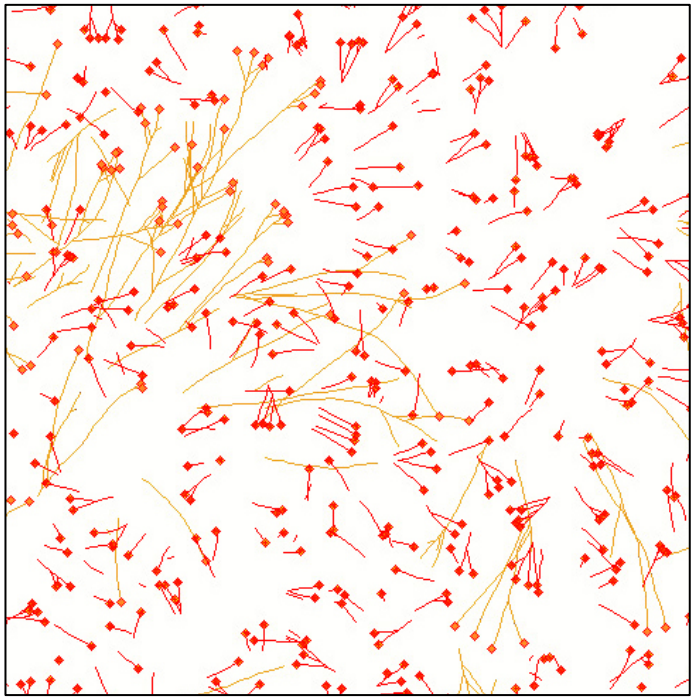
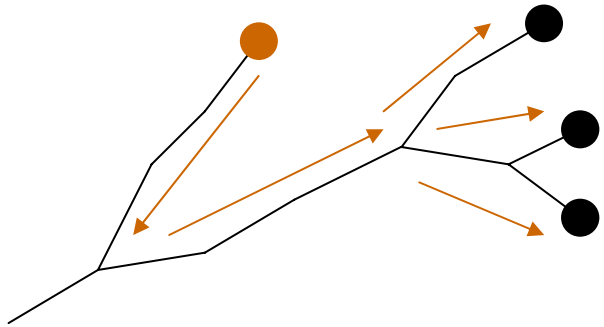
Modelling infection in clonal networks

Tomáš Koubek & Tomáš Herben





Introduction

The integration in clonal plants has

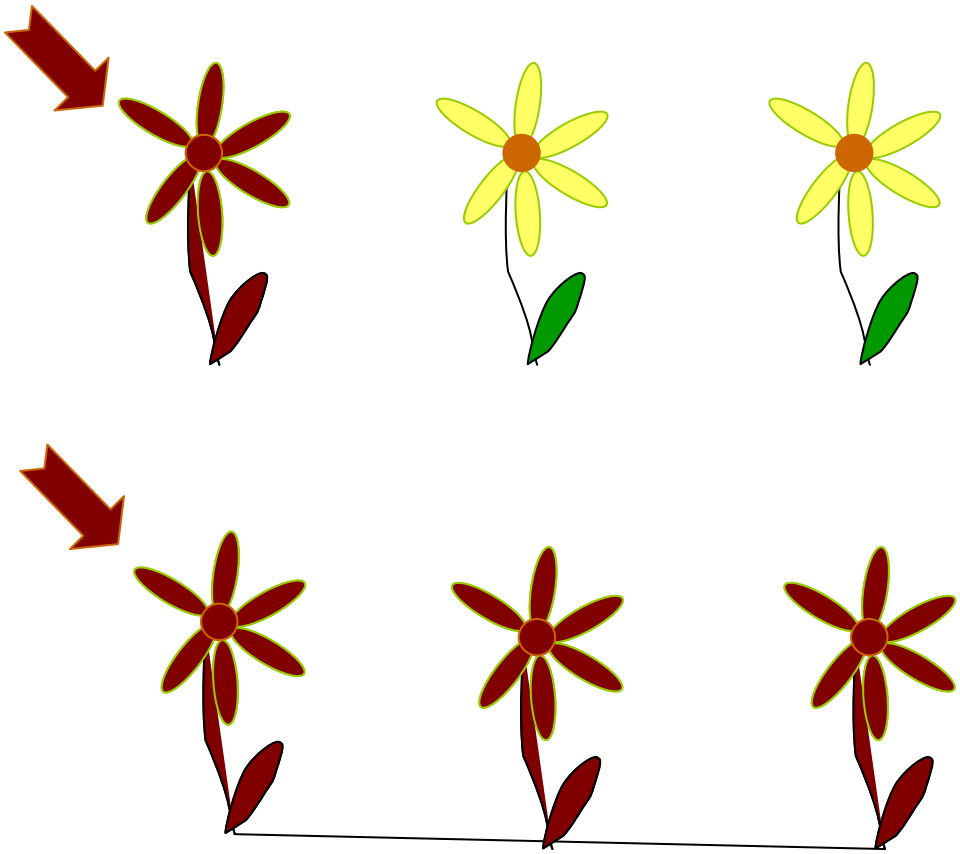
advantages

- support of young ramets
- resource sharing
- division of labour
- information sharing

disadvantages

- easy spread of diseases in the clonal network

Introduction



Hypothesis

1. The more integrated the clonal network is, the more the population of the species suffers from disease
2. With higher infection rates, the integrated networks are more influenced by the disease

⇨ this can be tested by spatially explicit model

The model (previous results)

1. Different arrangements of translocation directions (sinks) produce different growth forms of the plant
2. Translocation is beneficial even in homogeneous environment, because the plants themselves create the heterogeneity

Herben T. (2004) Evolutionary ecology

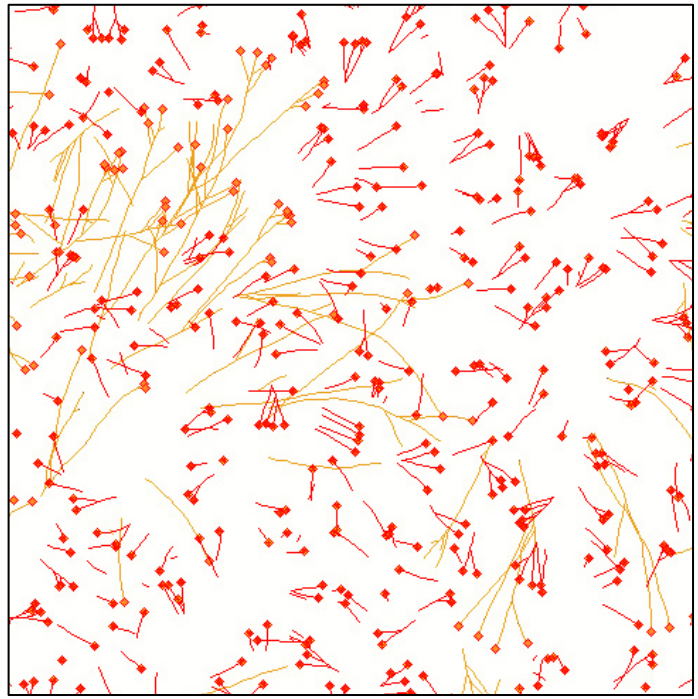
The model

RHIZOME

- processes
  - growth of rhizomes
  - branching
  - rhizome fragmentation

  - ramet formation and growth
  - resources acquisition
  - competition
  - translocation

  - infection at specified rate
  - infection spread and effects



http://www.natur.cuni.cz/~herben/rhizome/rhizome.html

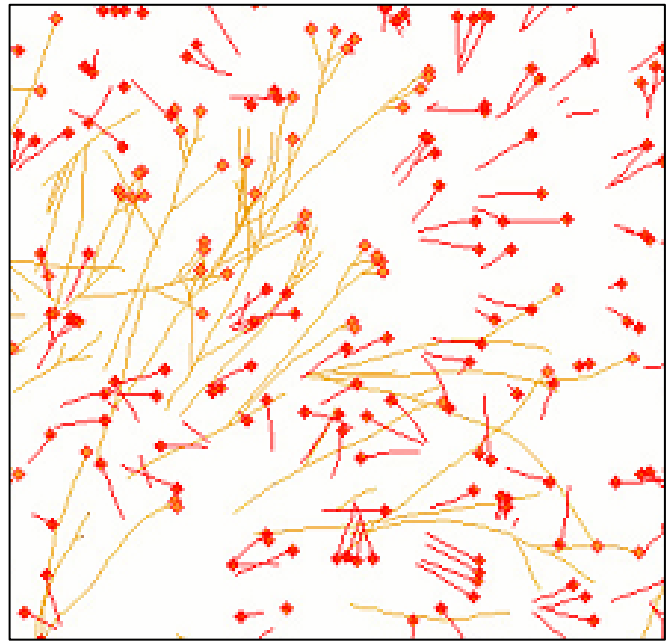
Settings

length of the network

⇩

SPECIES

- **splitter** – connection dies off when 10 nodes are formed
- **integrator** – connection dies off after 20 or 30 nodes are formed, otherwise identical to splitter
- integrator 10 nodes long used as control



Parameters

INFECTION RATE – proportion of ramets infected at each step, spatially independent, *zero means no infection*

(log scale from 0 to 0.1)

SEVERITY – proportion of resources retained by the ramet under pressure of the infection, *zero means the ramet is killed instantly*

(0 and 0.25)

PROPORTION SHARED – proportion of resources that can be translocated from one ramet through rhizomes

(0 and 0.1)

SHARING RANGE – length of integrator (10, 20 and 30)

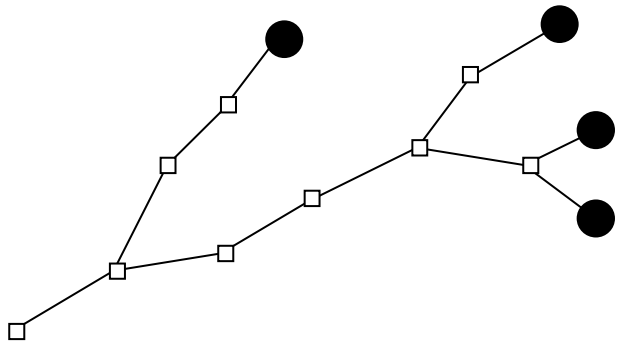
Settings

ARCHITECTURE

- ramets only on the growing tip (replacement type)
- only terminal branching possible

TRAITS

- no translocation cost
- plants produce seeds



INFECTION SPREAD

- immediate

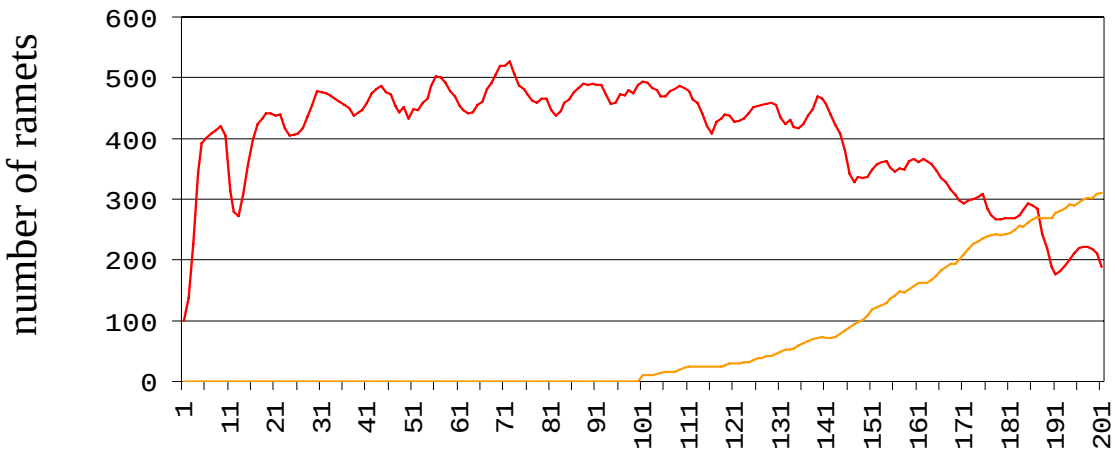
First results

With the same numbers of splitters and integrators put into the simulation, the **integrator always wins** except when both infection rates and severity of the disease are very high

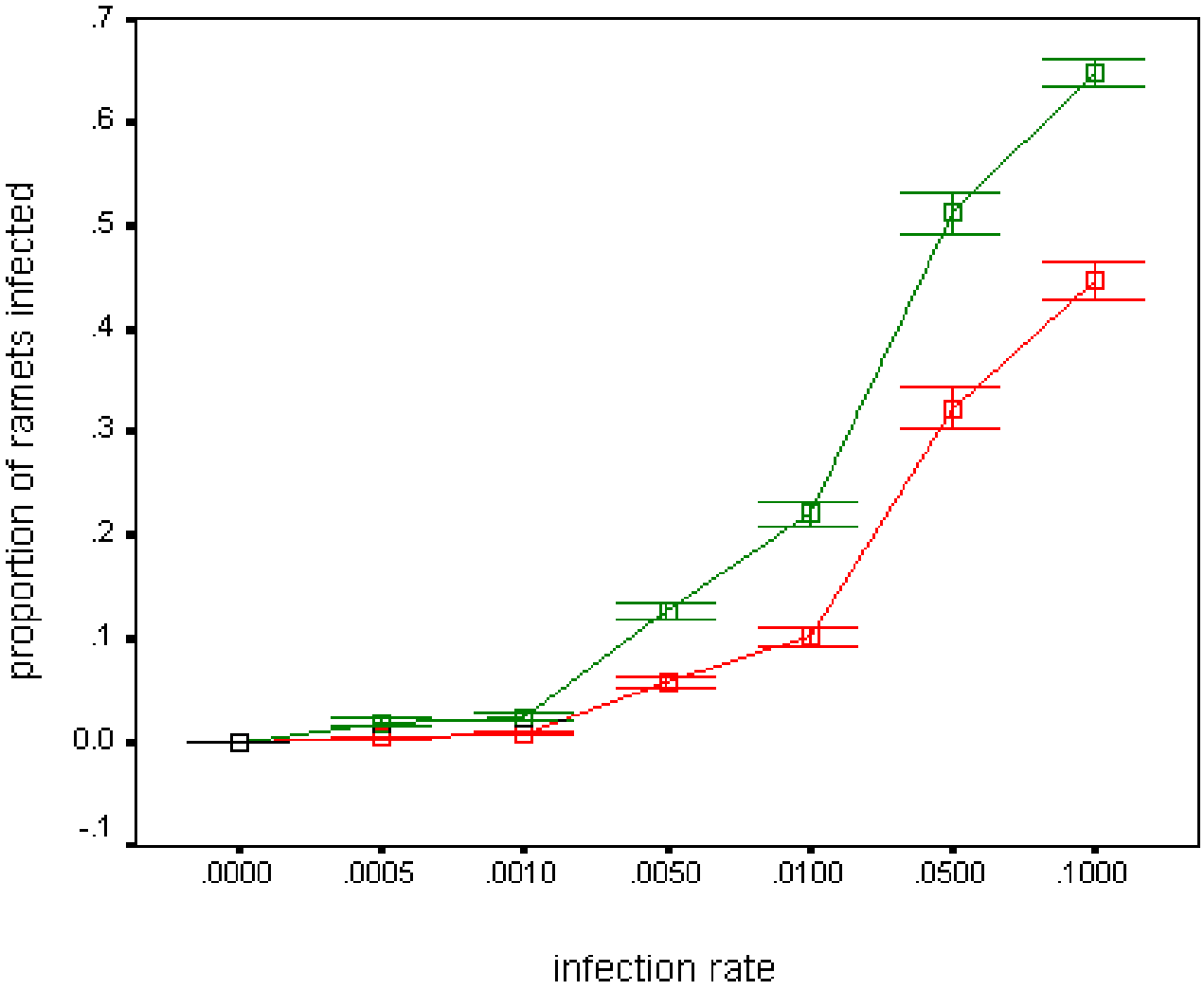
Simulation

COURSE OF SIMULATION

- **beginning** – start with 100 ramets of the splitter
- **after 100 steps** – 10 ramets of the integrator added
- **after 200 steps** – simulation stopped, numbers of ramets and infected ramets of both species were counted
- **20 runs**



Results

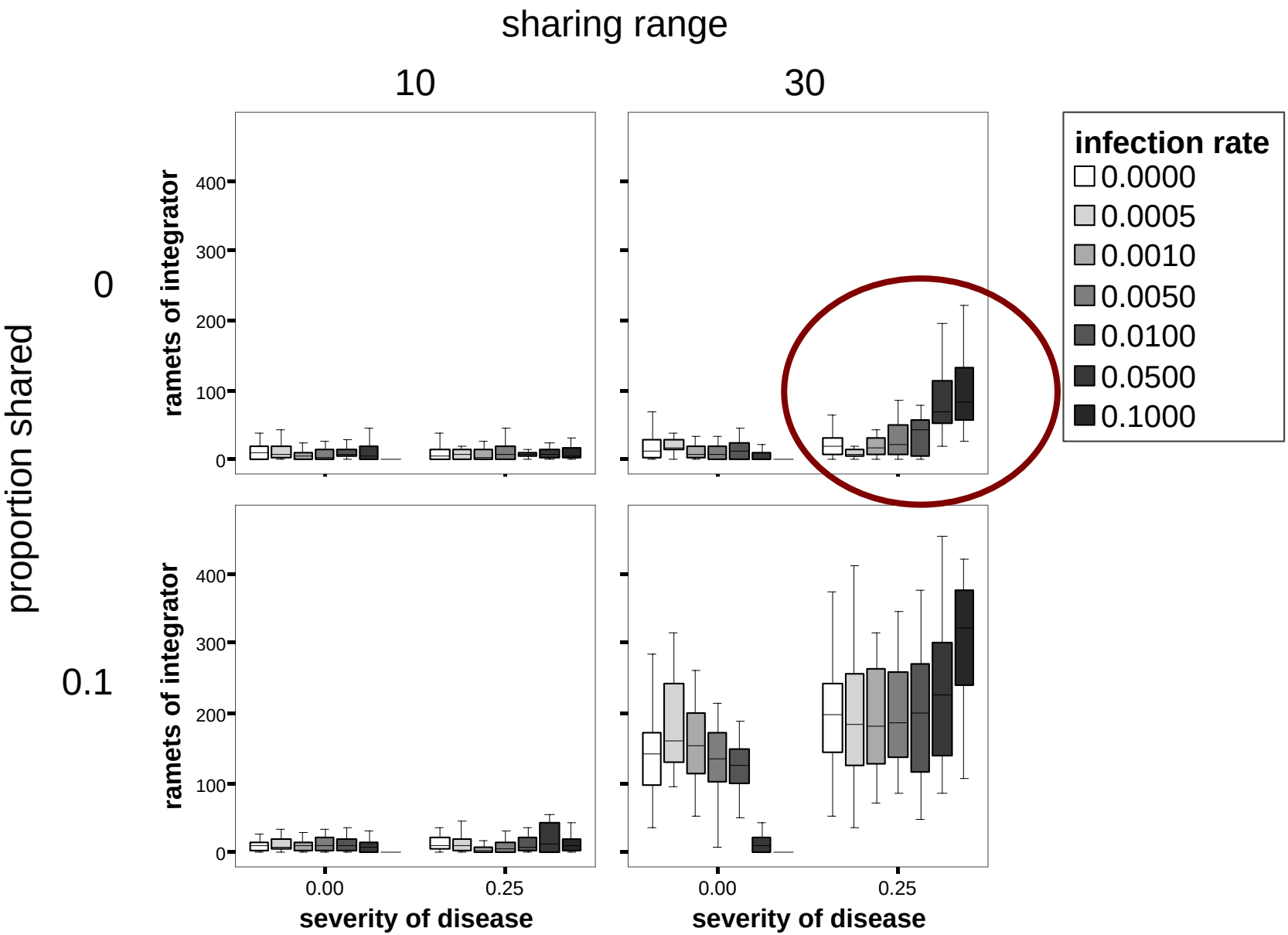


SPLITTER

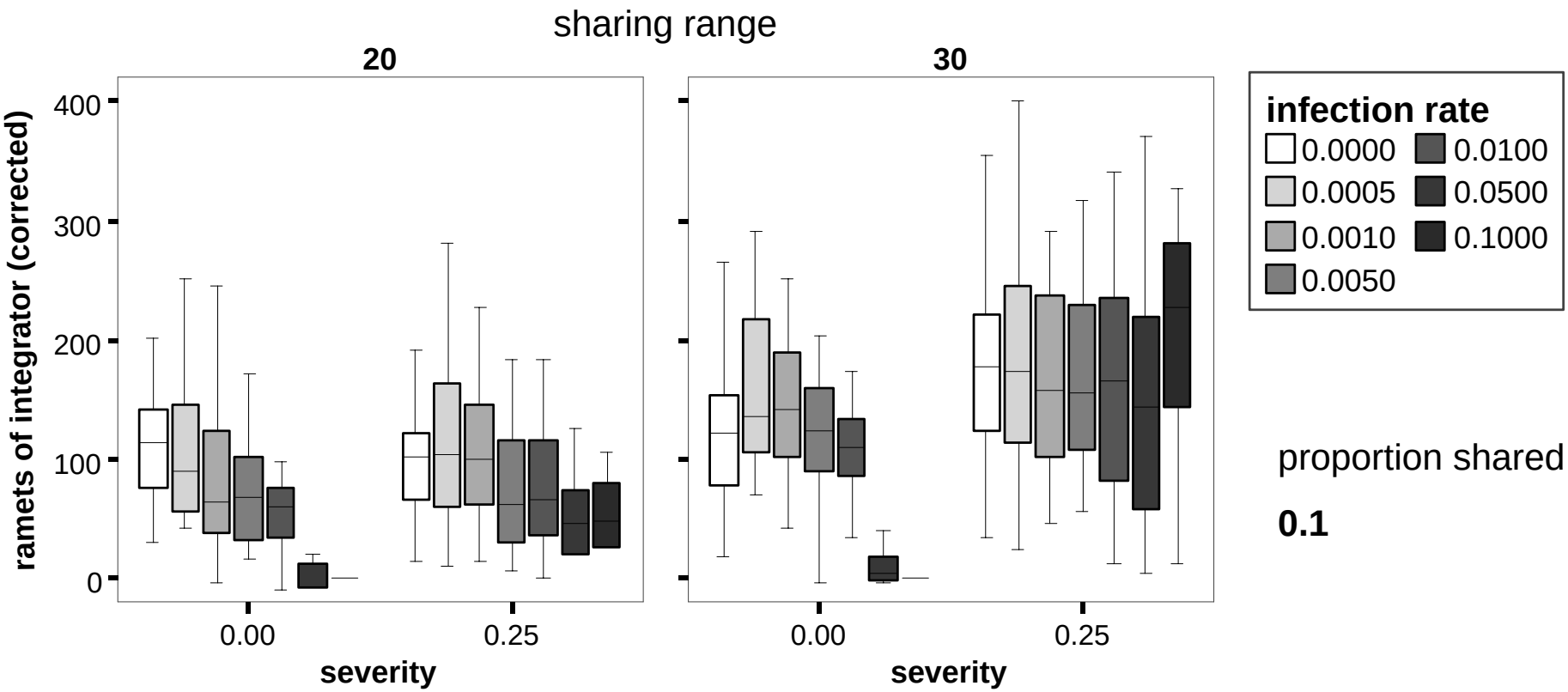
INTEGRATOR

severity **0.25**
proportion shared **0.1**

Results


sharing range
10
30
proportion shared
0
0.1
ramets of integrator
400
300
200
100
0
0.00
0.25
severity of disease
infection rate
0.0000
0.0005
0.0010
0.0050
0.0100
0.0500
0.1000

Results

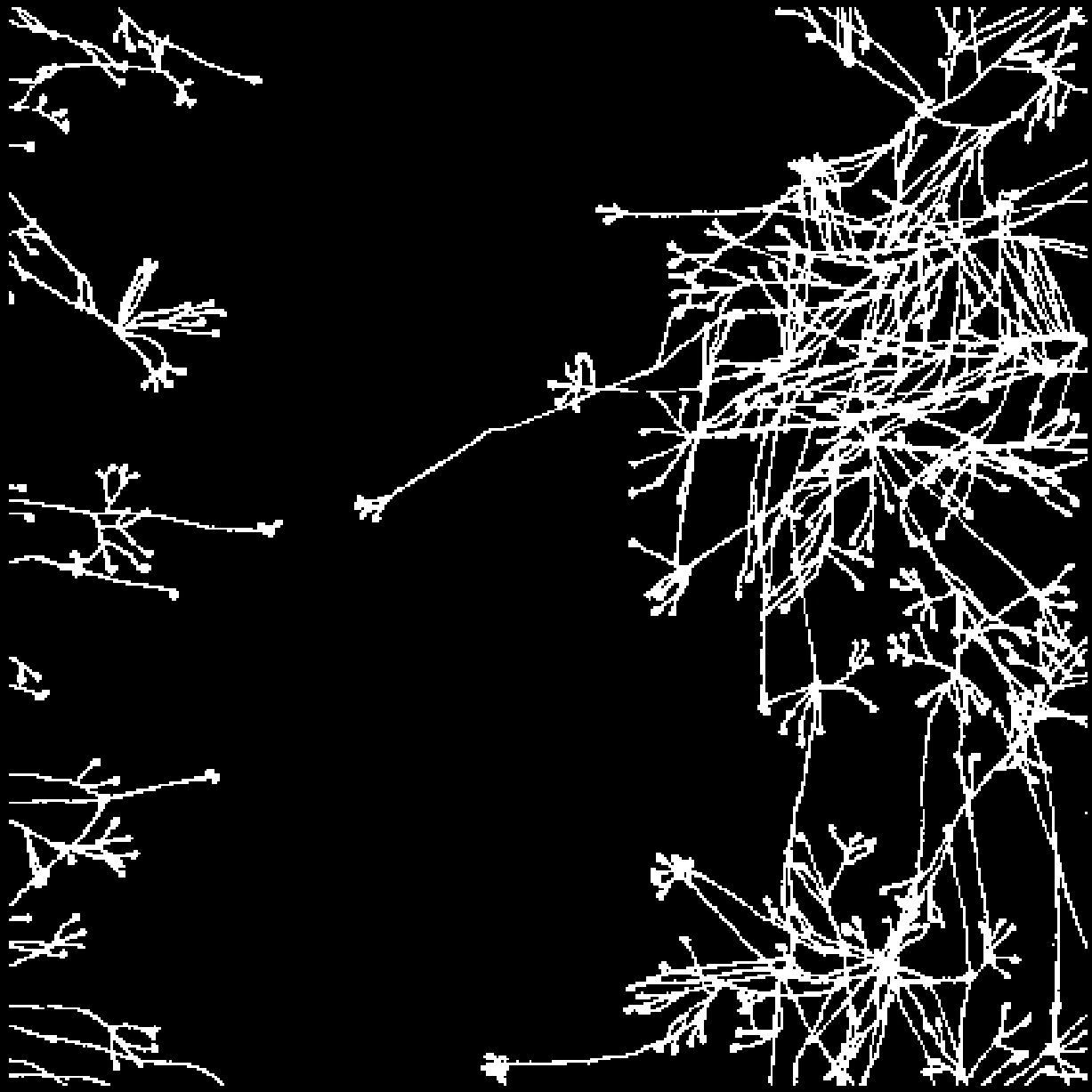


- with higher infection rates, integrator is less successful
- with longer interconnected system and mild disease, the integrator is more successful

Conclusions

1. The more interconnected the clonal network is, the more the genet suffers from disease
   - NO – the integrator is generally better competitor due to better use of translocation ability, which compensates for the negative effect of the disease
   - the more, with longer network, the integrator deals with high infection rates better

2. With higher infection rates, the long networks are more influenced by the disease
   - YES – high infection rates give comparative advantage to the splitter, especially when severity of the disease is high



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