2011年1月18日

生態学Ⅰ　第12回

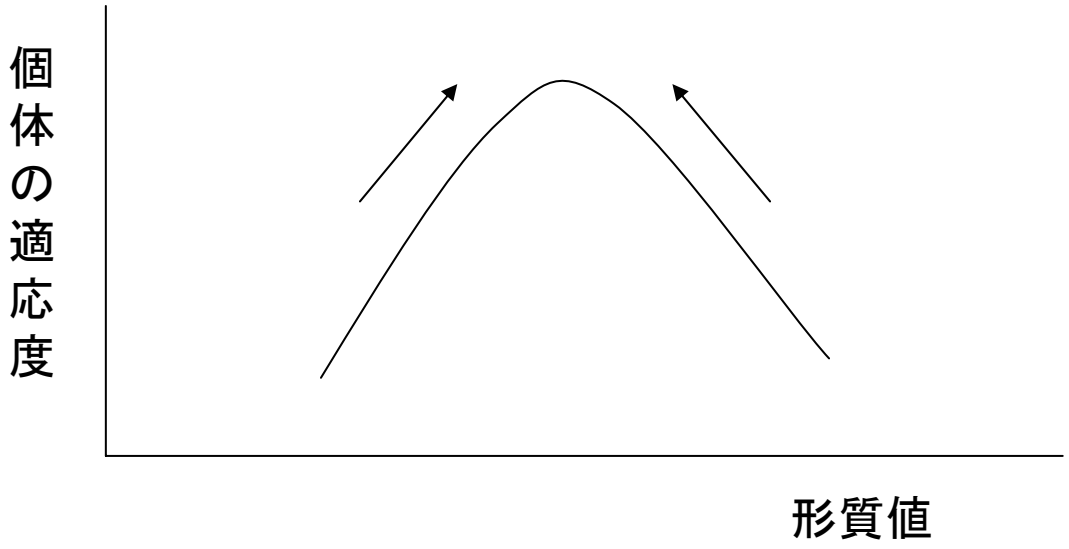
まとめ
生物多様性の保全

講義の流れ

- 第1回：適応度と最適化
- 第2回：自然淘汰
- 第3回：個体群動態と量的遺伝
- 第4回：量的遺伝（三村）
- 第5回：適応の遺伝的背景
- 第6回：遺伝的変異と有性生殖
- 第7回：トレードオフと性分配、花と送粉昆虫のコンフリクト
- 第8回：花と送粉昆虫の関係（川口）
- 第9回：性淘汰１
- 第10回：性淘汰２
- 第11回：性淘汰３

生物の表現型の特徴

- 「適応」・・・ある生育環境の下で生活していくうえで、非常に良くできている
- 「良くできている」状態とは？→最適化モデル



適応度 fitness

- ある形質を持つ1個体が生涯に残す子供の数の期待値
- 個体の値であり、種の値ではないことに注意

$$W = \sum_x l_x m_x$$

生涯繁殖成功度
Lifetime reproductive success

l_x　x令までの生残率（survivorship）

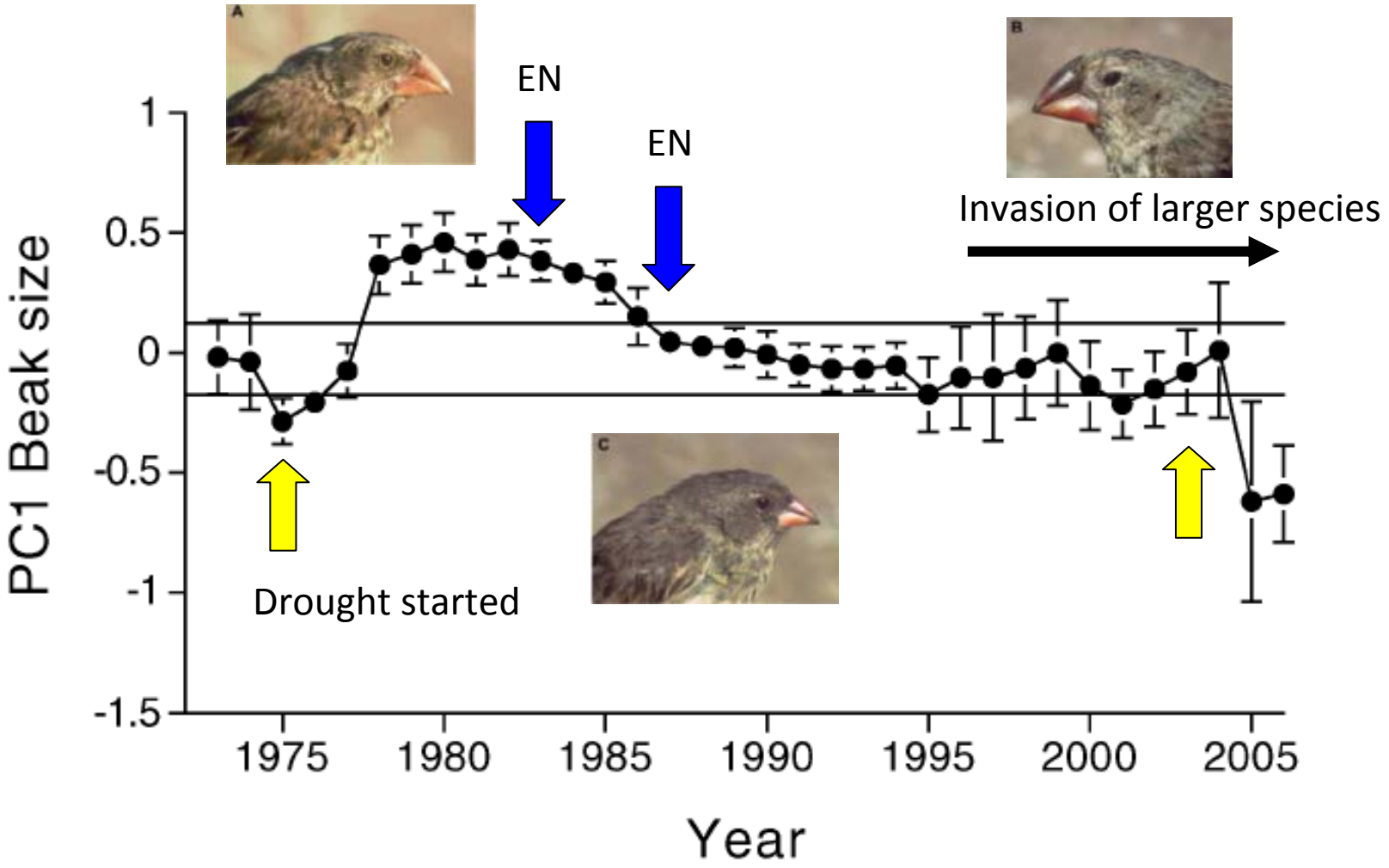
m_x　x令での産卵（産仔）数（fecundity）

自然淘汰の4つの前提

- There is variation among individuals.
- Some of the variation is heritable.
- Individuals vary in their success at surviving or reproducing.
- Reproduction is nonrandom.

Fig. 3-18

Beak size adaptation in medium ground finches



From Grant and Grant (2002)

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

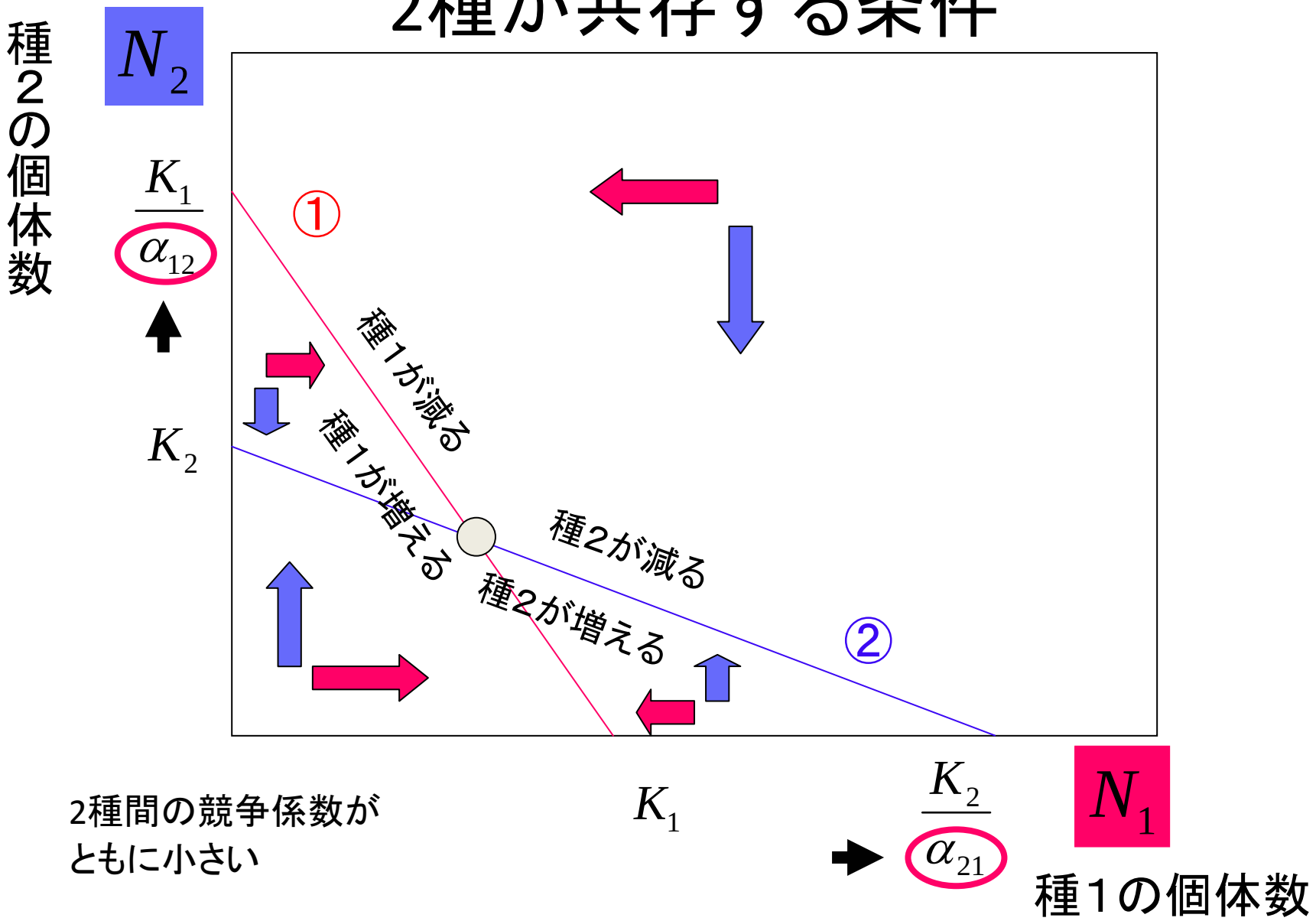
$$\Rightarrow \quad N_2 \leqq \frac{K_1}{\alpha_{12}} - \frac{N_1}{\alpha_{12}} \quad \cdots \quad ①$$

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

種2が増える条件
Sp2 increases

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

Condition for co-existence
2種が共存する条件



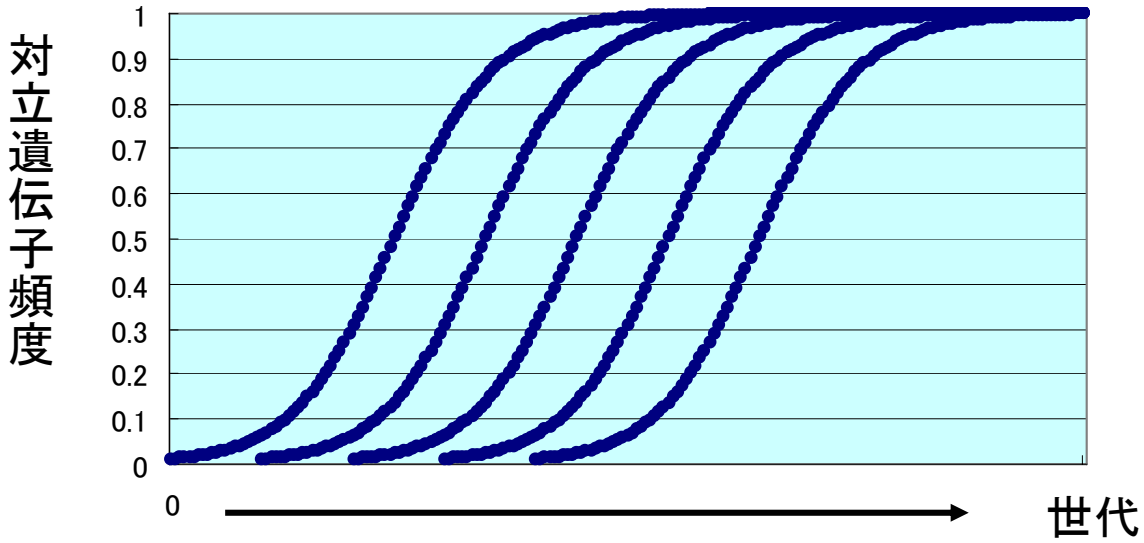
2種間の競争係数が
ともに小さい

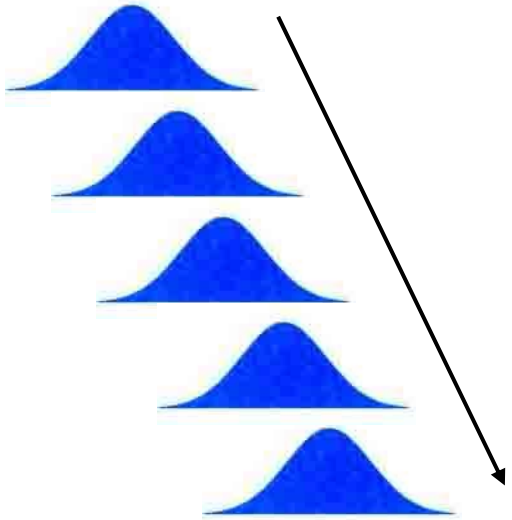
ミゾホウズキ属の姉妹種

- *Mimulus lewsii*
  - ハナバチ媒花　bee-pollinated
  - アントシアンが少ない・花弁広い pinky flower
  - 蜜量が少ない low volume of honey
  - おしべ・めしべは花弁より短い shorter stamen and pistil

- *Mimulus cardinalis*
  - ハチドリ媒花 bird-pollinated
  - アントシアンが多い・花弁細い reddish flower
  - 蜜量が多い high volume of honey
  - おしべ・めしべが突出する longer stamen and pistil

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





Polygene model

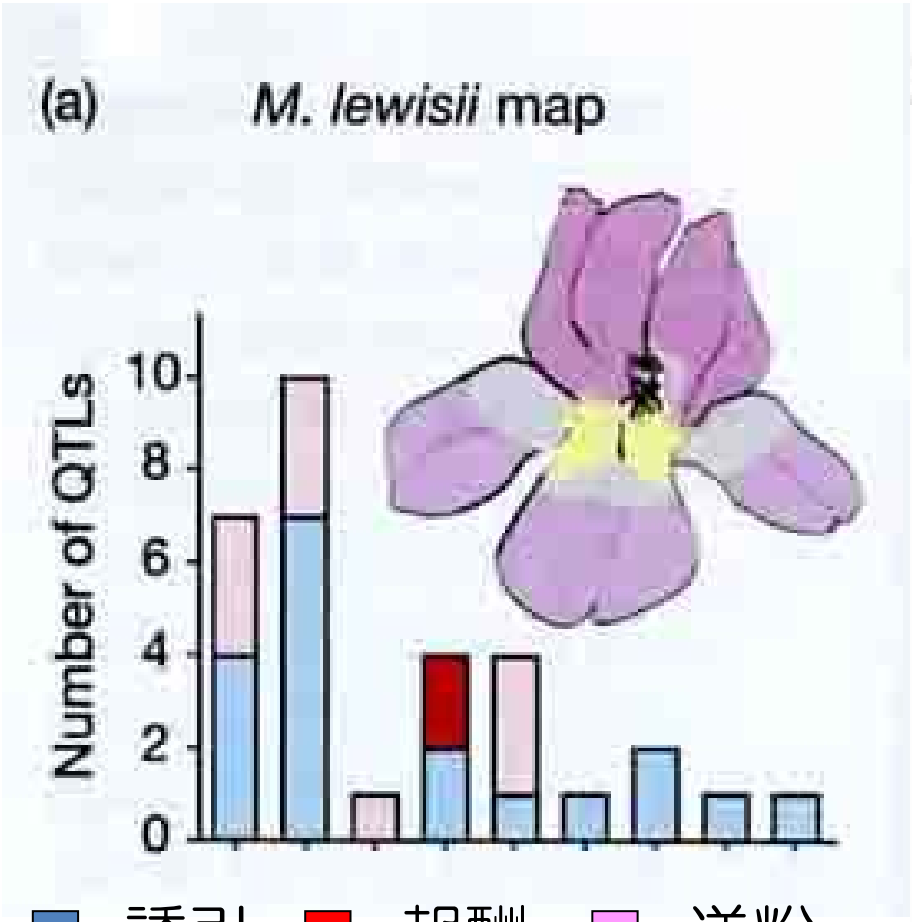
Mimulus lewsii x M. cardinalis

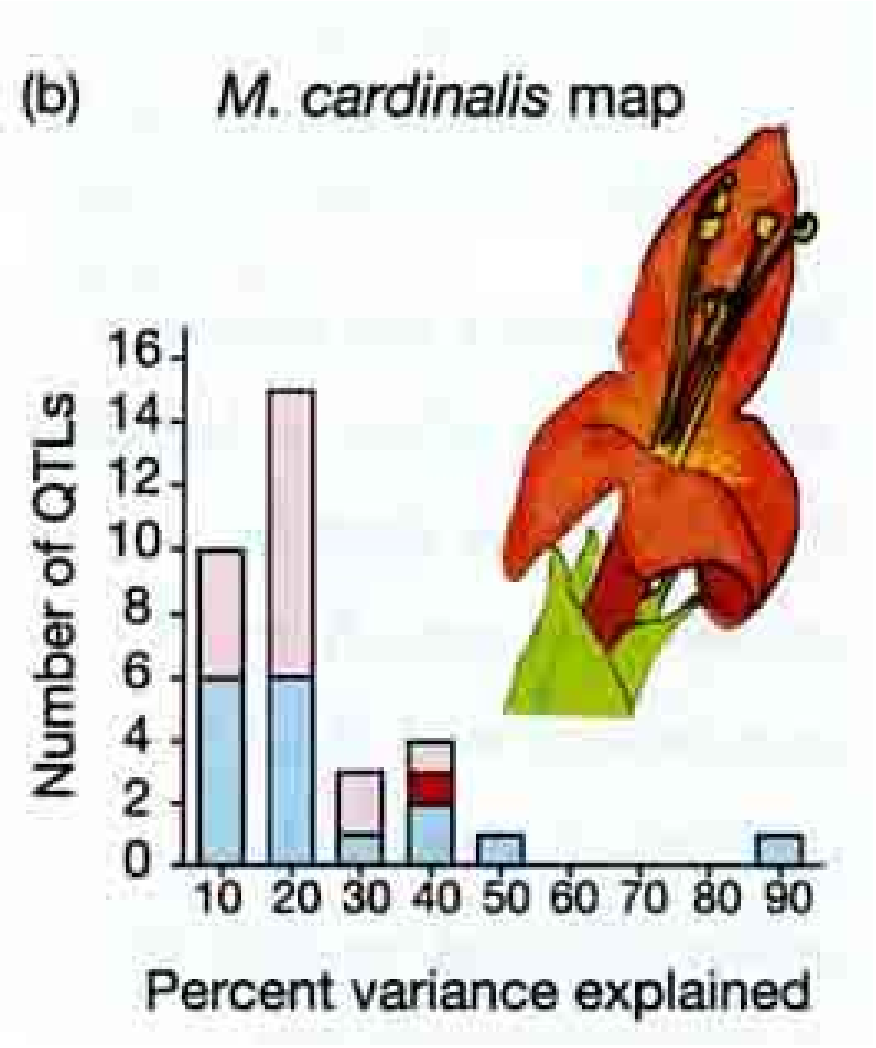
F2世代における形質の分離

Schemske & Bradshaw (1999) PNAS 96: 11910-11915

Fig. 9-9

ＱＴＬの表現型効果の分布





Trade-off: flower size vs number

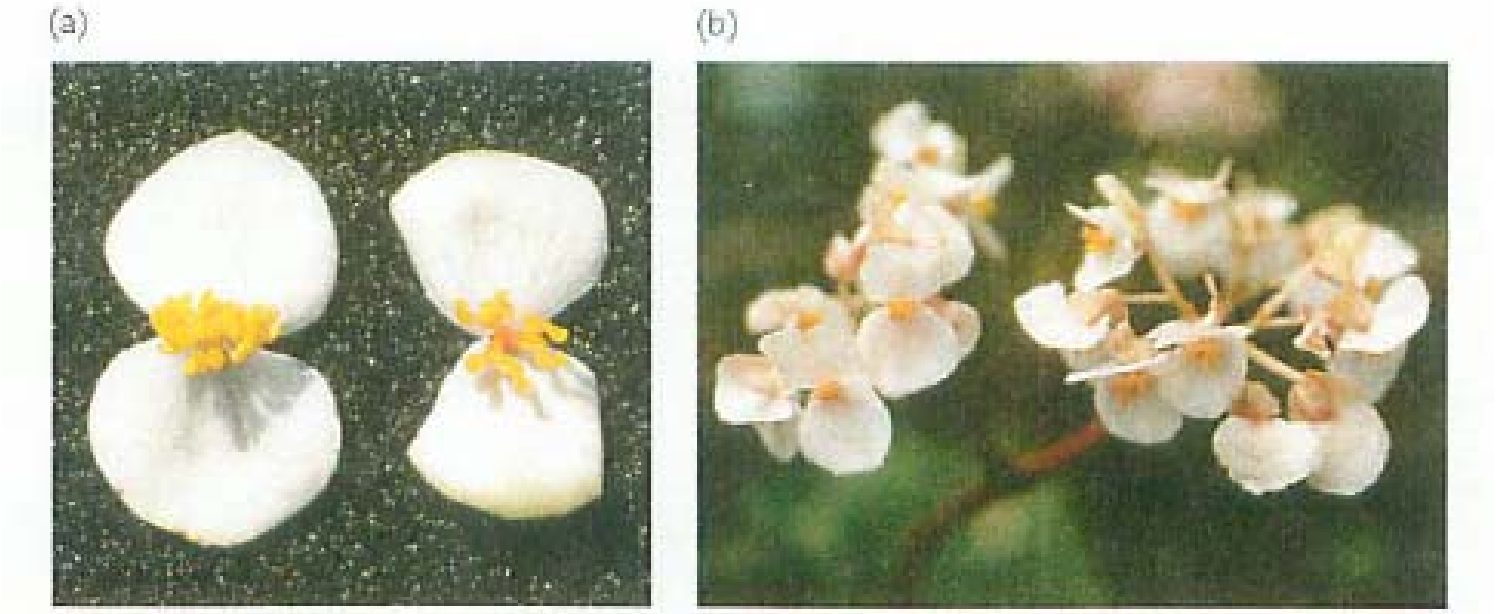
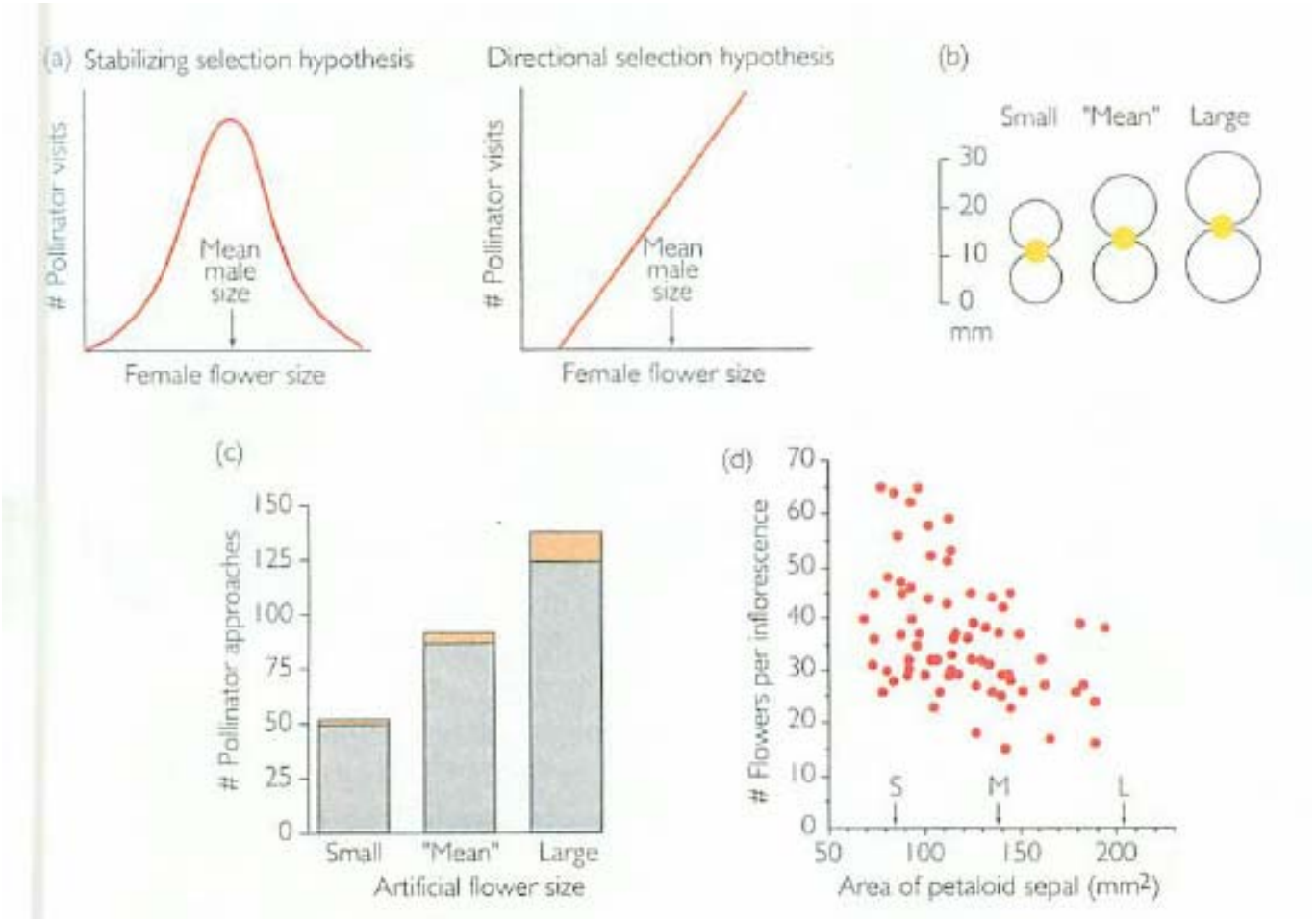


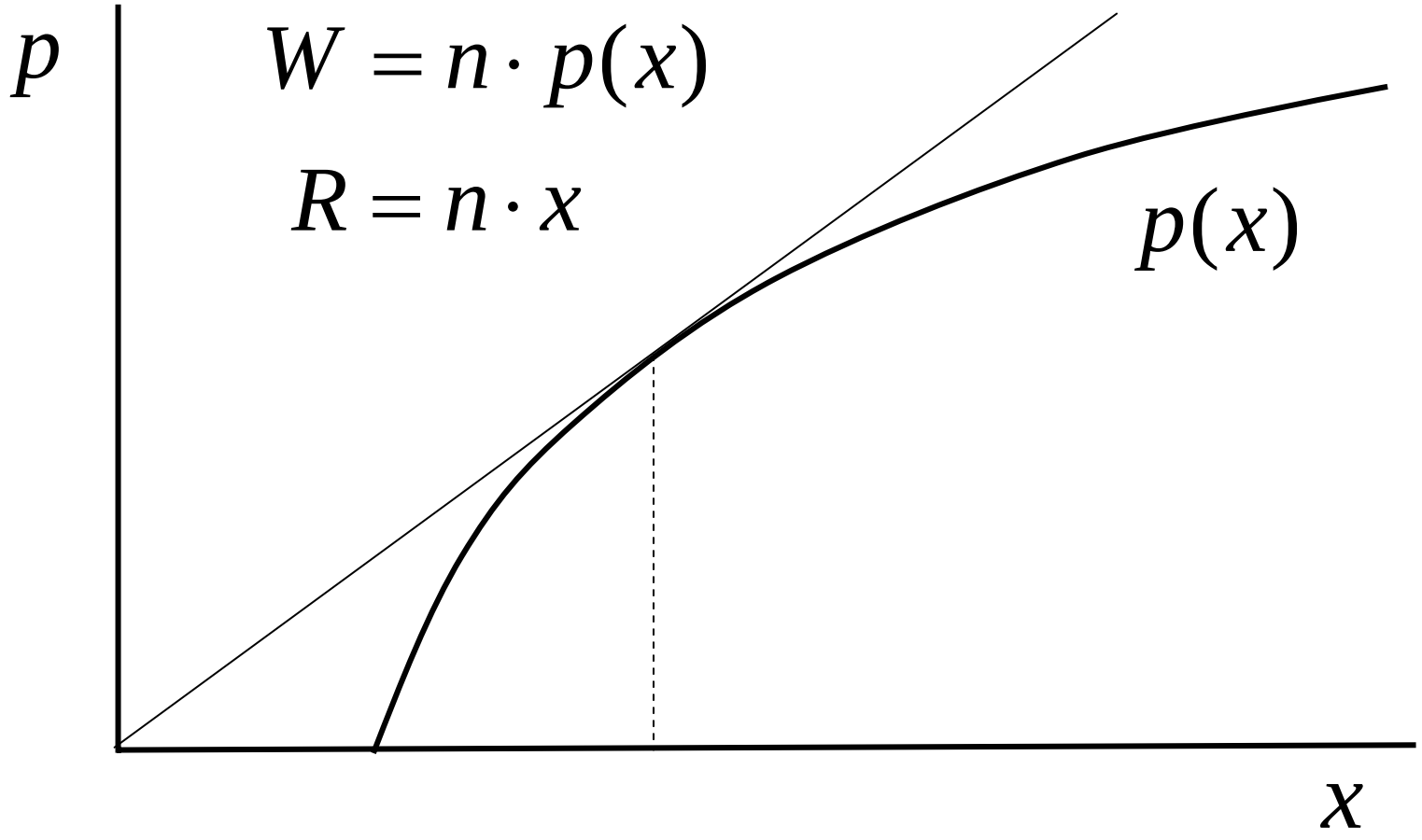
Figure 10.20 ***Begonia involucrata*** (a) Male (left) and female (right) flowers. The flowers lack true petals. Instead, each has a pair of petaloid sepals. The sepals are white or pinkish. In the center of each flower is a cluster of yellow anthers or stigmas. The stigmas of female flowers resemble the anthers of males. (b) An inflorescence, or stalk bearing many flowers. Each inflorescence makes both male and female flowers. Typically, the male flowers open first, and the female flowers open later. The inflorescence shown is unusual in having flowers of both sexes open at once.

Fig. 10-21

Trade-off: flower size vs number



Trade-off: flower size vs number



Sex allocation model

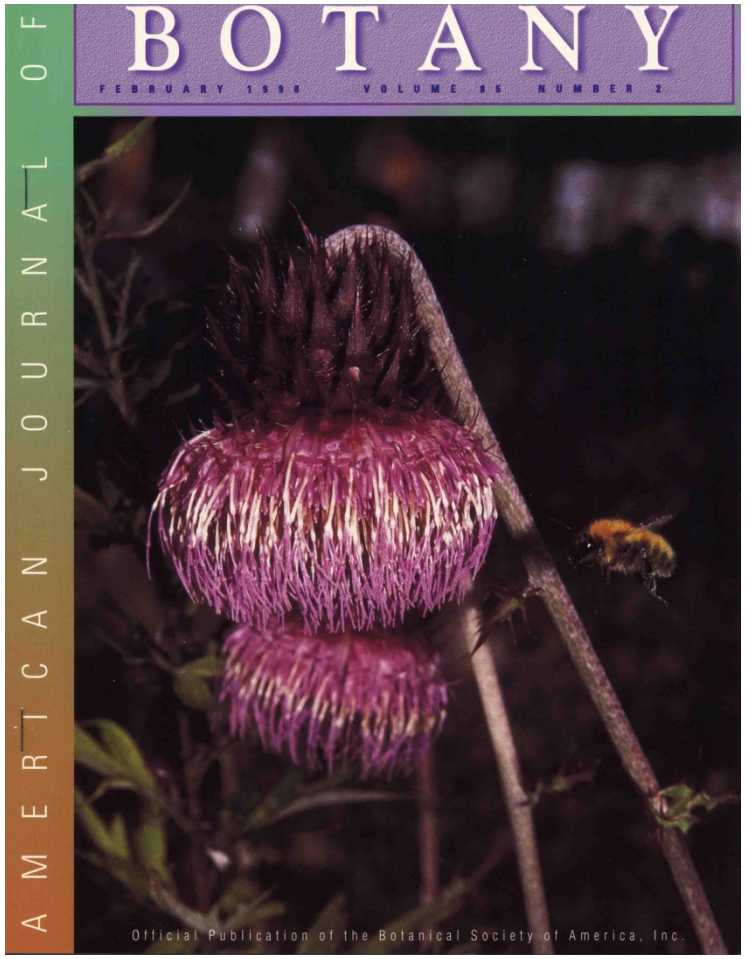
Fitness of a mutant $$W = \frac{1}{2} y + \frac{1}{2} x \frac{y^*}{x^*}$$

Resource allocation $$R = ax + by$$

Evolutionarily stable state（ESS） 進化的に安定な戦略

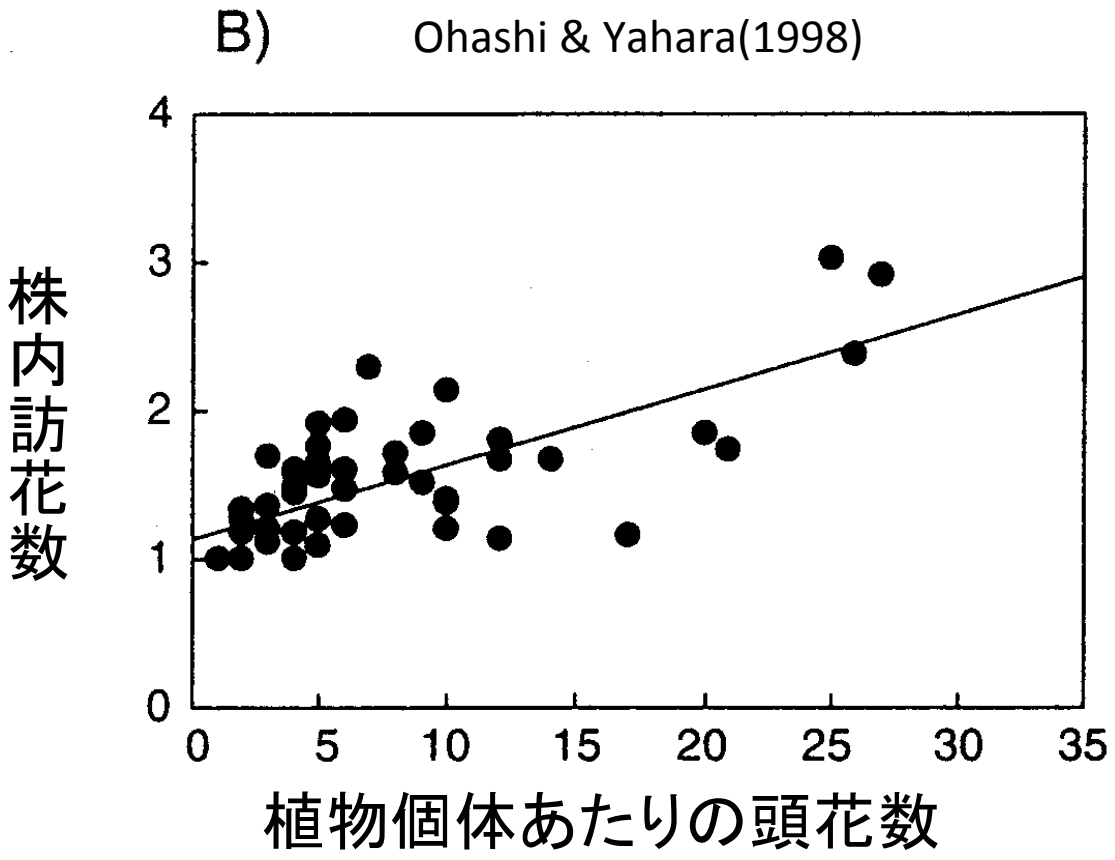
$$\left.\frac{\partial W}{\partial x}\right|_{x=x^*} = \frac{1}{2}\left(\frac{\partial y}{\partial x} + \frac{y^*}{x^*}\right) = \frac{1}{2}\left(-\frac{a}{b} + \frac{y^*}{x^*}\right) = 0$$

フジアザミとトラマルハナバチ

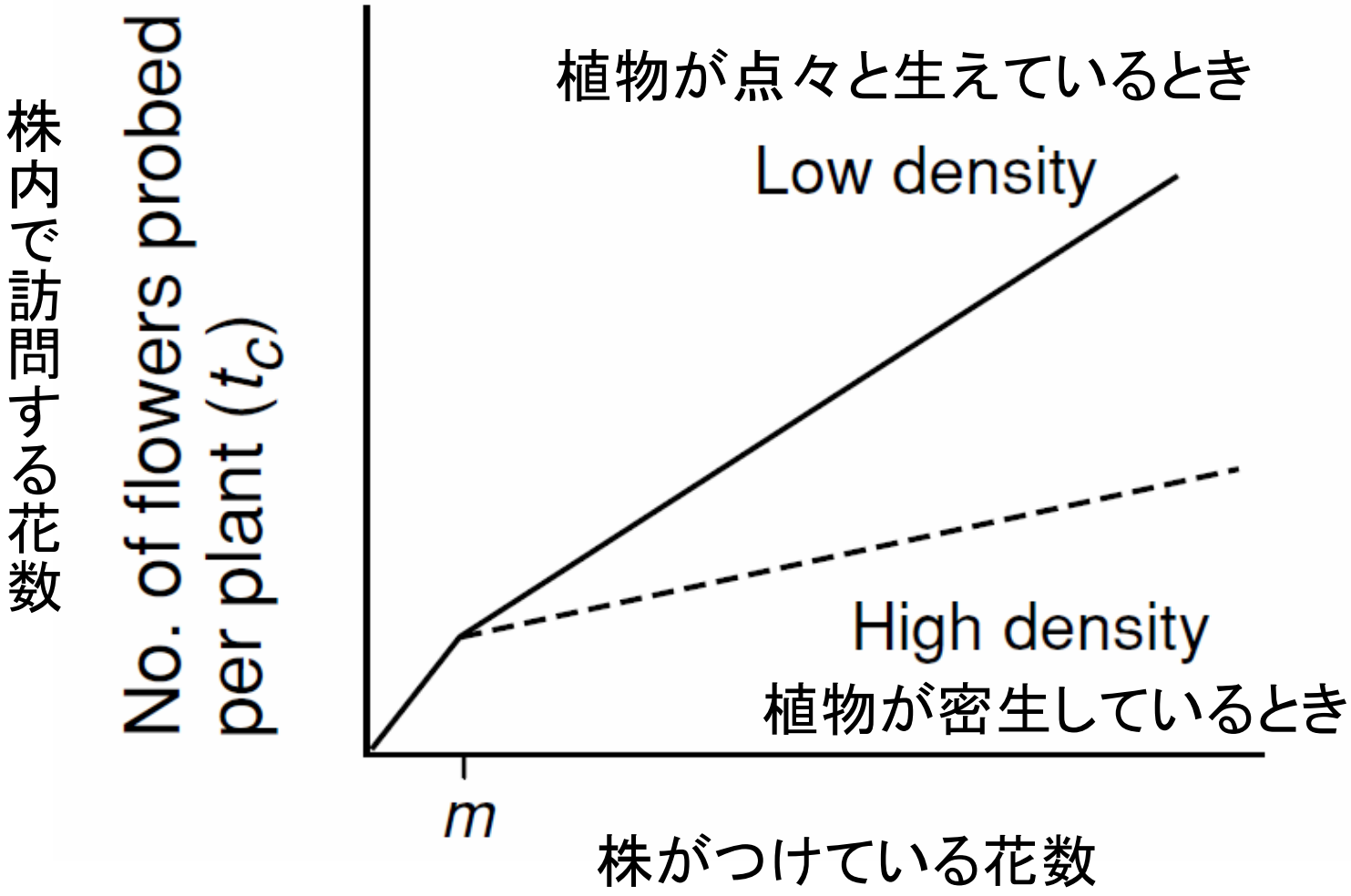


Ohashi & Yahara(1998)
Amer J Bot 85:219-224

フジアザミの花数とトラマルハナバチの株内訪花数の関係



Ohashi & Yahara モデルの予測



植物と訪花昆虫のコンフリクト

- 植物の花の戦略
  - 個体の適応度＝「自分が残す種子数＋花粉親として残す種子数」を最大化
  - 昆虫の行動を「操作」して隣花受粉を避ける
- 花を利用する昆虫の戦略
  - 単位時間あたりの収穫量を最大化
  - これは適応度を最大化することにつながる

Apparently non-adaptive differences

(a) Red deer

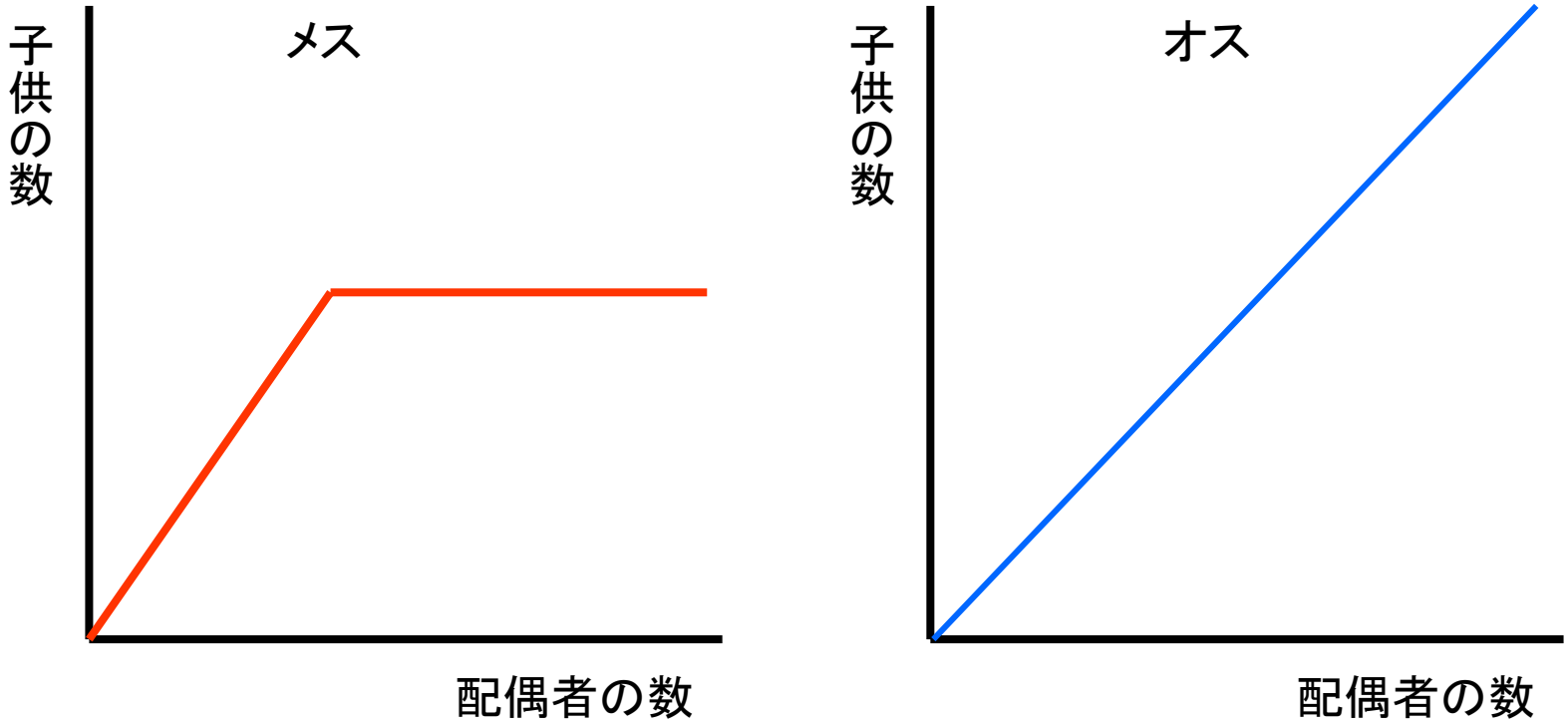
(b) Guppies

(c) Golden toads

Figure 11.1 The differences between males and females (the sexual dimorphism) in red deer (*Cervus elaphus*), guppies (*Poecilia reticulata*), and golden toads (*Bufo periglenes*) In (a), the male is on the left; in (b) and (c), the male is on the top.

Fig. 11.5

Bateman's principle



Bateman (1948) tested this prediction in lab populations of the fruit fly, and found that number of mates had a larger effect on RS of males than on RS of females.

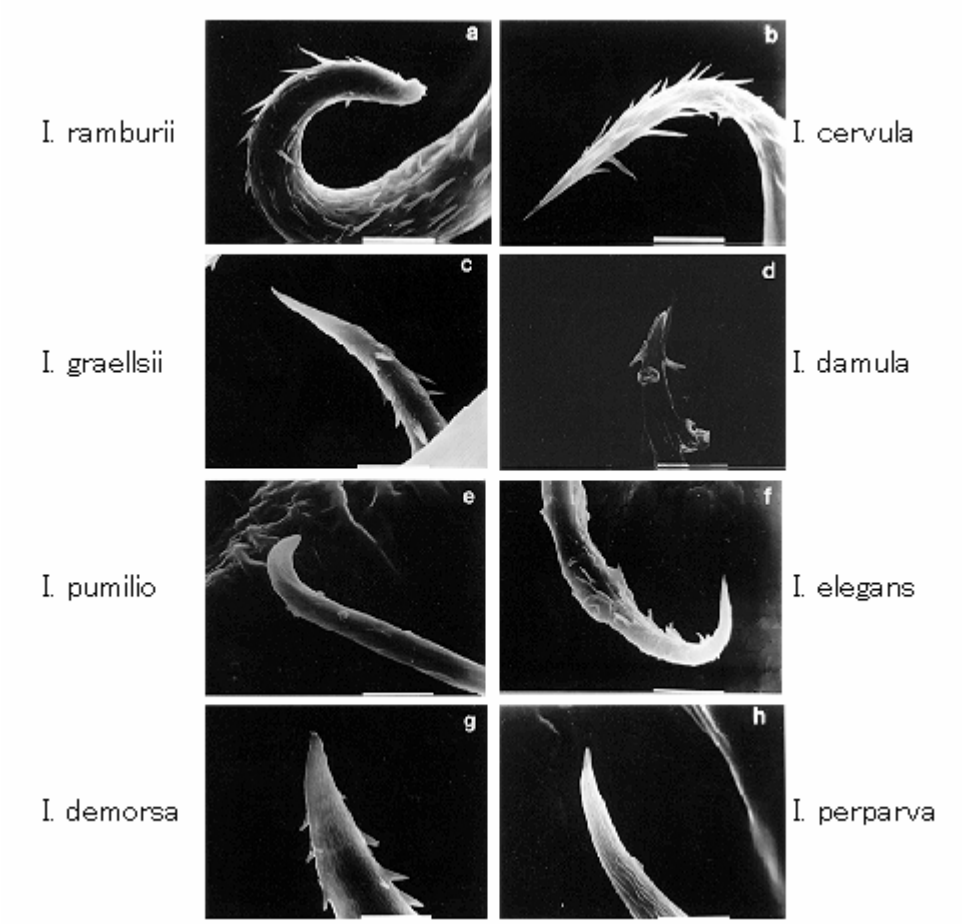
Hooknose and jack in coho salmon

- Hooknoses
  - Fighting strategy
- Jacks
  - Sneaky strategy
- An distinction: the iguana vs the coho
  - Making the best of a bad situation
  - ESS

http://yusukekoseki.michikusa.jp/research.htm

Sperm competition in *Ischnura*

http://farm1.static.flickr.com/8/12606903_a1cd751c29.jpg



http://www.uta.edu/biology/robinson/odonate_research.htm

Infanticide: 子殺し

The African Lion

Infanticide & Female Response

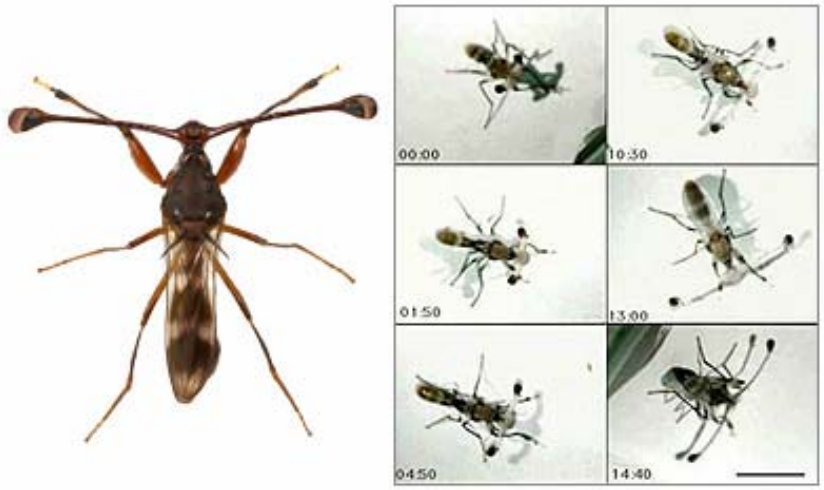
Home ¨ Habitat ¨ Predator/Prey ¨ Social Spacing ¨ Social Organization ¨ Mating Systems
Egalitarianism ¨ Infanticide ¨ Agonistic Behavior ¨ References

Image Courtesy of ABC-Kid.com

http://www.bio.davidson.edu/people/vecase/Behavior/Spring2004/shelburne/infanticide.html

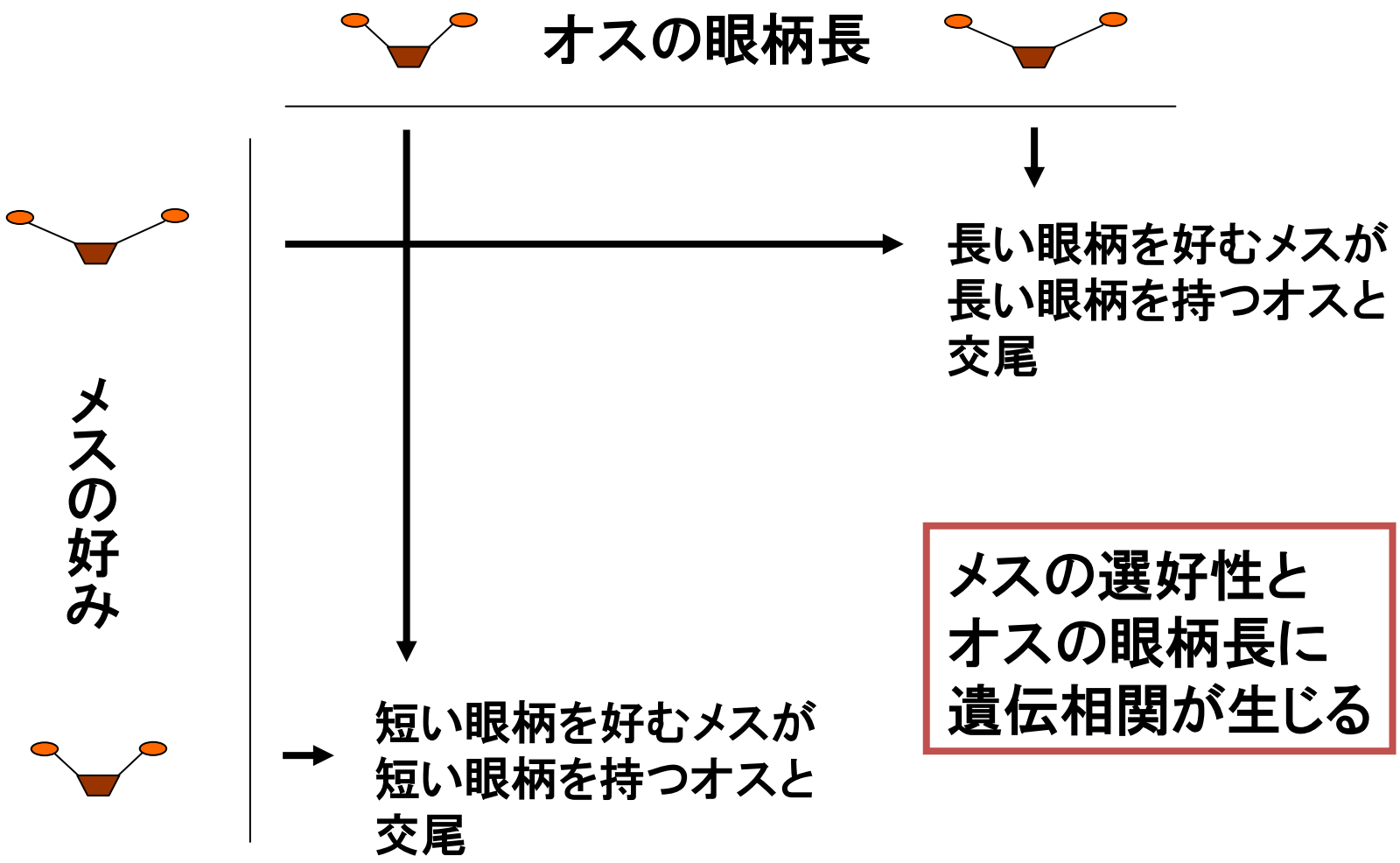
Stalk eyed fly シュモクバエ

http://www.africamuseum.be/museum/treasures/diopsidae/pic



http://dorcus.blogsome.com/images/stalk.jpg

Runaway sexual selection

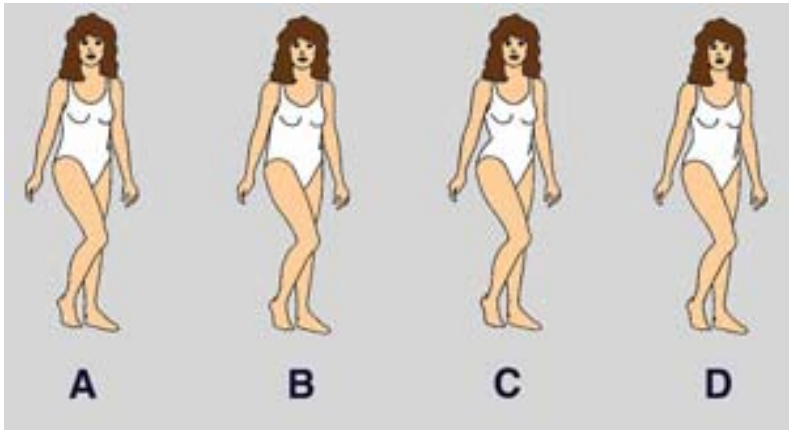


メスの選択:まとめ

- Good gene hypothesis
  - 遺伝的に質の良いオスを選ぶ
  - Handicap principle; honest signal
- Sexy son hypothesis
  - もてるオスを選ぶ（ Runaway ）
- Direct benefit hypothesis
  - 贈り物をくれるオスを選ぶ
  - But, “gifts” are often poisonous for females

人間の性的二型

- 自然淘汰の産物？　それとも性淘汰の産物？
  - 身長
  - 声変わり
  - Waist-Hip ratio



ヒトにおける性淘汰

- 雌雄の成熟期がほぼ等しく、オスも子育てに長い時間を費やす
  - メスだけでなくオスも選ぶ
  - 「浮気はオスの戦略」論は安易な一般化
- 性差は比較的小さい
  - 多くの形質において、自然淘汰と性淘汰が同じ方向で作用した可能性が大きい