Resource heterogeneity can facilitate cooperation

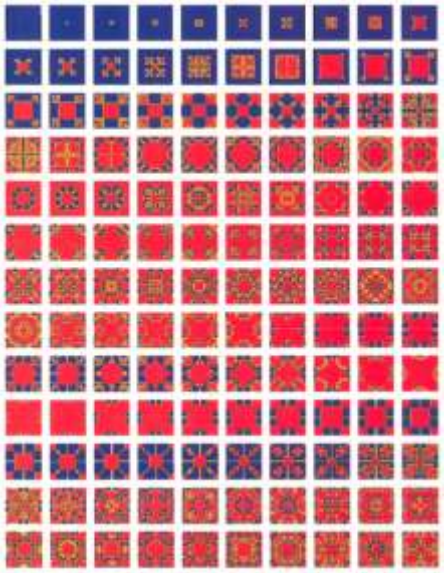
Ádám Kun[1,2] & Ulf Dieckmann[1]

[1] Evolution and Ecology Program, IIASA, Laxenburg, Austria

[2] Dpt. Plant Taxonomy and Ecology, Eötvös University, Budapest, Hungary

Previous research

- Population structure is advantageous for cooperation
- However, in earlier studies every individual has the same amount of resource



Model description

- Individuals are located on either poor or rich sites
- Individuals are either cooperators (invest all of their resources) or defectors (no investment)
- Individuals play a 2-person Public Good Game (equivalent to a Prisoner's Dilemma) with all their neighbors

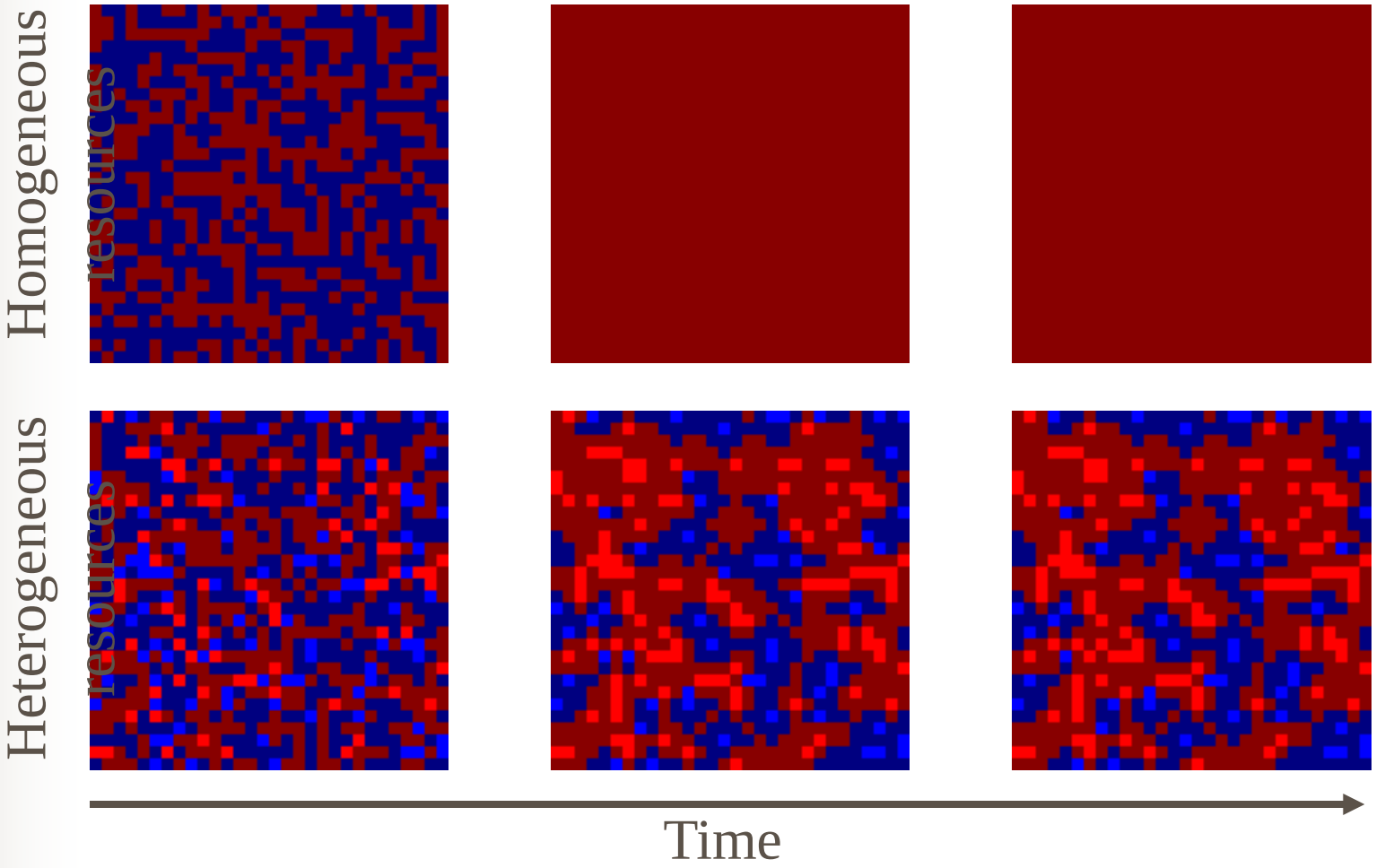
Payoff matrix

	Second player	Rich site		Poor site	
First player		Cooperate	Defect	Cooperate	Defect
Rich site	Cooperate	$2c+1$	c	$c+1$	c
	Defect	$bc+b+c$	$bc+b-1$	$bc+b$	$bc+b-1$
Poor site	Cooperate	$c+1$	0	1	0
	Defect	$b+c$	$b-1$	b	$b-1$

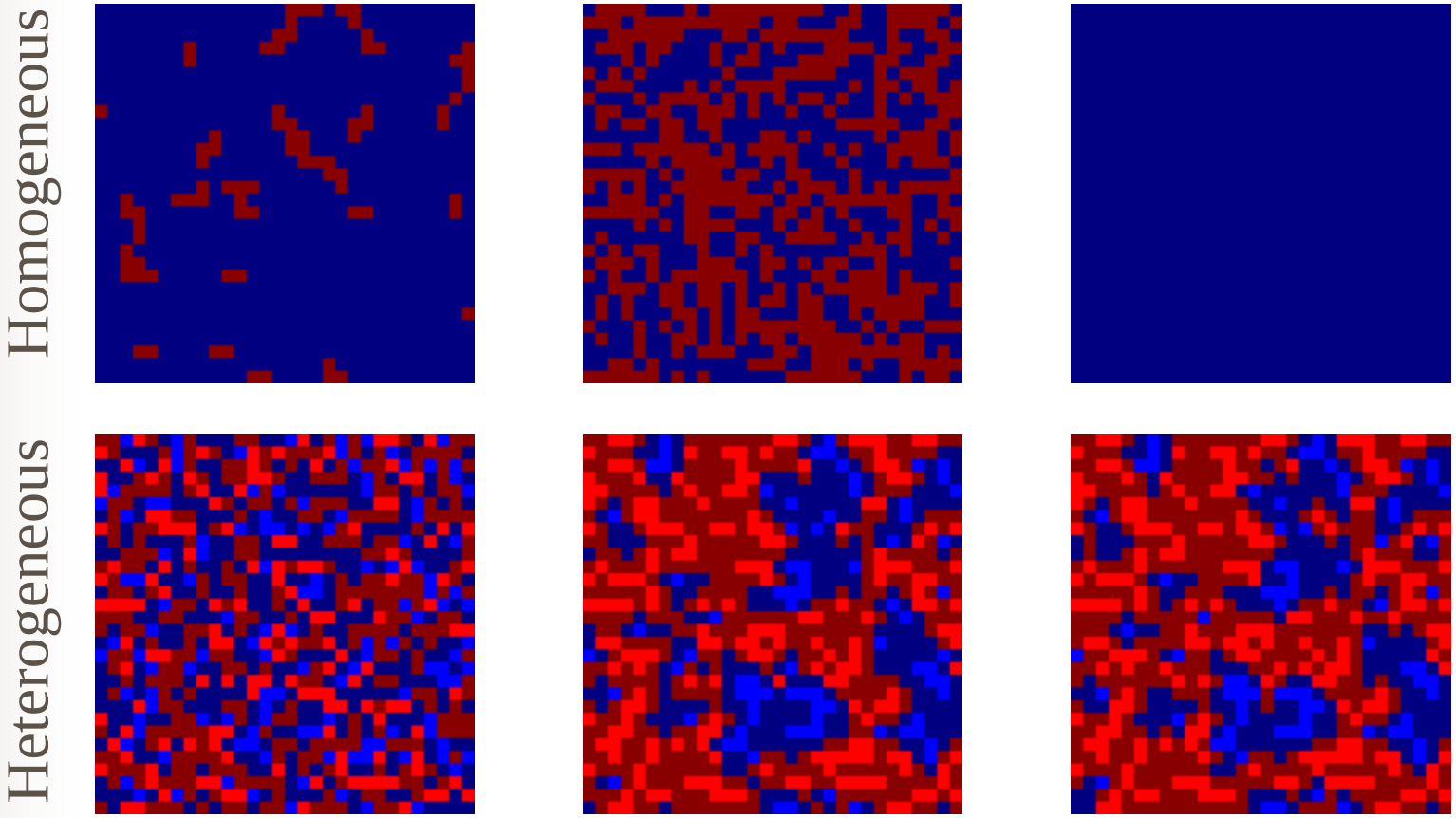
$$b = 2/r$$

$$c = \left(R_2 - R_1\right)/R_1$$

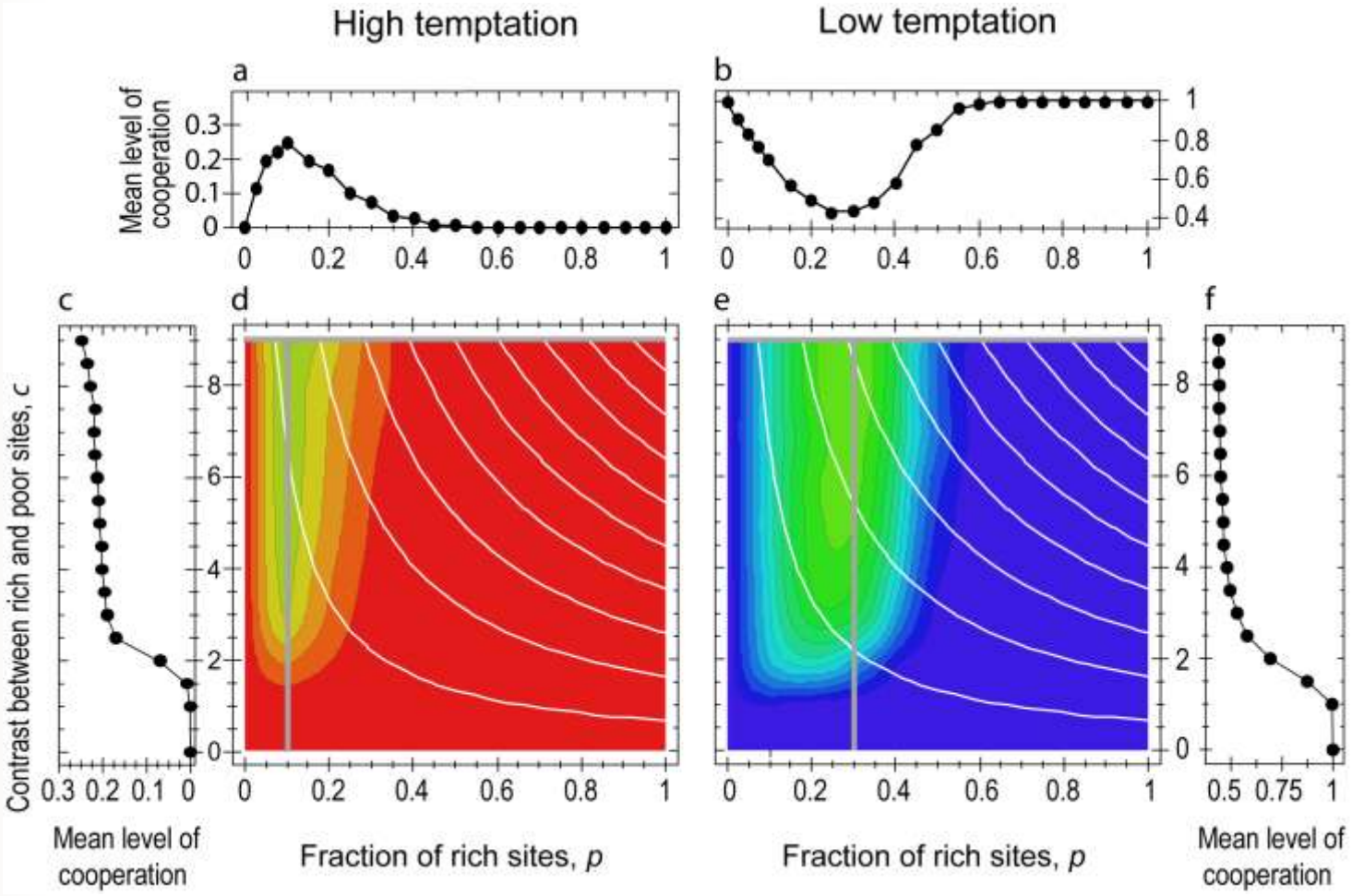
High temptation to defect



Low temptation to defect



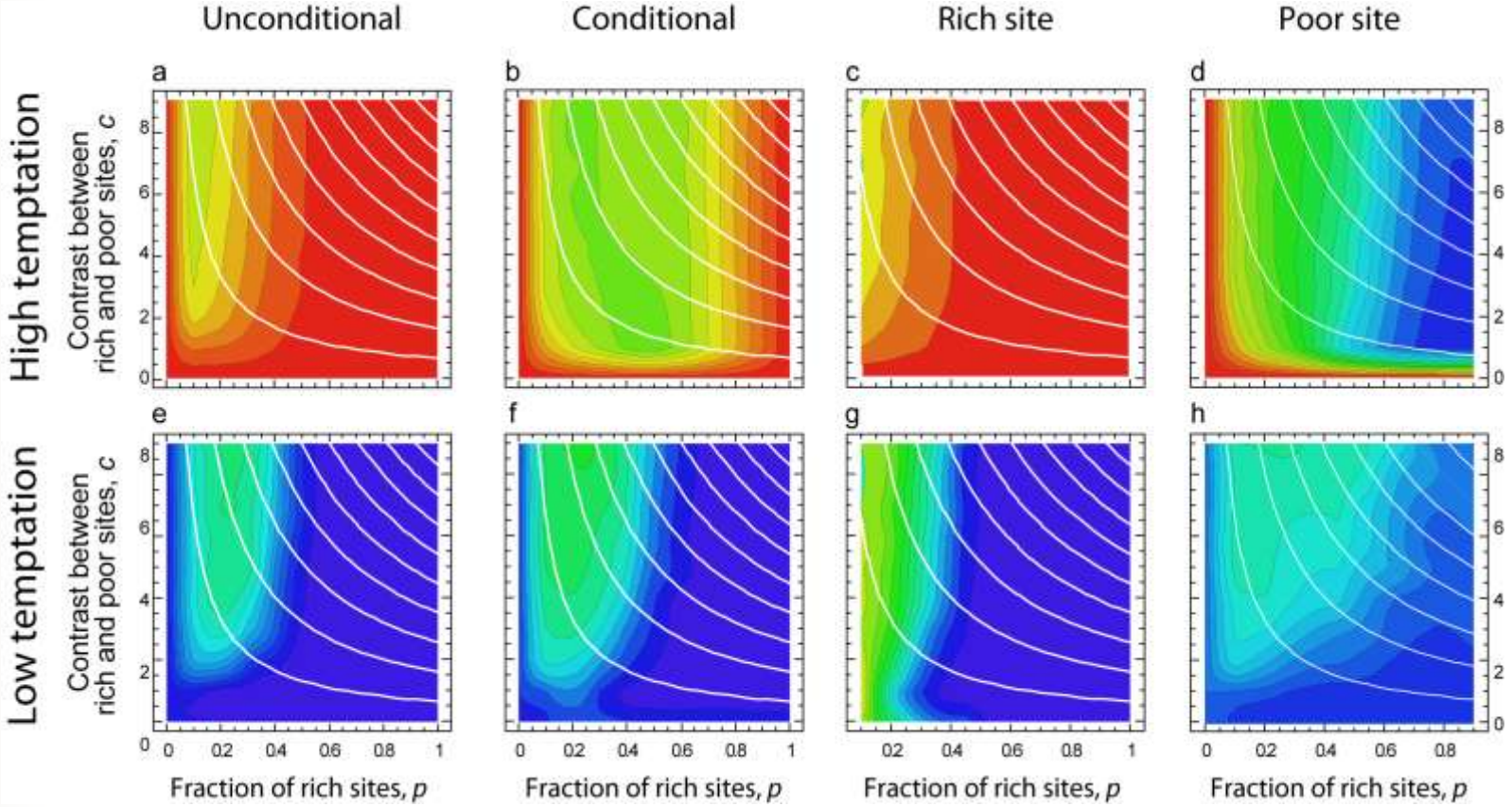
Heterogeneity alters cooperation



Results are robust

- Update rules
- Error in the execution of the strategies
- Interaction topology (8 neighbors, random regular graph)
- 5-player Public Good Game

Evolving investment levels



Conclusions

- Heterogeneity allows cooperation to persist where otherwise it could not
- Heterogeneity can be shaped to maximize cooperation