

Matrix models of populations infected by fungal pathogen – predictions and reality

Interactions of plants with other trophic levels such as pathogenic fungi can have great influence on plant populations. The quantification of the effect on different scales should be the way to determine if the influence is really important. Unfortunately the studies on this subject usually only aim at one level and so they can't show the general picture. My aim is:

- ☞ To examine the whole life cycle of a plant with pathogen included and excluded and to compare these life cycles using matrix a model
- ☞ Compare the results of the model with real values observed in the nature

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STUDY SYSTEM

Falcaria vulgaris – *Puccinia sii-falcariae*

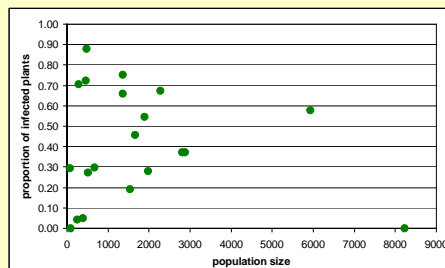
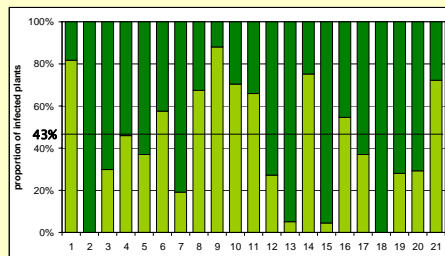
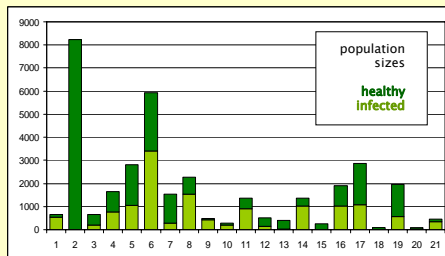
healthy



infected (with monoecious rust)



landscape level



population level

- Healthy and infected plants were labeled (100 plants both) and measured in **4 populations**
- These were found and measured in the second year (and third for one pop.)
- Data were processed into **matrices** and their **growth rates (λ)** and **proportions of infected plants** were computed

Locality **Jahodová stráž** (transitions 2004–2005 and 2005–2006) life-cycle matrices

		t						whole population $\lambda = 0.94$
		healthy			infected			
t+1	healthy	juv	veg	fer	juv	veg	fer	healthy part $\lambda = 1.11$
	healthy	juv	0.50	0.41	5.32	0.06	0	
infected	healthy	veg	0.19	0.38	0.08	0	0	0
	infected	fer	0	0.03	0.67	0	0	0
good year	healthy	juv	0.27	0.08	0	0.56	0.33	0
	infected	veg	0.04	0.11	0.17	0.21	0.61	0
bad year	healthy	fer	0	0	0.08	0	0	0
	infected	juv	0	0	0	0	0	0

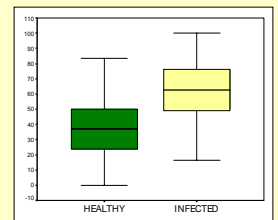
• predicts 27% healthy and 73% infected plants

		t						whole population $\lambda = 0.83$
		healthy			infected			
t+1	healthy	juv	veg	fer	juv	veg	fer	healthy part $\lambda = 0.92$
	healthy	juv	0.46	0.24	1.427	0.02	0	
infected	healthy	veg	0.15	0.41	0.17	0	0	0
	infected	fer	0.08	0	0.25	0	0	0
good year	healthy	juv	0.08	0.12	0	0.68	0.58	0
	infected	veg	0.04	0.12	0.08	0.07	0.31	0
bad year	healthy	fer	0	0	0.08	0	0	0.25
	infected	juv	0	0	0	0	0	0

• predicts 28% healthy and 72% infected plants

If you put both those years in single model using **stochastic modelling** (random sequence of the these two years projected), interesting things arise:

- stochastic growth rate is $\lambda = 0.95$, which is more than both years separately
- projected population composition is **39% healthy and 61% infected**
- this can be compared with the **real values** which are **45% healthy and 55% infected** plants in the population



• bootstrapped values of healthy and infected part of the population

- ☞ the populations are of various sizes and have various infection rates
- ☞ the mean infection rate is around **43%**
- ☞ as the population size decreases, the infection rates get more variable
- ☞ there are two populations with almost no infection (nr. 2 and 18) – this is probably caused by extreme climatic conditions at the sites

data for transition 2005–2006

☞ GRASSLANDS	λ	infection rates	
		projected	real
• Jahodová stráž	0.83	72%	55%
• U doubravy	0.75	50%	37%
☞ RUDERAL SITES			
• Koridor	1.07	50%	57%
• U strašáka	2.20	30%	37%

☞ the **growth rates** are generally **lower** at the natural **grasslands**

☞ the **infection rates** are generally **lower** at the **ruderal sites**

☞ the projected values of infection rates are not exactly corresponding with the real values



☞ Matrix models of the populations predict grassland localities to decrease, partly because of the disease, the projected infection rates however don't fit the real values

☞ Ruderal sites have populations rather growing in size with projected infection rates lower than for the grassland populations

☞ Stochastic model (combination of two years) can produce more realistic values of infection rates