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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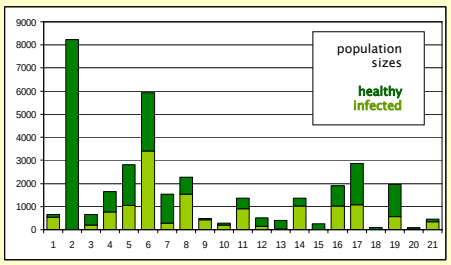
STUDY SYSTEM

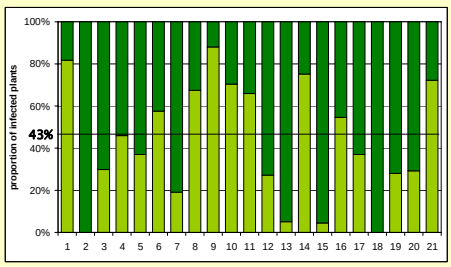
Falcaria vulgaris – Puccinia sii-falcariae

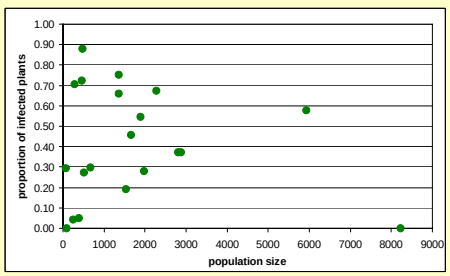
healthy

infected (with monoecious rust)

landscape level







- 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

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 stráň** (transitions 2004–2005 and 2005–2006) life-cycle matrices

t+1		t: healthy juv	healthy veg	healthy fer	infected juv	infected veg	infected fer
healthy	juv	0.50	0.41	5.32	0.06	0	0
	veg	0.19	0.38	0.08	0	0	0
	fer	0	0.03	0.67	0	0	0
infected	juv	0.27	0.08	0	0.56	0.33	0
	veg	0.04	0.11	0.17	0.21	0.61	0
	fer	0	0	0.08	0	0	0

whole population λ = 0.94

healthy part λ = 1.11

good year

- predicts 27% healthy and 73% infected plants

t+1		t: healthy juv	healthy veg	healthy fer	infected juv	infected veg	infected fer
healthy	juv	0.46	0.24	1.427	0.02	0	0.38
	veg	0.15	0.41	0.17	0	0	0
	fer	0.08	0	0.25	0	0	0
infected	juv	0.08	0.12	0	0.68	0.58	0
	veg	0.04	0.12	0.08	0.07	0.31	0
	fer	0	0	0.08	0	0	0.25

whole population λ = 0.83

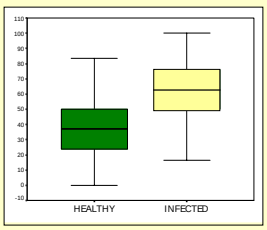
healthy part λ = 0.92

bad year

- 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 **λ = 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 popultion

data for transition 2005–2006	λ	infection rates: projected	real
GRASSLANDS			
• Jahodová stráň	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

x

- 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