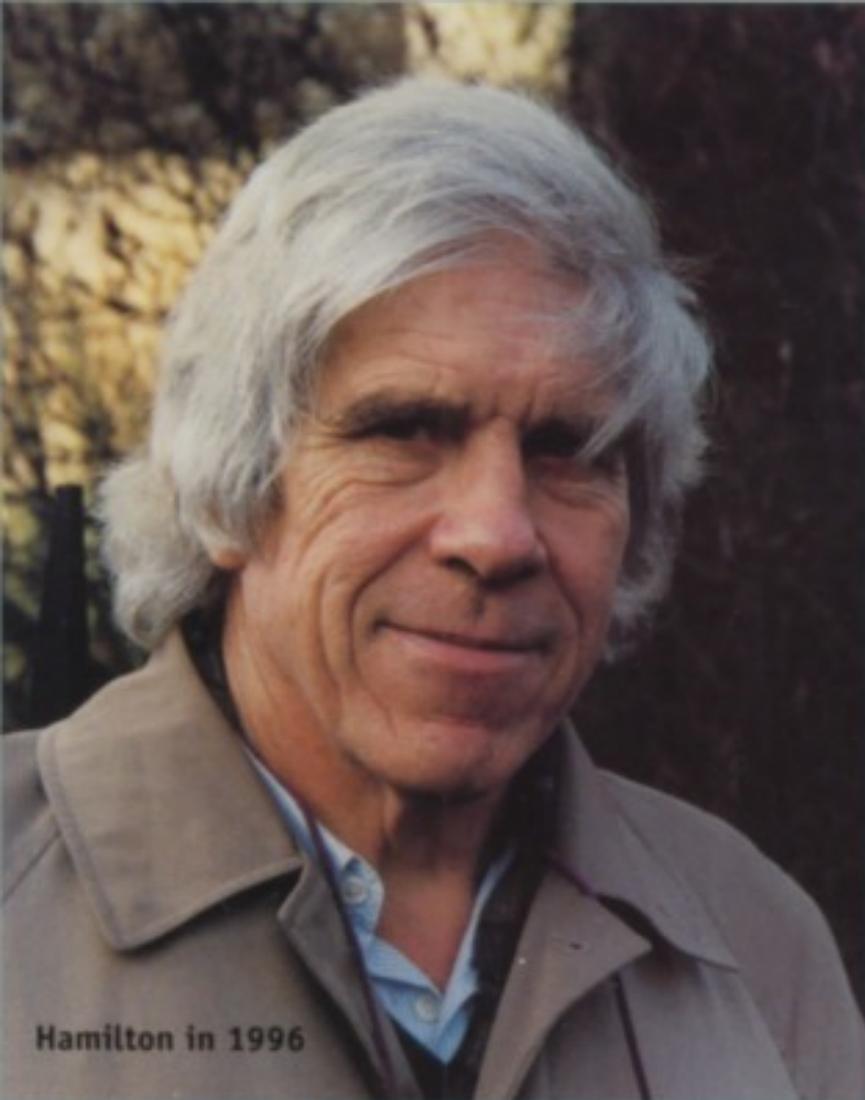


L'altruisme



L'altruisme

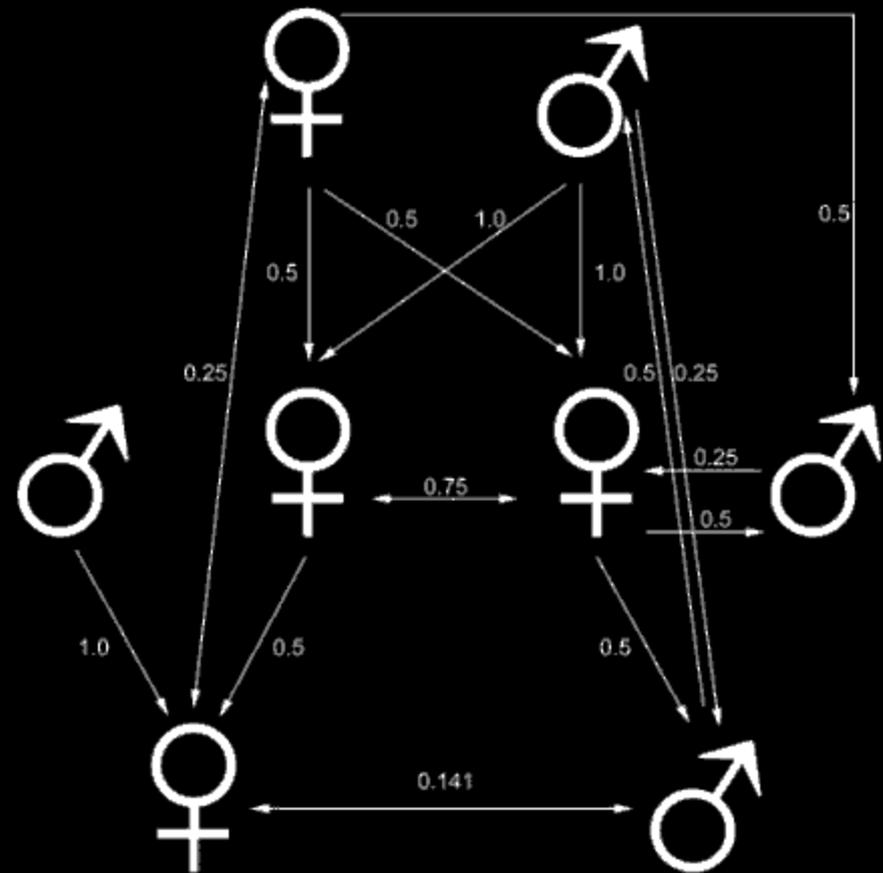
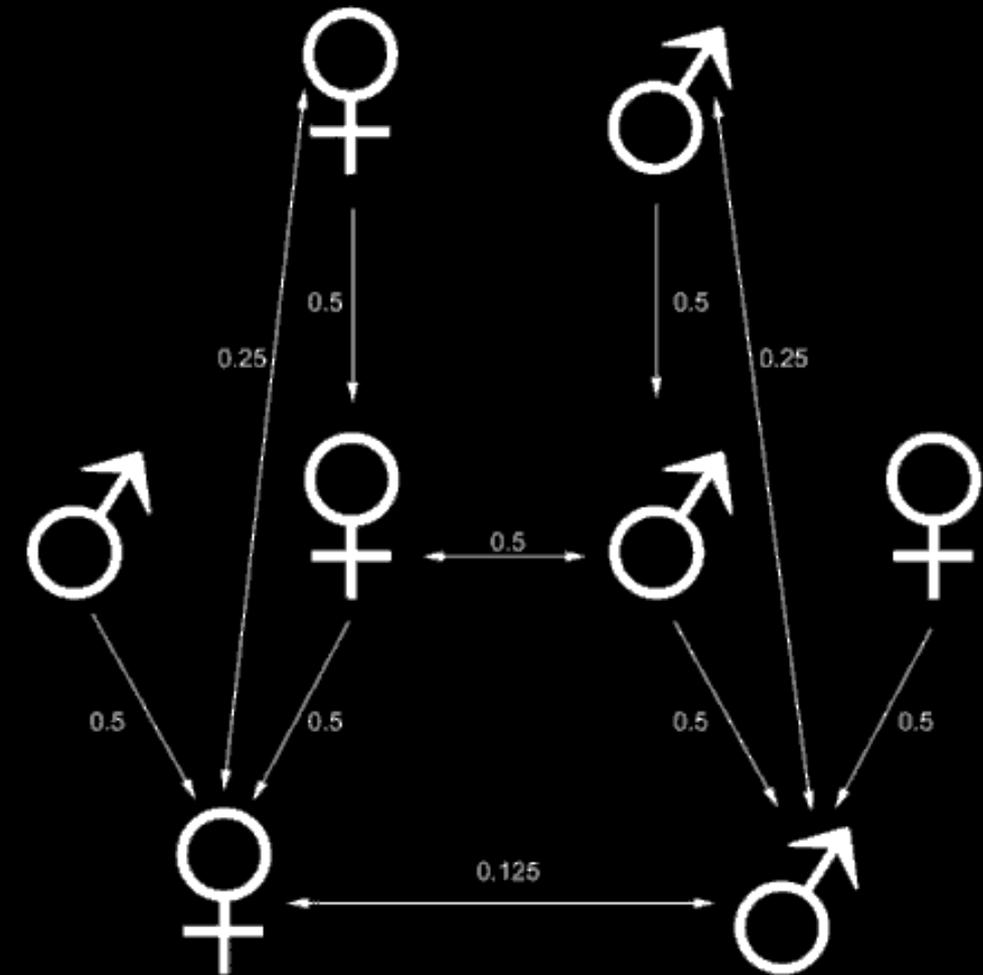




Hamilton in 1996



$$C < R \times B$$



L'altruisme











L'altruisme





L'altruisme













Information

Short sequence

Gene

Genome

„

Gene Pool

Avatar

Nucleotides

Nucleic Acid

Chromosome

Cell

Individual

Family

		Joueur 2	
		Coopère	Trahit
Joueur 1	Coopère	3 / 3	0 / 4
	Trahit	4 / 0	1 / 1

Joueur 2

Coopère

Trahit

Joueur 1

Coopère

3 / 3

0 / 4

Trahit

4 / 0

1 / 1



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"A fascinating, provocative, and important book."

—Douglas R. Hofstadter,
author of Gödel, Escher, Bach

THE Evolution OF Cooperation

ROBERT AXELROD

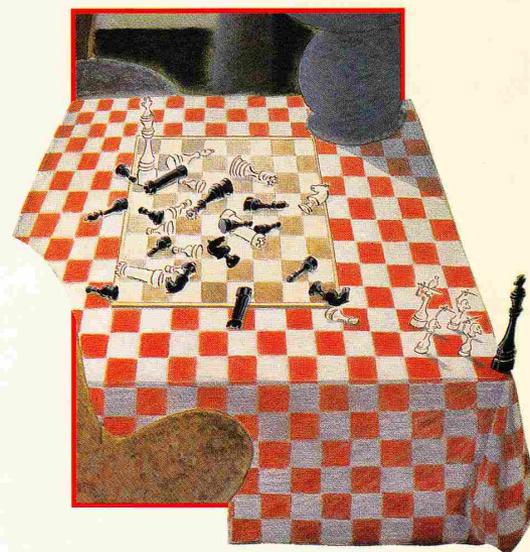
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D O N N A N T

D O N N A N T

THÉORIE DU COMPORTEMENT COOPÉRATIF



Sciences humaines

Joueur 2

Coopère

Trahit

TFT

Joueur 1

Coopère

30/30

0/40

30/30

Trahit

40/0

10/10

11/ 9

TFT

30/30

9/11

30/30

Joueur 2

Coopère

Trahit

TFT

Joueur 1

Coopère

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0/40

30/30

Trahit

40/0

10/10

11/ 9

TFT

30/30

9/11

30/30





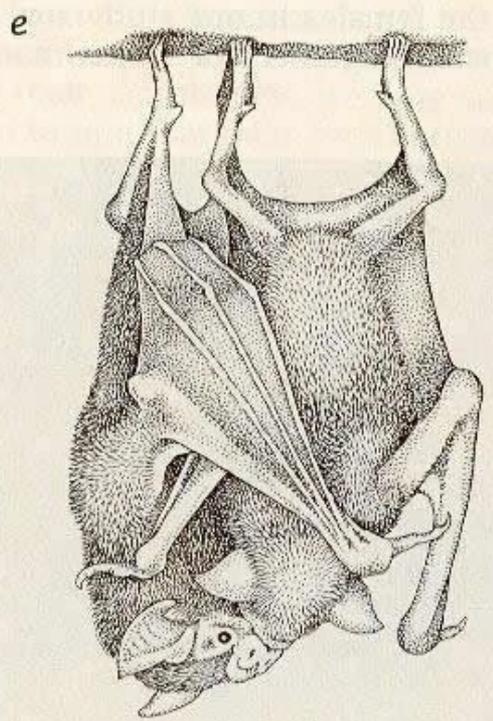
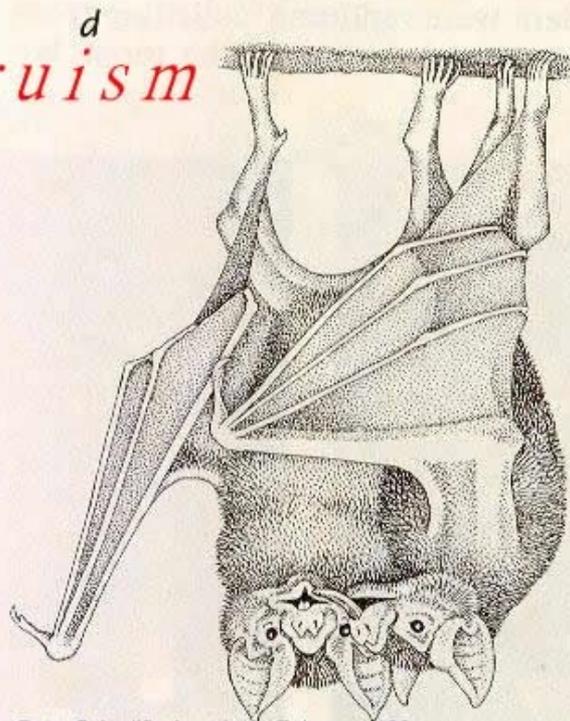
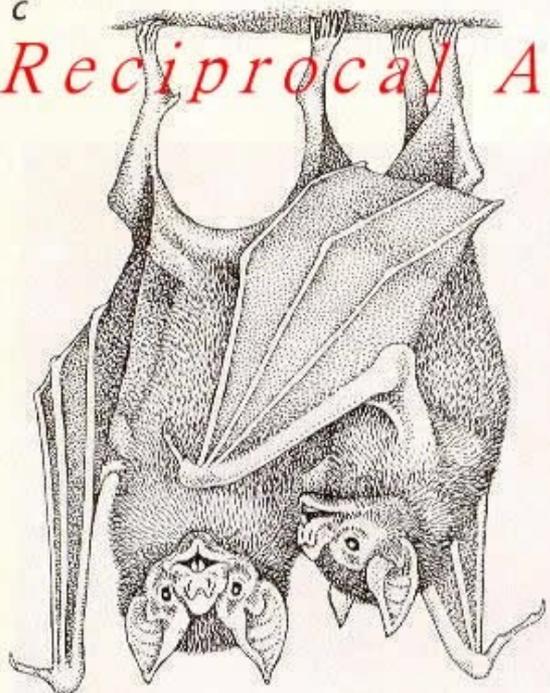




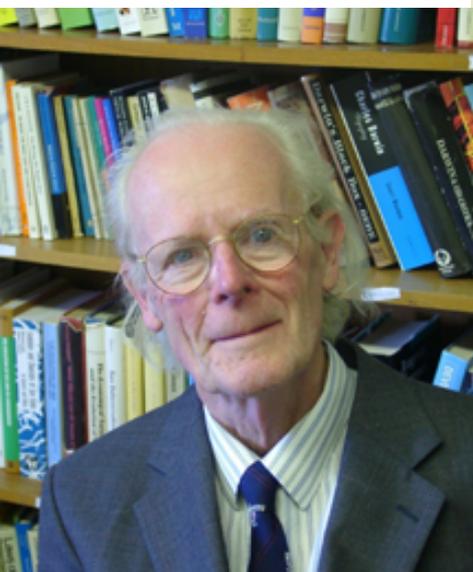
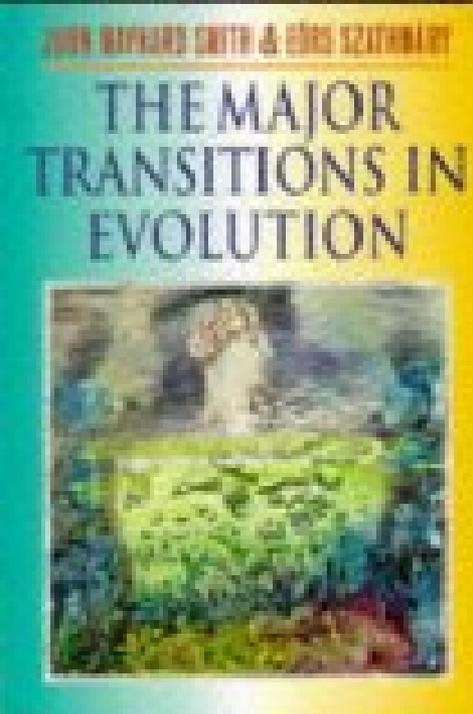


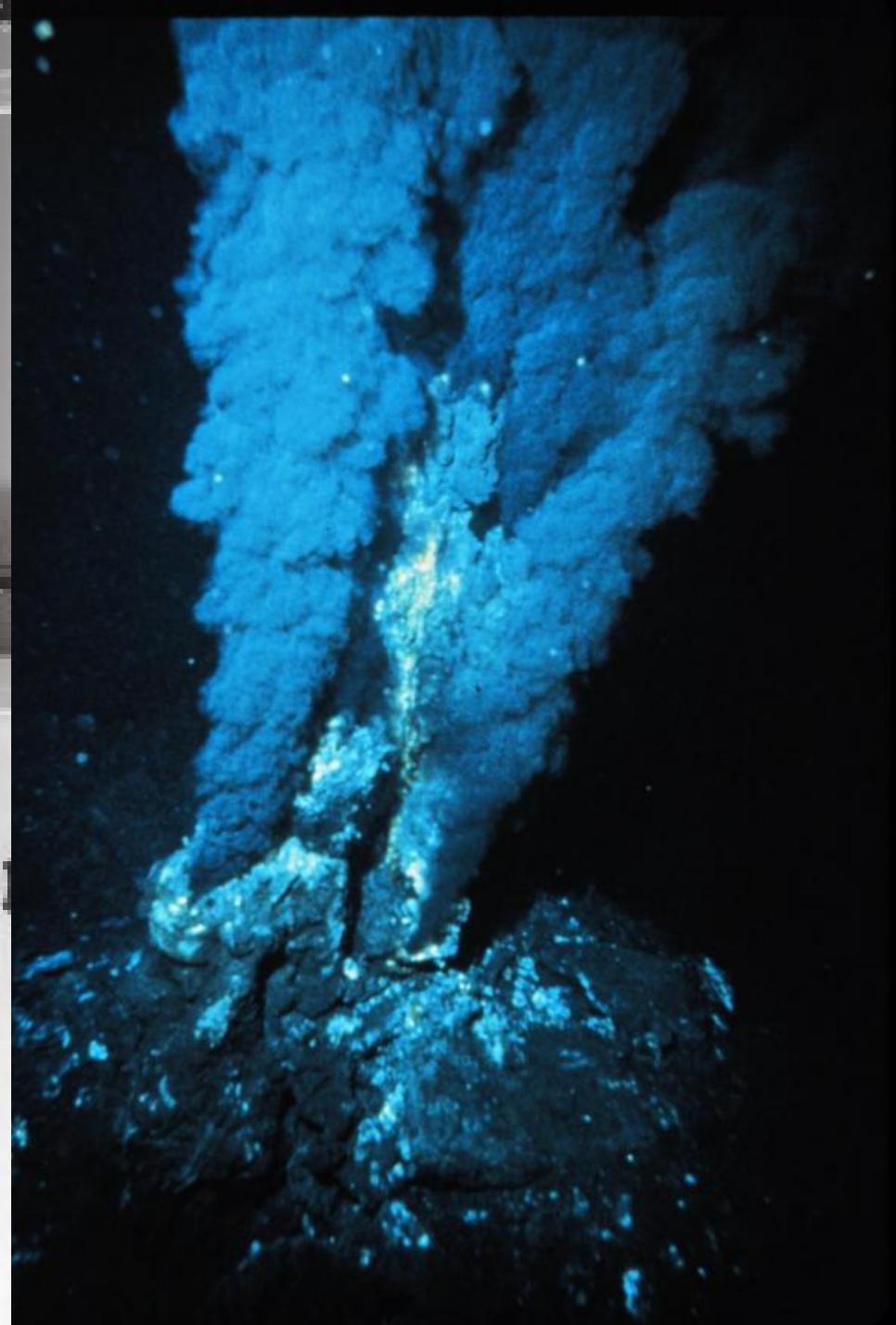
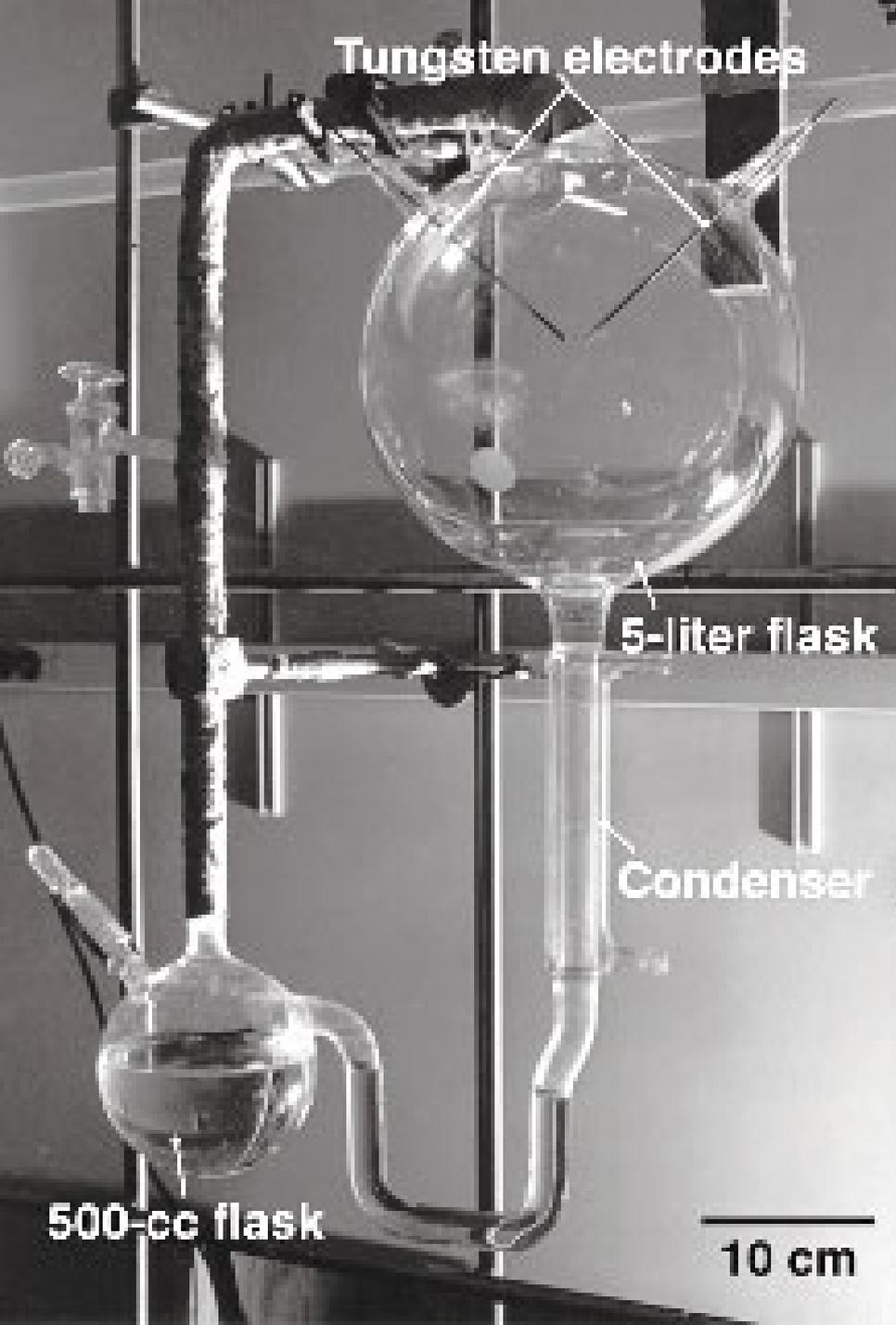


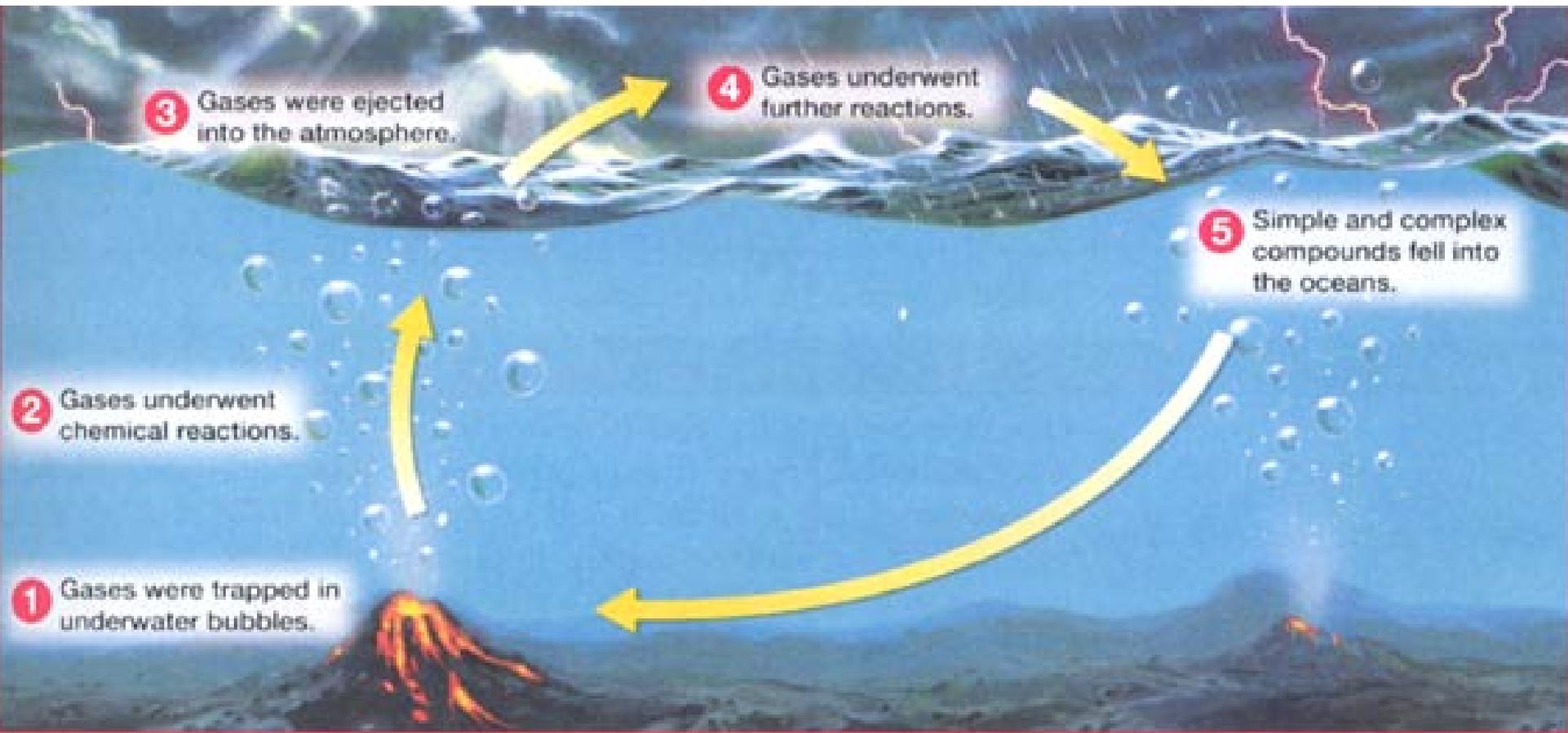
Reciprocal Altruism

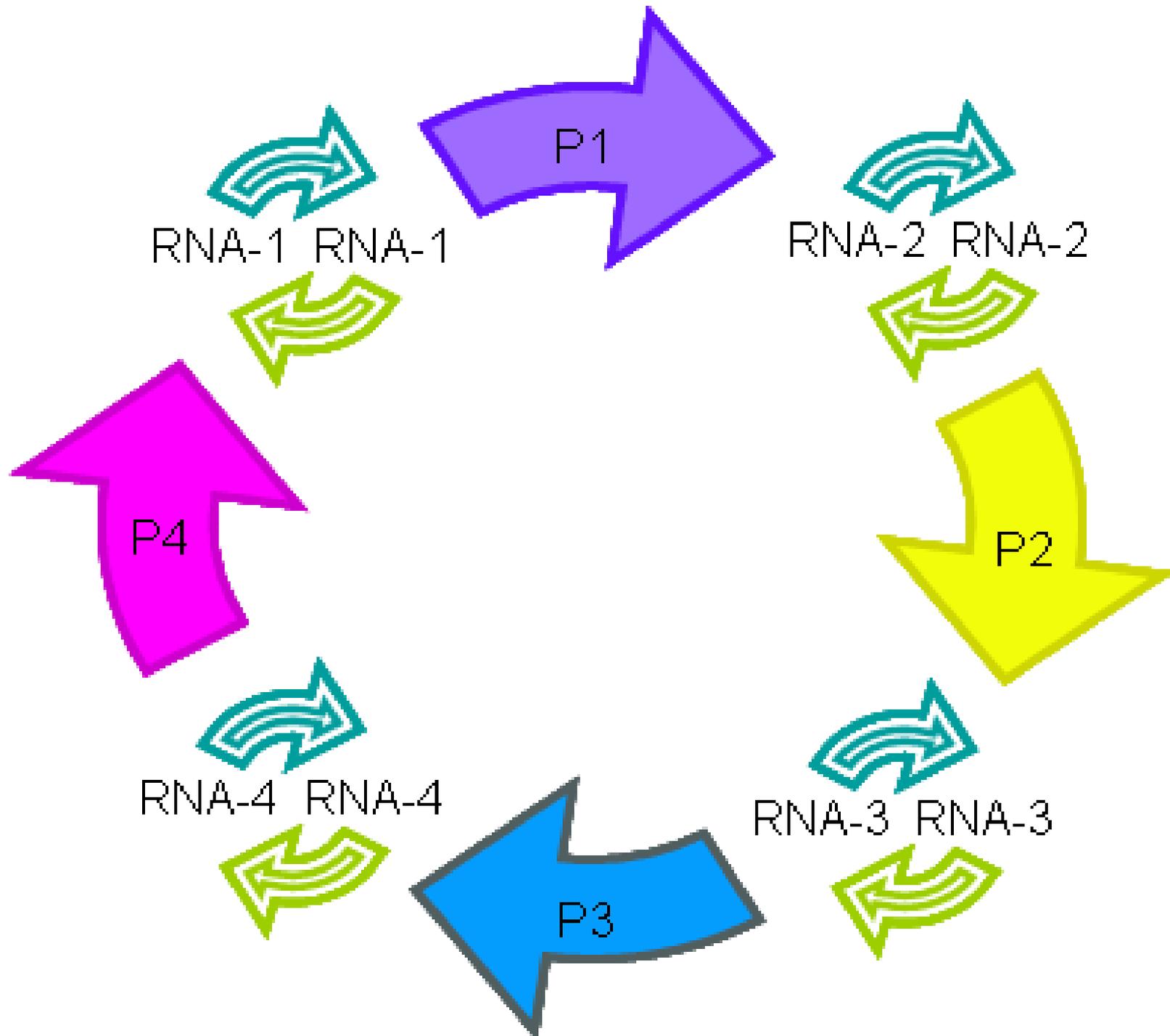


Taken with permission from Wilkinson 1990: Food Sharing in Vampire Bats. Scientific American, February p80









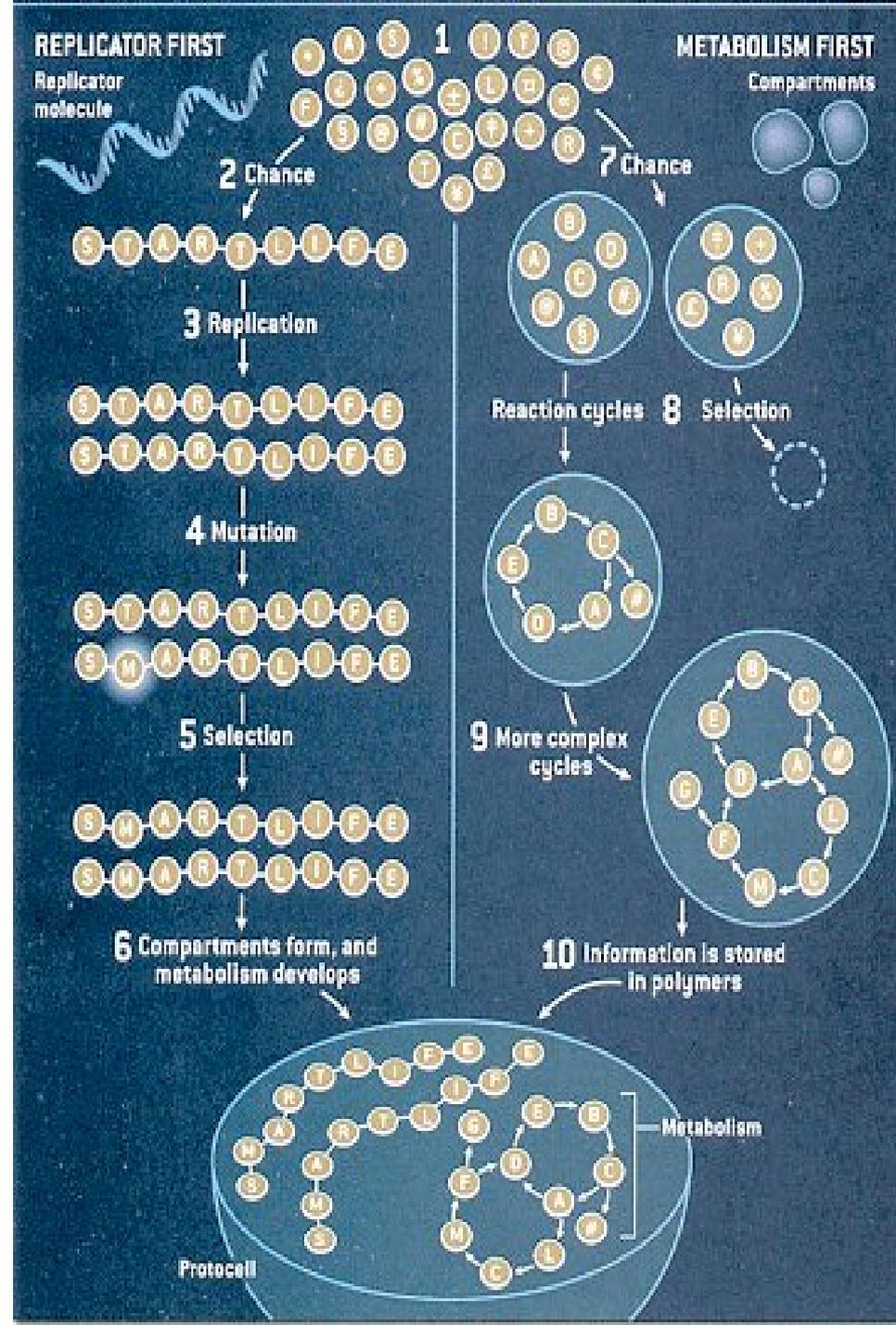
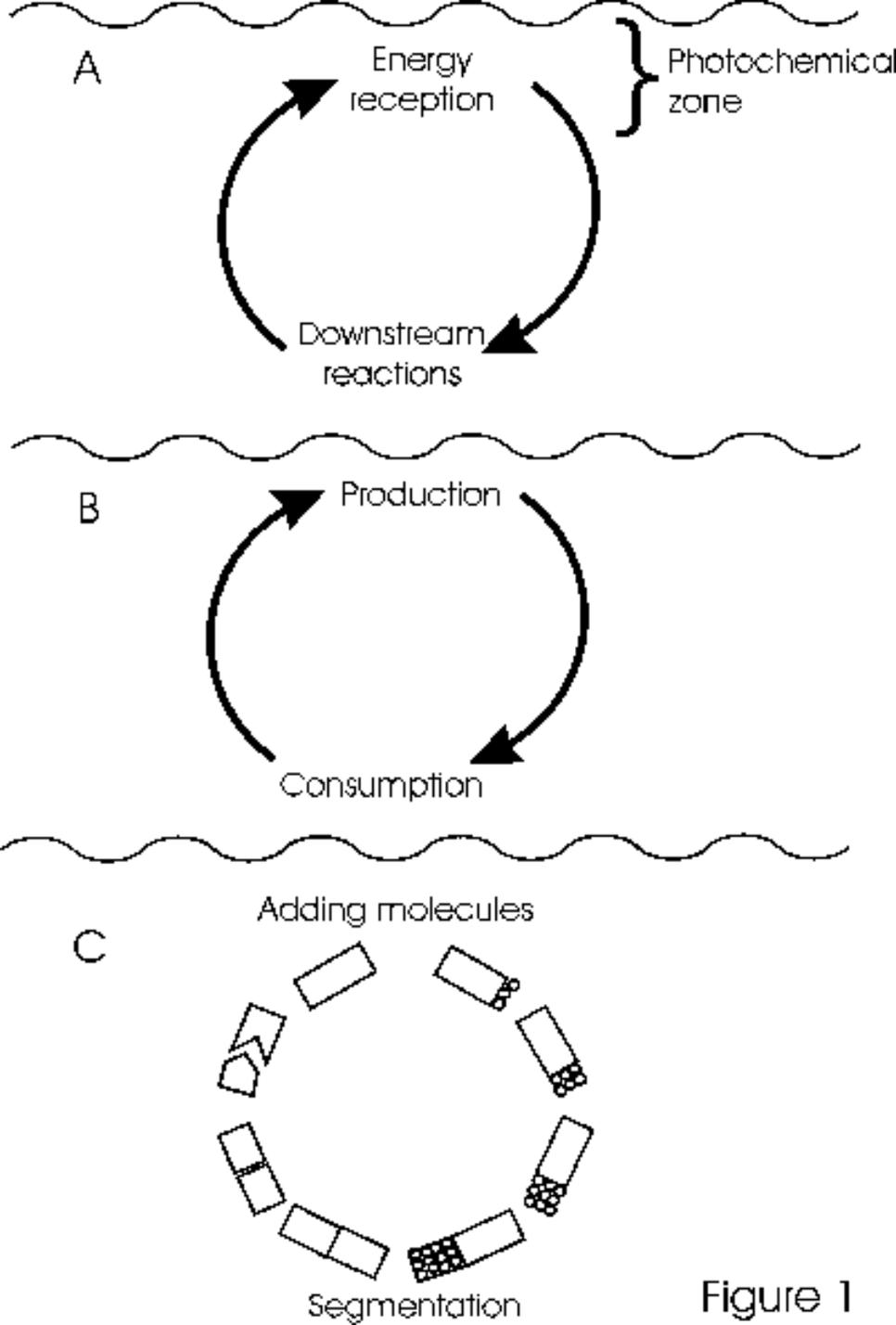
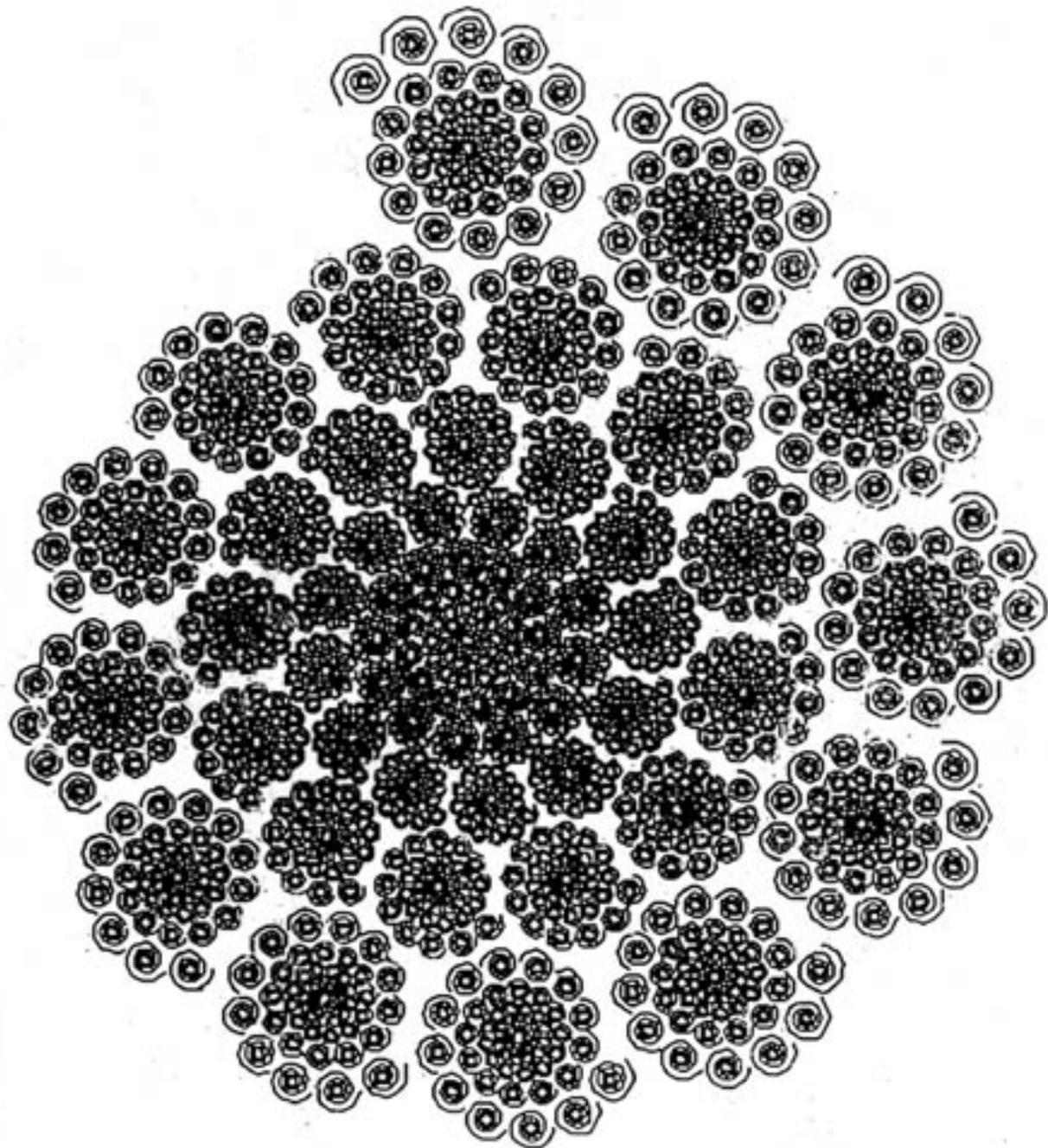
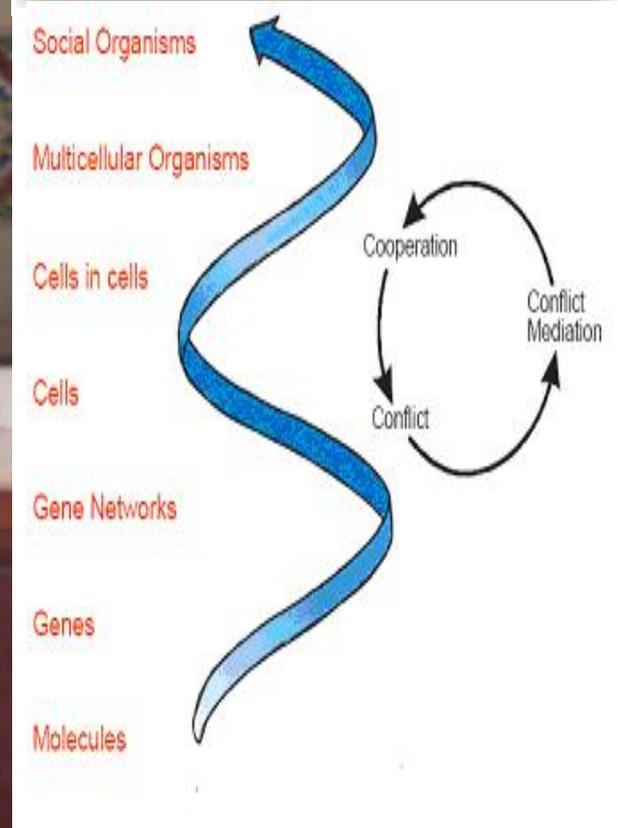
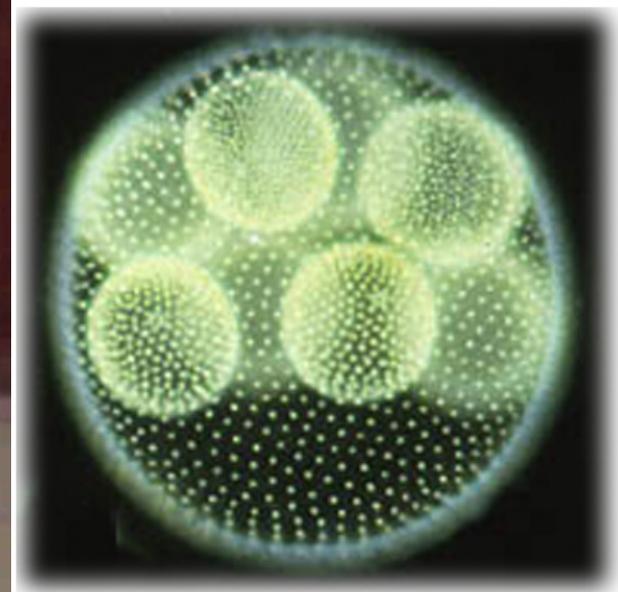
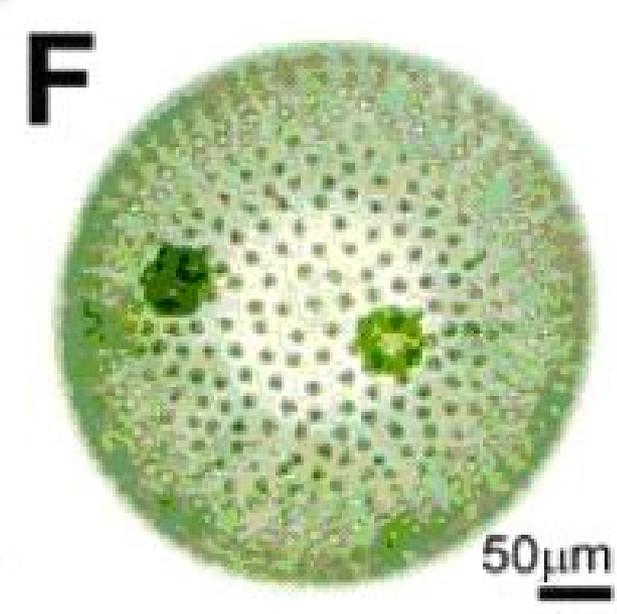
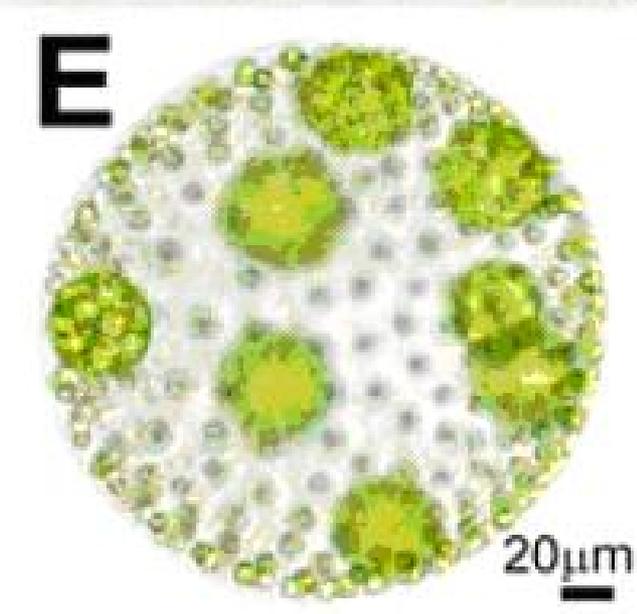
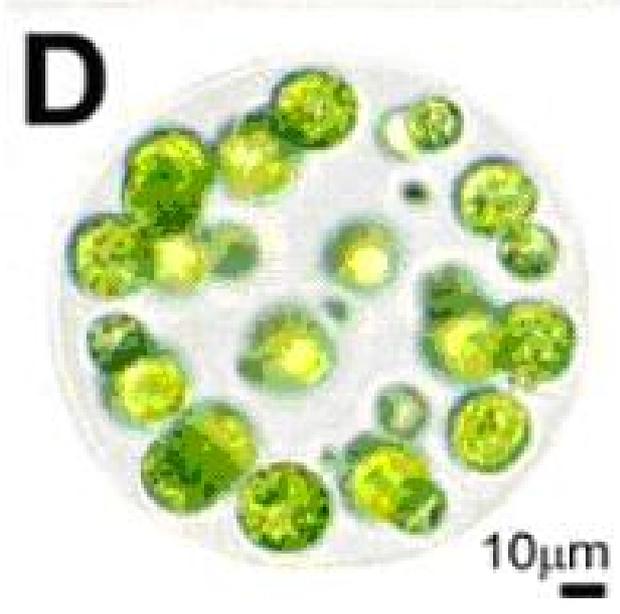
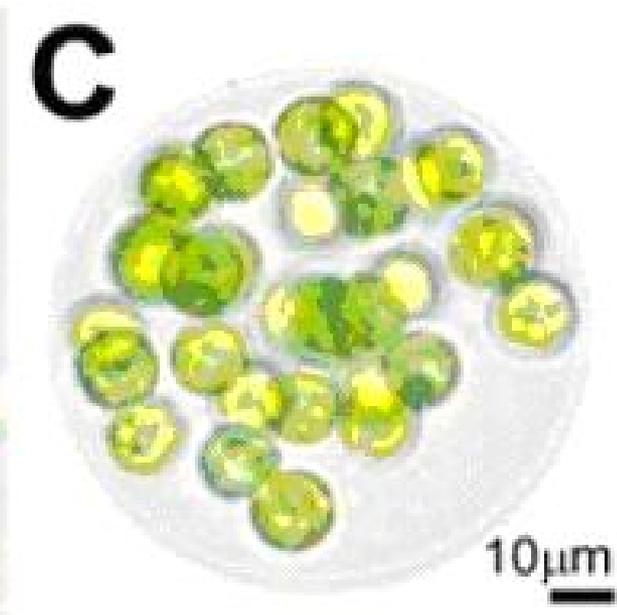
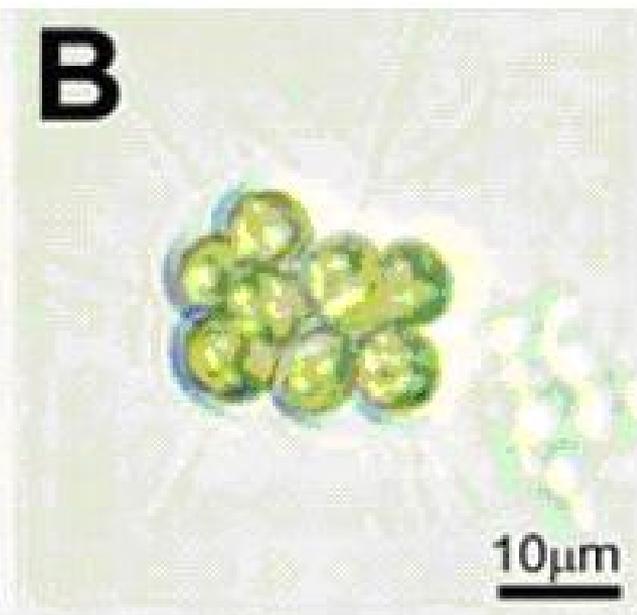
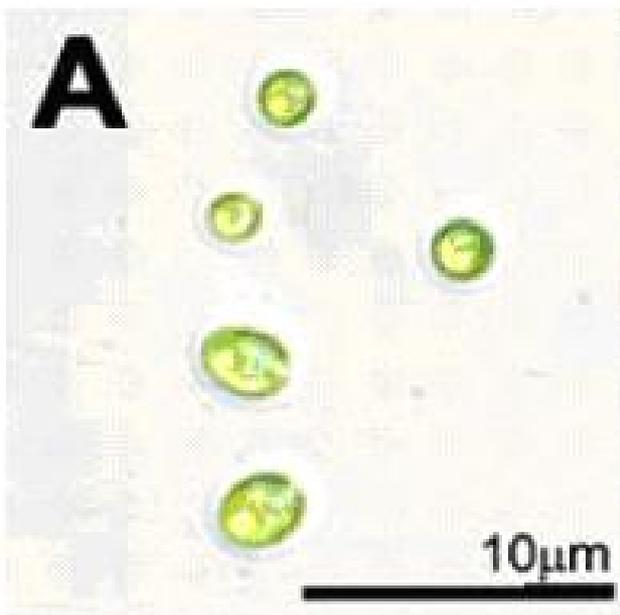
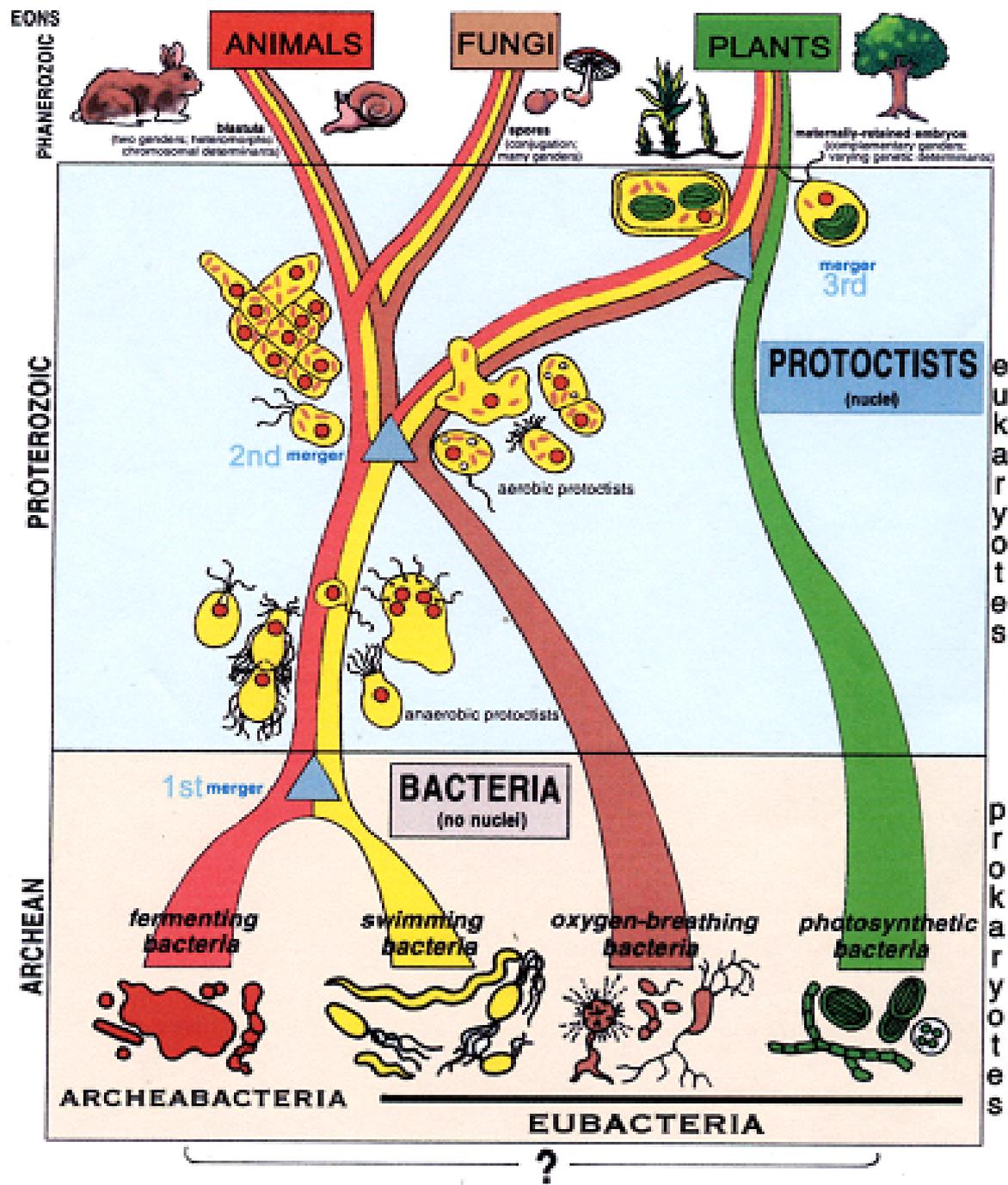


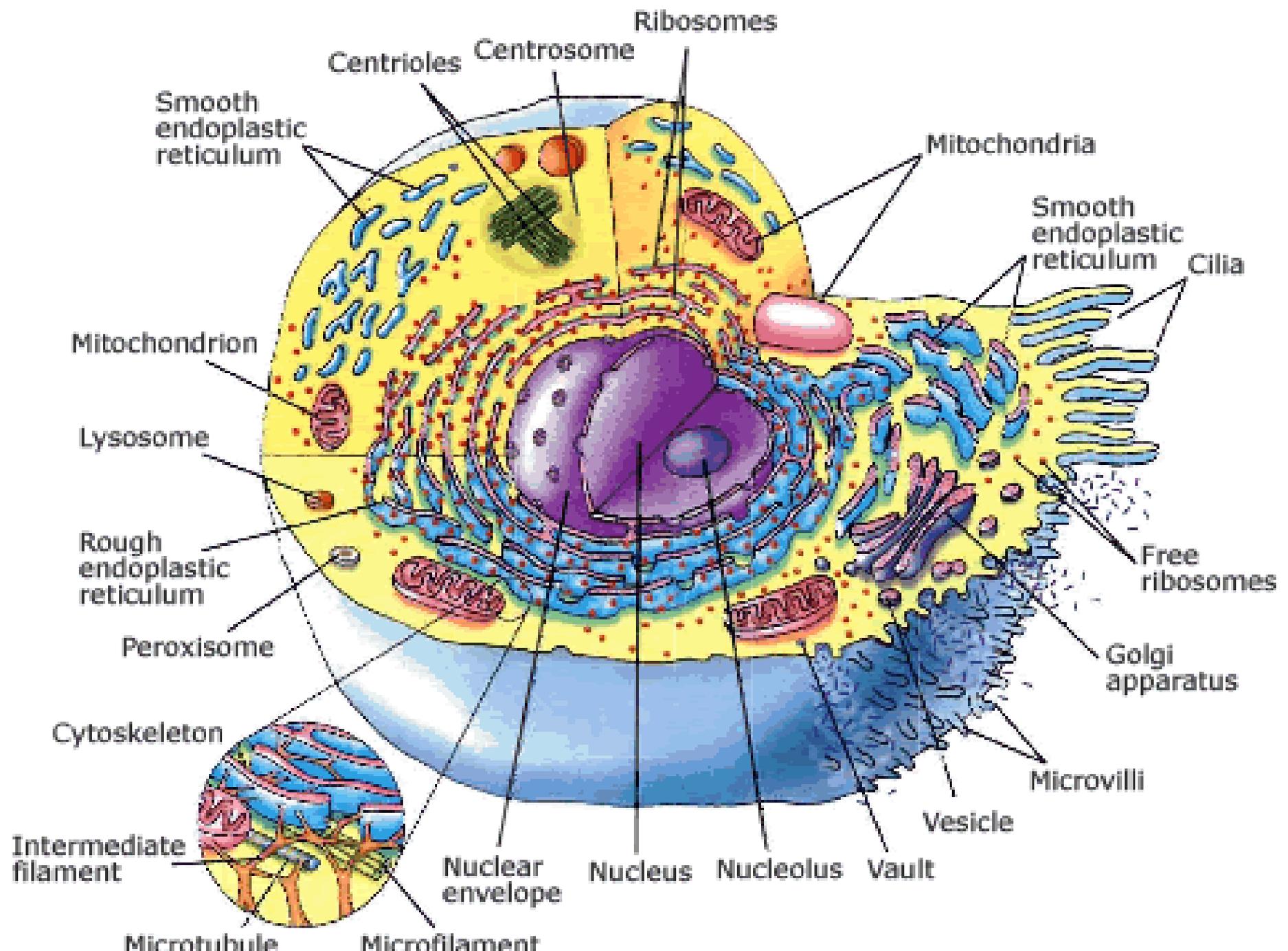
Figure 1

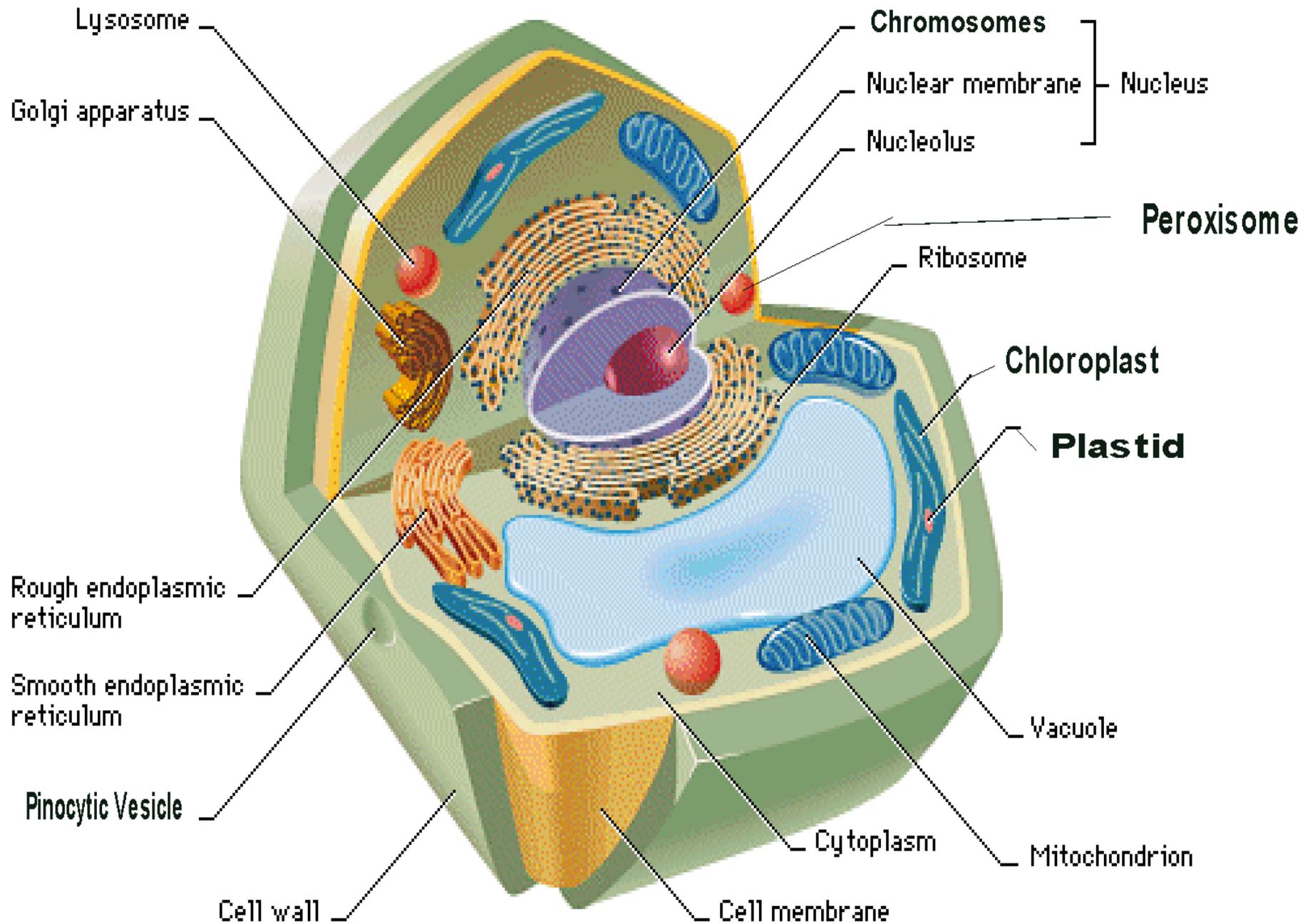














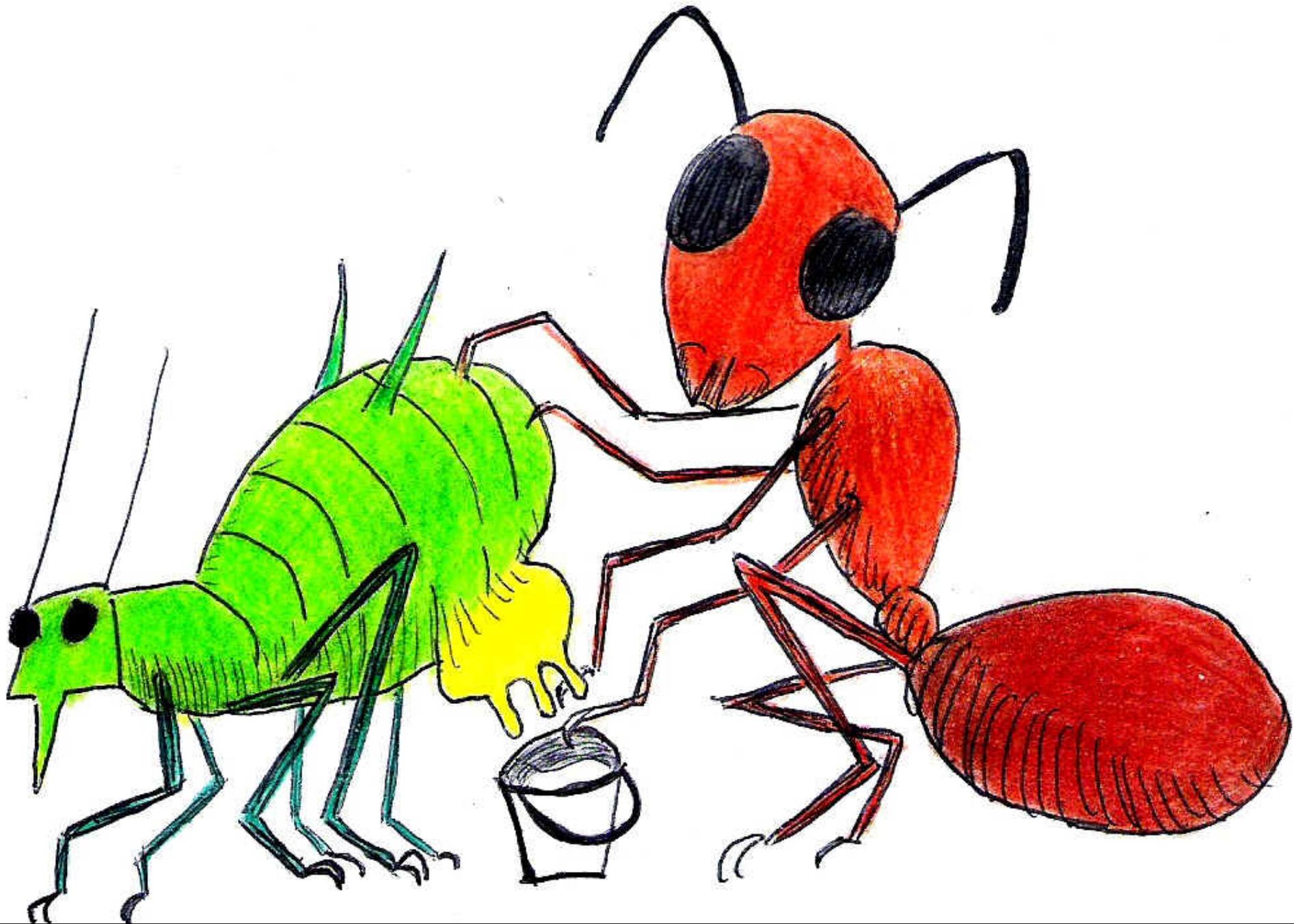


Robin Ngiam 2007











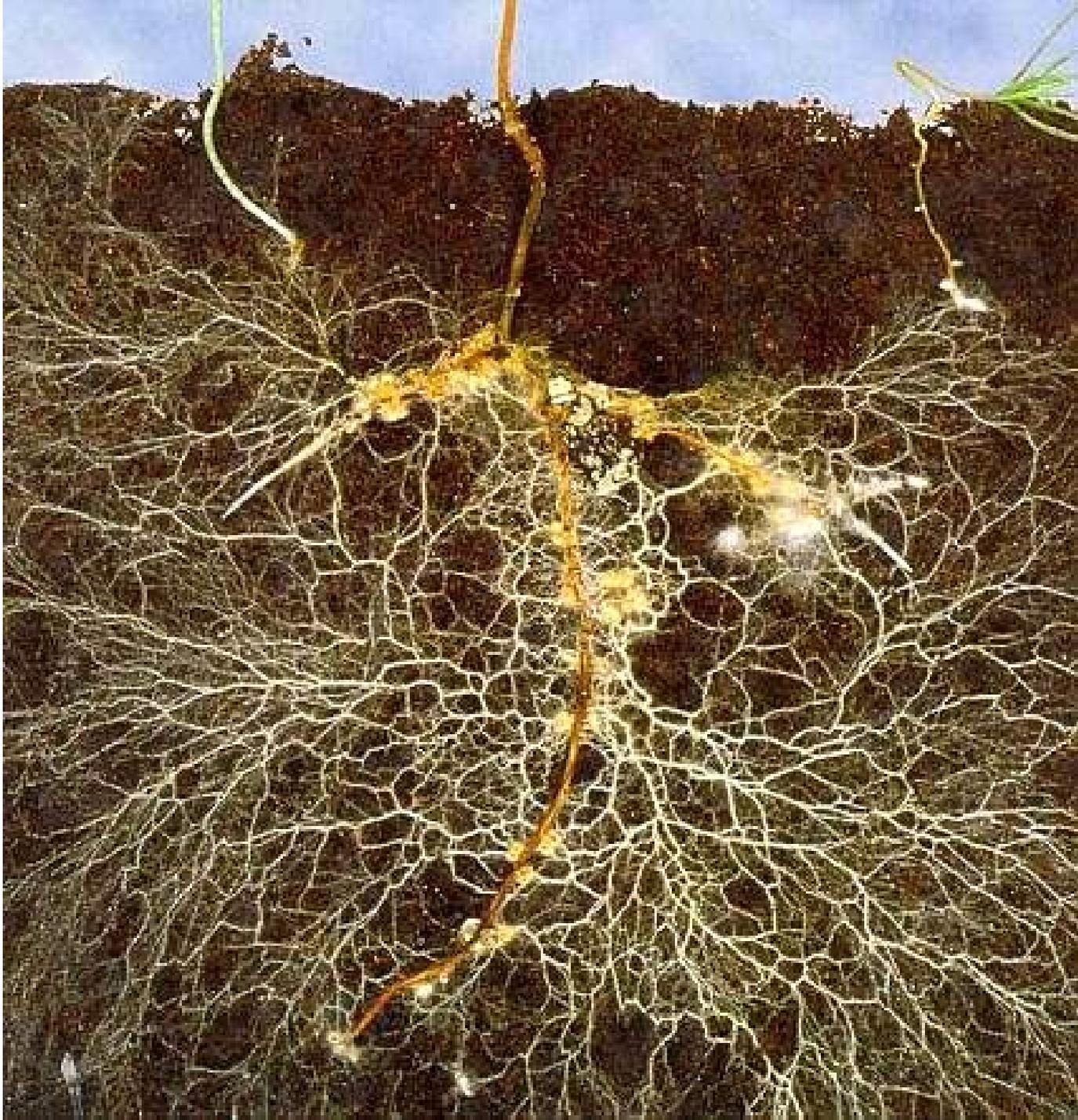






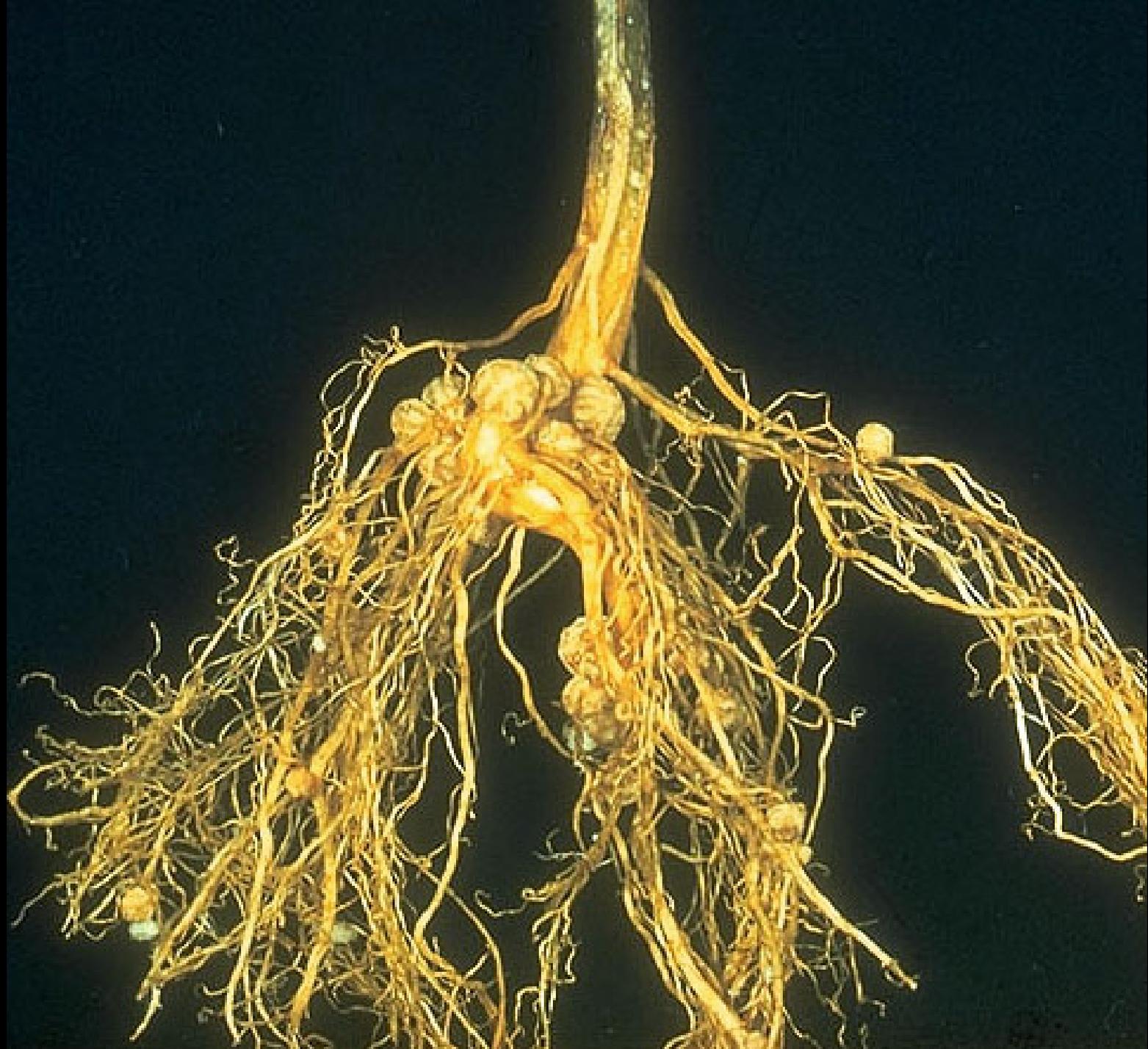




















(c) RDB

Le genre *Ficus* (Moraceae)

La figue : une inflorescence fermée











Seres



Information

Short sequence

Gene

Genome

„

Gene Pool

Ecosystem

Avatar

Nucleotides

Nucleic Acid

Chromosome

Cell

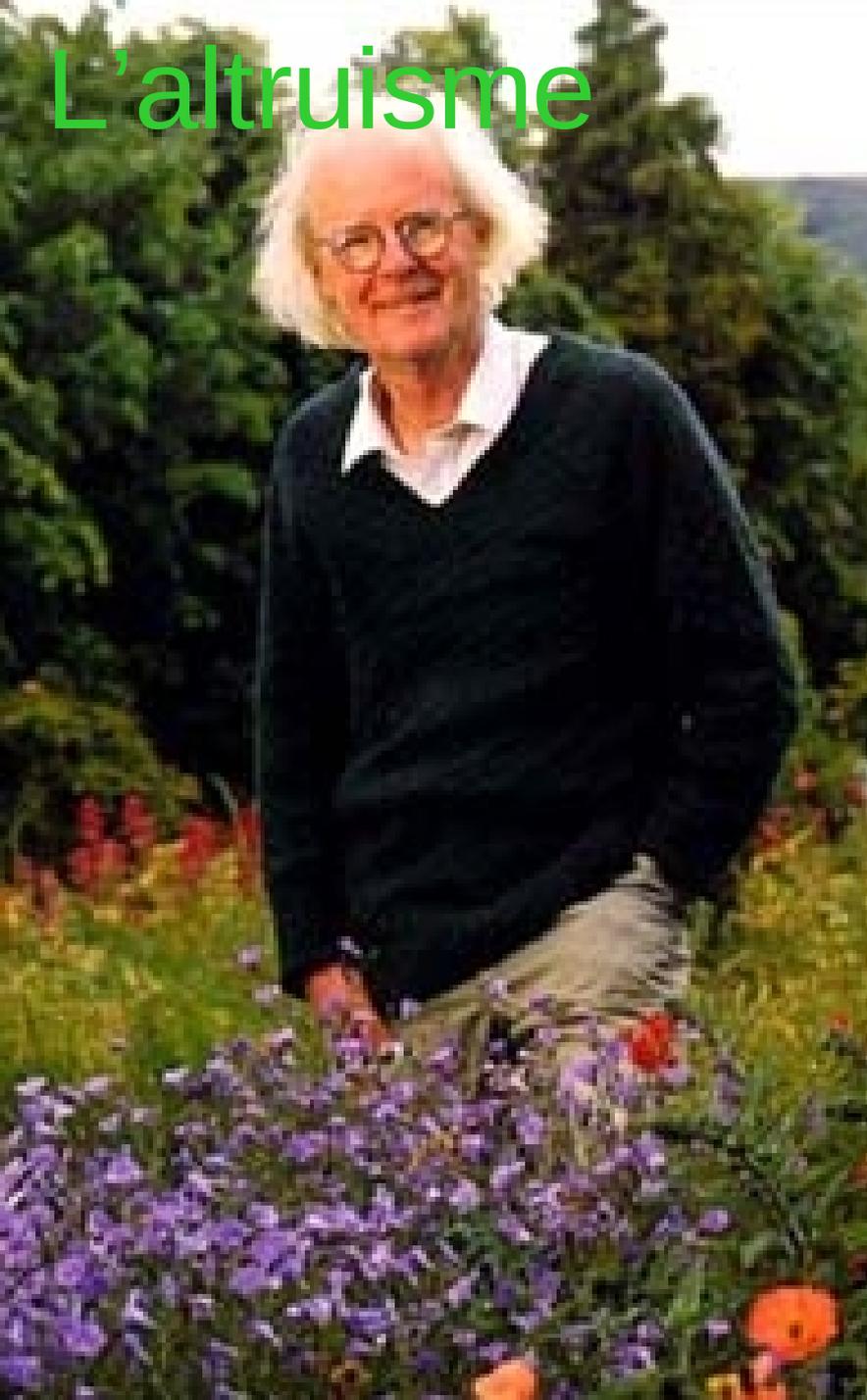
Individual

Family

Population



L'altruisme

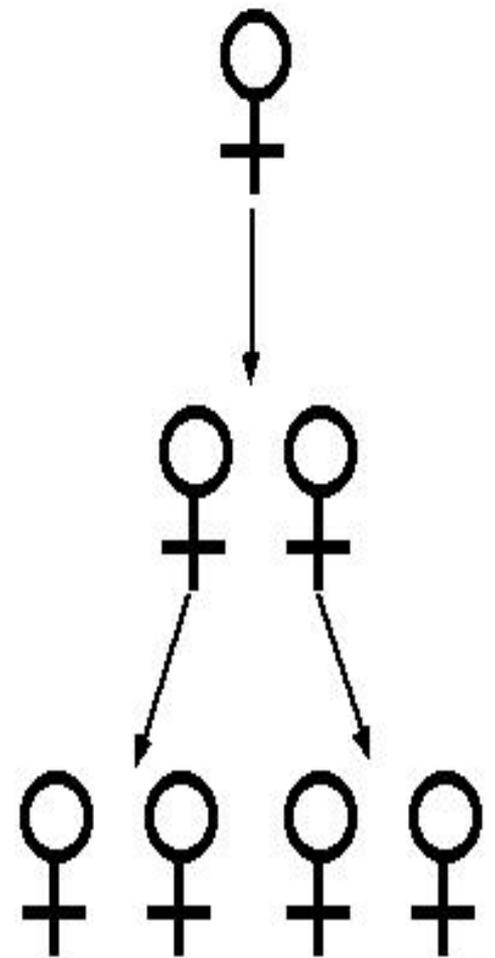


THE COST OF MALES

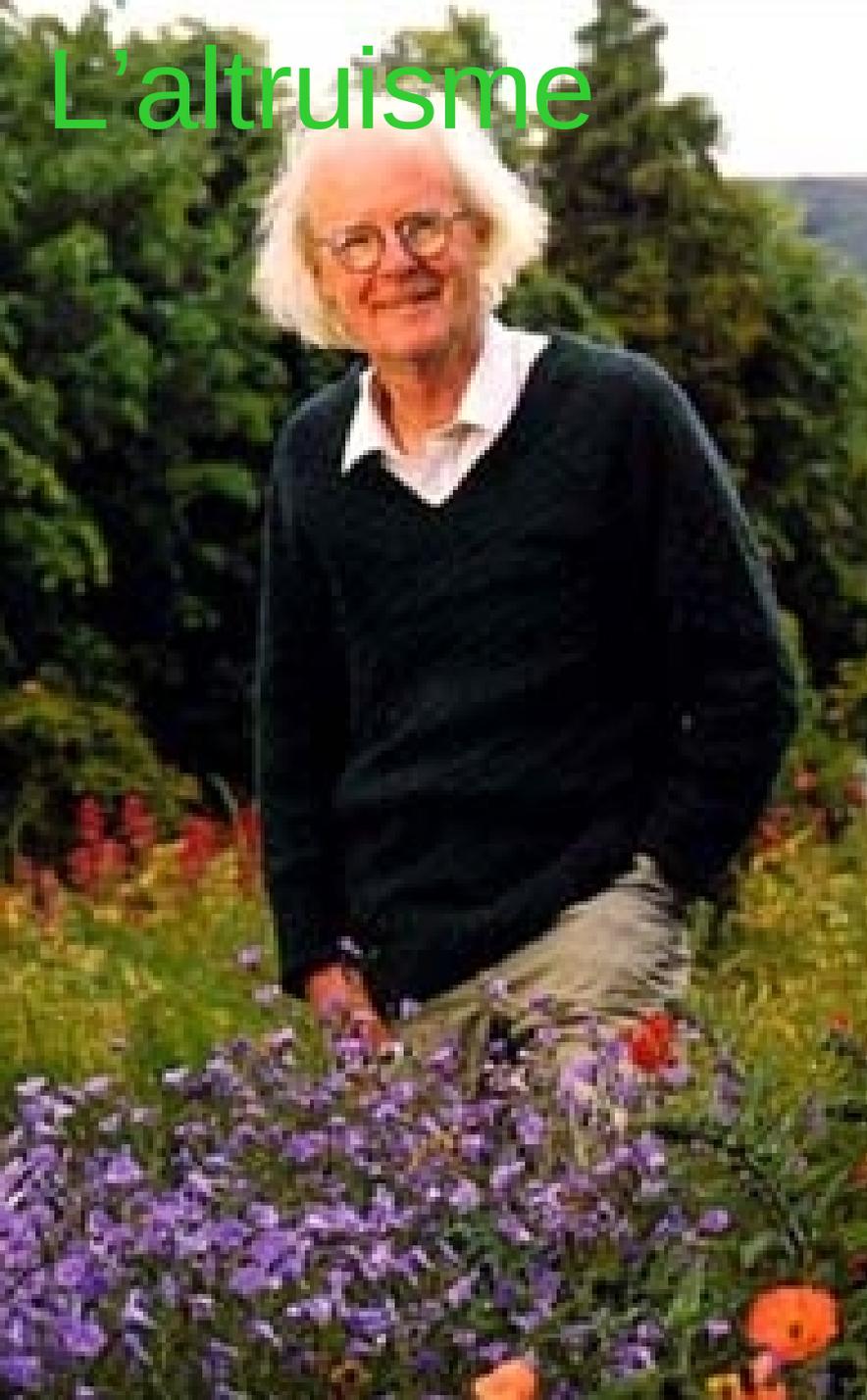
SEXUAL FEMALE



CLONAL FEMALE



L'altruisme



2 (asexués/sexués)

$2^2 = 4$

$2^3 = 8$

...

$2^{10} = 1024 \approx 10^3$

...

$2^{20} \approx 10^6$

$2^{30} \approx 10^9$

$2^{40} \approx 10^{12}$





C
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Photo by David Ferro





Information

Short sequence

Gene

Genome

„

Gene Pool

Avatar

Nucleotides

Nucleic Acid

Chromosome

Cell

Individual

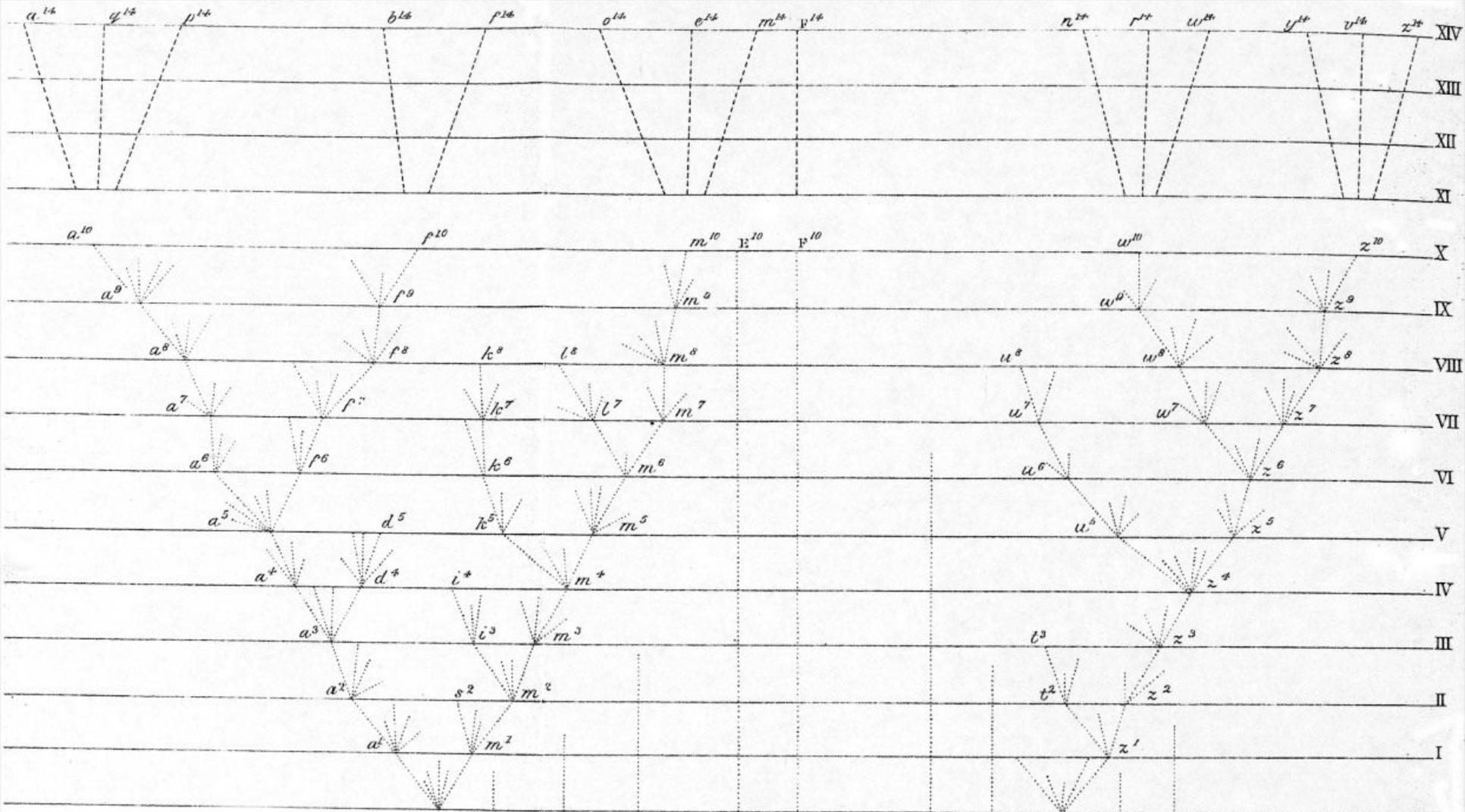
Family

Population

Species

Phylum





The writings of Charles Darwin on the web

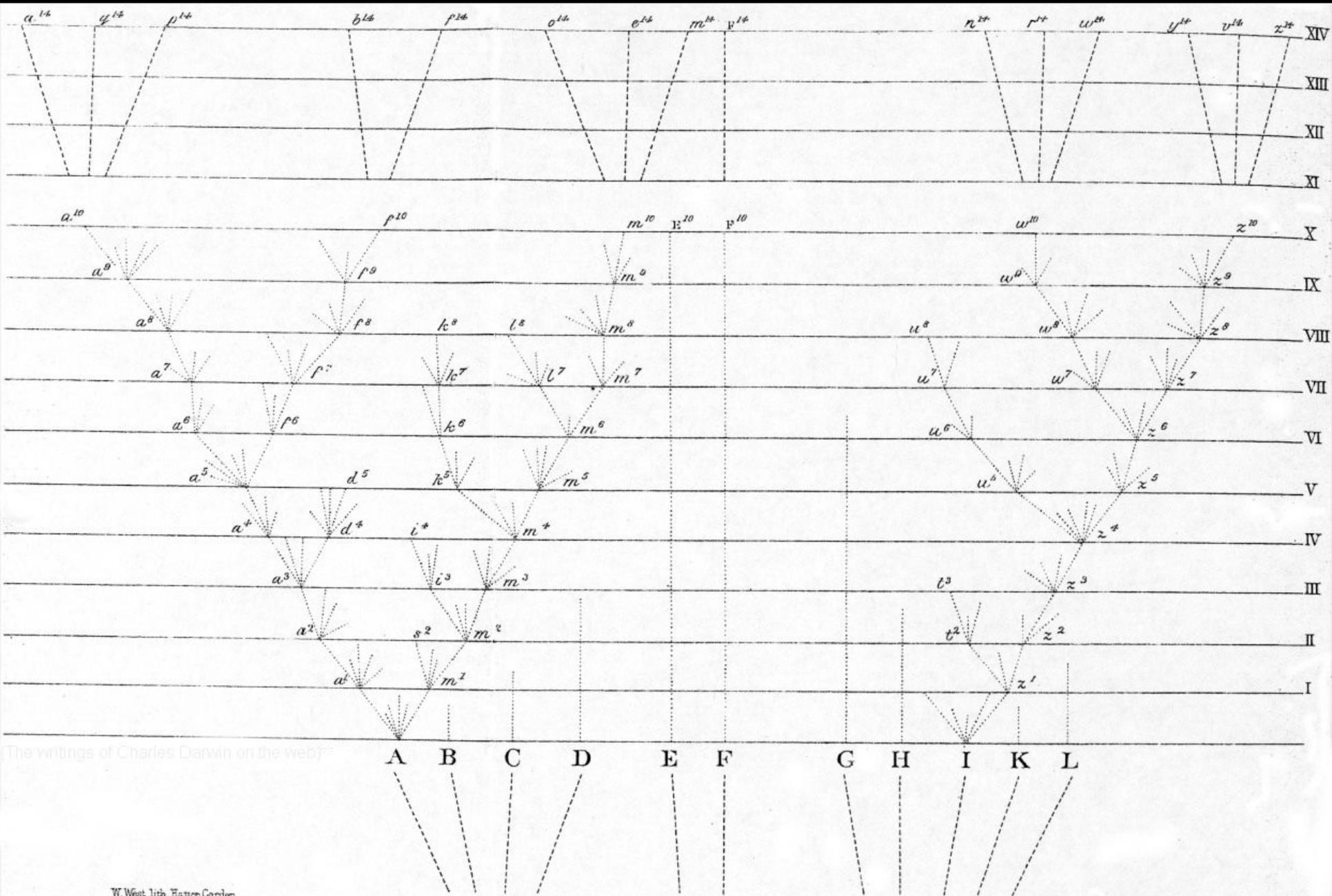
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W. West Irish, Hutton, Garden.

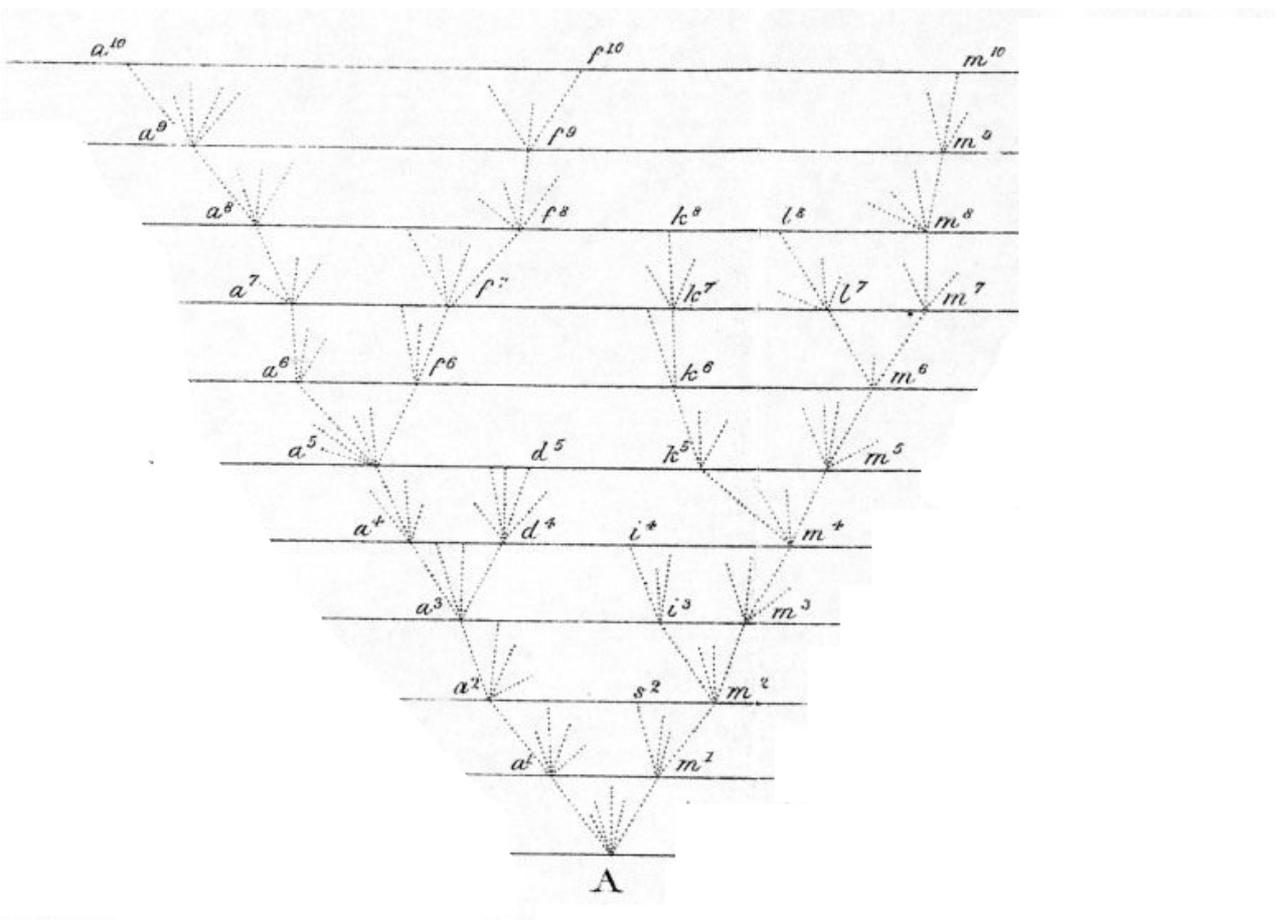
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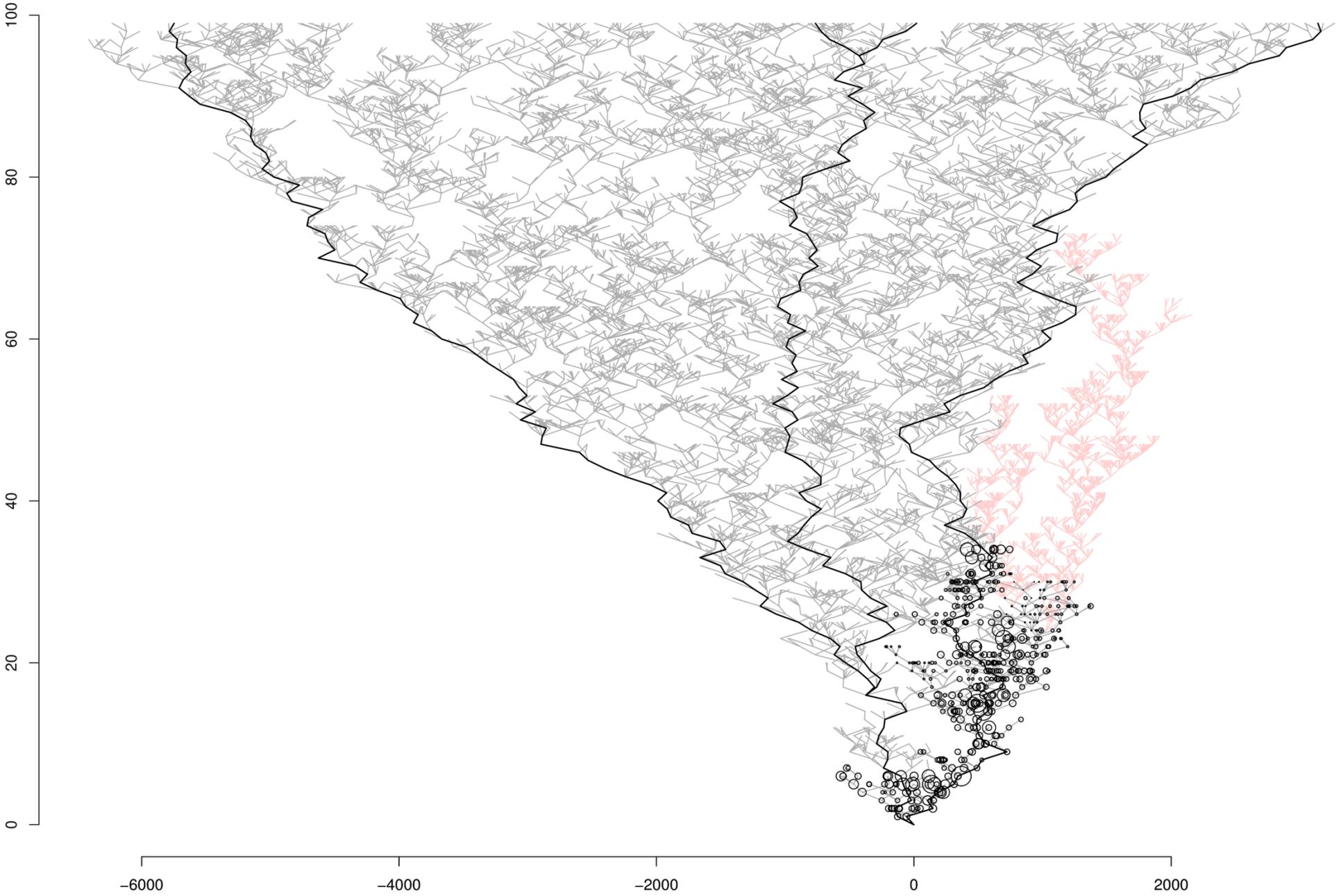
(1) H. Berni
et al.,
Science,
229, 1277, 1980
(2) R.E.
Michod
et al.,
Genetics,
118, 31, 1981
(3) J. Ma
Smith
et al.



The writings of Charles Darwin on the web



L'altruisme



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„

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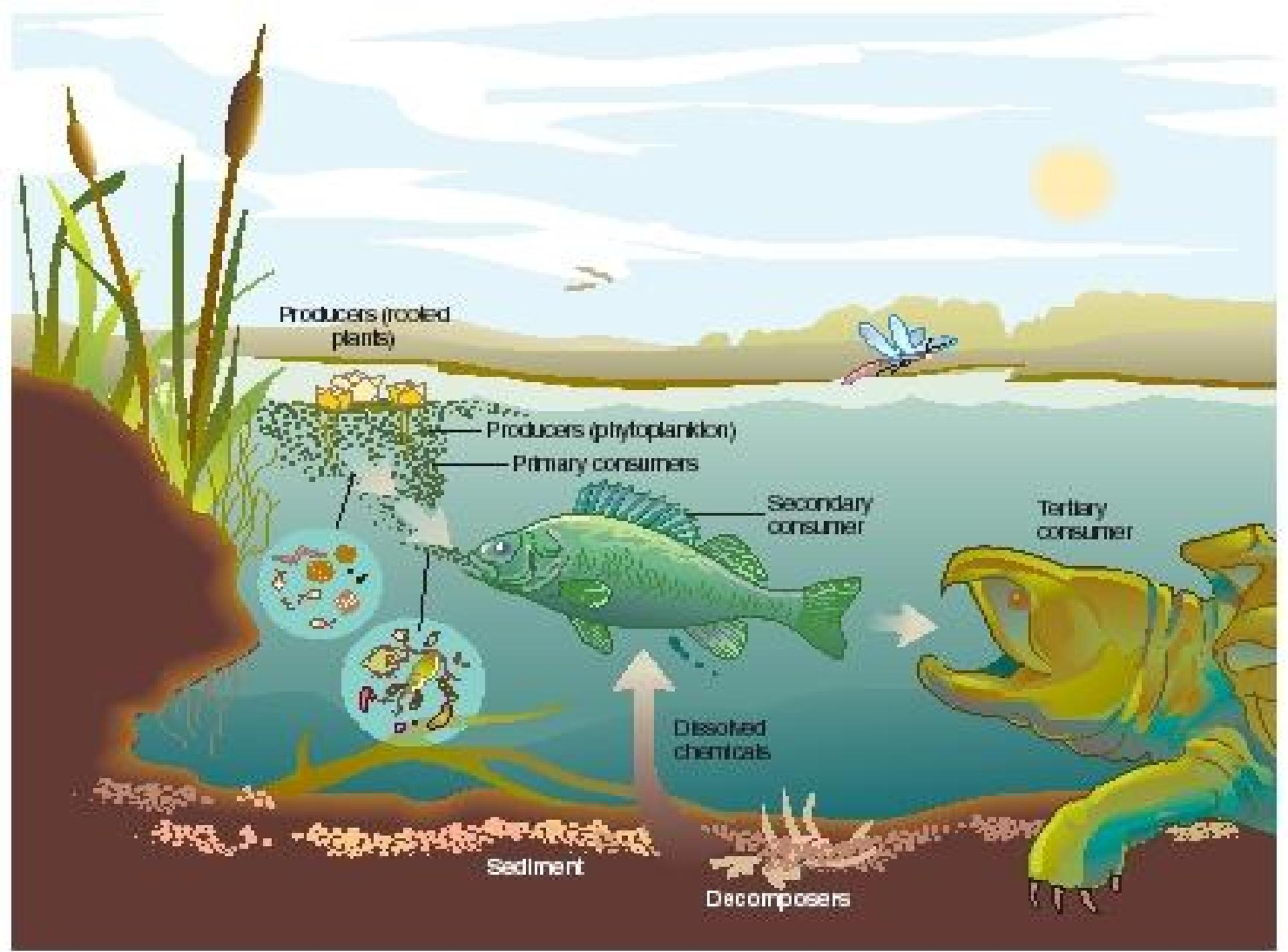
Individual

Family

Population

Species / Phylum

Ecosystem



Producers (rooted plants)

Producers (phytoplankton)

Primary consumers

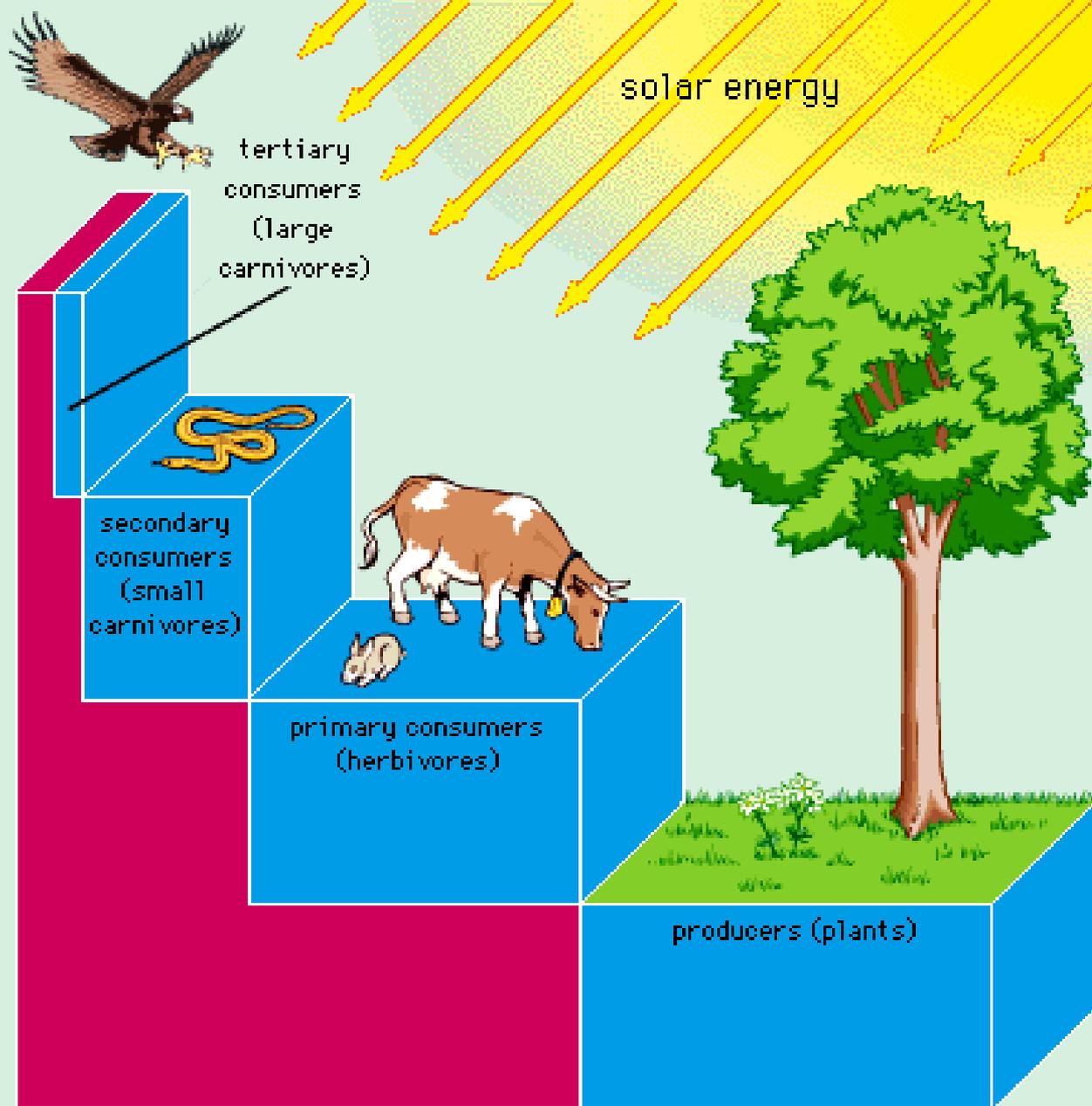
Secondary consumer

Tertiary consumer

Dissolved chemicals

Sediment

Decomposers



■ energy flowing through the system ■ heat energy lost from the system

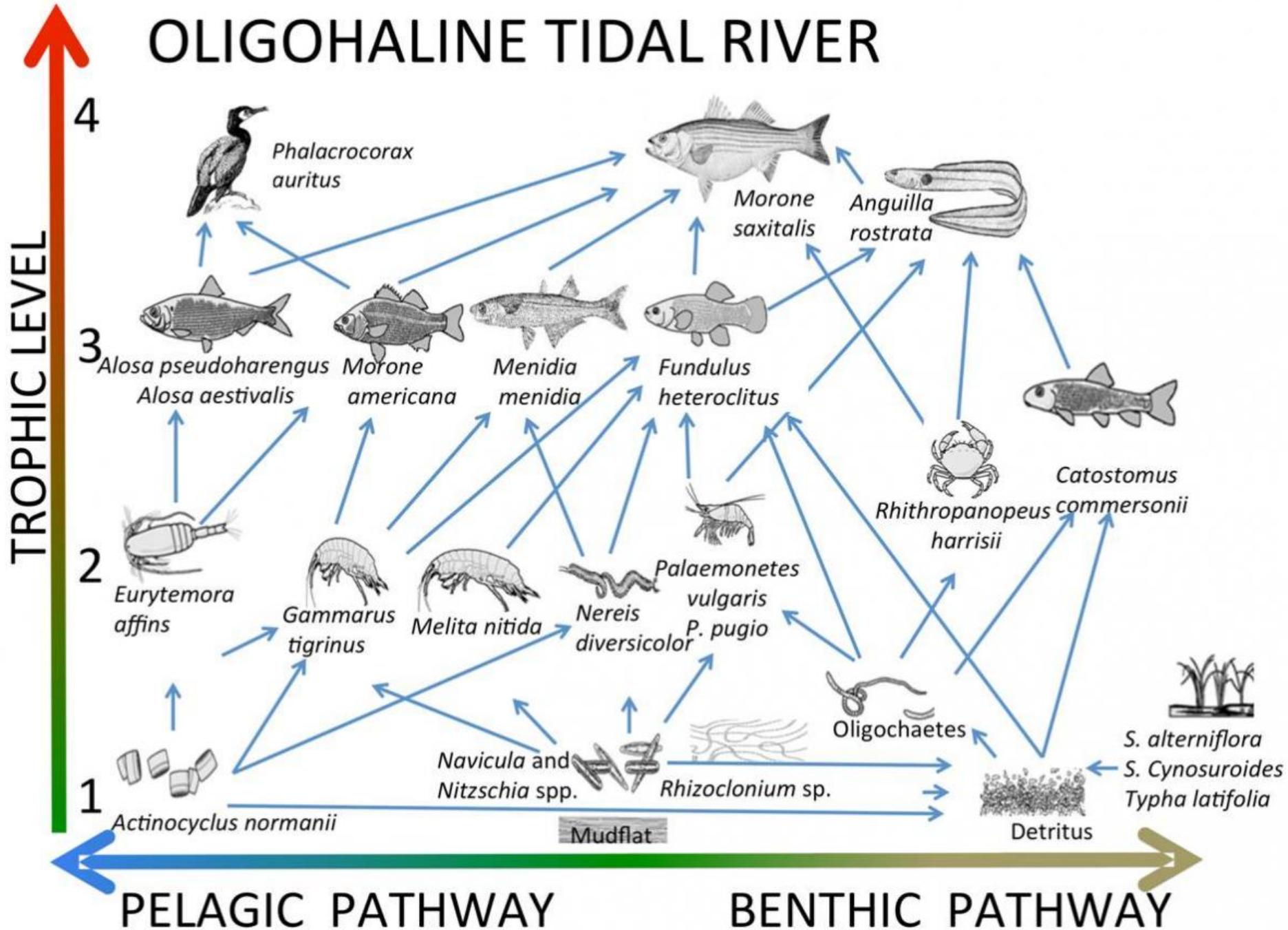


LAKE ECOSYSTEM

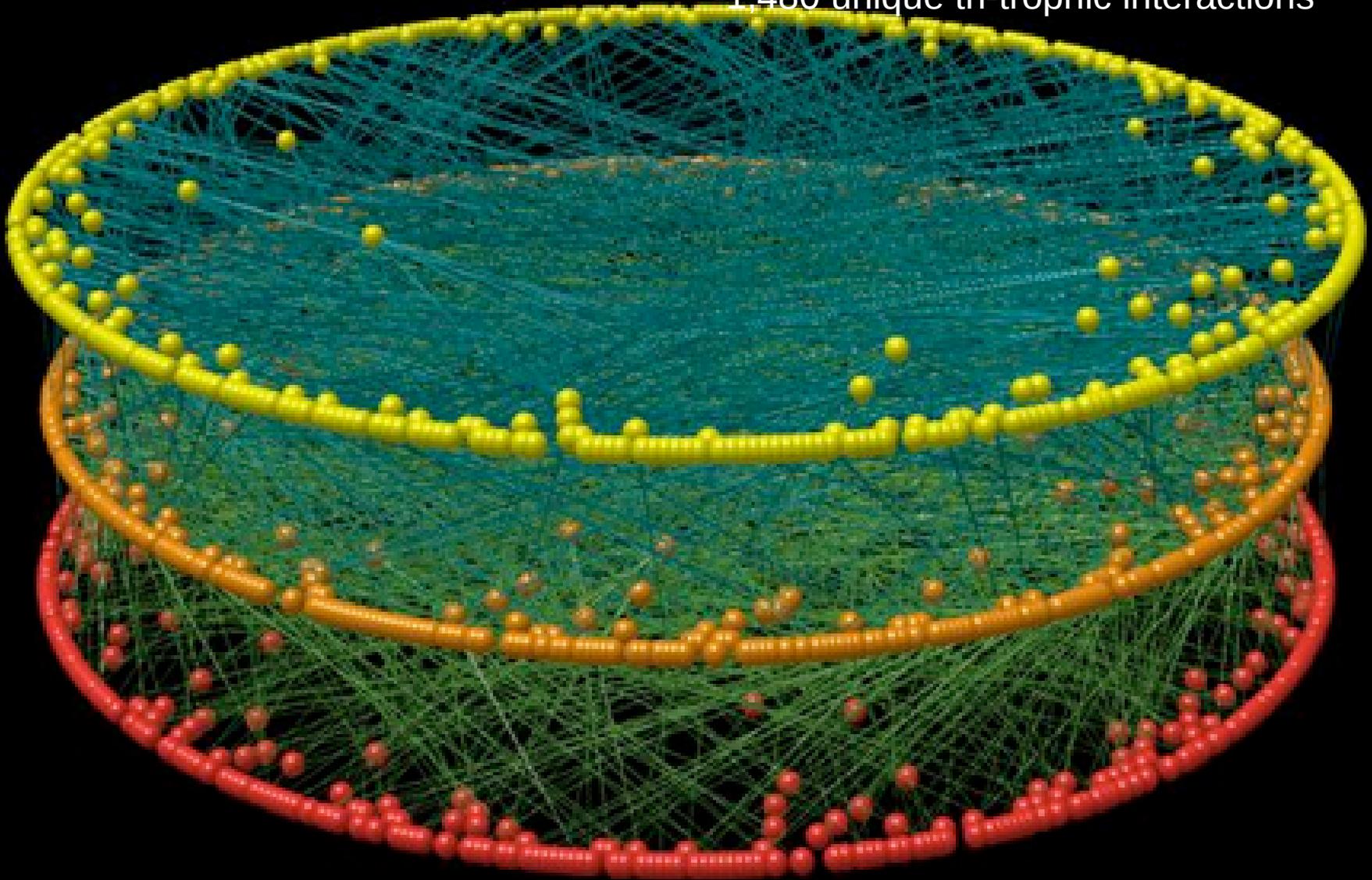
Printed by the Department of Natural Resources,
Wildlife Resources Division, Aquatic Education Program.



OLIGOHALINE TIDAL RIVER



- 509 sp. of wasps (top)
- 735 sp. of host caterpillars (middle)
- 647 sp. of caterpillar food plants (bottom)
- 1,480 unique tri-trophic interactions



Network 3D: Visualizing and Modelling Food Webs

