The maintenance of sex

Rapid demographic advantage versus slow evolutionary cost of asexuality

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Fecundity

$$f(k) \propto (1-s)^{k}$$
Effect of single mutation
$$f_{\rm A}(k_{\rm A}) < \frac{1}{-4} \iff (1-s)^{k_{\rm A}-k_{\rm S}} < 1$$

condition for maintenance of sex due to deleterious mutations

 $f_{\rm S}(k_{\rm S})$



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Rapid demographic advantage versus slow evolutionary cost of asexuality

Assuming an asexual is initially equivalent to a sexual, deleterious mutations must accumulate impossibly fast or have unrealistically large fitness effects for sexuality to be maintained.



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with 37 or more an asexual with one

mutations, *k*



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mutations, k

- Works if sexual population already quite loaded with mutations
- See exercise sheet 5



• Environment favours specific allelic associations



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 Asexuals should lose out as the allelic associations of an asexual lineage are fixed



Fluctuating epistasis Example

- Population with two types of habitats, each favouring a specific combination of alleles.
- Combination changes at each generation with probability *p*.
- Start with a population of sexuals. Introduce asexuals through mutation.



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Fluctuating epistasis But...

- Environmental and genetic assumptions seem unrealistic.
- Allowing for refugia makes it much more difficult to maintain sexual reproduction:





• Coevolution of host and parasites.







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- Lock and key system where parasites can only target host with matching genotype.



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- Lock and key system where parasites can only target host with matching genotype.
- Selection on parasites to match dominant host, selection on host to evade dominant parasite.
- Creates fluctuating epistasis in host.



An ecological model of fluctuating epistasis Red queen dynamics



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Red queen dynamics can trigger fluctuating epistasis, favouring sexual reproduction.















Summary

- Maintenance of sex is not straightforward: rapid demographic advantage versus slow evolutionary cost of asexuality.
- Strong epistasis can mitigate demographic advantage as fitness decreases rapidly with new mutations.
- Fluctuating epistasis also disadvantages asexuals who cannot easily create novel allelic combinations.
- Ecological interactions can lead to red queen dynamics and fluctuating epistasis, favouring sexual reproduction.
- But existing models do not fully answer the question.

