Networks and stability

Part 3C. – Examples for networks

Peter Csermely

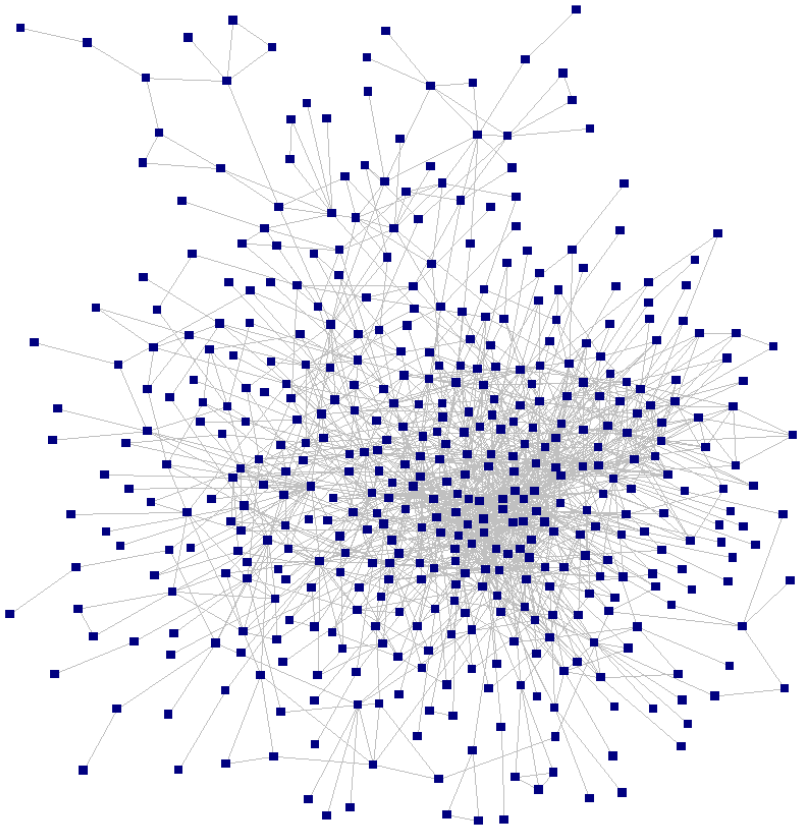
www.weaklink.sote.hu

1. network topology (II.20-27.)
2. network dynamics (III.6.-13.)
(III.20.-27. no lectures)
3. **examples for networks (IV**.3.10.-**24.)**
(IV.17. Easter)
4. synthesis (V.1. holiday, V.8.)
(V.13. consultation)

Examples for networks

- molecules
- networks in the cells
- networks from cells
- **social networks (social-nets)**
- cultural networks
- ecosystems

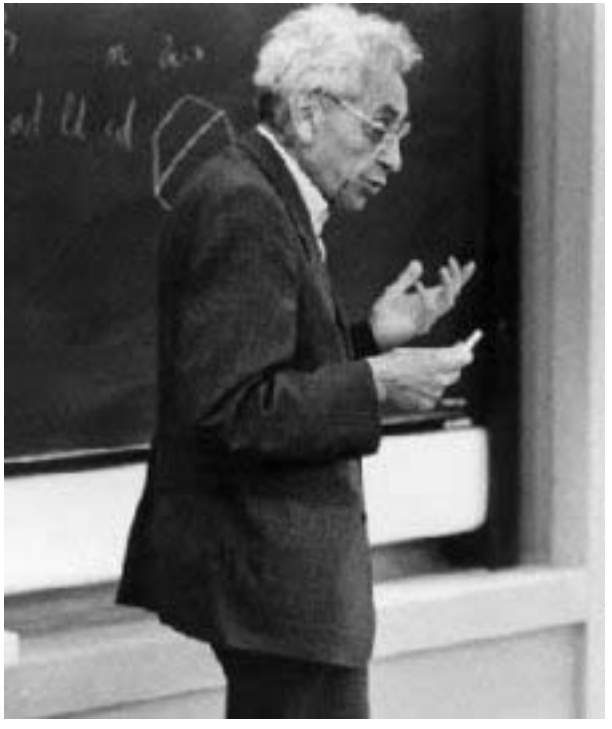
The Erdős-net



509 co-authors of Pál Erdős
(having an Erdős number of 1)
(Erdős number 2: >6984 persons)

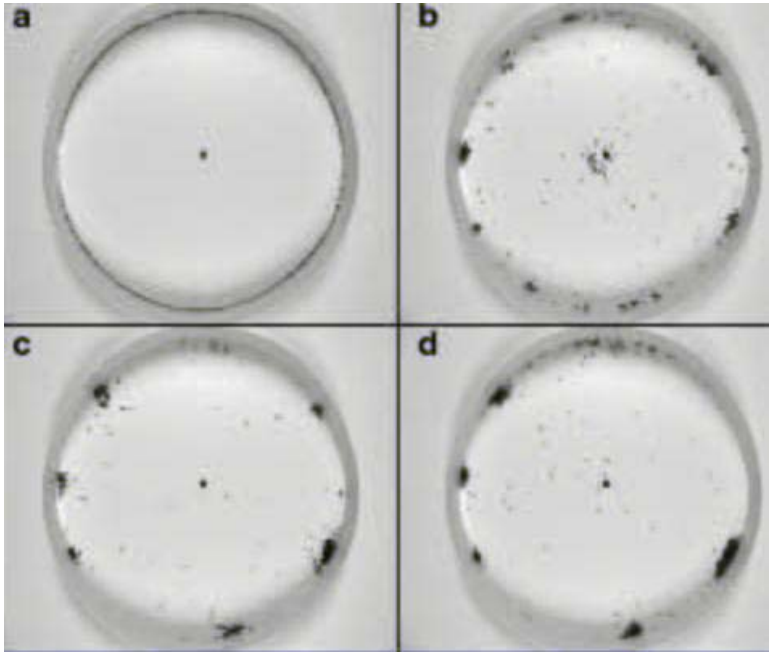
Where is Erdős?

Erdős is already in another dimension...



Pál Erdős
1913-1996

Ant behavior

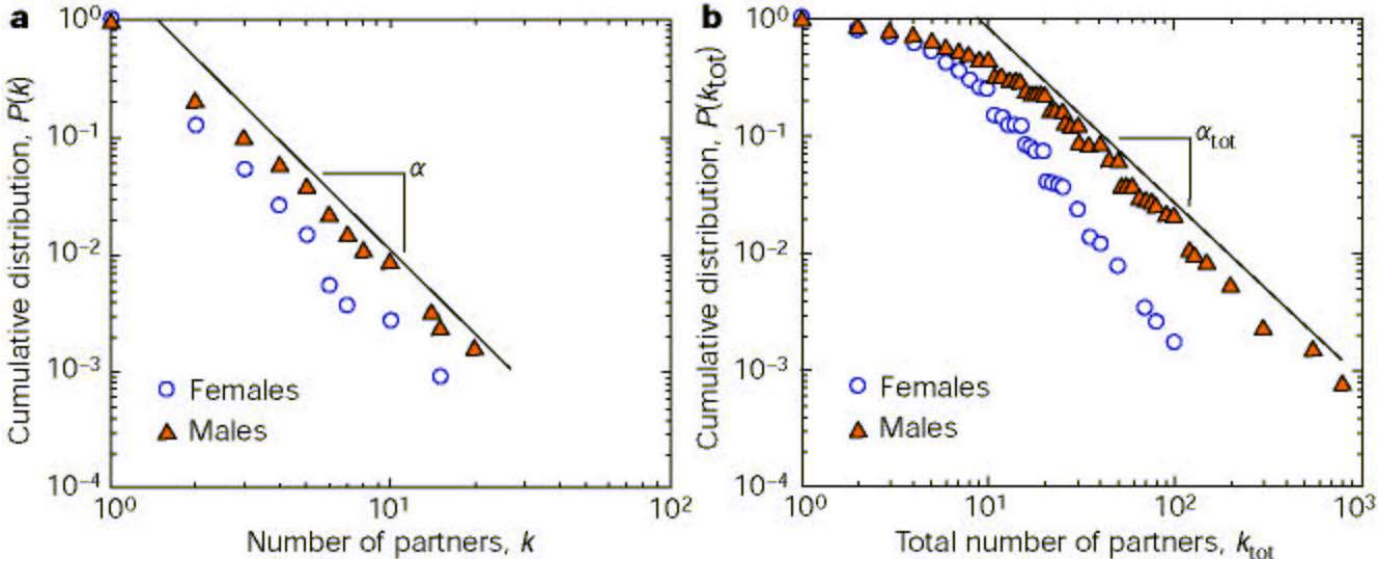


distribution of 400 corpses after 6, 12, 45 h

emergence of scale-free pattern…

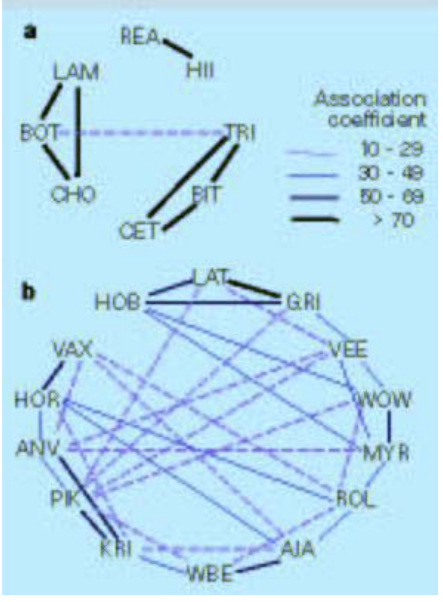
PNAS 99, 9645

Scale-free sex: preferential attachment



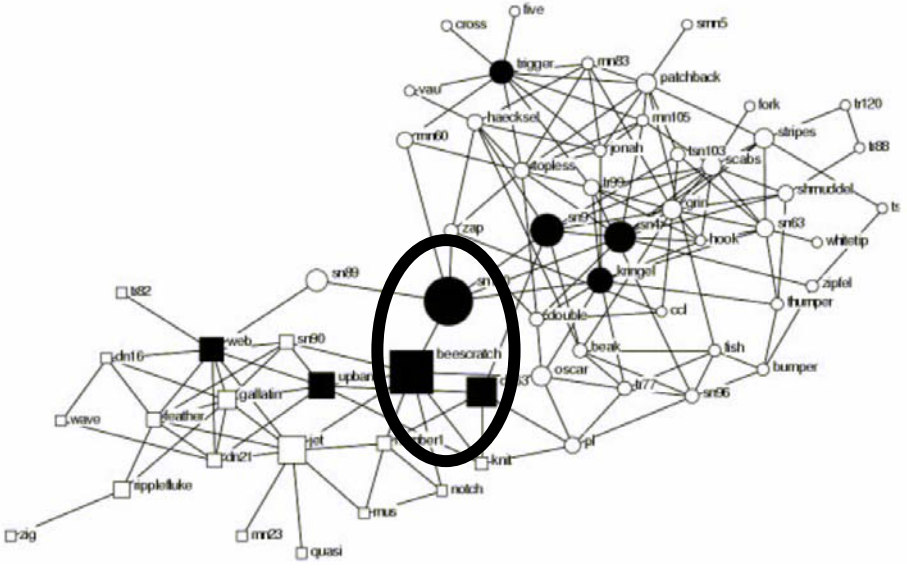
Nature 411, 907

Dolphin networks



Nature 397, 571

superalliances
(modularity, hierarchy)



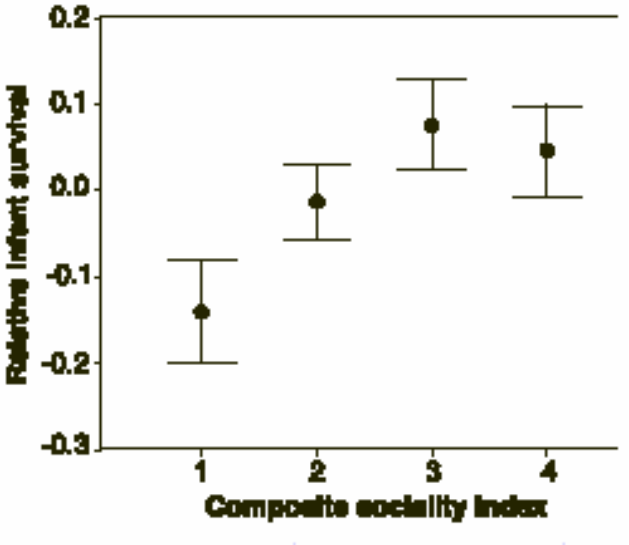
Lusseau & Newman Proc. Roy. Soc 271:S477 -04-

small worlds, bridges, VIP-s

Women stabilize the society

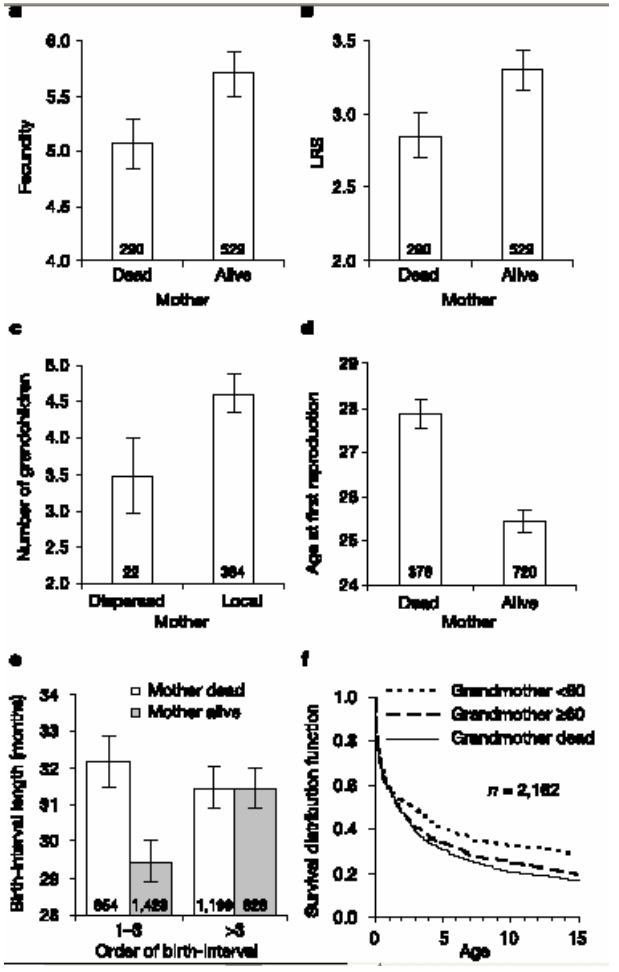
Social Bonds of Female Baboons Enhance Infant Survival

Joan B. Silk,[1]* Susan C. Alberts,[2,4] Jeanne Altmann[3,4,5]



Silk et al. Science 302, 1231

Afghanistan
Romeo and Juliet

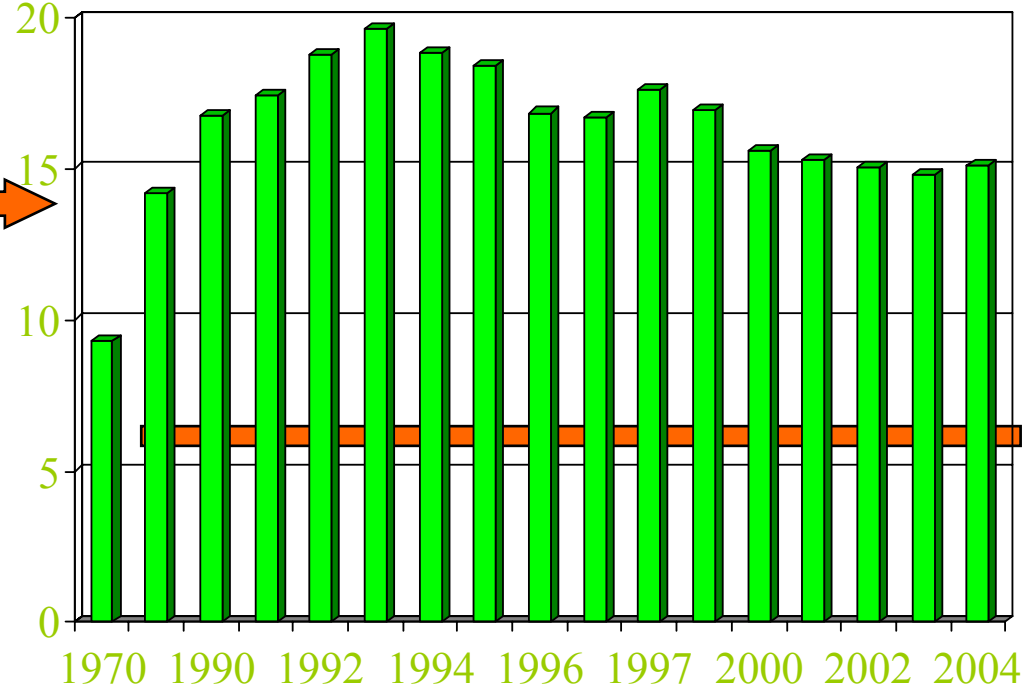


Lahdenpera et al
Nature 428, 178

The society stabilizes women

mortality rate of 50-54 ys. men/1000 pers.

1938



Women

Hung. Stat. Office

men compete (cortisol)
women cooperate (weak links)

Kopp and Réthelyi,
Brain Res. Bull. 62, 351

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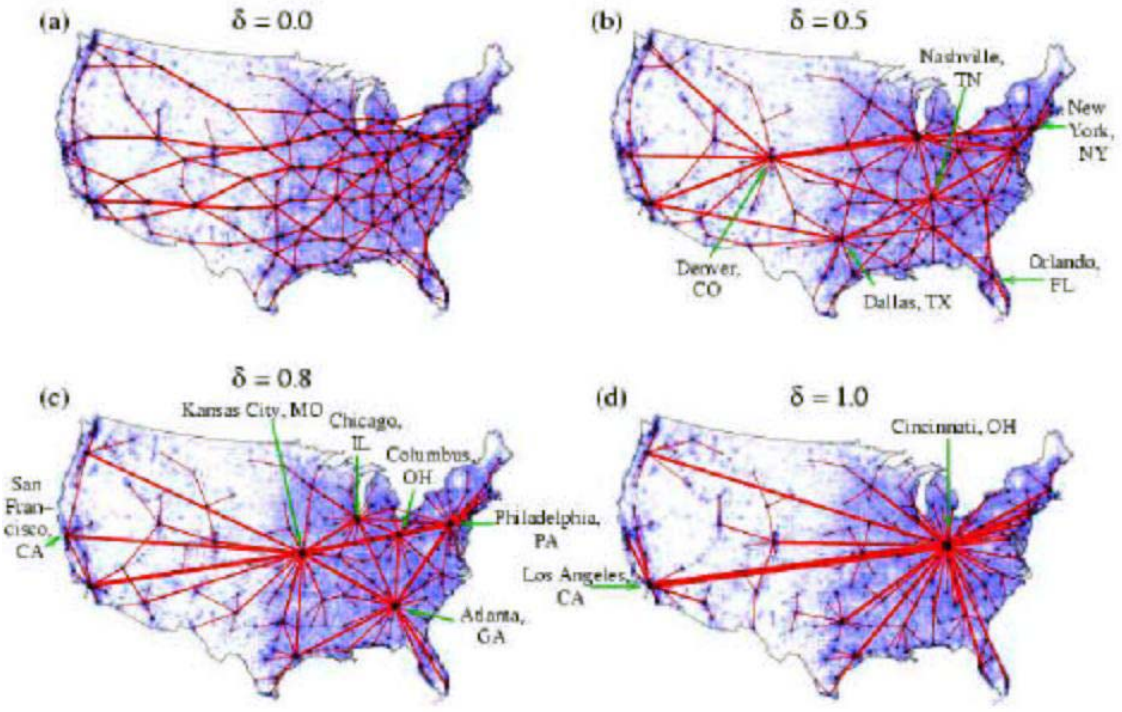
- **cultural networks**
- ecosystems

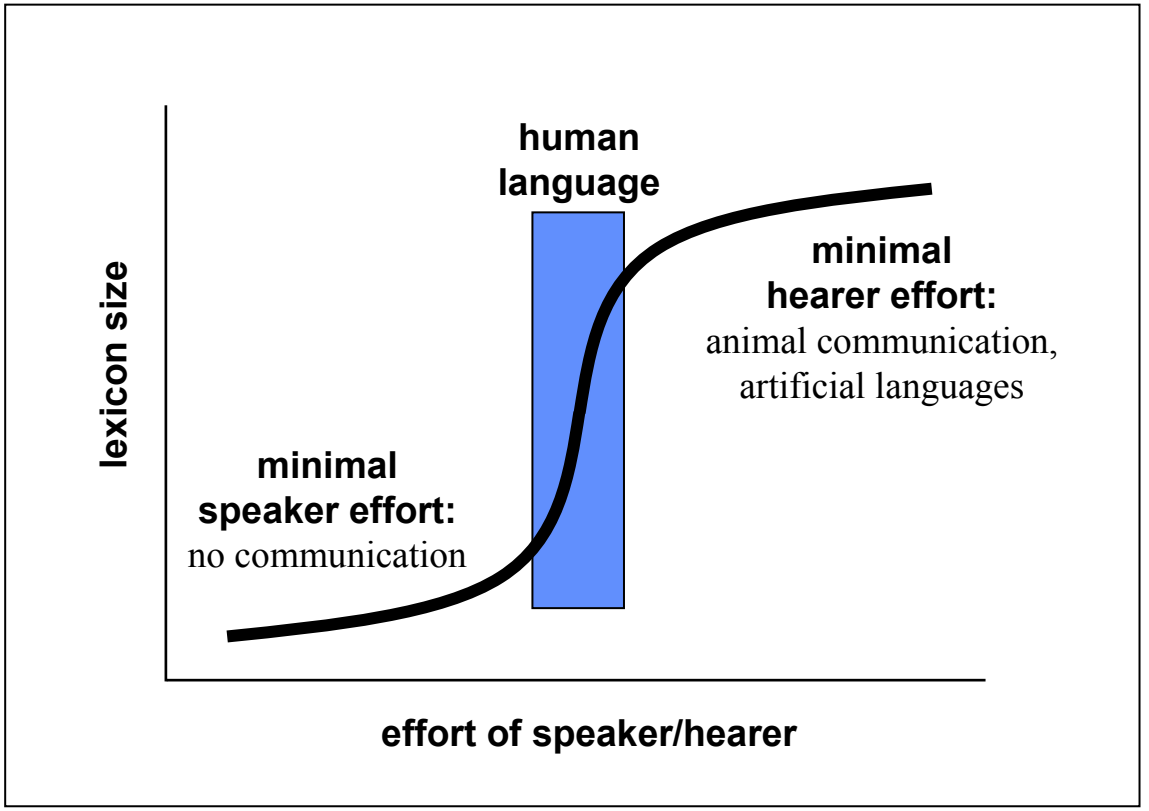
Traffic networks



cond-mat/0603278

optimal US-traffic net with
increasing costs of flight changes

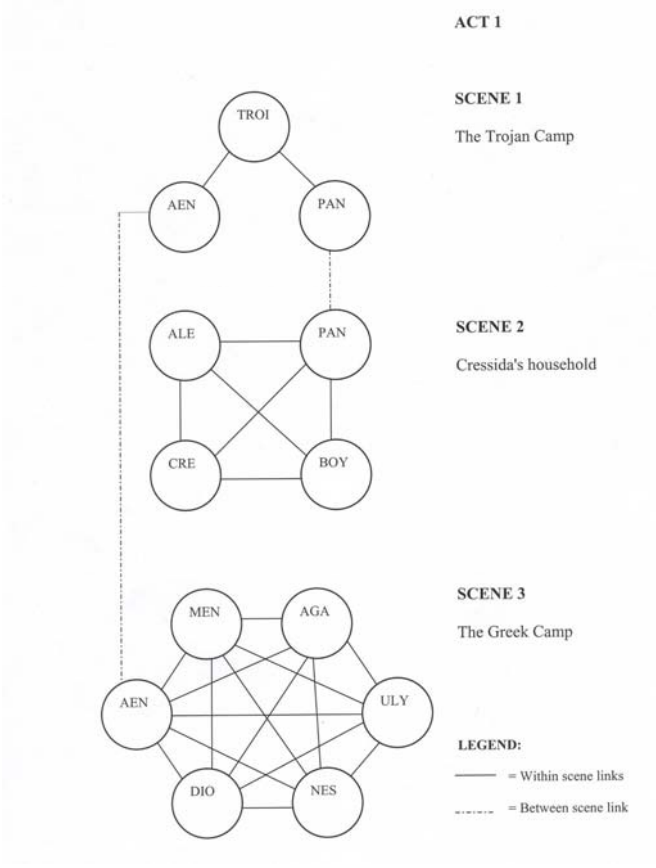
Zipf-law of the language-net



PNAS 100, 788

Drama-scenes

Shakespeare: Troilus and Cressida

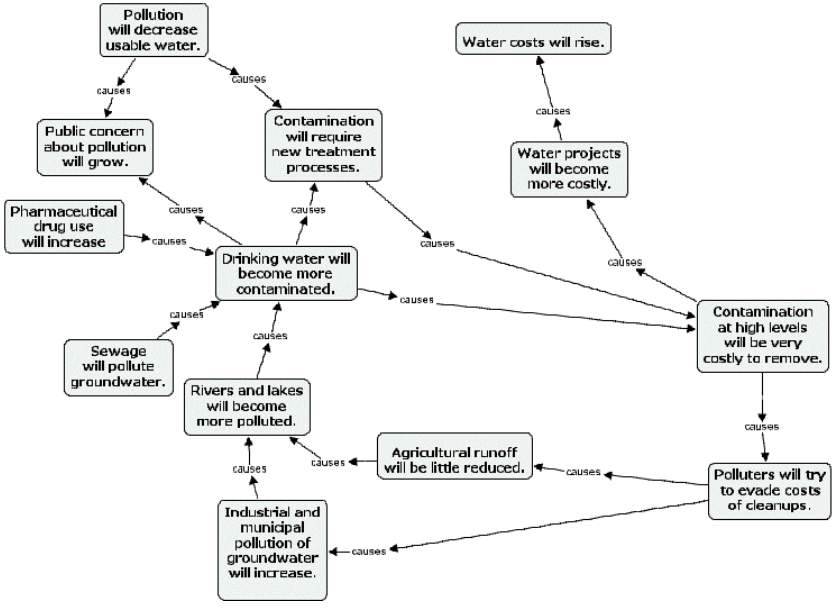


weak links connect and stabilize the scenes

Stiller and Hudson,
J. Cult. Evol. Psychol. 3, 57

social dimensions
social circles
catharsis – relaxation
congitive dimensions – masterpieces

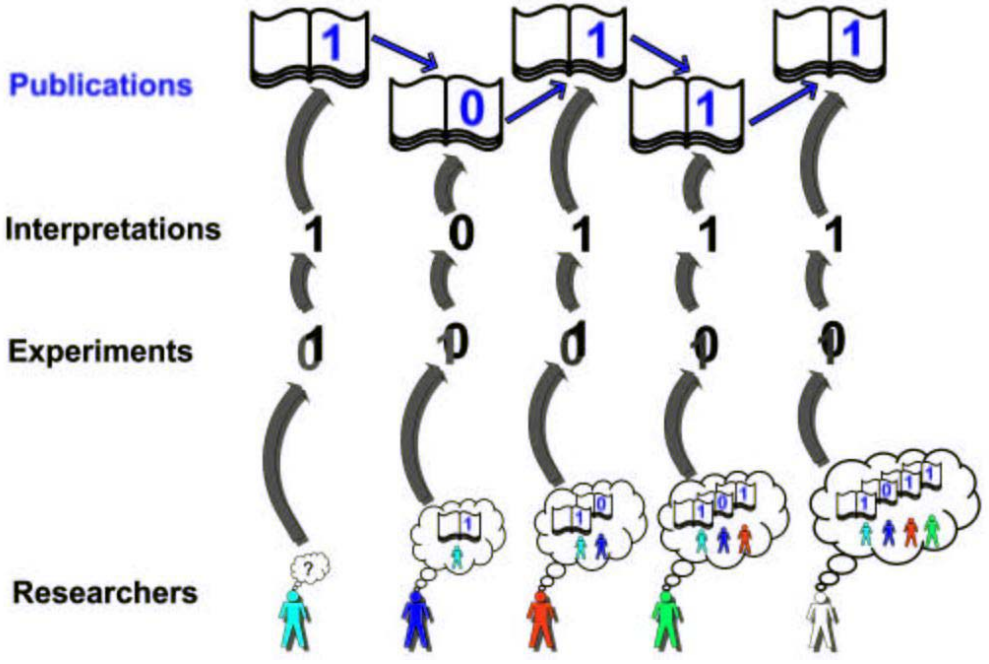
Important predictions are hubs



Raymond L. Johnson
Futures 36, 1095

„Some predictions are more interesting than others."
„...not because they differ boldly from a consensus view but because they relate to a number of other predictions to form a web of interlinked expectations."

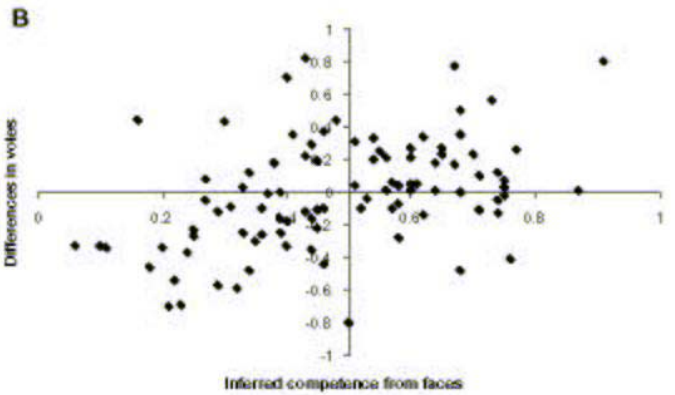
Scientific judgements are not independent



PNAS 103, 4940

optimistic universe: <5% false results
pessimistic universe: >90% false results

The power of judgements: US elections



competent: winner

not competent: looser

70% of cases
Science 308, 1623

The benefit of perfect judgements

1926 → 1996 one USD to

- US Treasury bills → 14 USD
- S&P 500 → 1,340 USD
- perfect foresight in each month: 2,296,183,456 USD

PNAS 96,9991

Examples for networks

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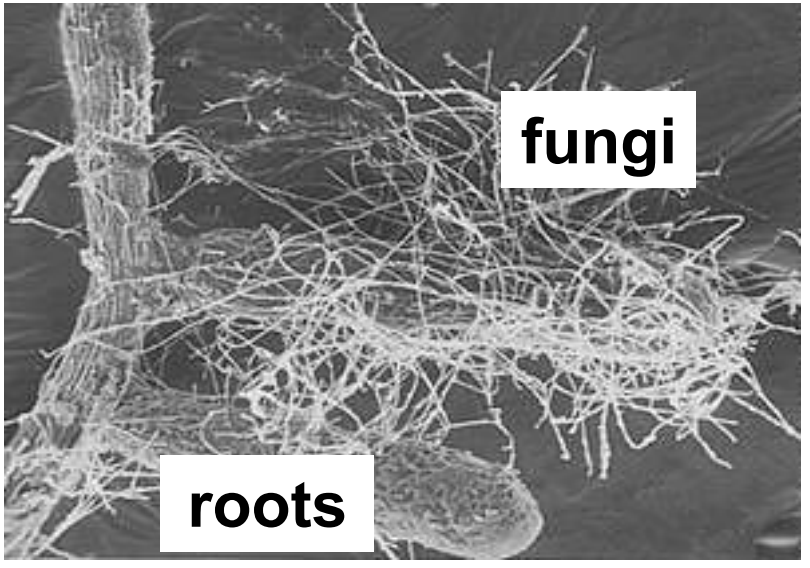
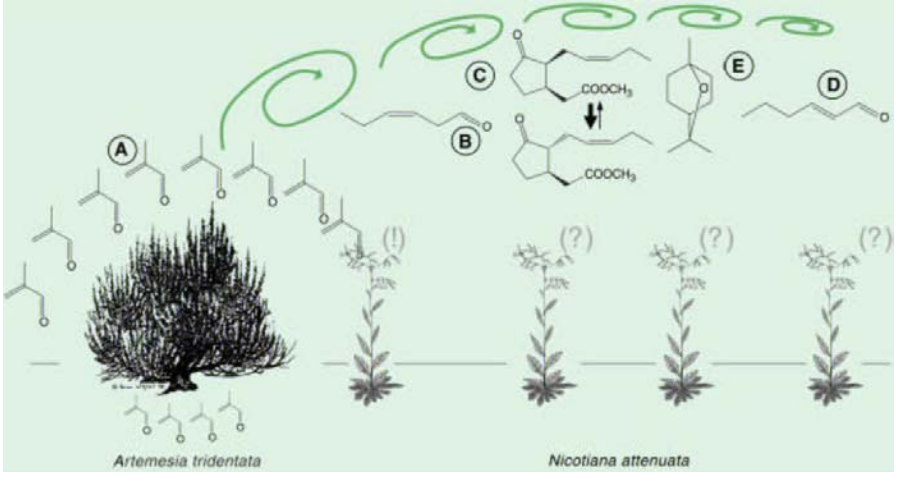
- **ecosystems**

Wood-wide web



mycorrhiza
100 m/g soil

danger signals elicit
stress conditioning



Science 311, 812

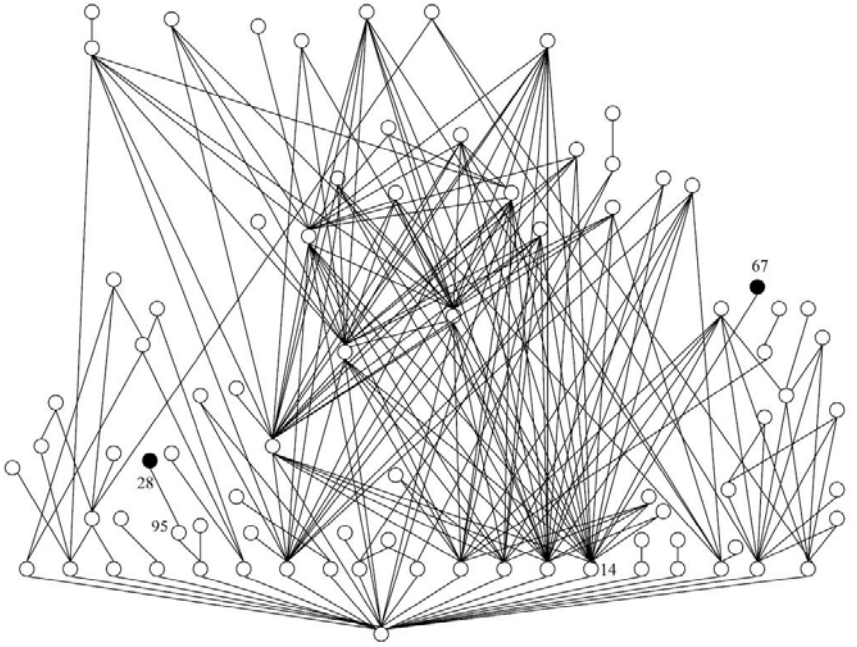
Ecosystem shifts

Table 1 Characteristics of some major ecosystem state shifts and their causes

Ecosystem	State I	State II	Events inducing shift from I to II	Events inducing shift from II to I	Suggested main causes of hysteresis	Factors affecting resilience
Lakes	Clear with submerged vegetation	Turbid with phytoplankton	Killing of plants by herbicide Killing of *Daphnia* by pesticide High water level	Killing of fish Low water level	Positive feedback of plant growth Trophic feedbacks	Nutrient accumulation
Coral reefs	Corals	Fleshy brown macroalgae	Killing of coral by hurricane Killing of sea urchins by pathogen	Unknown	Prevention of coral recolonization by unpalatable adult algae	Nutrient accumulation Climate change Fishing
Woodlands	Herbaceous vegetation	Woodlands	Fires Tree cutting	Killing of grazers by pathogen Hunting of grazers	Positive feedback of plant growth Inedibility of adult trees	Overgrazing Climate change
Deserts	Perennial vegetation	Bare soil with ephemeral plants	Climatic events Overgrazing by cattle	Climatic events	Positive feedback of plant growth	Climate change
Oceans	Various	Various	Climatic events	Climatic events	Physical	Fishing Climate change

Nature 413, 591

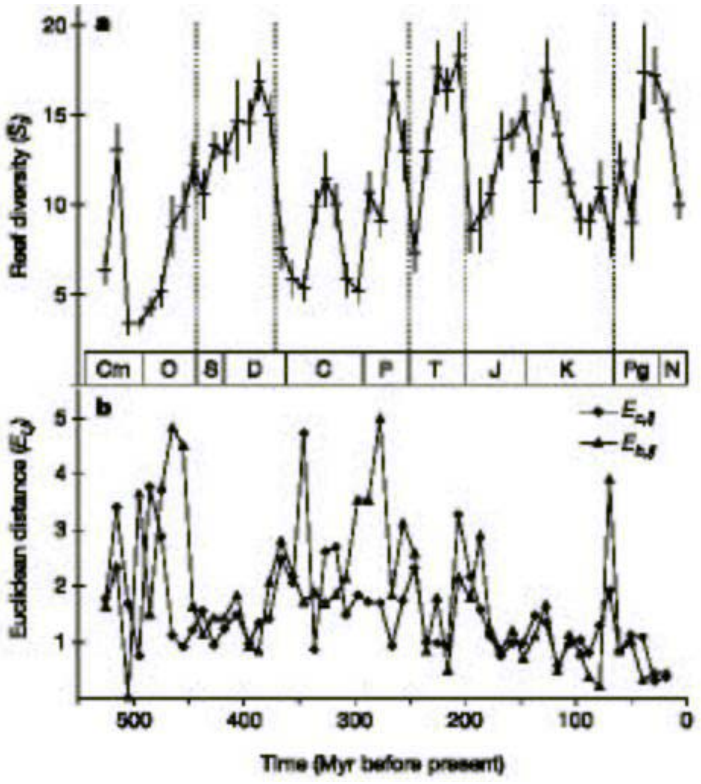
Keystone species: link-number is not all



67: 52 species
28: 4 species
one link each

Jordán-Scheuring Oikos 99, 607

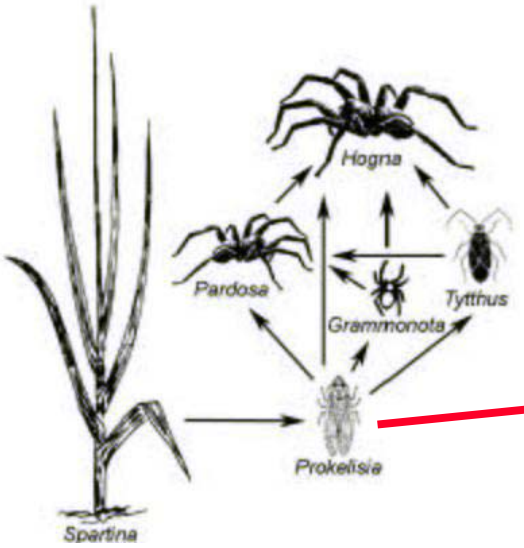
Diversity leads to stability



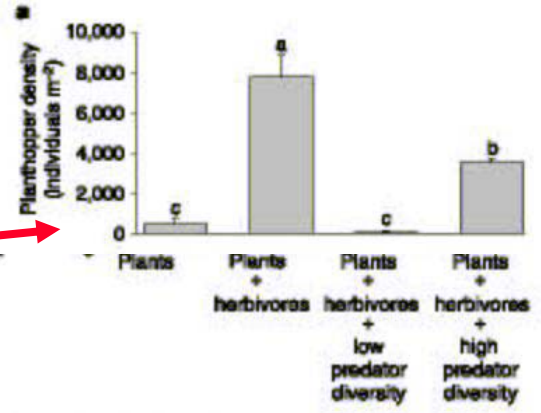
data of >3,300 coral reefs

Nature 433, 410

(Top) predator diversity is crucial for stability

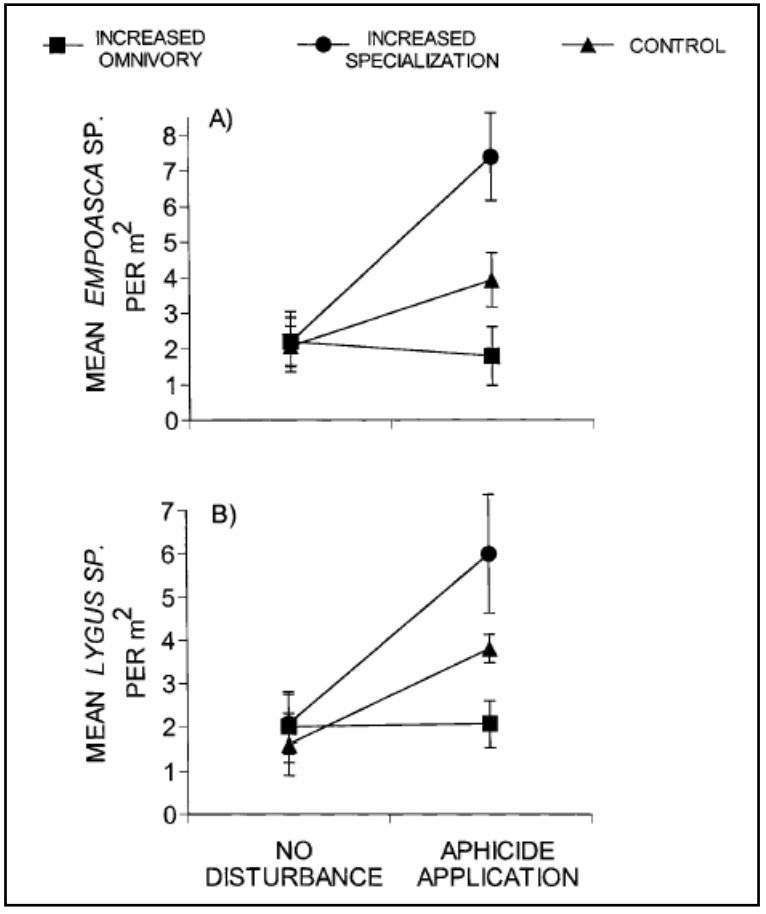


herbivore density



Nature 429, 407

Omnivores are good



againts species-fluctuations and cascading extinctions

Fagan,
Am. Naturalist 150, 554