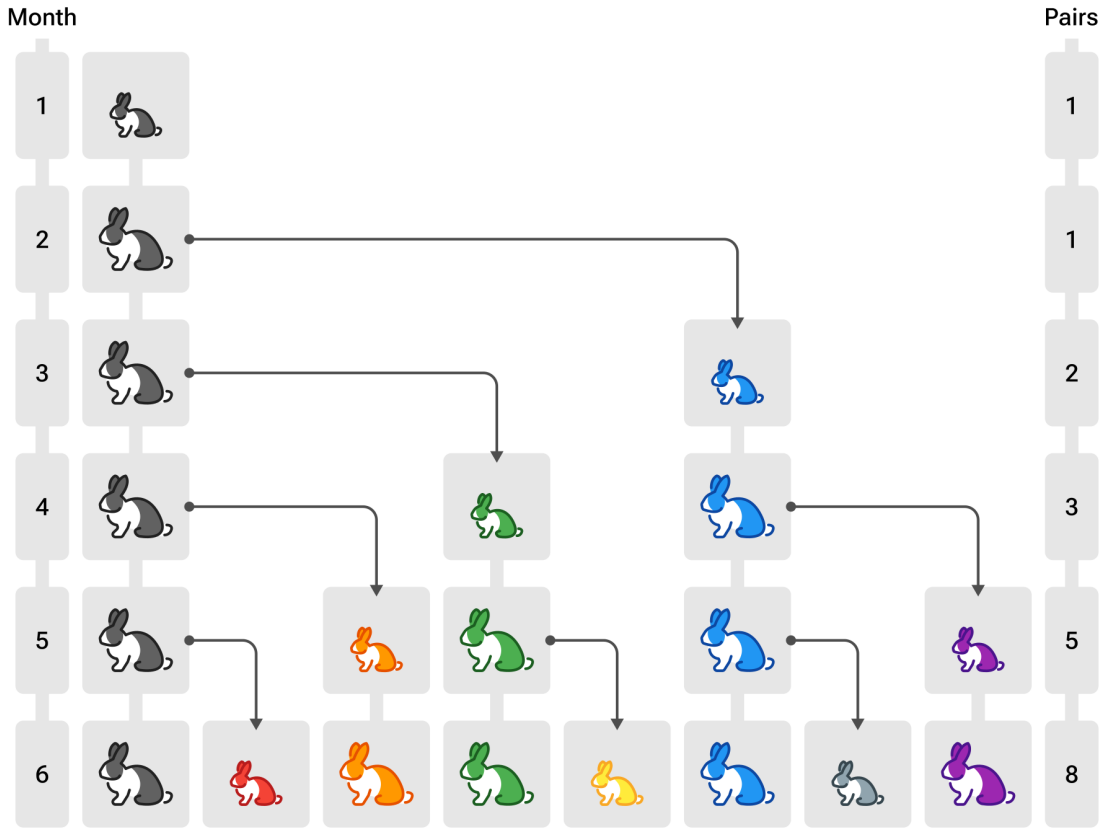
What is...mathematical biology?

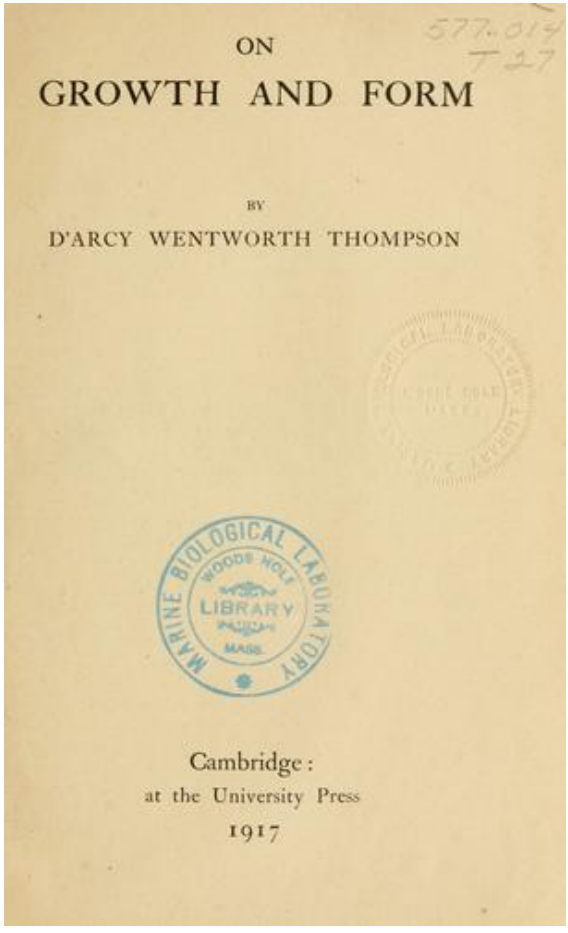
Or: Subfields of mathematics 14

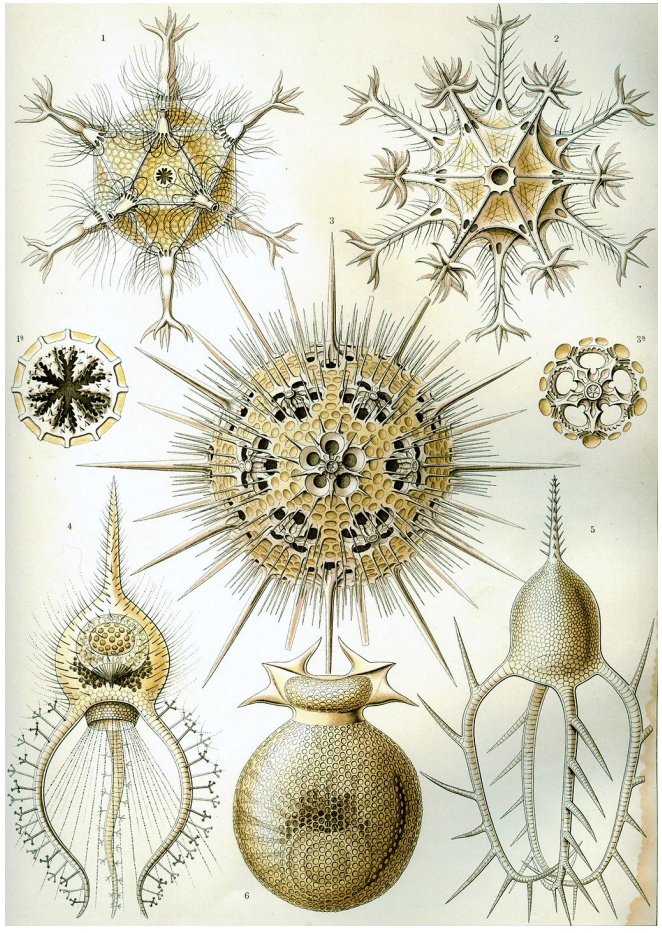
Rabbit counting



- Early mathematical biology (MB) Rabbit counting
- This is a prototypical example of a model
- Fibonacci was way ahead of their time

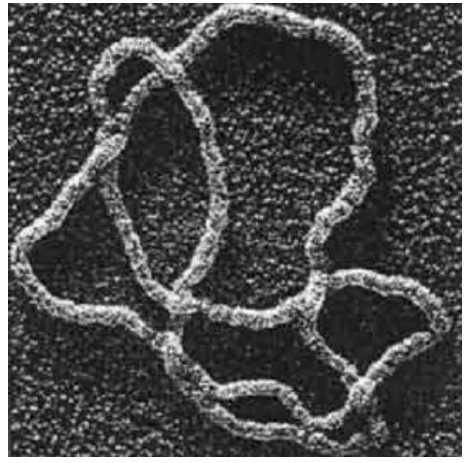
The beginnings

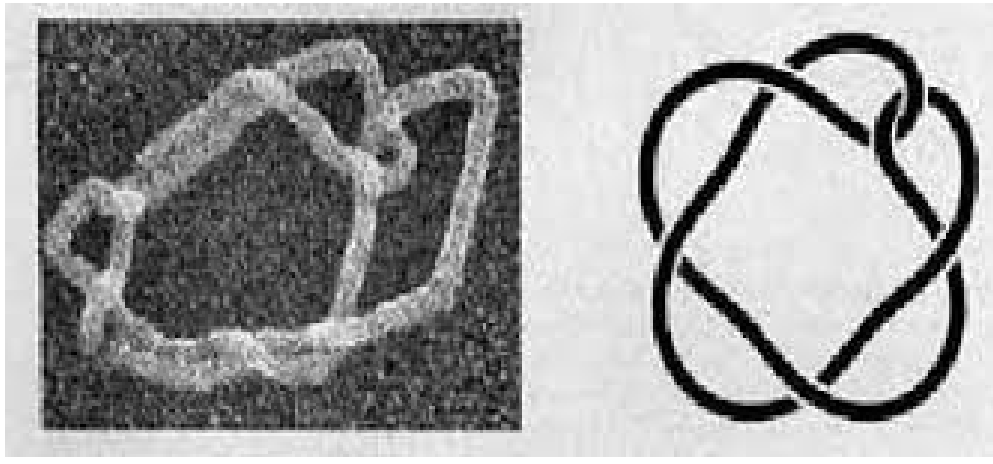




- On Growth and Form (1917) is often regarded as the first instance of MB
- Example It is argued that the weight of an animal increase with the cube of its length
- Catch Thompson (the author) rejected natural selection

Life is hard



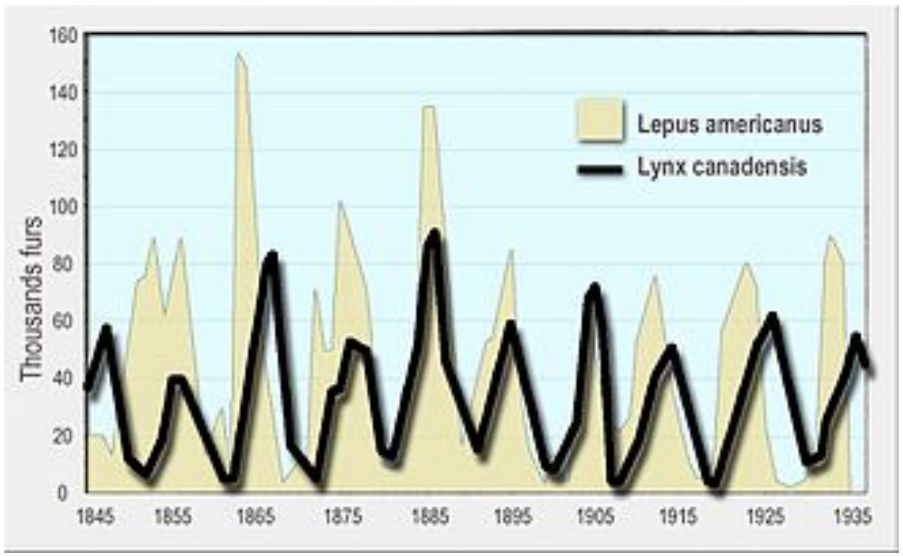


- Complexity of life $\Rightarrow$ MB uses most fields of mathematics
- One often has surprising connections
- Example The way how DNA forms knots is determines many of its properties

Enter, the theorem

The Lotka–Volterra equation is (t = time):

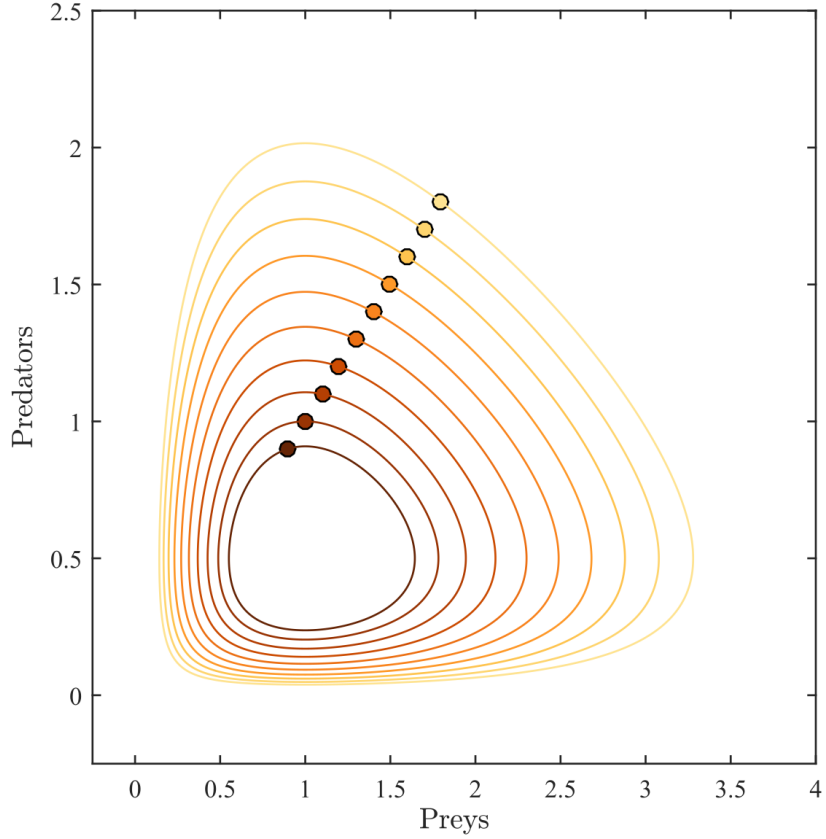
$dx/dt = \alpha x - \beta xy$ and $dy/dt = -\gamma y + \delta xy$ with $\alpha, \beta, \gamma, \delta \in \mathbb{R}_{>0}$



This models the prey-predator dynamics

- x = # 'rabbits', y = # 'foxes', α, δ = growth rate, β, γ = death rate
- Nowadays differential equations are use everywhere to model the world
- MB answers similar questions!

Population dynamics



- Above $\alpha = 2/3$, $\beta = 4/3$, $\gamma = \delta = 1$ and different starting values
- Note the fixed point (= equilibrium) at $(1, 0.5)$
- Upshot We can use mathematics to explain the behavior of population growth

Thank you for your attention!

I hope that was of some help.