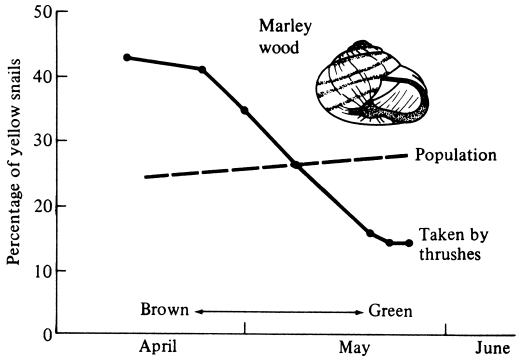
1. In his article "The Great Chain of Being", author Sean Nee critiqued Dawkins recent book "The Ancestor's Tale". What particular aspect did he attack?

The anthropocentric viewpoint.

2. Why do humans eat so much candy and drink so many soft drinks? Rate the following explanations as proximate or ultimate:
   - The sensory input from taste receptors in the tongue to selected brain cells leads to a positively reinforcing sensation of sweetness. ___proximate_____
   - Our primate ancestors depended on sugar-rich fruits; from these ancestors, we have inherited the same liking for sugars that they had.____ultimate_____

3. What factor explains the color polymorphism in European land snails? Explain using features in the following graph.



Predation by thrushes/ Negative frequency dependent selection.

Early in the season, yellow (green looking) snails are targeted by their predators because they stand out against the brown background color. Later in the season the roles are reversed.

4. One "explanation" for the existence of sex is that it provides a "long-term advantage" to a population by providing genetic variation (through recombination); the population is thus less subject to future extinction from any one particular environmental factor. What is an important problem with this "explanation"?

It relies on group selection.

5. Order the following species according to their generation time and r_{max}: fruit flies, human beings, mice, sequoia trees, *E. coli.*

   Generation time: E. coli < fruit flies<mice<human beings< sequoia trees
   r_{max}: E. coli > fruit flies > mice > human beings > sequoia trees

6. Complete the following life table. Give the replacement rate, the generation time and the Leslie matrix. Calculate how many newborns (age class zero) there will be in the next time step (assume mortality happens before reproduction). Show your work! What can you tell about this population:
   a. Reproductive strategy: Iteroparous species
   b. Intrinsic rate of increase: r is close to zero, but still positive, it can be approximated by $r=\ln(R_0)/T= 0.01295$.

Age class	Nx	mx	lx	lx.mx	x.lx.mx	Ex	Vx
0	100	0	1	0	0	1.17	1.02
1	10	6	0.1	0.6	0.6	1.7	10.2
2	5	6	0.05	0.3	0.6	1.4	8.4
3	2	6	0.02	0.12	0.36	1	6

Ro	1.02
T	1.52941

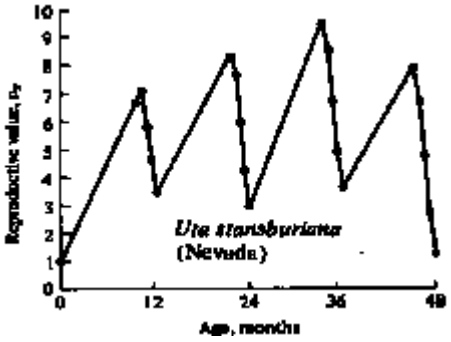
Leslie matrix

0.6	3	2.4	0	0
0.1	0	0	0	0
0	0.5	0	0	0
0	0	0.4	0	0
0	0	0	0	0

N0 in next time step:

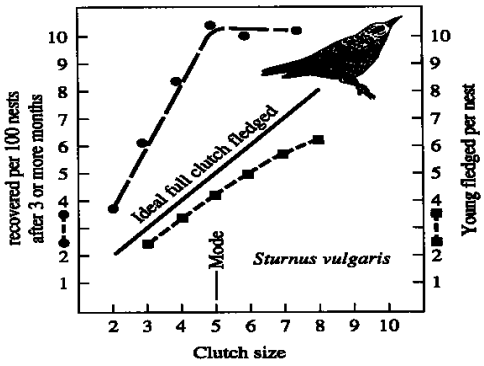
N0(t+1) = 102

7. The following graph gives you the reproductive value of a lizard (*Uta stansburiana*) throughout it's lifetime. Explain the jagged structure of this graph.



The lizard population experiences great mortality each winter. After winter, the surviving lizards are facing a good period for reproduction. Throughout the favorable season, their reproductive value decreases, because after each clutch, they are closer to the next winter, their chance of survival decreases sharply and they have fewer remaining eggs to produce that season. After the next winter, the reproductive value peaks again.

8. Lack argued that there is an optimal clutch size for birds. What was his major argument? According to the following graph, what is the optimal clutch size for *Sturnus vulgaris*? How does this graph provide evidence for Lack's theory?



Too few eggs result in lower fitness, too many eggs result in underfed chicks with lower survival (again lower fitness)– so there is an optimum in between.
Optimum for *Sturnus vulgaris* is 5.
The number of fledged chicks deviates more and more from the ideal line for larger clutch sizes.
Mortality in the three first months shows that it is not beneficial to have clutch sizes greater than 5.

9. Derive the Verhulst-Pearl equation, starting from the exponential model. Define all terms and show all mathematical steps and assumptions. Use graphs if they simplify your explanation.

Birth and death rates dependent on population density; inhibitory effect of individuals on population growth.

$$b_N = b_0 - x.N$$
$$d_N = d_0 + y.N$$

Carrying Capacity: K = number of a population when at equilibrium

$dN/dt = 0$ when $N=K$

At equilibrium, define $K=N$ and $r=b_0 - d_0$

- $b_N = d_N$
- $b_0 - x.N = d_0 + y.N$
- $N(x+y) = b_0 - d_0$

- ♣ $K (x+y) = r$
- ♣ $K = r /(x+y)$
- ♣ $x + y = r/K$

Derivation:

- ♣ $dN/dt = r_N.N = (b_N – d_N).N$
- ♣ $dN/dt = (b_0 – x.N – d_0 – y.N).N$
- ♣ $dN/dt = [(b_0 – d_0) – (x + y).N].N$
- ♣ $dN/dt = [r – (r/K).N].N$
- ♣ $dN/dt = rN – rN^2/K$
- ♣ $dN/dt = rN (1-N/K)$
- ♣ **$dN/dt = rN [(K-N)/K]$**
  - **Note:** $dN/dt= 0$ when $[(K-N)/K]=0$ when $N=K$

10. Winemiller identified a third "life strategy" in fish, apart from "r-selected" and "K-selected" species. What is the name of this third category? Explain why this category does not fit in the r-K continuum – use some life history traits in your explanation!

Periodic species/ bet-hedging species

Correlate of r-selected species are: short generation times, high fecundity, low juvenile survivorship
Correlates of K-selected species are: long generation times, low fecundity, high juvenile survivorship
Periodic species have: long generation times, high fecundity, low juvenile survivorship

11. Several hypotheses explaining population cycles rely on time-lags. Name and explain two hypotheses that assume a time lag.

e.g. Time Lag hypothesis: When the response of a population to overcrowding exhibits a time-lag, this results in the overshooting of the carrying capacity. Afterwards, the population crashes below K.
e.g. Predator-prey oscillations: there is a time lag between the prey and predator population reaching maximum densities. At low predator density, the prey population can increase. Due to higher prey availability, the predator population starts to increase. At high predator densities, prey densities decrease, …
e.g. Food quantity hypothesis: similar to predator-prey, but at herbivore level.
e.g. Nutrient Recovery Hypothesis: similar to food quantity, but longer time lag due to necessary remineralization of nutrients from fecal materials.

12. Give one big advantage and one big disadvantage of sexual reproduction.

(+) more rapid evolution due to recombination
(-) fitness is reduced to _ of an asexual species

13. Birds often have defended territories. The benefit of a territory is that the bird easily can find food. The cost of the territory is that the bird has to defend it to intruders. In the table below, four different territories, their sizes and associated costs and benefit are given. What is the optimal territory for the bird? Explain.

Territory	Size	Cost	Benefit
A	100	1000	2000
B	100	1000	3000
C	200	3000	4000
D	200	4500	5000

B is the optimal territory for this species. (benefit- cost) are maximized for this choice of territory.

14. A species shows a clumped distribution in a landscape. If you have a map with the location of all individuals, you can place a regular grid on this map and count the number of individuals in each grid cell. How does the ratio mean to variance (mean = average number of individuals in a grid cell; variance = how different the numbers per grid cell are) compare with the mean and variance of a dispersed species?

Variance is higher for the clumped distribution, mean/variance is then lower for the clumped distribution.

15. The optimal family sex ratio is often 50:50, except in some cases. Describe and explain one of these cases.

E.g. The populations sex ratio is not near equilibrium.
E.g. There is a sexual dimorphism in energy demands to raise daughters and sons
E.g. There is differential mortality of the sexes during the period of parental care.

16. How can haplodiploidy explain the social structure in a beehive?

Workers are 75% related to female offspring of the queen, while they would only be 50% related to their own offspring.

17. What is an alternative mating tactic for females? For males?

Females: sneak copulations with another male - cuckoldry
Males: satellite males

18. Explain the following terms/ expressions:

a. Precession and recession of good and bad alleles

Good alleles tend to show up early in life, bad alleles later in life. A favorable trait is more advantageous when it shows up before/during the reproductive age. Unfavorable traits will only be maintained in a population when they show up after the reproductive age, otherwise they impact fitness negatively and will probably get weeded out by NS.

b. Latitudinal gradient in clutch size

It has been observed that birds at high latitudes have larger clutch sizes than birds at lower latitudes.

c. Prey diversity hypothesis to explain (b)

Prey diversity at high latitudes is lower than at low latitudes. This might allow for a more efficient search image (and possibly larger population size of the prey) at high latitudes, which in turn allows more chicks to be fed.

d. Polygyny threshold

The minimum difference in territory quality held by males that is sufficient to favor bigamous matings by females.

e. "Sexual dimorphism does not always result from sexual selection."

You can also have ecological sexual dimorphism, e.g. cases where males and females have different foraging behavior to avoid competition

f. " If my five (adorable) nephews were in a life threatening situation, I would risk my life to save them."

Hamilton' s rule states: r.n.B-C>0
If my three (adorable) **(n=5)** nephews **(r=0.25)** were in a life threatening situation **(B=1)**, I would risk my life **(C =1)** to save them.
0.25*5*1-1>0