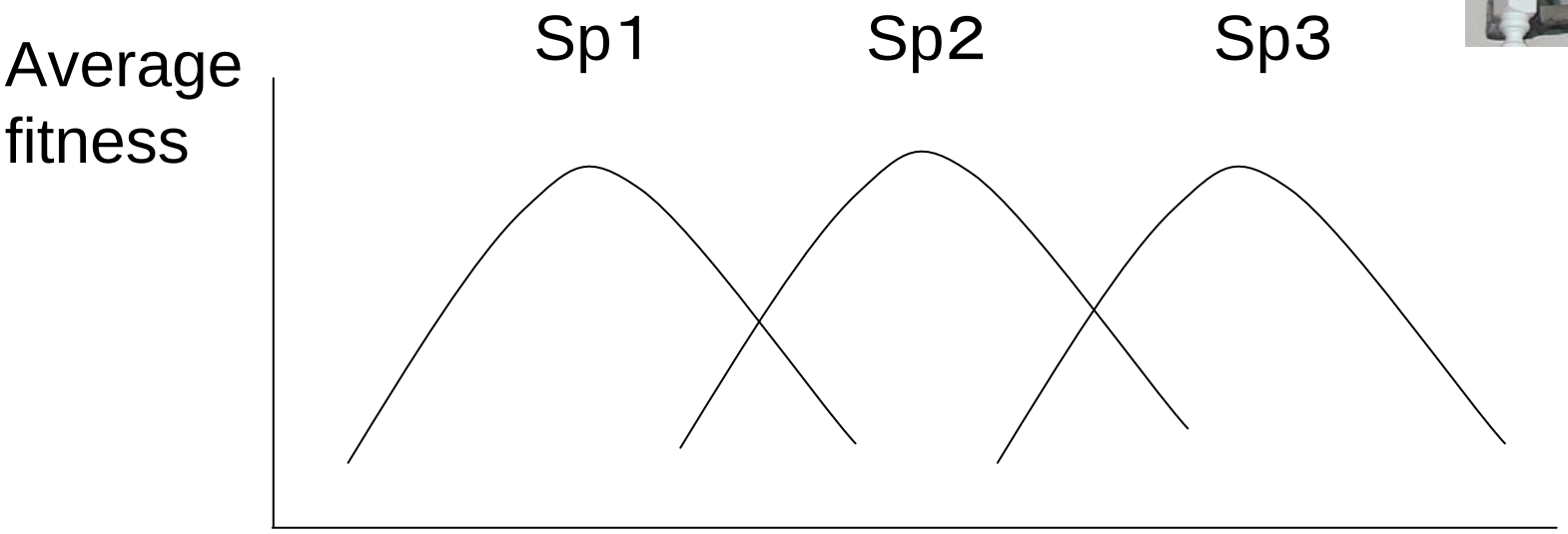
2010年10月18日

生態学Ⅰ　第4回

個体群動態
Population dynamics
量的遺伝学（1）
Quantitative genetics 1

ニッチ niche


Sp1
Sp2
Sp3
Average fitness
State of resource, not of phenotype

Average fitness 平均適応度

$$\overline{W} = \frac{1}{n} \sum_{i=1}^{n} w_i$$

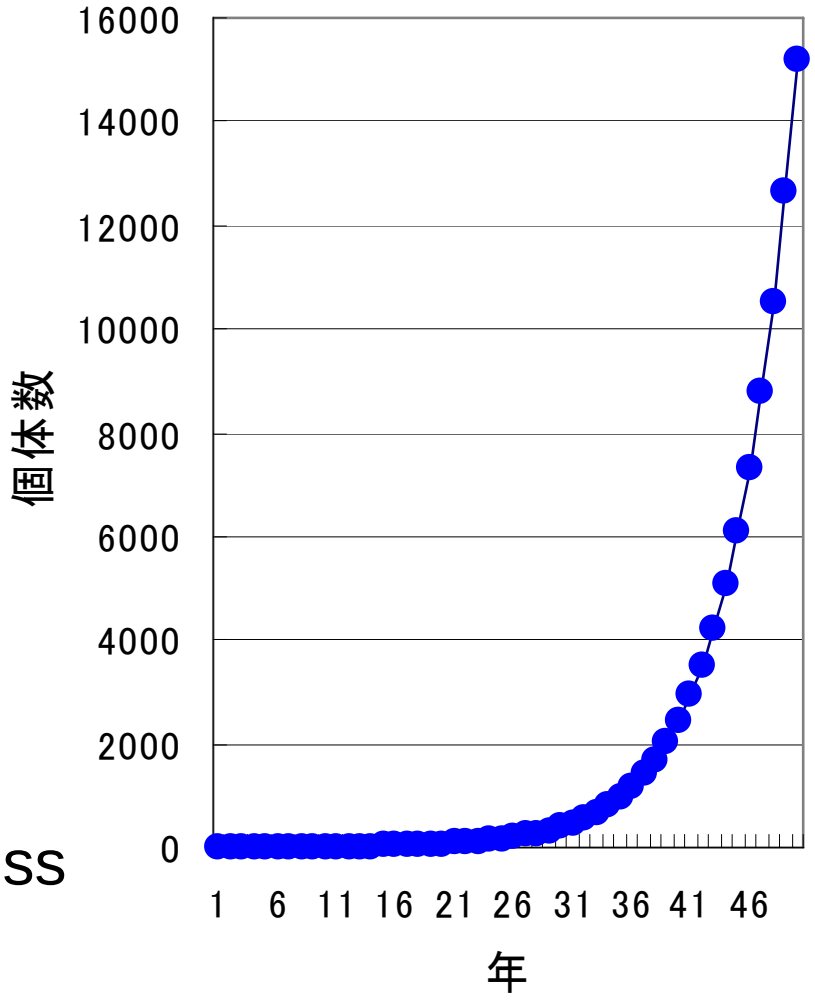
Average value depends on the definition of a population from which *n* individuals are sampled.

Exponential growth 指数増加

$$\frac{dN}{dt} = rN$$

例：$N(0)=2$, $r=1.2$

r: intrinsic growth rate;
equivalent to average fitness

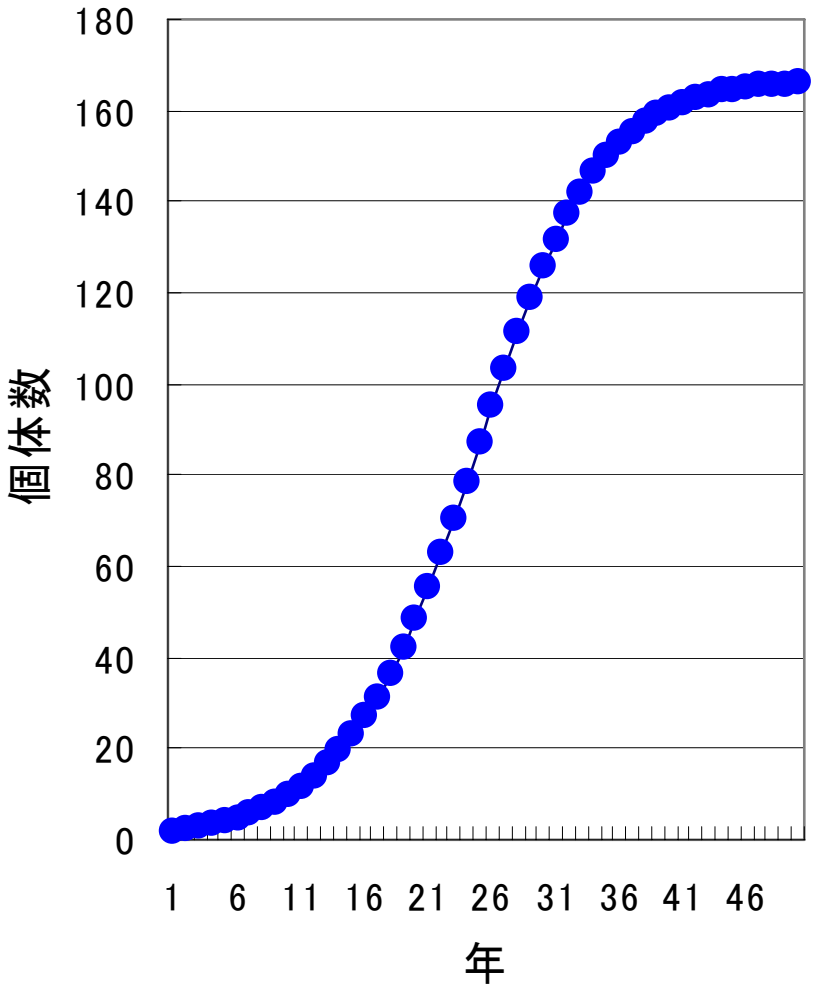


Logistic growth ロジスチック成長

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

密度効果

K: 環境収容力
Carrying capacity



Competition equation 競争方程式

$$\frac{dN_1}{dt} = r_1 N_1 \left(1 - \frac{N_1 + \alpha_{12} N_2}{K_1}\right)$$

$$\frac{dN_2}{dt} = r_2 N_2 \left(1 - \frac{N_2 + \alpha_{21} N_1}{K_2}\right)$$

競争方程式の平衡点

$$\frac{dN_1}{dt} = r_1 N_1 (1 - \frac{N_1 + \alpha_{12} N_2}{K_1}) \geqq 0$$

種1が増える条件
Sp1 increases

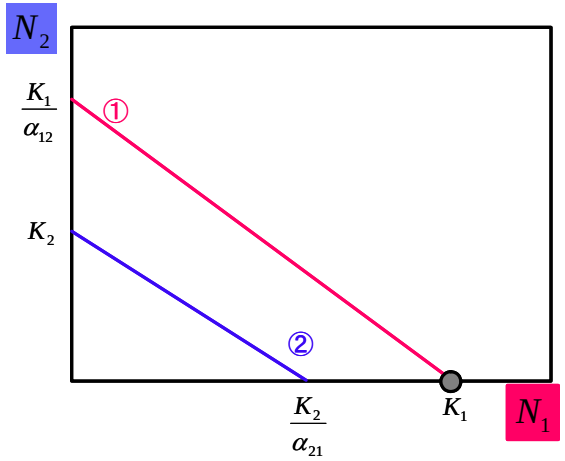
$$\Rightarrow \quad N_2 \leqq \frac{K_1}{\alpha_{12}} - \frac{N_1}{\alpha_{12}} \quad \cdots \quad ①$$

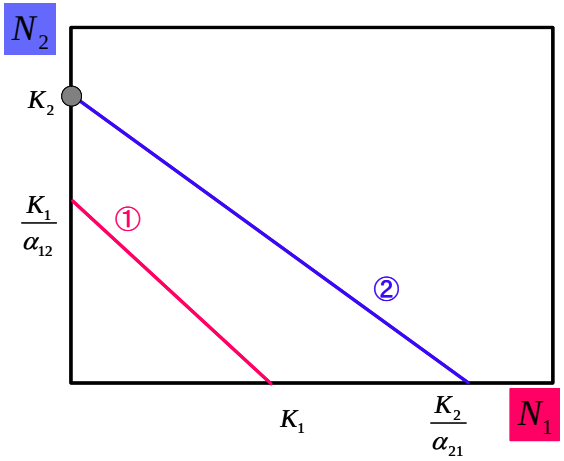
$$\frac{dN_2}{dt} = r_2 N_2 (1 - \frac{N_2 + \alpha_{21} N_1}{K_2}) \geqq 0$$

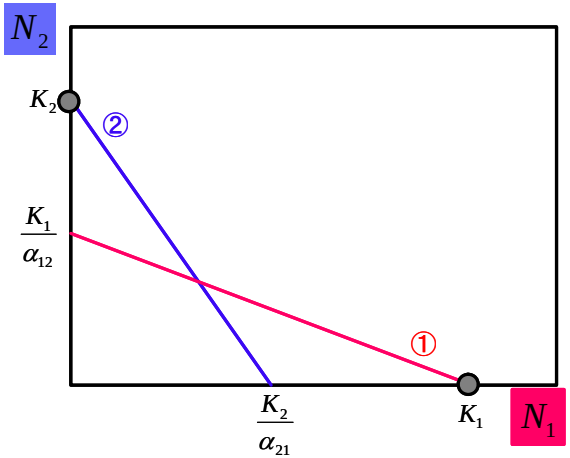
種2が増える条件
Sp2 increases

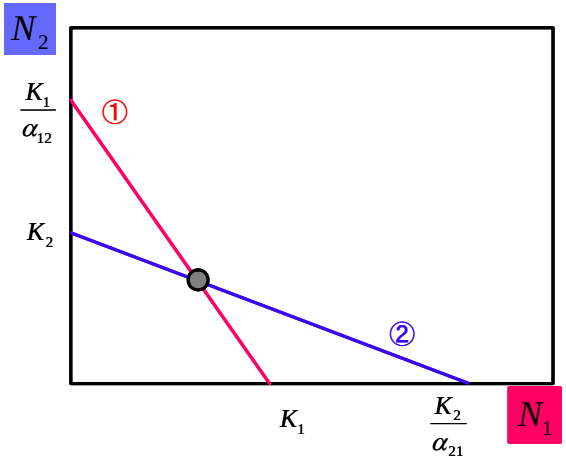
$$\Rightarrow \quad N_2 \leqq K_2 - \alpha_{21} N_1 \quad \cdots \quad ②$$

Four cases 4つの場合

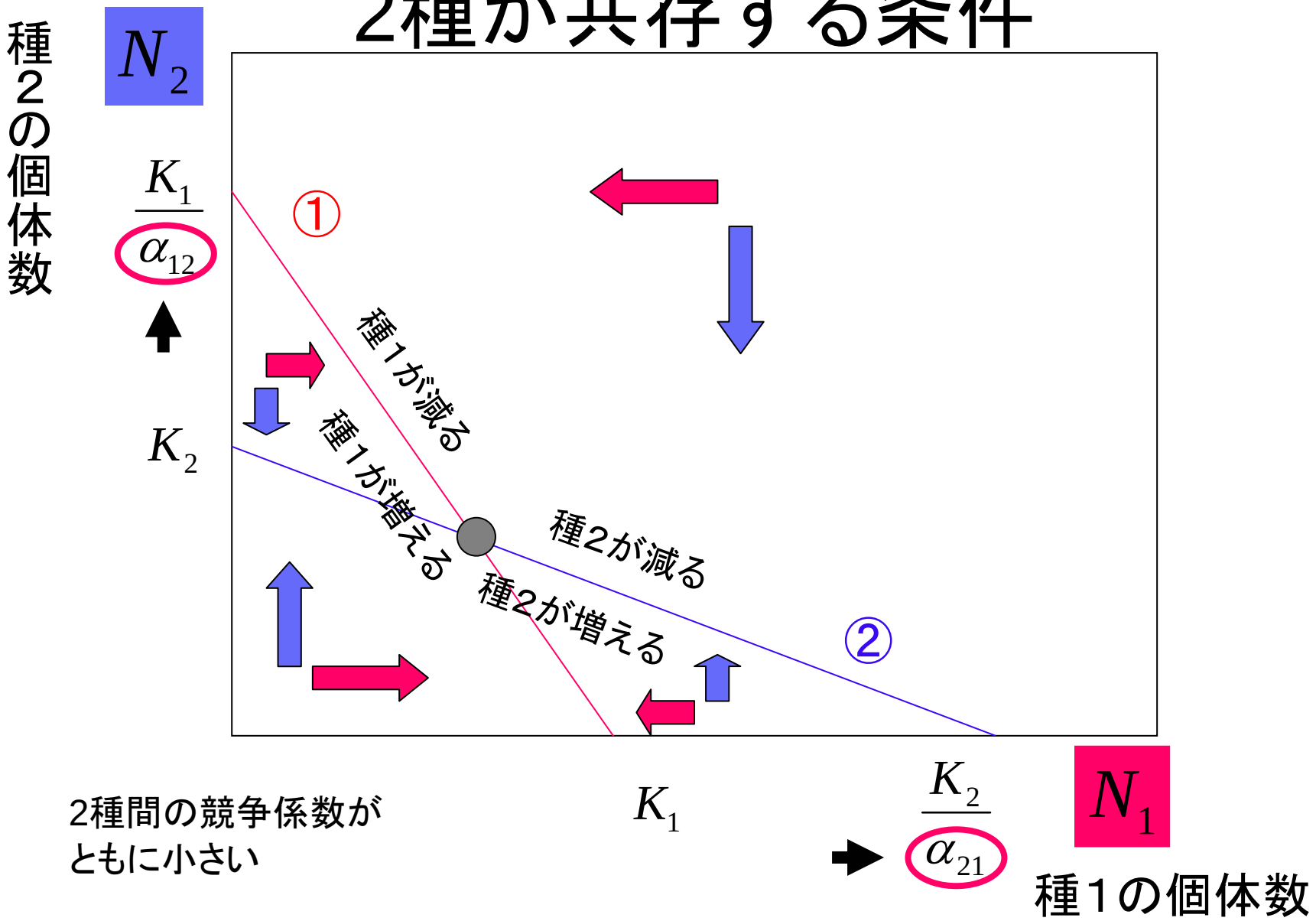






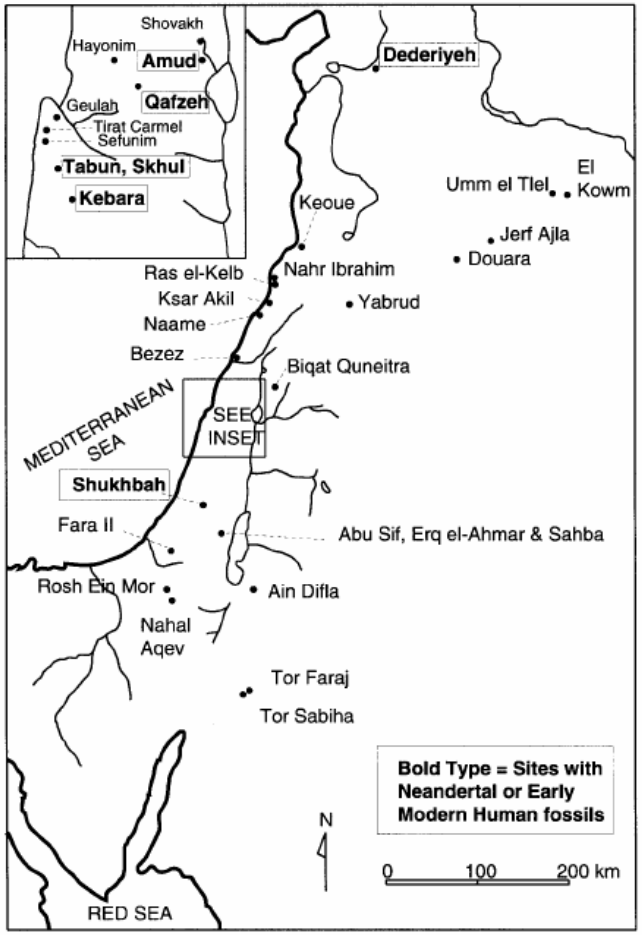


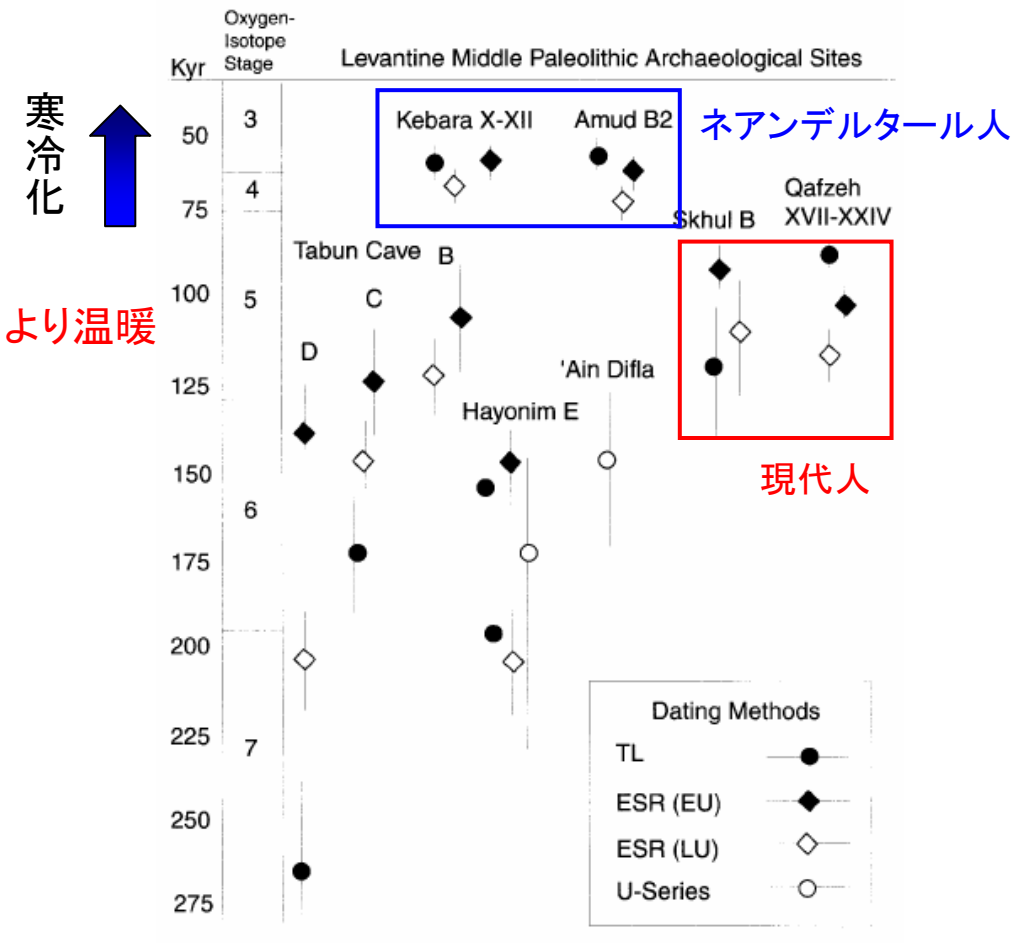
Condition for co-existence
2種が共存する条件



2種間の競争係数が
ともに小さい

レバントの化石人骨
現代人とネアンデルタール人の交代





Shea (2003) Neanderthals, competition, and the origin of modern human behaviour in the Levant.

Homework: the case of mutualism

$$\frac{dN_1}{dt} = r_1 N_1 (1 - \frac{N_1 - \alpha_{12} N_2}{K_1})$$

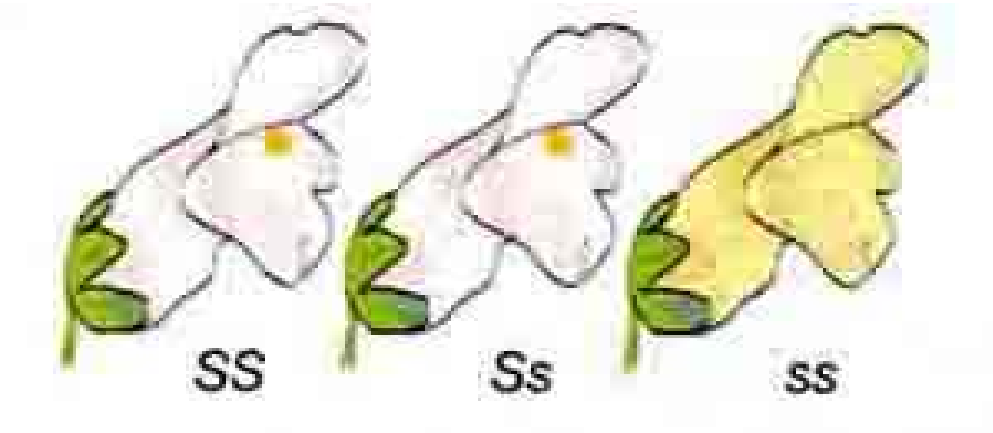
$$\frac{dN_2}{dt} = r_2 N_2 (1 - \frac{N_2 - \alpha_{21} N_1}{K_2})$$

The above equations describe changes of population size in two mutualistic species. Using these equations and graphic representations of population dynamics, derive and explain consequences of mutualism.

Key points

- Adaptation by natural selection occurs within a population
  - often through competition among individuals of the same population of the same species.
- Competition between species results in extinctions or coexistence
  - without any genetic changes

メンデル遺伝学 Mendelian genetics



- 遺伝は対立遺伝子（allele）の伝達・分離によって説明できる
- 対立遺伝子には優性・劣性の関係がある
- 別の遺伝子座」（ locus ）に位置する対立遺伝子は独立に伝達される

Chapter 6: 詳しくは系統進化学で

Genetic background of phenotypic changes

- 1遺伝子座2対立遺伝子モデル
  1 locus 2 allele model

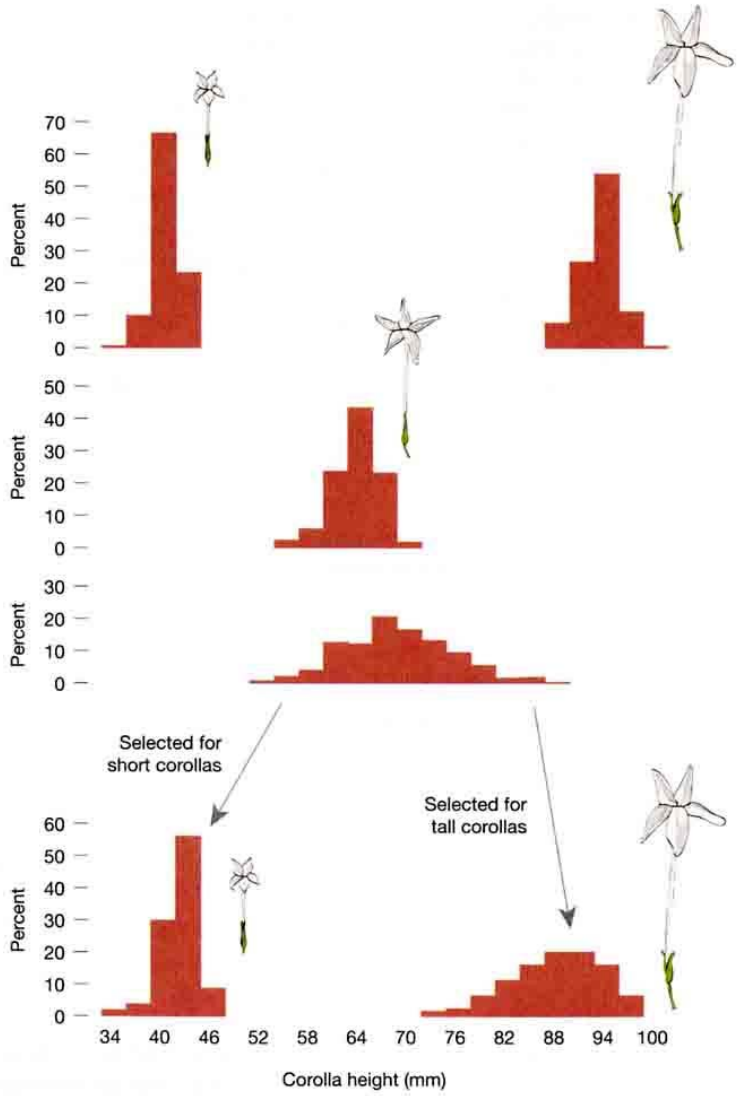
Genotype	AA	AA’	A’A’
Frequency	pxp	2pq	qxq
Relative fitness	1	1+hs	1+s
Frequency in the next generation	pxp/T	2pq(1+hs)/T	qxq(1+s)/T

Quantitative phenotypic variation

- 量的な表現型変異

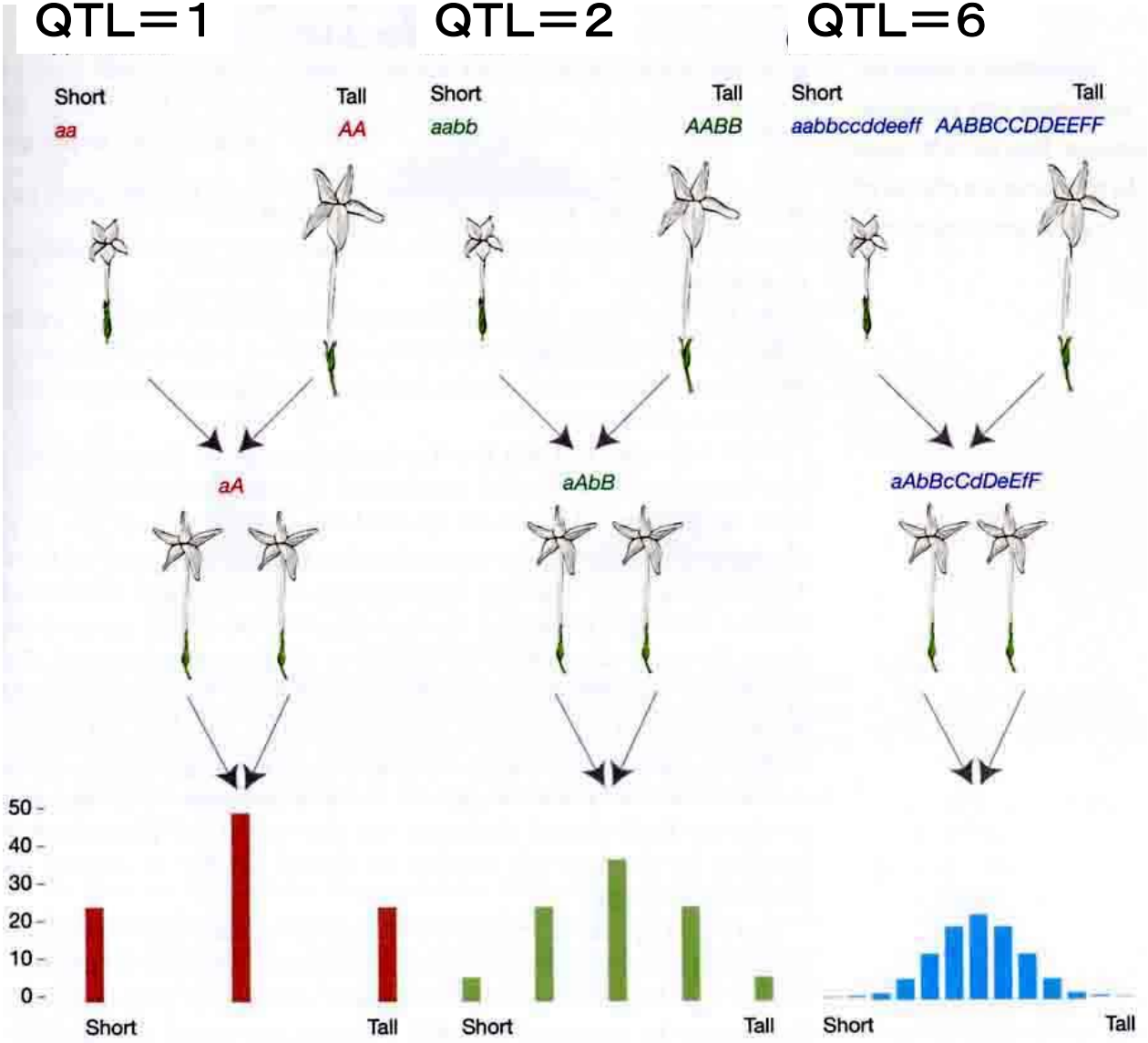
Evolutionary Analysis, Pearson edition, Fig 9.1

Quantitative genetic variation

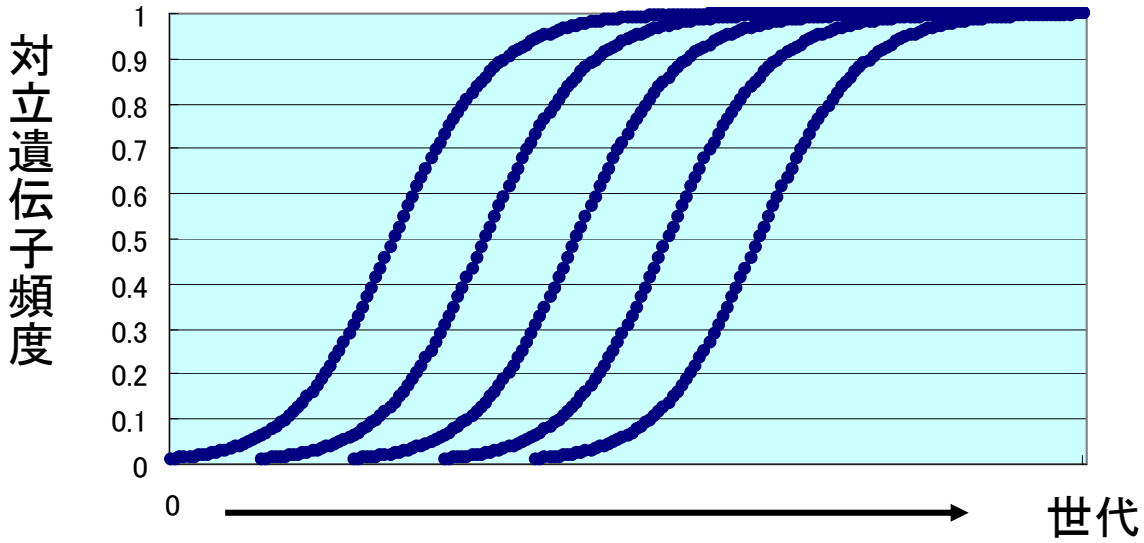


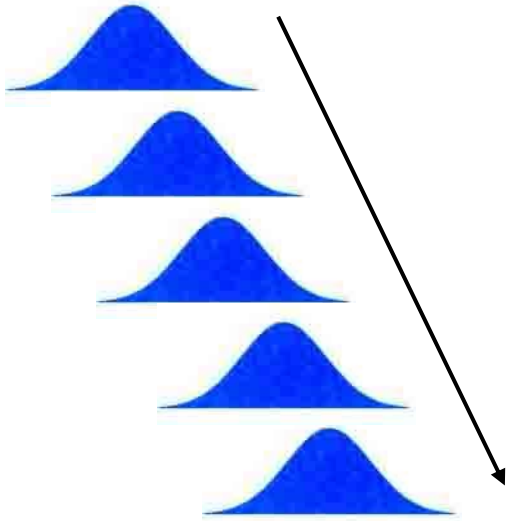
1, 2, 6 locus (QTL) models

QTL：量的形質の遺伝子座



対立遺伝子頻度の変化
Changes of allele frequency





Polygene model

Qestion

- In the competition equation, we neglected genetic changes or evolution.
- If two species competing with each other can change traits associated with the strength of interspecific competition, how does the prediction of the competition equation change?