Systematic Analysis of *C. elegans* Population Dynamics

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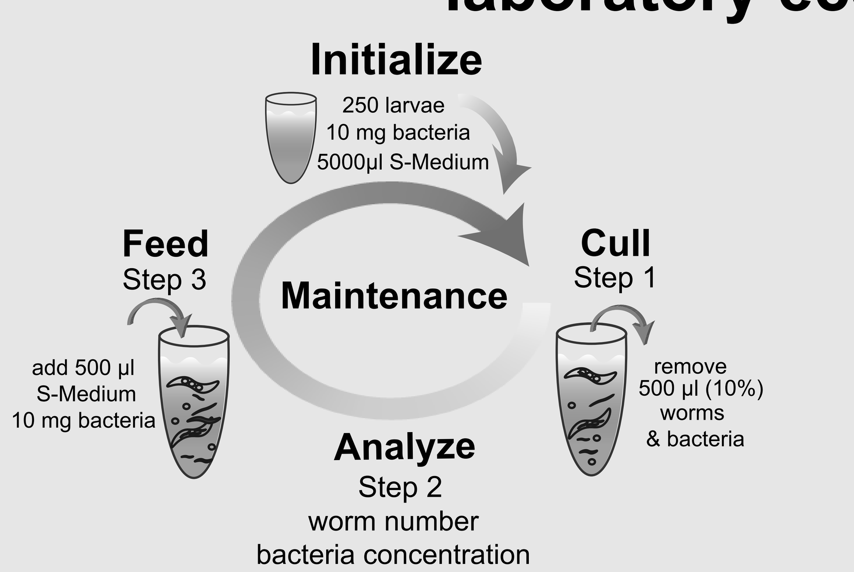
Abstract

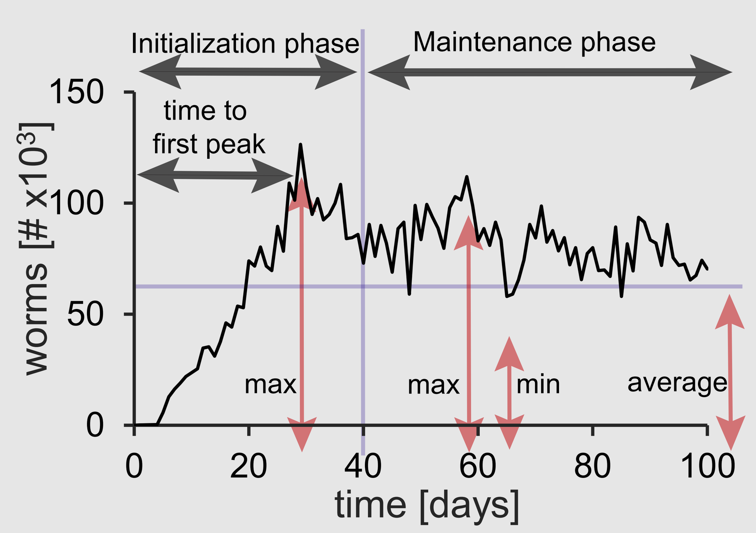
Birth and death rates control population dynamics. However, it is unknown how different reproductive and aging traits impact the survival of populations. To determine the effect of different lifespans and varying reproductive rates on population dynamics, we analyzed wild-type and mutant populations of the model organism *Caenorhabditis elegans* in a laboratory ecosystem and in the corresponding computational simulation wormPOP. We used mutants of *C. elegans* with varying reproductive schedules as well as long- and short-lived mutants. In the lab, we collected data from experiments using the mutant strains *tra-3*, which produces more eggs, and *daf-2*, which has a long lifespan. We will discuss the impact of these different reproductive schedules and lifespans on the population dynamics of C. elegans.

Goals

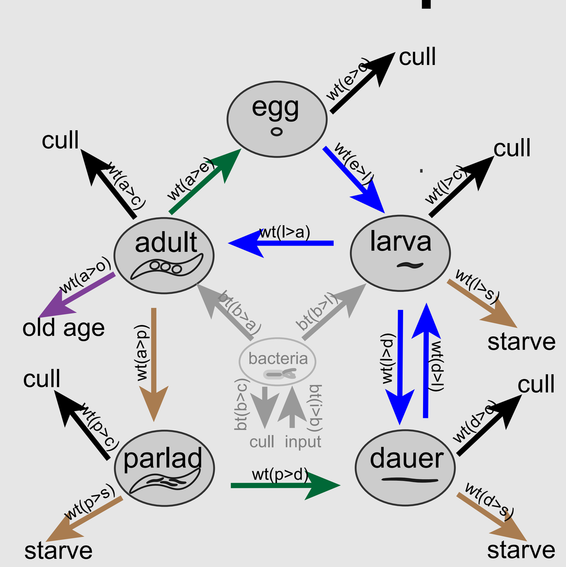
- To analyze the effects of lifespan and reproductive traits on a population
- To explore how variation in lifespan and reproduction impacts aging in populations

laboratory ecosystem





computational simulation



Trait	Parameter Altered
Wild-type lifespan	Adult lifespan: 160
Short lifespan	Adult lifespan: 32
Long lifespan	Adult Lifespan: 240
Wild-type reproduction	Fertility span: 1
Early reproduction	Fertility span: 0.5
Late reproduction	Fertility span: 2

Results

Figure 1: Number of worms for each mutant over time

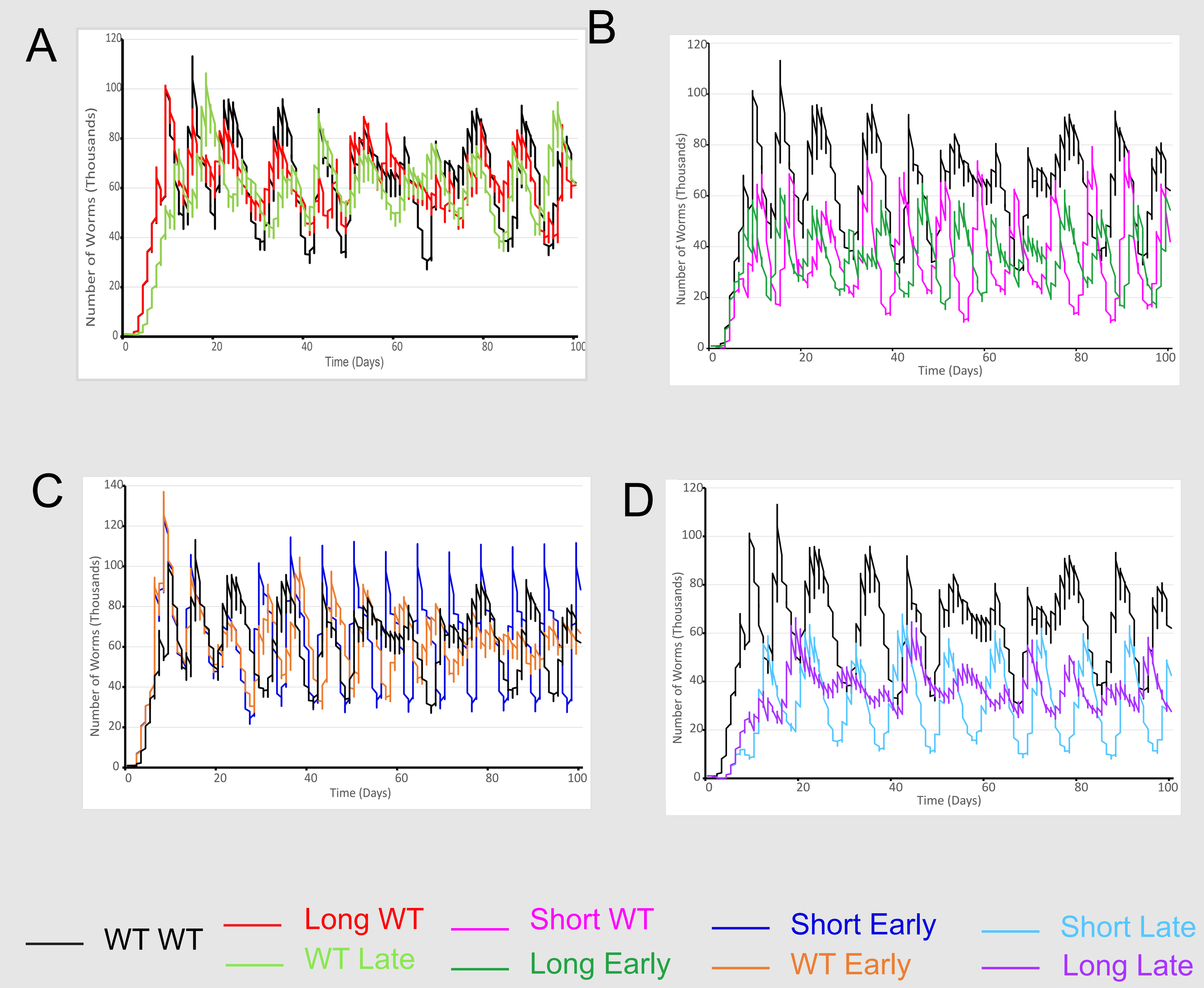
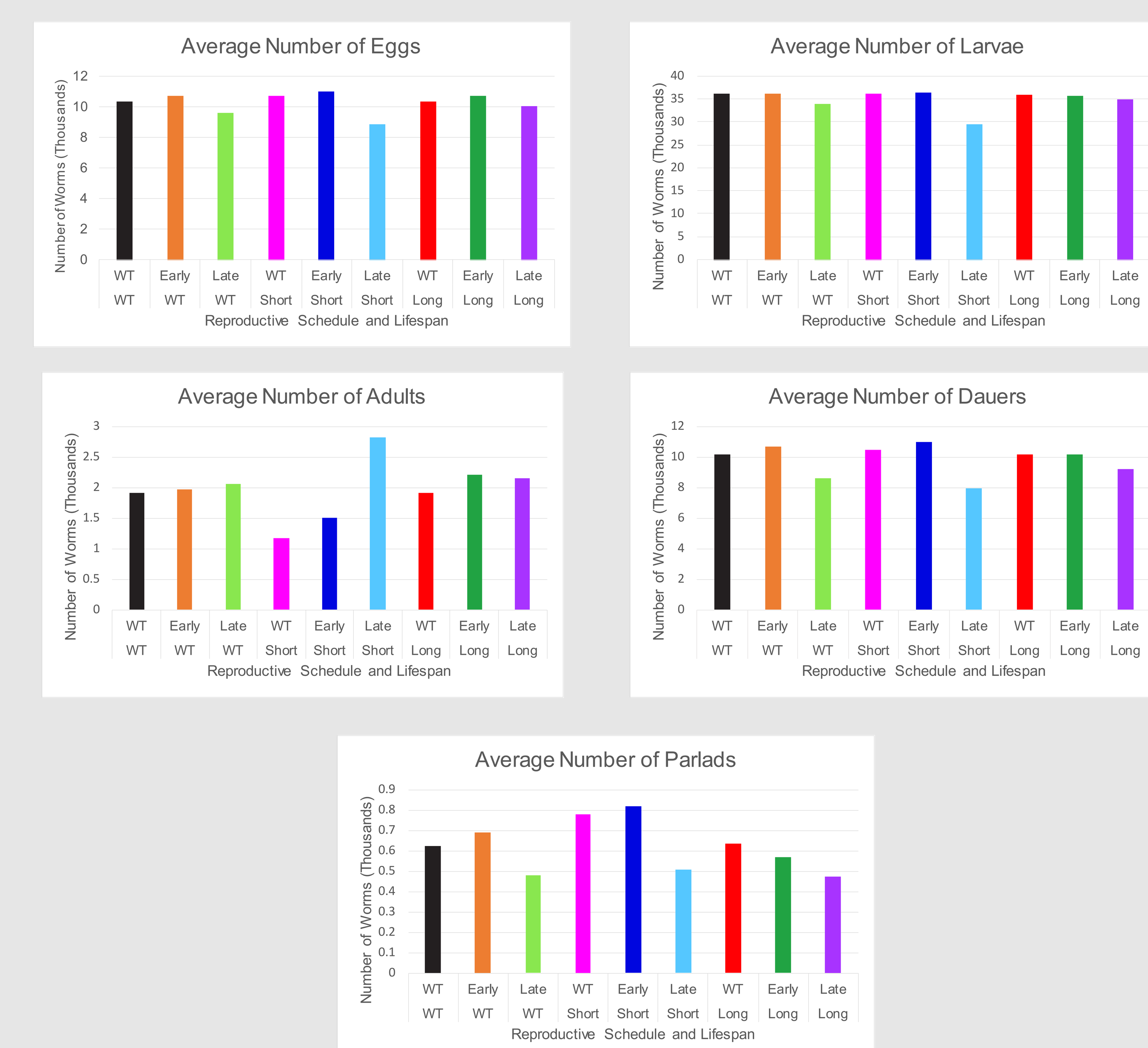


Figure 2: Average number of worms at each stage



Discussion

Short-lived worms with late reproduction had populations with significantly higher rates of deaths due to old age. The normal reproductive span of hermaphrodites ends before the worms die of old age. However, the simulated short lived worms only have an average lifespan of 2 days, meaning that worms die before the completion of their natural fertility span, which has a length of roughly a week. Increasing the length of the fertility span, like we did with short lived worms with late reproduction, further reduced the effective fertility of these worms. Populations of short-lived and late-reproducing worms grew slower than normal lifespan and late-reproducing worm populations, which indicates that short lifespans in combination with late reproduction further reduced offspring production. Statistical tests indicate that changes in reproduction were the most impactful on average populations of each worm type, with populations of late-reproducing worms being most significantly different from other populations.

Future Experiments

- using laboratory strains that more closely match the simulated reproductive mutants
- using simulated mutants that more closely match the laboratory strains
- applying more advanced mathematical analyses to population dynamics data

Scharf, A., Mitteldorf, J., Armstead, B., Schneider, D., Jin, H., Kocsisova, Z., Tan, C, Sanchez, F., Brady, B., DiAntonio, G.B., Wilson, A., and Kornfeld, K. (2022) A laboratory and simulation platform to integrate individual life history traits and population dynamics. *Nat Comput Sci* 2, 90-101. https://doi.org/10.1038/s43588-022-00190-8.