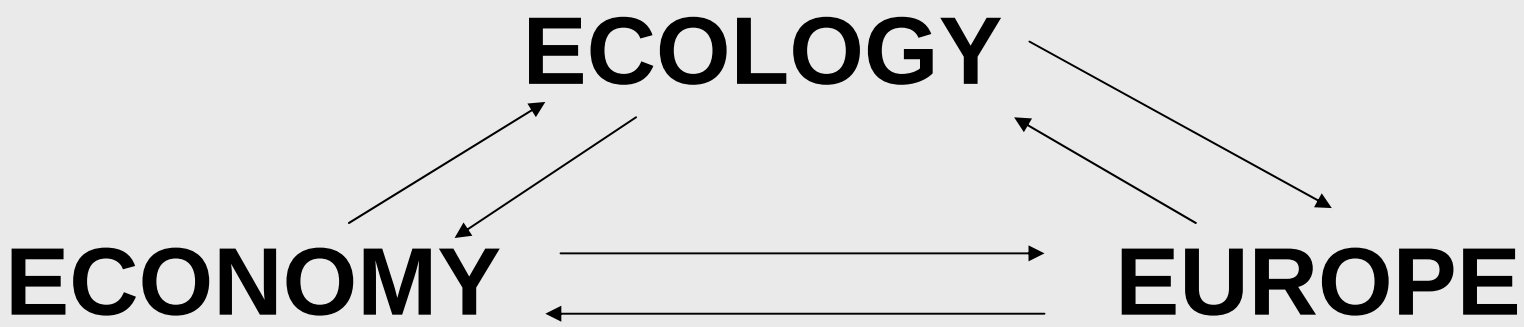
HELECOS

ΕΛΛΗΝΙΚΗ ΟΙΚΟΛΟΓΙΚΗ ΕΤΑΙΡΕΙΑ

HELLENIC ECOLOGICAL SOCIETY

6th Congress



Francisco Castro Rego

Centre for Applied Ecology “Baeta Neves” (CEABN/ISA)
Lisboa, Portugal

ECONOMY

The term “Economy” is derived from the Greek words:

“oikos” - house, and

“nomos” – law

“Economics”, meaning originally “household management”, is the branch of social sciences dealing with the ways **resources** are used to satisfy individual and collective human material needs

Some early works on **economy**:

Principles of political economy (1820)

Definitions in political economy (1827)

Thomas Robert Malthus (1766-1834)

With a basis on **population** theory

An Essay on the Principles of Population (1798)

Thomas Robert Malthus (1766-1834)

Exponential growth law

N = *population*
•*r* = growth rate,
•*t* = time

$$\frac{dN}{dt} = rN$$

The power of population is so superior to the power of the earth to produce subsistence for man…

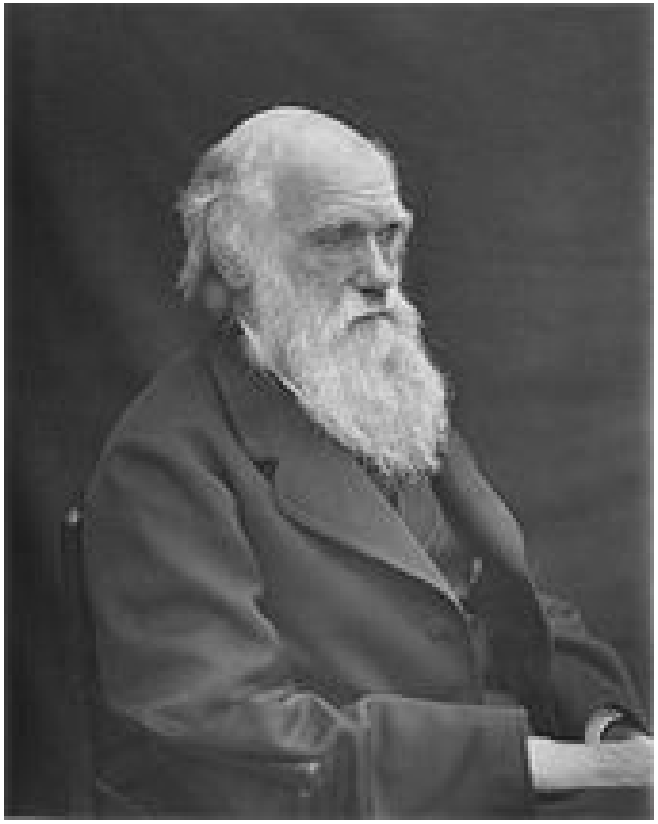
The main peculiarity which distinguishes man from other animals is the power which he possesses of very greatly increasing these means

Verhulst published in 1838 the logistic equation:

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

where K is the **carrying capacity**, or the maximum number of individuals that the environment can support

Pierre François Verhulst (1804-1849)



Charles Darwin (1809-1882)

The **struggle for life**

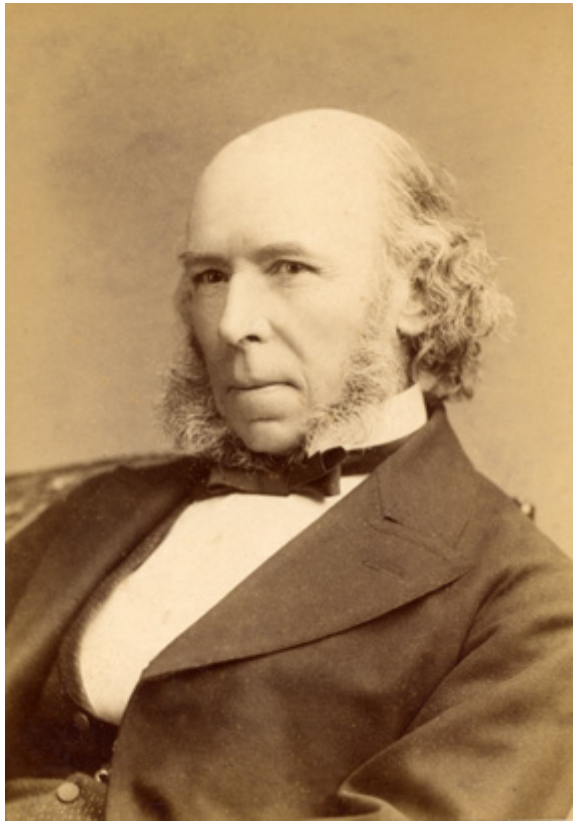
“Owing to this struggle for life, any variation, if it be in any degree profitable to an individual of any species, will tend to the preservation of that individual, and will generally be inherited by its offspring”

“I have called this principle… by the term of Natural Selection”

Origin of the Species (1859)

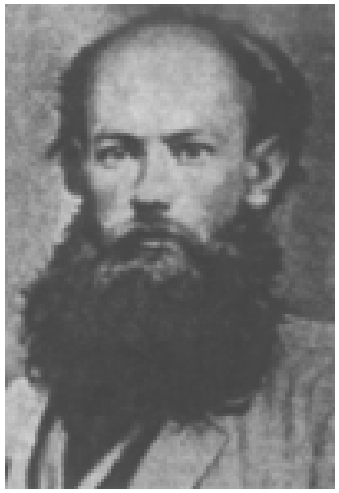
Herbert Spencer is credited with starting the concept of Social Darwinism.

The phrase "survival of the fittest" has been applied to principles of unrestrained **competition**.



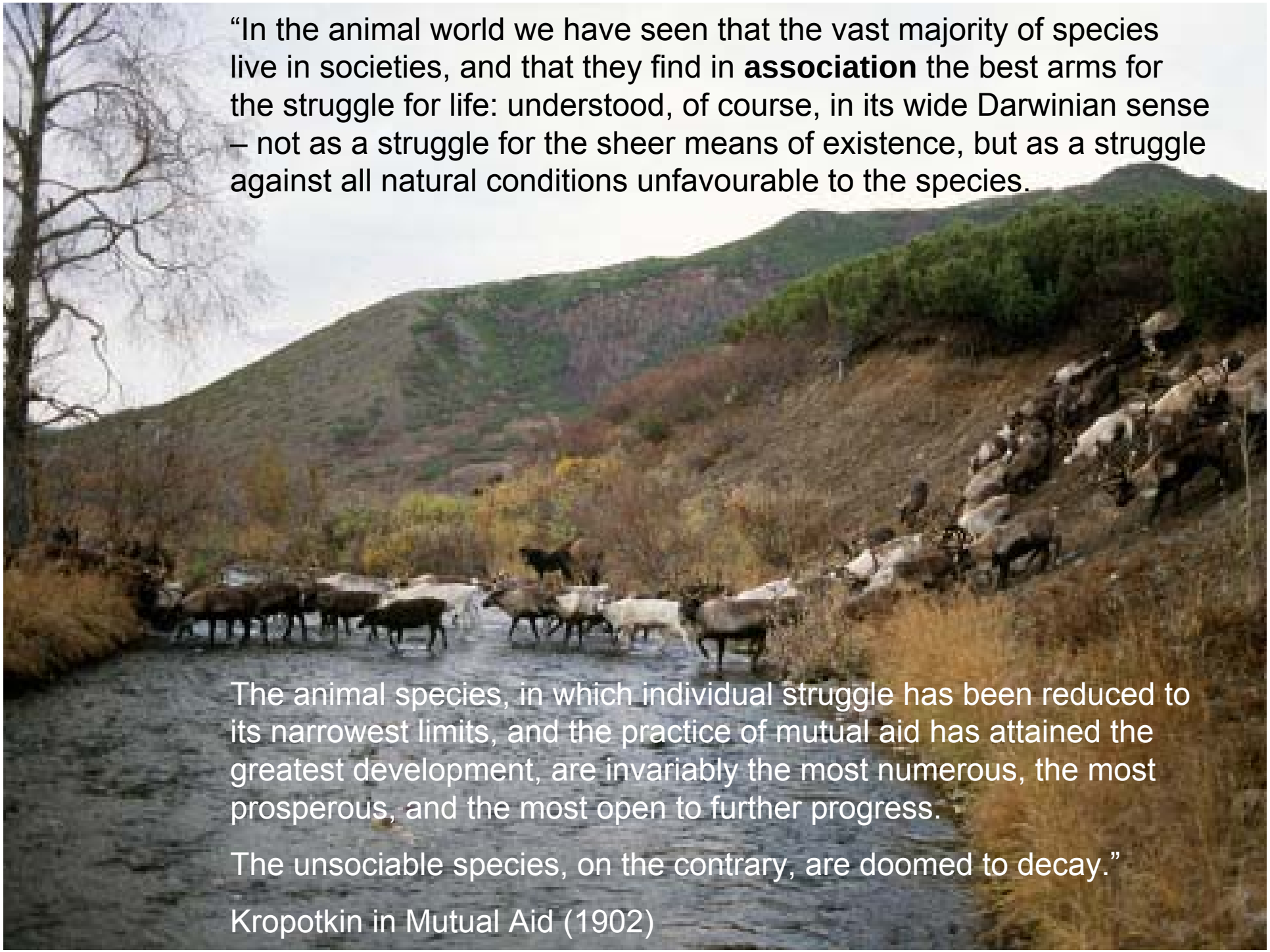
Herbert Spencer (1820-1903)

The catchy term “survival of the fittest” was coined by the philosopher Herbert Spencer, a champion of the free market, and this signalled the introduction of Darwinian thinking into the political arena



Piotr Kropotkin
(1842-1921)

Trying to illustrate Darwin´s concepts on the **struggle for existence**, the Russian Prince and Naturalist Piotr Kropotkin made several expeditions in Siberia, starting in 1864

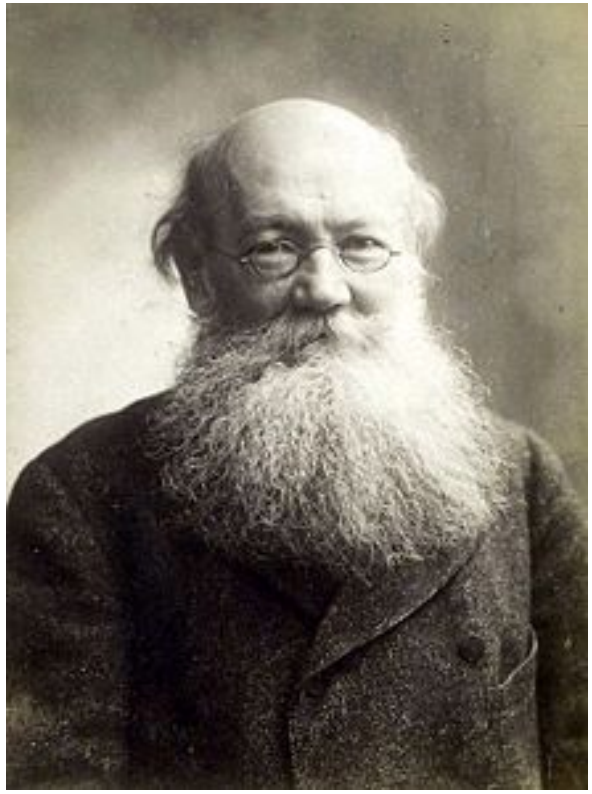


“In the animal world we have seen that the vast majority of species live in societies, and that they find in **association** the best arms for the struggle for life: understood, of course, in its wide Darwinian sense – not as a struggle for the sheer means of existence, but as a struggle against all natural conditions unfavourable to the species.

The animal species, in which individual struggle has been reduced to its narrowest limits, and the practice of mutual aid has attained the greatest development, are invariably the most numerous, the most prosperous, and the most open to further progress.

The unsociable species, on the contrary, are doomed to decay.”

Kropotkin in Mutual Aid (1902)



Piotr Kropotkin (1842-1921)

In “Mutual Aid: a Factor of Evolution” (1902), Peter Kropotkin concludes:

“Besides the law of Mutual Struggle there is in Nature the law of **Mutual Aid**, which, for the success of the struggle for life, and especially for the progressive evolution of the species, is far more important than the law of mutual contest.

This suggestion… was, in reality, nothing but a further development of the ideas expressed by Darwin himself.”

Kropotkin was a famous ideologue of anarchism, indicating that human cooperation is not imposed from authority but has its origins in natural conditions

ECOLOGY

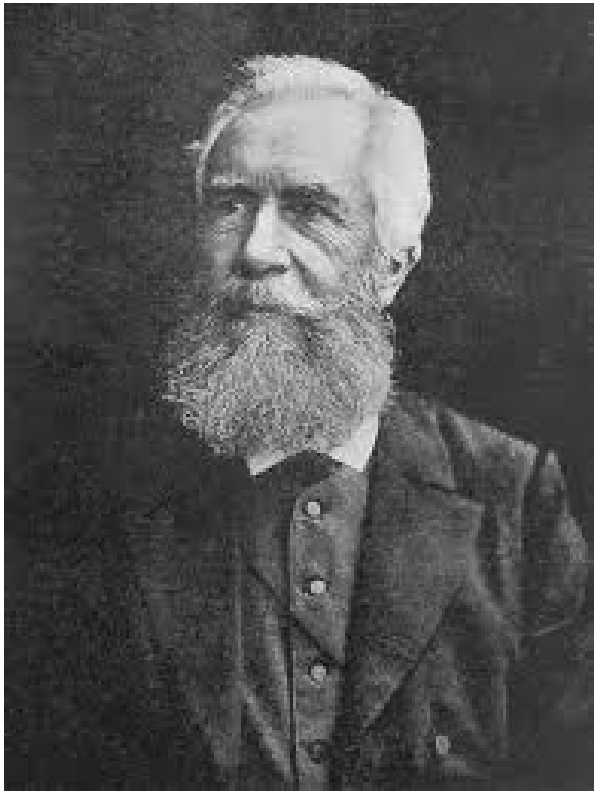
The term “Ecology” is derived from the Greek words:

“oikos” - house, and

“logos” – science

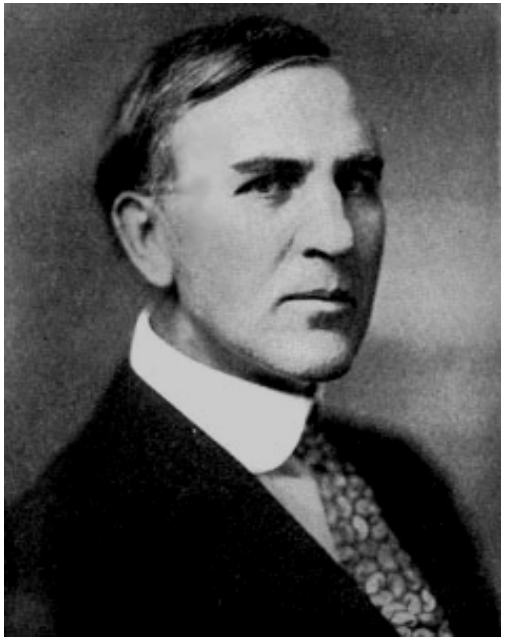
The word was first used in 1866 by Haeckel:

"By ecology we mean the body of knowledge concerning the **economy of nature**, the total relations of the animal to both its inorganic and organic environment; including its friendly and inimical relations with those animals and plants with which it comes into contact."



Ernst Haeckel (1834–1919)

A debate in Plant Ecology:



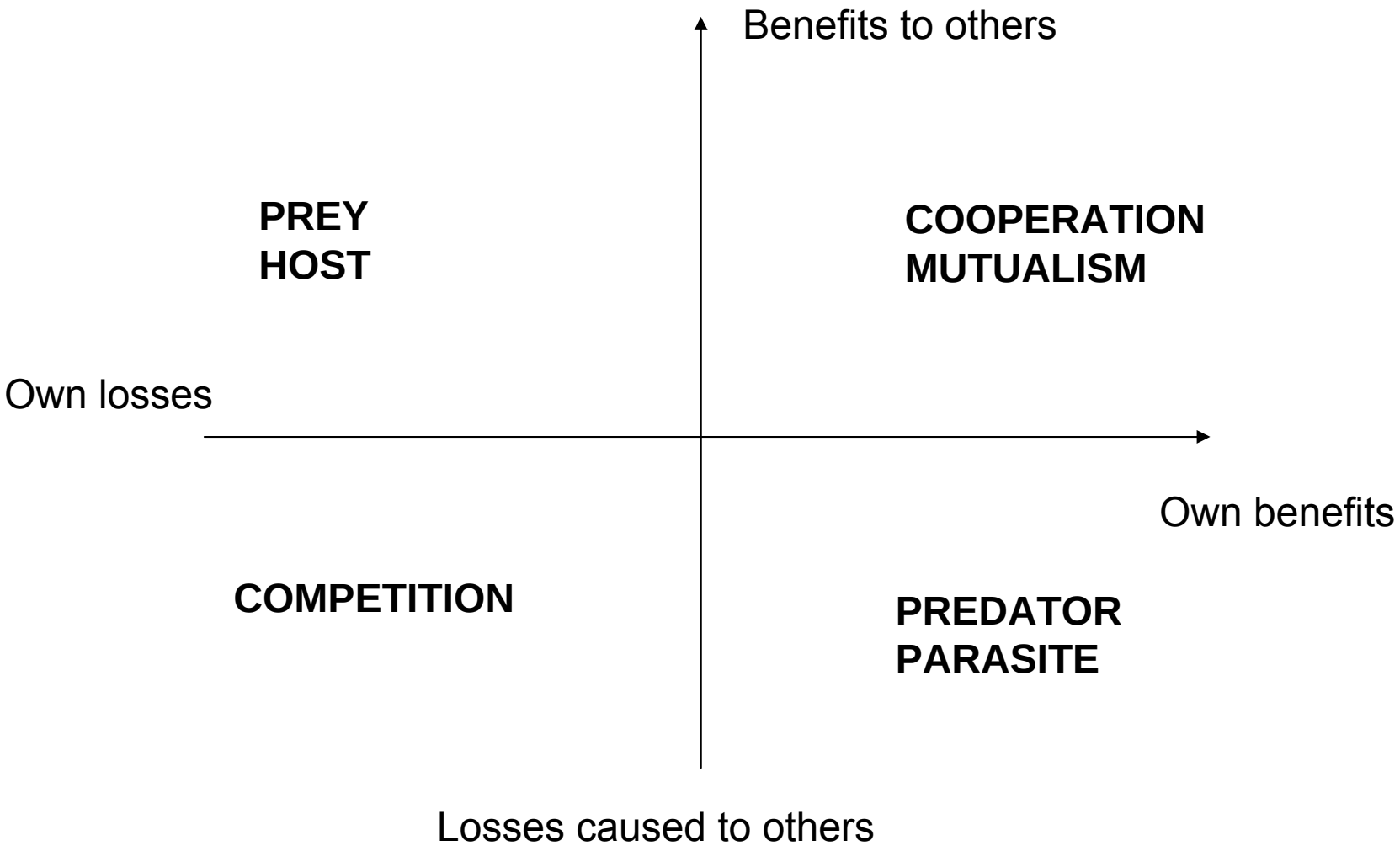
Frederic Clements
(1874-1945)

Clements proposed that the development of vegetation could be understood as a sequence of stages of plant **associations** resembling the development of an individual organism.

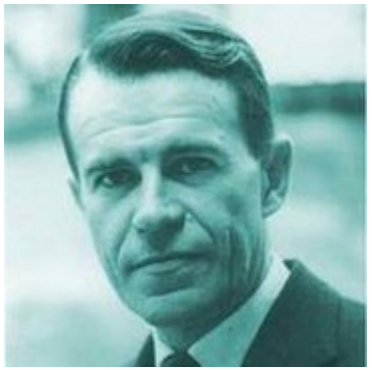
Henry Gleason
(1882–1975)

Gleason proposed the Individualistic concept, in which the phenomena of vegetation depend completely upon the phenomena of the **individual** species.

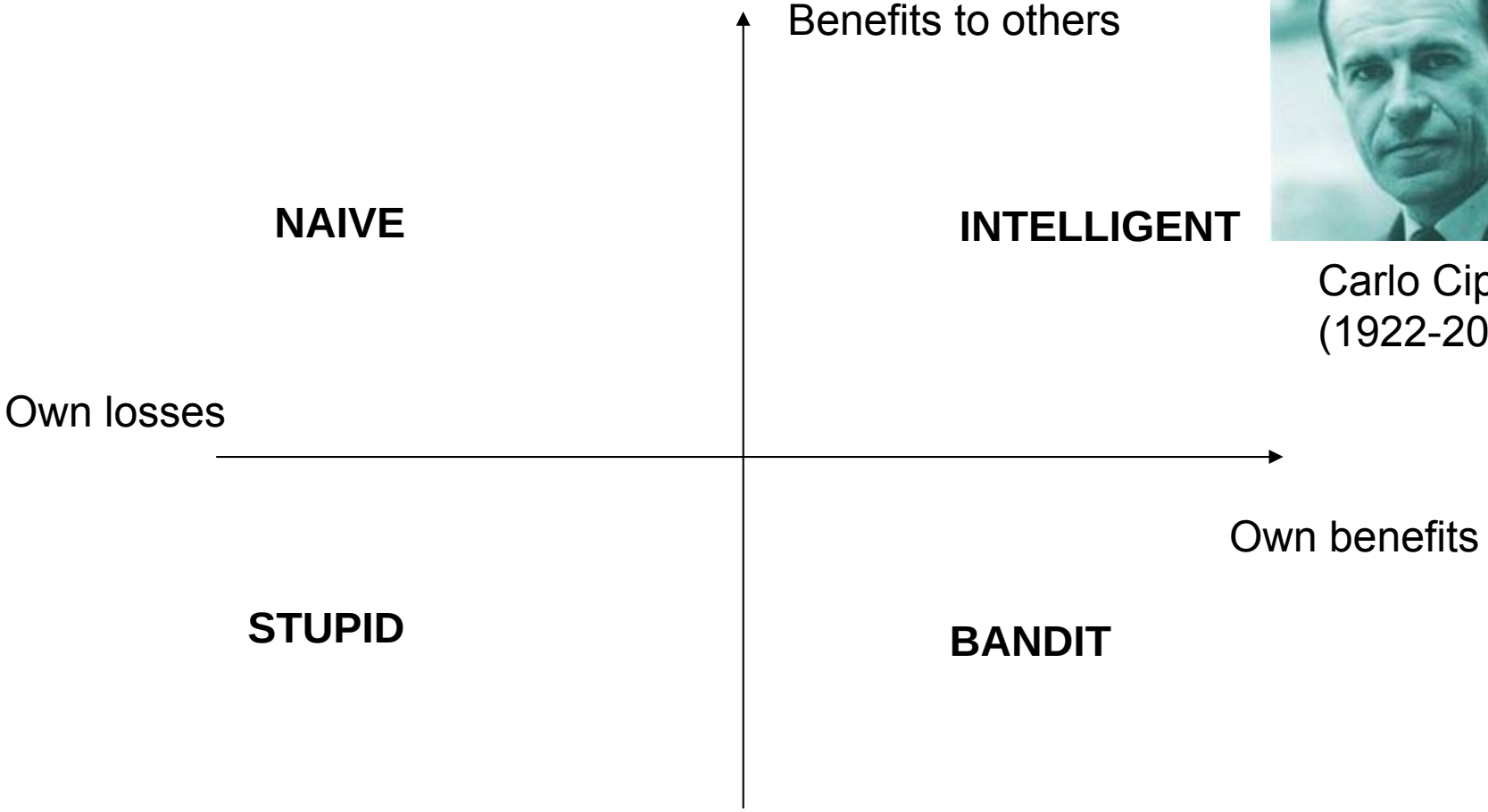
In ecological science different types of **interactions** between species are considered:



In social sciences these types of interactions can be viewed in a similar way, as in the provocative essay on “The fundamental laws of **human stupidity**” of Carlo Cipolla (1988):



Carlo Cipolla
(1922-2000)



Cipolla's **fundamental laws** of stupidity:

A stupid person causes losses to others while himself incurring losses

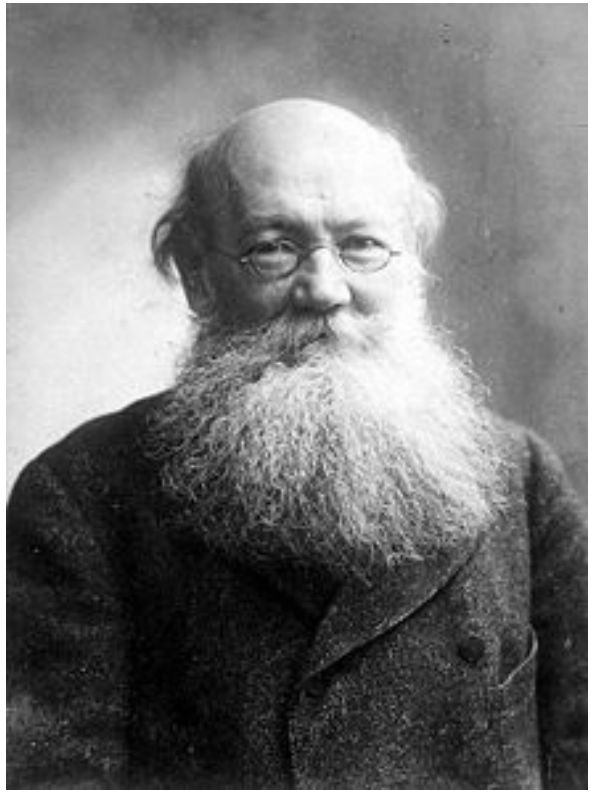
The number of stupid individuals is always underestimated

The probability that a certain person is stupid is independent of any other characteristic

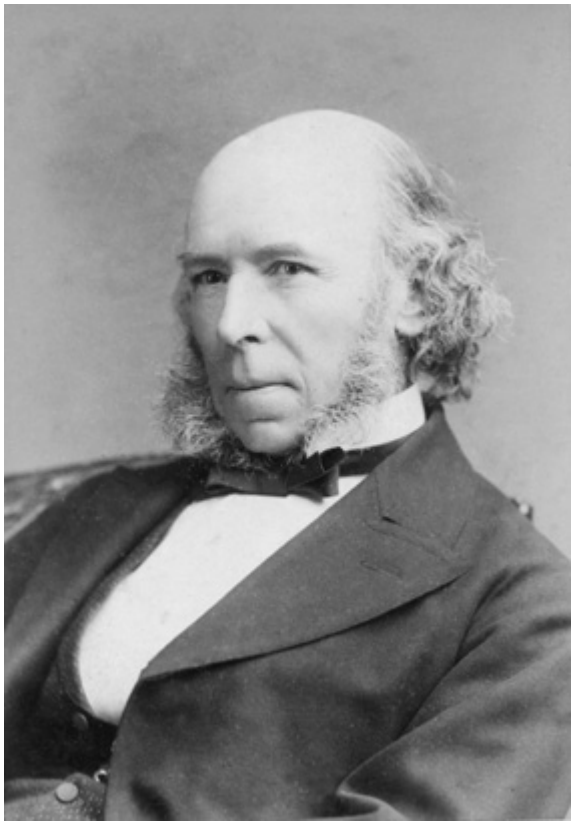
Non-stupid people always underestimate the damaging power of stupid individuals

A stupid person is the most dangerous type of person

Piotr Kropotkin (1842-1921)

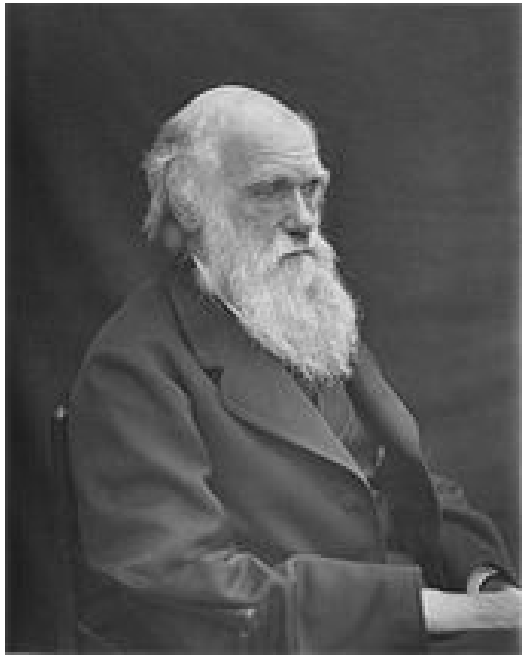


Herbert Spencer (1820-1903)



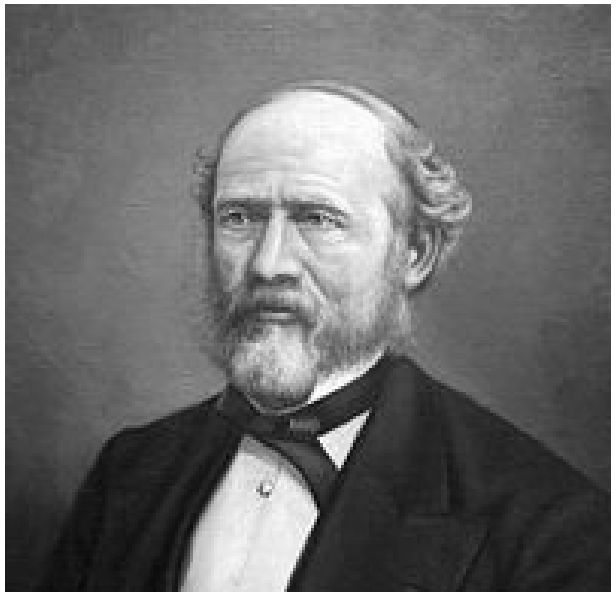
COOPERATION	OR	COMPETITION ?
MUTUAL AID	OR	MUTUAL STRUGGLE ?
SOCIAL	OR	INDIVIDUAL ?
INTELLIGENT	OR	STUPID ?

Darwin tried already to solve this apparent paradox in “Descent of Man”:



“It must not be forgotten that although a high standard of morality gives but a slight or no advantage to each individual man and his children over the other men of the same tribe… an increase in the number of well-endowed men and an advancement in the standard of morality will certainly give an immense **advantage to one tribe over another**”

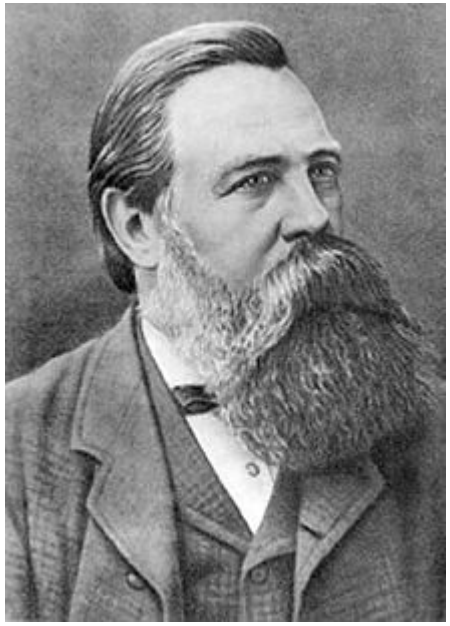
Early anthropological work



Lewis Morgan
(1818-1881)

In the late 1850s and 1860s, Morgan collected kinship data and studied the social structure of **Native American Tribes**, especially the Iroquois.

He is known for his theories of social evolution.



Friedrich Engels
(1820-1895)

After the work of Morgan, Engels wrote his book on “The Origin of the **Family**, Private Property and the State” (1884).

It was considered that sexual competition was the vital issue in nonhuman primate society and earliest human society.

Early human kinship was described as matrilineal.

This kinship solidarity empowered women to take action against uncooperative males.

The book contains a comprehensive historical view of the family in relation to issues of class, female subjugation and private property.

Kin Selection

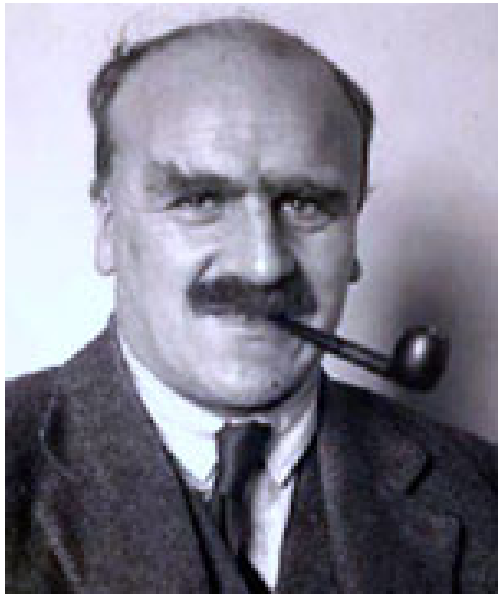
Natural selection puts a premium on individual reproductive success

How can this mechanism shape behavior that is altruistic in the sense that it benefits others at the expense of one´s own progeny?

One approach is kin selection (helping one´s own genes in the bodies of others)

Close relatedness among individuals explains a huge degree of cooperation.

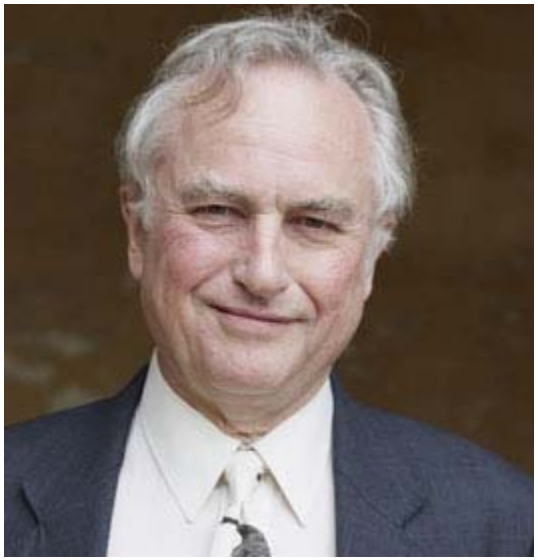
But human cooperation also works among non-relatives, mediated by economic rather than genetic ties.



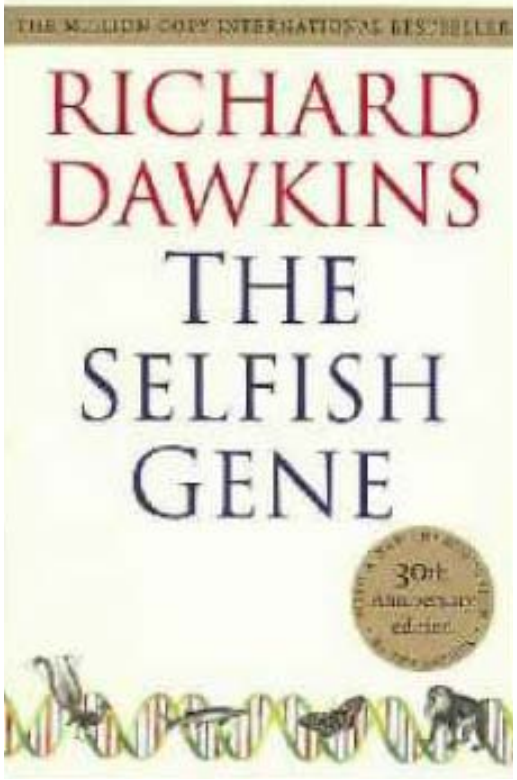
John Burdon Haldane
(1892-1964)

“I would lay down my life
for two brothers
or eight cousins”

Kin Selection



Richard Dawkins
(born 1941)



(1976)

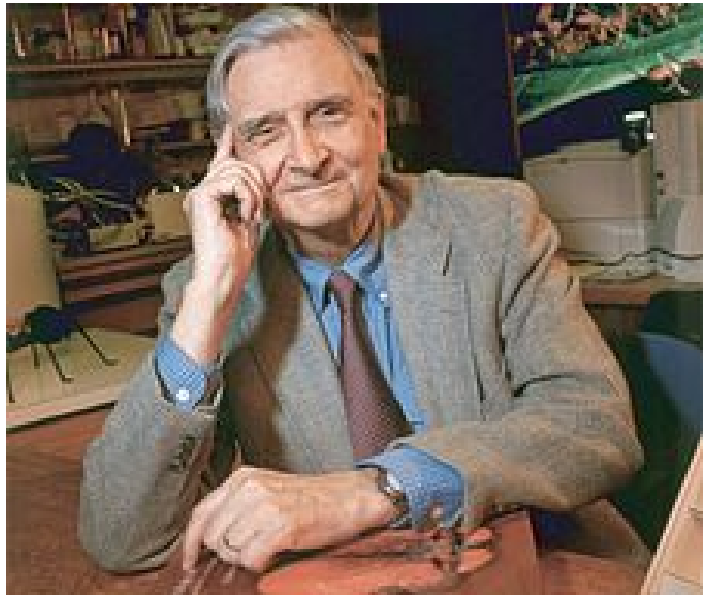
Natural selection takes place at more than one level of the biological **hierarchy**.

Selfish individuals might out-compete altruists within groups, but internally altruistic groups out-compete selfish groups.

This is the essential logic of what has become known as **multilevel selection** theory.

Total evolutionary change in a population can be regarded as a final vector made up by two component vectors, within and between-group selection, that often point in different directions.

Edward Wilson (born 1929)



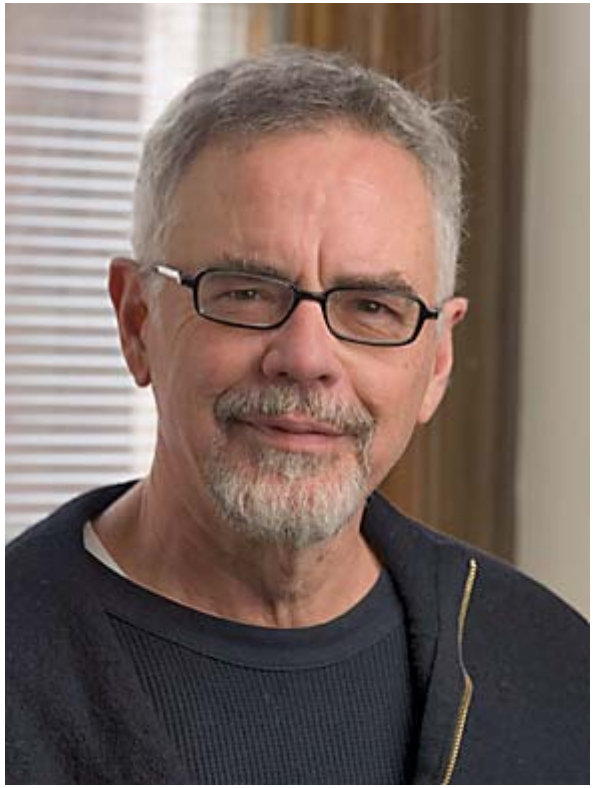
Wilson, D.S., and E.O. Wilson. 2007. Rethinking the theoretical foundation of Sociobiology. The Quarterly Review of Biology 82(4): 327-347.

The Evolution of **Reciprocal Altruism** (1971)

In modern society an enormous apparatus of law and enforcement makes the temptation to cheat resistible.

But how can reciprocal altruism work in the absence of those authoritarian institutions so despised by Kropotkin´s anarchists?

This difficult question is best answered by first considering a simple, idealized system, borrowed by R. Trivers, a sociobiologist, from game theory, known as the Prisoner´s Dilemma.



Robert Trivers (born 1943)

COOPERATE

OR

CHEAT ?

THE PRISONER´S

DILEMMA

In this game two players have only to decide whether they wish to cooperate with each other or not.

In this example, if both choose to cooperate, they will get a reward of 3 points each.

If both cheat they will get only 1 point each.

But if one player cheats and the other cooperates, the cheater receives 5 points, whereas the player who chooses to cooperate receives nothing.

Will they cooperate?

The payoff matrix for one game of the Prisoner´s Dilemma

Player B \ Player A	Cheats	Cooperates
Cooperates	A gets 5 B gets 0	**MUTUAL COOPERATION** A gets 3 B gets 3
Cheats	**MUTUAL CHEATING** A gets 1 B gets 1	A gets 0 B gets 5

No matter what the first player does, the second´s best option is to cheat.
But the first player is exactly in the same position.
The logic leads inexorably to **mutual cheating**.

Repeated games:

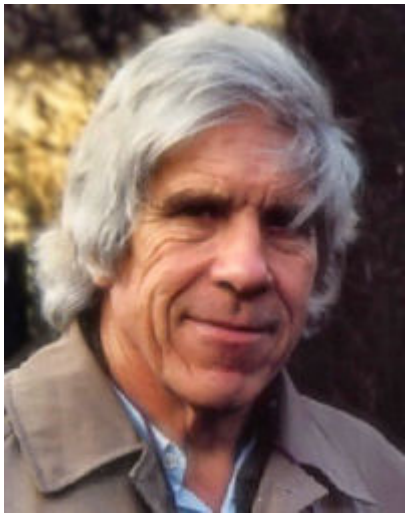
In a computer tournament for the Prisonner´s Dilemma the best score was attained with the simplest of all strategies submitted:

TIT FOR TAT: cooperating in the first move and doing whatever the other player did in the preceding move.

Cooperation based on reciprocity can get started in a noncooperative world, can thrive in a variegated environment, and can defend itself once fully established.

The Evolution of Cooperation (1981)
Axelrod and Hamilton

Robert Axelrod (born 1943)

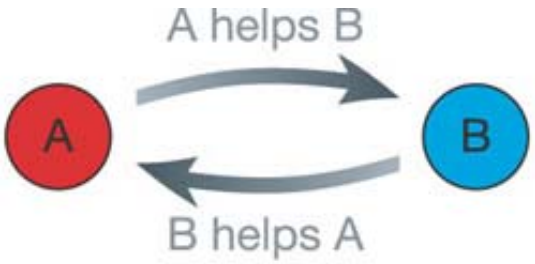


William Hamilton (1936-2000)

This approach is **direct reciprocity**

(helping others in expectation of direct return benefits)

DIRECT RECIPROCITY



Direct reciprocity means simply the principle of **give-and-take**.

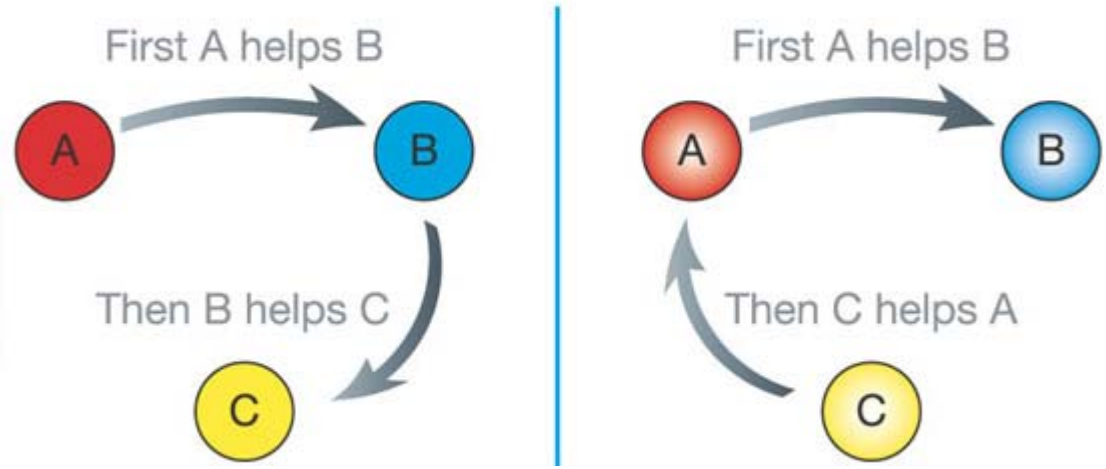
When I scratch your back, I expect you to scratch mine in return.

This form of reciprocity is recognized in popular sayings such as “tit for tat”.

The evolution of cooperation by direct reciprocity requires that players recognize their present partner and remember the outcome of previous encounters.

Direct reciprocity requires **reasonably advanced cognitive abilities**.

INDIRECT RECIPROCITY



Although simple forms of indirect reciprocity can be found in animals, only humans seem to engage in the full complexity of the game.

Indirect reciprocity has **substantial cognitive demands**.

Indirect reciprocity leads to the evolution of morality and social norms

Sigmund, K., Fehr, E., and M.A. Nowak. 2002. The **Economics of Fair Play**. Scientific American 286: 81-85.

For a long time, theoretical economists postulated a being called *Homo economicus*, a rational individual relentlessly bent on maximizing a purely selfish reward.

But some economists are increasingly fascinated by the sharing and helping that goes on within office pools, households, families.

How does economic exchange work in the absence of explicit contracts and regulatory institutions?

Karl Sigmund (born 1945)

Why do we value fairness and cooperation over seemingly more rational selfishness? How can Darwinian generosity arise?

The Ultimatum Game

Somebody offers you a sum of money, with the condition that you **agree** with some other anonymous person how to share the sum.

You can make a single offer of how to split the sum and the other person can only say yes or no.

If the answer is yes, the deal goes ahead.

If the answer is no, neither of you get anything.

What will you do?

In **game-theory** analysis, which assumes that people are selfish and rational, you should offer the smallest possible share and the responder should accept it.

But this is not how most people play the game.

Instinctively, many people feel they should offer 50 percent, because such a division is “fair” and therefore likely to be accepted. In fact, more than half of all responders reject offers that are less than 20 percent.

But here is the puzzle:

Why should anyone reject an offer as “too small”? The only rational option for a selfish individual is to accept any offer…

We conclude that most people all over the world place a high value on **fair** outcomes.

Indirect reciprocity stimulates the evolution of **moral systems**.

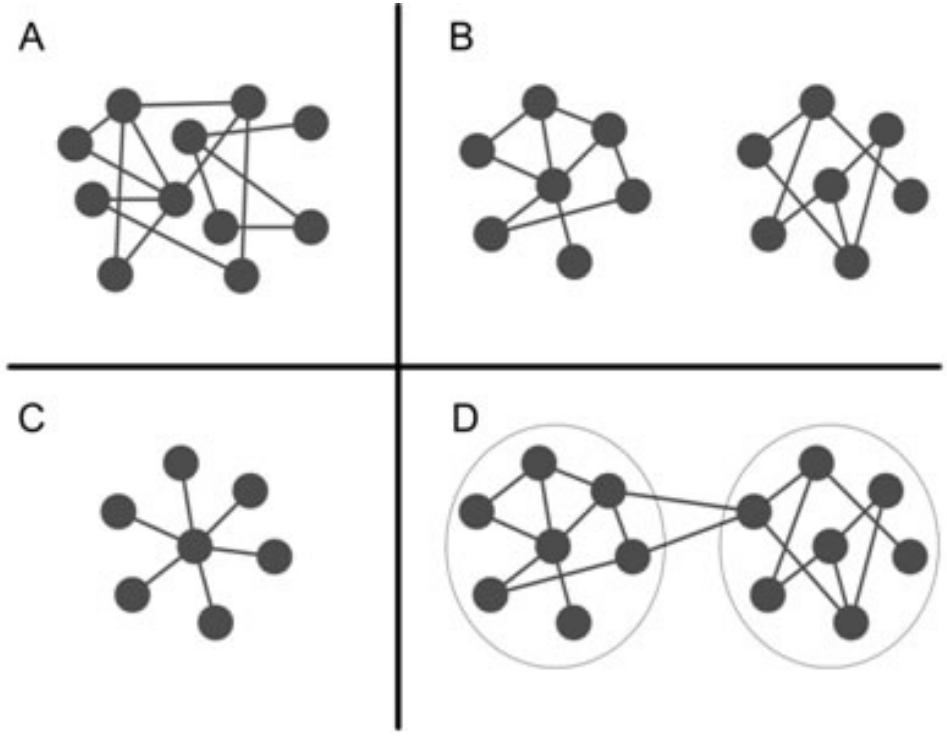
Examples from many cultures and religions:

“Give and it shall be given unto you”	Luke´s Gospel
“What you wish your neighbors to be to you, you will also be to them”	Sextus the Pythagorean
“Love your neighbor as yourself”	Christianity and Judaism
“Hurt no one so that no one may hurt you”	Farewell Sermon of Muhammad
“He is kind to the kind; he is also kind to the unkind”	Taoism
“Do unto others as you would have them do to you”	Golden Rule

NETWORK RECIPROCITY

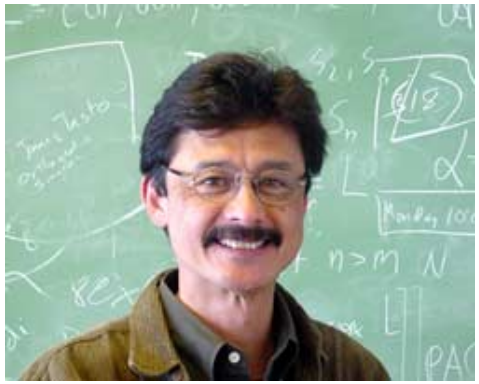
Spatial structures or social networks imply that some individuals interact more frequently than others.

Cooperators can prevail by forming **network clusters**, where they help each other.



Robert May

Simon Levin



George Sugihara

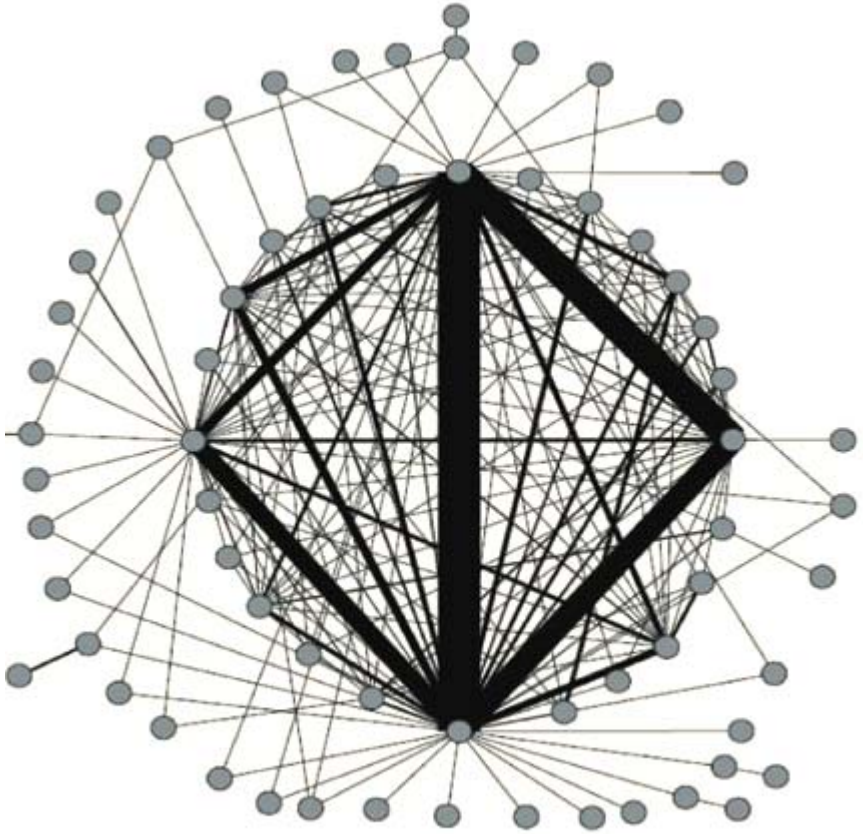
May, R.M., Levin, S.A. and G. Sugihara. 2008.

Ecology for bankers

There is a common ground in analysing financial systems and ecosystems.

Nature 451: 893-895.

Catastrophic changes in the overall state of a system can ultimately derive from how it is organized.



Ecologists have long suggested that **modularity** and **redundancy** of components and pathways can promote robustness.

Sparseness of strong linkages can confer greater stability in systems whose components (nodes, banks, species) have some **self-regulation**.

EUROPA

In ancient **Greek mythology**, Europa was a Phoenician princess.

For Homer, Europe was a mythological queen of Crete, not a geographical designation.

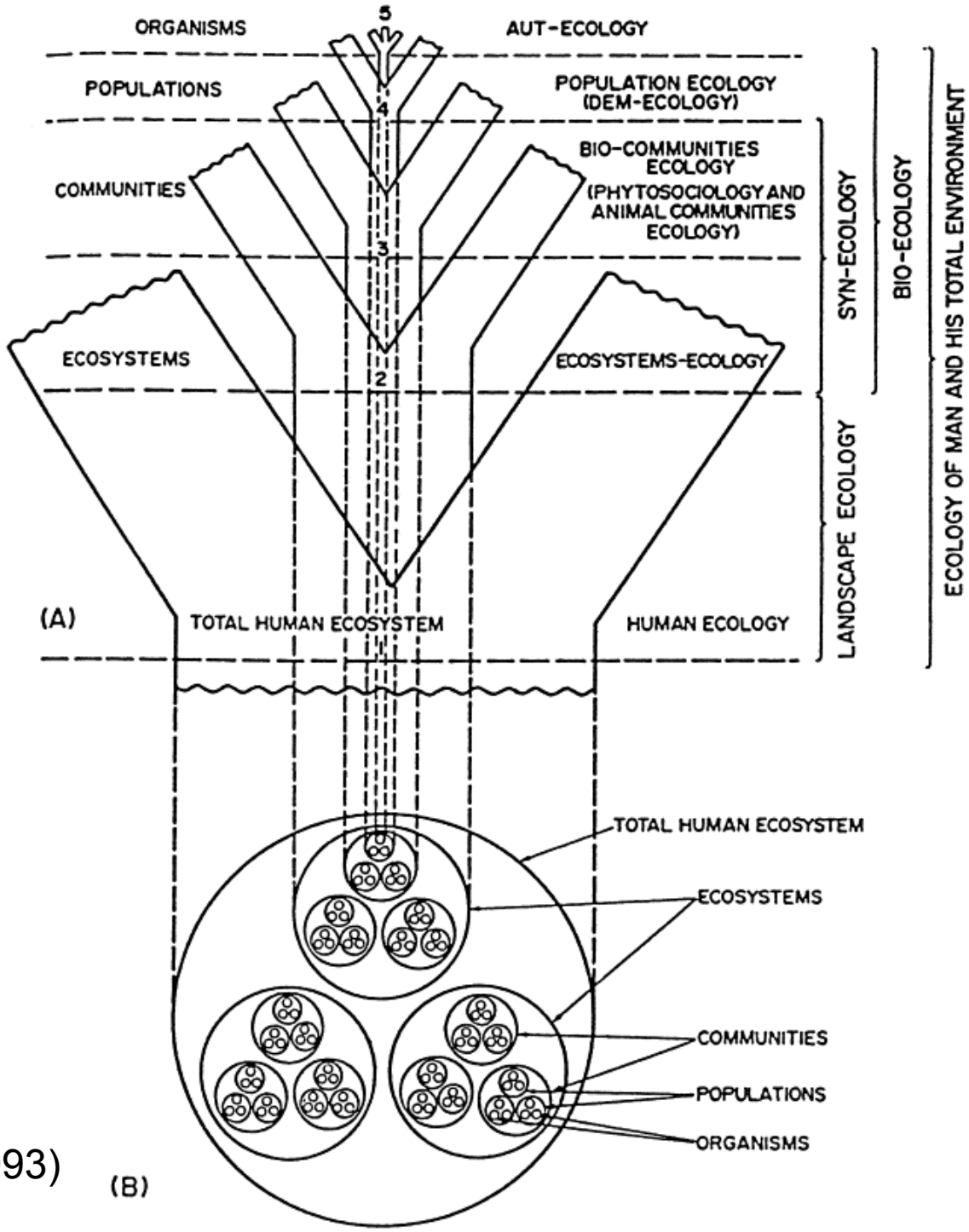
Later, Europa stood for central-north Greece, and by 500 BC its meaning had been extended to the lands to the north.


Finland
Sweden
Estonia
Latvia
Lithuania
Ireland
United Kingdom
Denmark
Nether-lands
Poland
Belgium
Germany
Luxembourg
Czech Rep.
Slovakia
France
Austria
Hungary
Romania
Slovenia
Portugal
Spain
Italy
Bulgaria
Greece
Cyprus
Malta
?

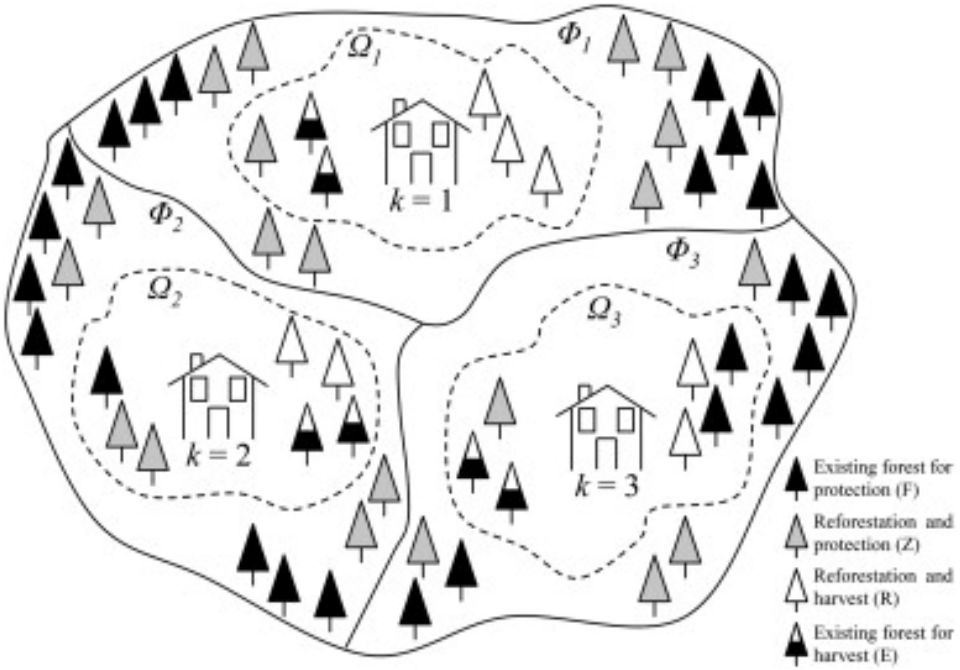
The **Ecological Hierarchy**

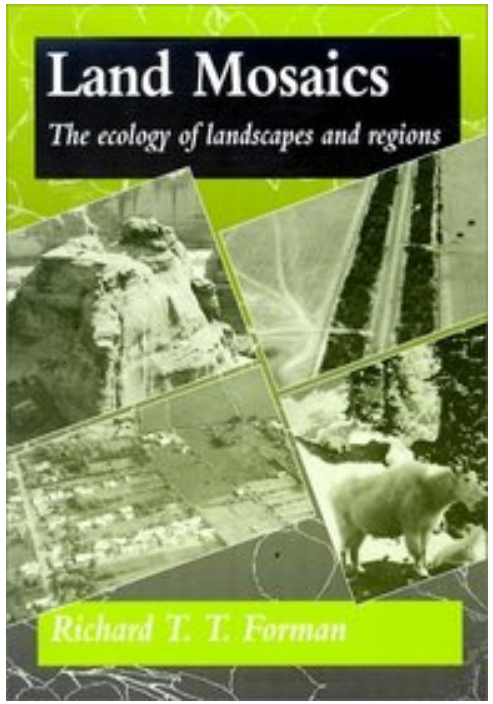
Zev Naveh
(1919-2011)

Landscape Ecology:
Theory and Applications (1993)



Is Europe a **mosaic** of adjacent interacting ecosystems?

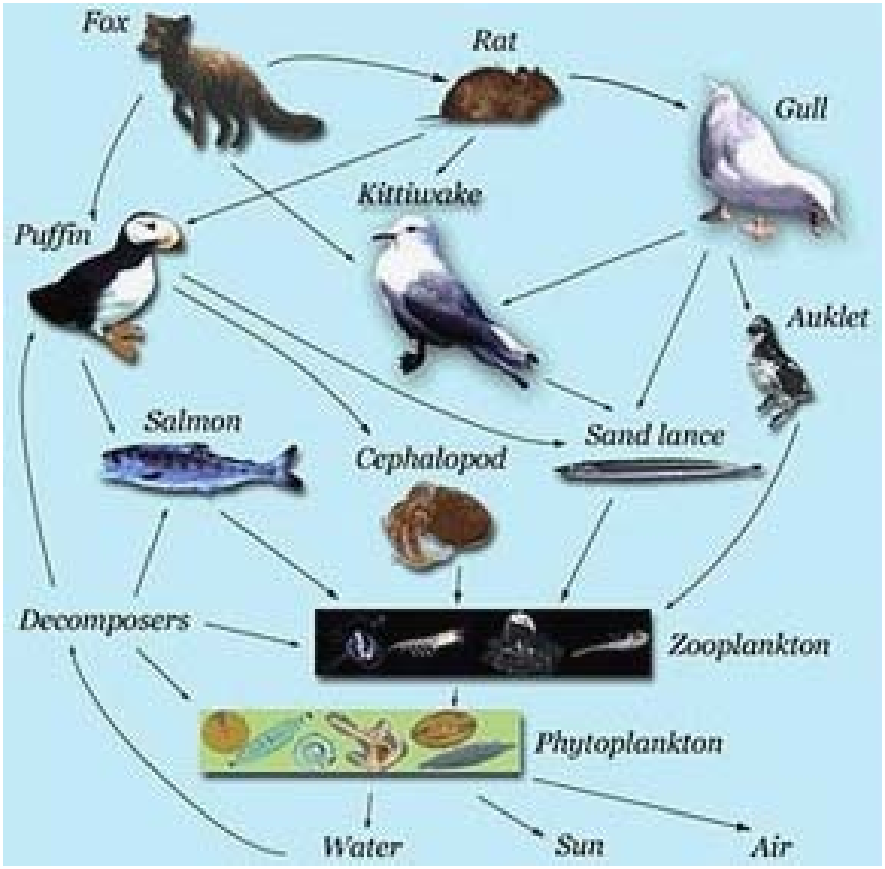




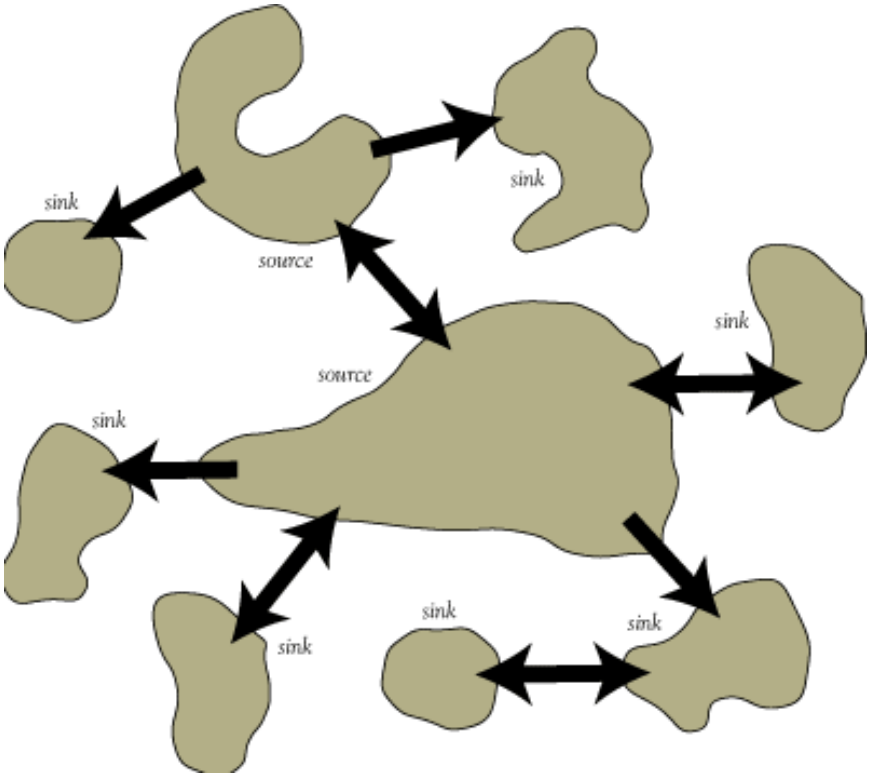
European Community

Is **Community** the appropriate term?

In political and economical terms are we considered **different species** that live in the same geographical area?



Ore are we a **Meta-Population**?



Ilkka Hanski
(born 1953)

Are we governed by the equations for the **interactions** between species?

The Lotka–Volterra equations:

$$\frac{dx}{dt} = x(\alpha - \beta y)$$

$$\frac{dy}{dt} = -y(\gamma - \delta x)$$

x is the number of prey

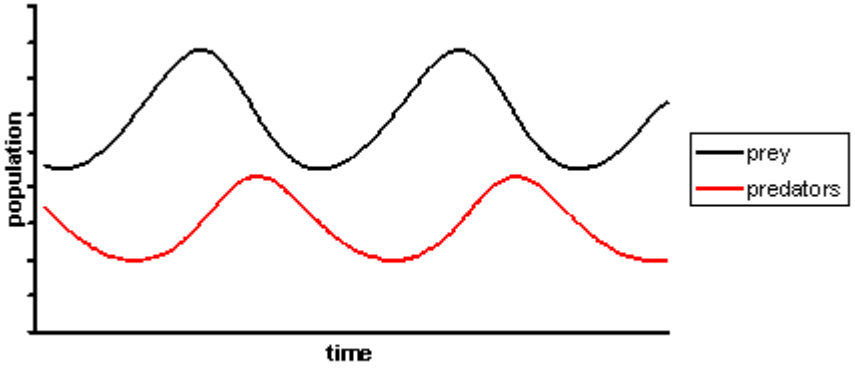
y is the number of predator

t represents the time; and

α, β, γ and δ are parameters describing the interaction of the two species.

Alfred Lotka
(1880-1949)

Vito Volterra
(1860-1940)



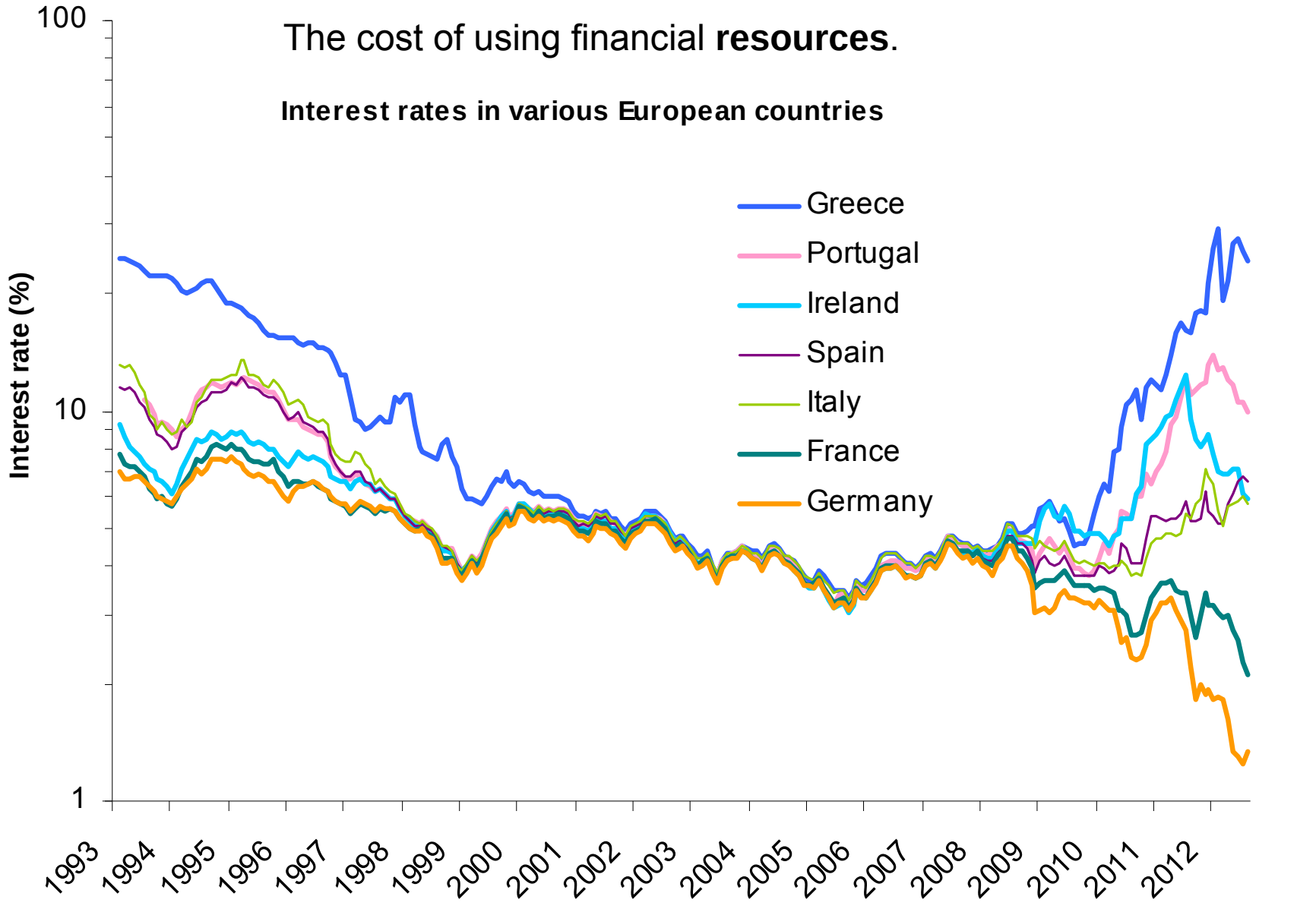
May, R.M. 1976. **Simple mathematical models with very complicated dynamics**. Nature 261: 459-467.

Robert May (born 1938)

The familiar Lotka-Volterra systems of differential equations used in ecology to describe two competing species are very tame: dynamic trajectories will converge on some stable equilibrium point which may represent coexistence or extinction of one species.

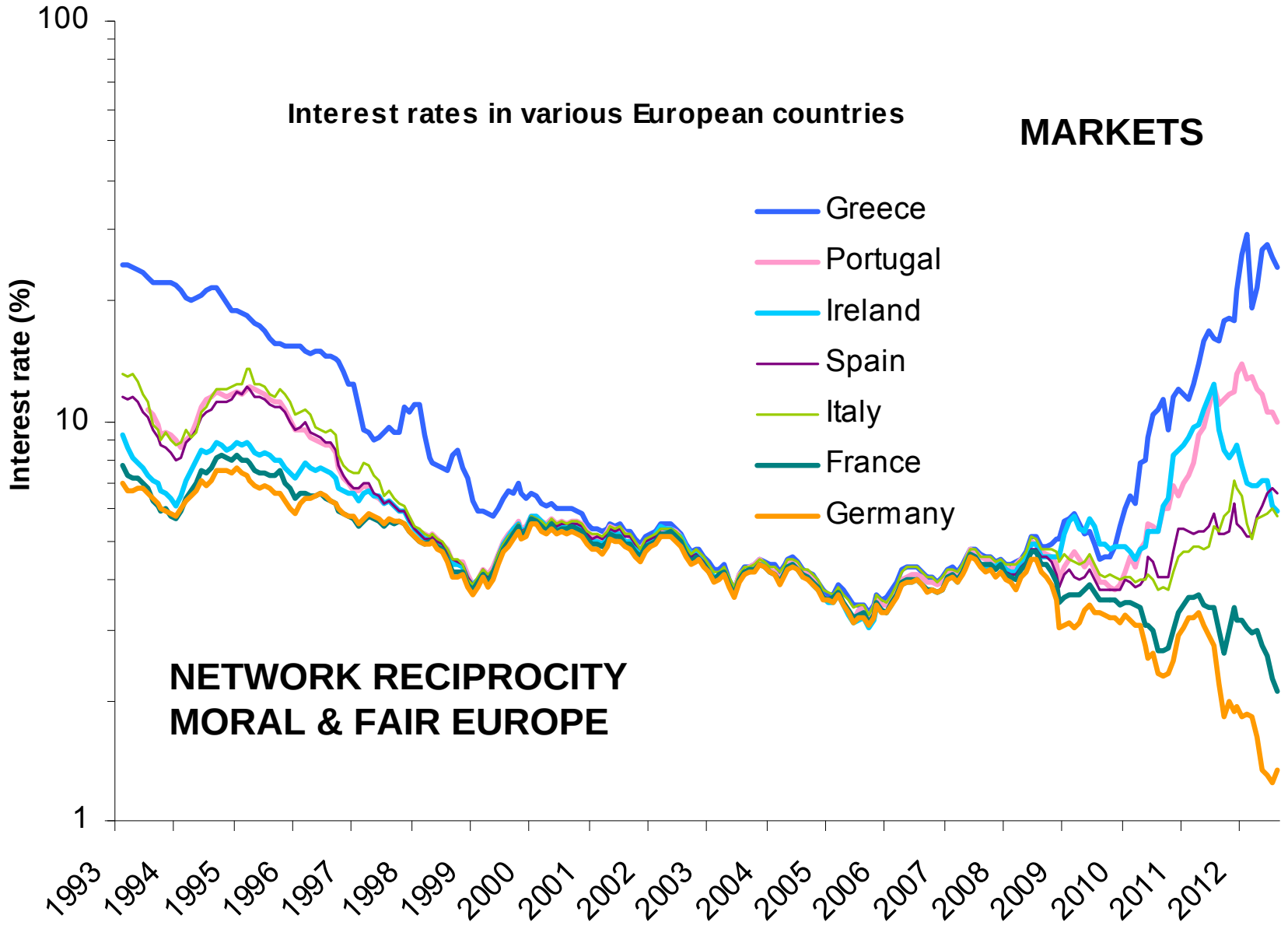
For 3 or more species these simple discrete nonlinear system of equations can exhibit a surprising array of bizarre dynamical behavior.

Not only in research, but also in the everyday world of **politics and economics**, we would all be better off if more people realized that simple non-linear systems do not necessarily possess simple dynamical properties.



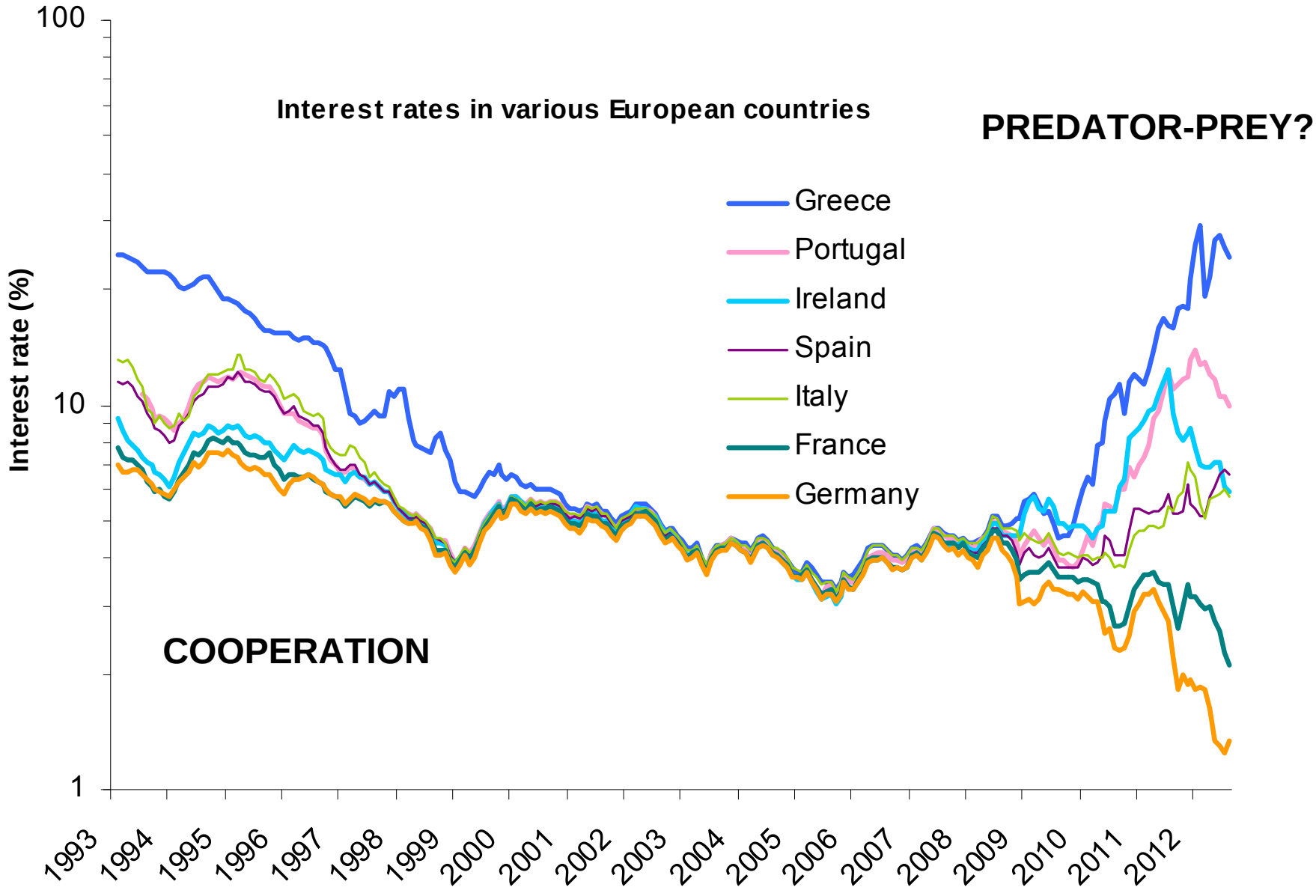
Sources: ECB and European Commission.

Statistical Data Warehouse (SDW): Euro Area, SDW, Long-term Interest Rates



Sources: ECB and European Commission.

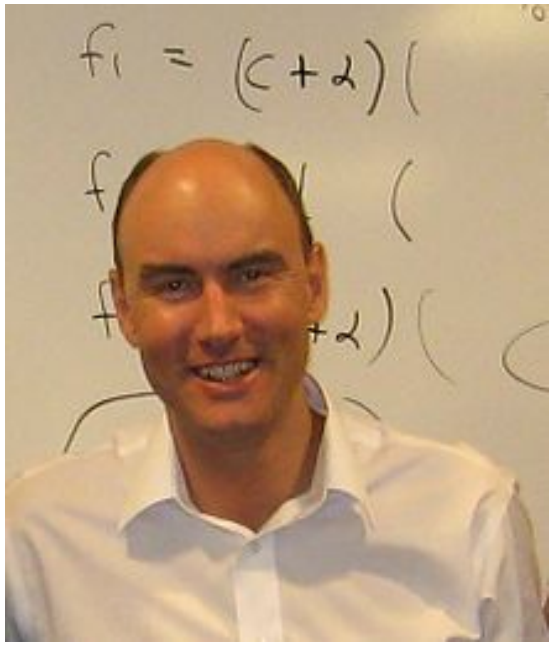
Statistical Data Warehouse (SDW): Euro Area, SDW, Long-term Interest Rates



Sources: ECB and European Commission.

Statistical Data Warehouse (SDW): Euro Area, SDW, Long-term Interest Rates

Nowak, M. and R. Highfield. 2011. Super Cooperators. Evolution, Altruism and Human Behaviour or Why **We Need Each Other to Succeed**. Canongate. Edinburgh.



Martin Nowak (born 1965)

Many problems that challenge us today can be traced back to a profound tension between what is good and desirable for society as a whole and what is good and desirable for an individual.

That conflict can be found in global problems such as climate change, pollution, resource depletion, poverty, hunger, and overpopulation.

Although human beings are the dominant cooperators on Earth, man has no alternative but to evolve further… because we face serious global issues, many of which boil down to a fundamental question of survival.

We now have to manage the planet as a whole.

We must become familiar with the science of cooperation.

Now, more than ever, the world needs **SuperCooperators**.