2009年12月14日

生態学Ⅰ　第9回

11章「性淘汰」
Chapter 11 Sexual selection

「非適応的」性差の進化
Evolution of ‘non-adaptive’ sexual dimorphism

Sexual dimorphism

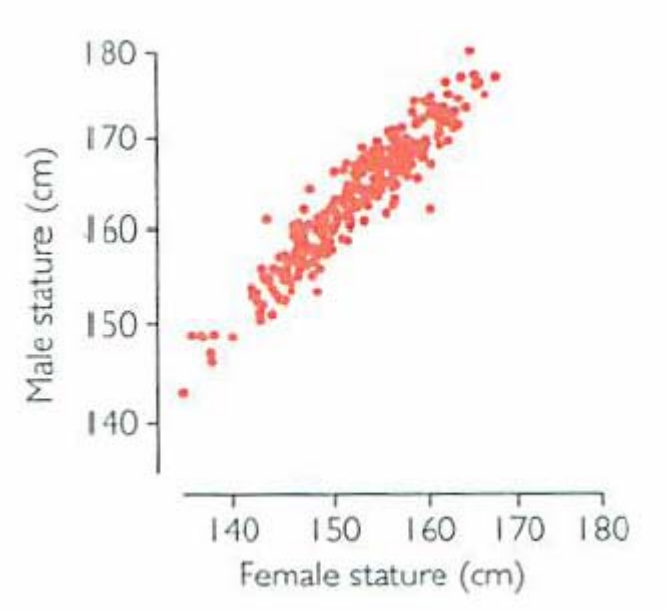
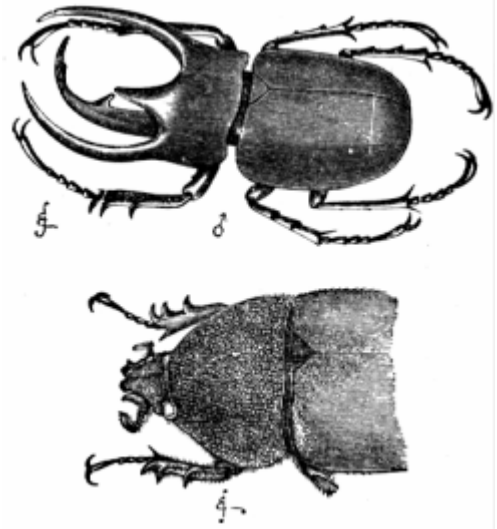
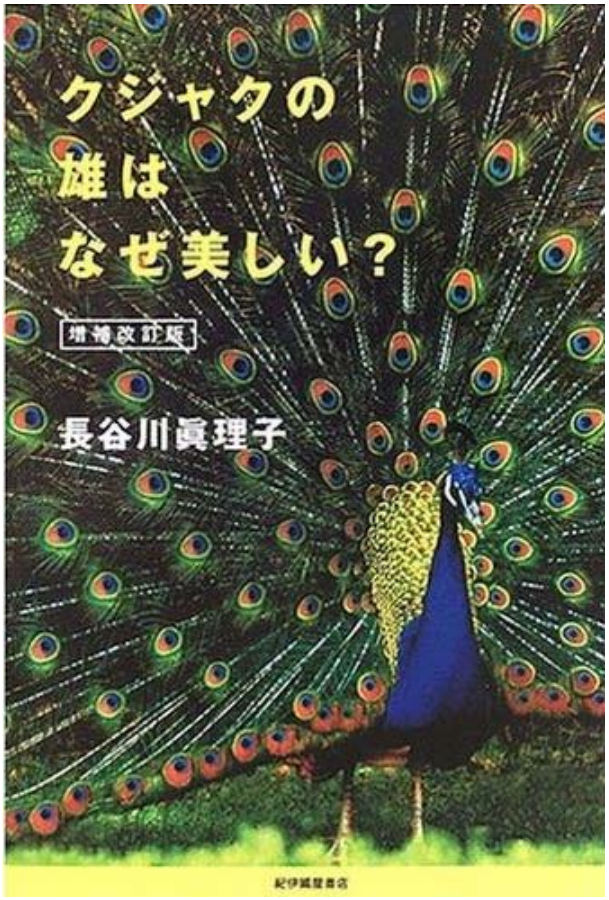


Figure 11.2 Women and men differ in height For each of more than 200 human societies, the average height of the men is plotted against the average height of the women. The diagonal line shows where the points would fall if men and women were of equal height. People vary widely in height from society to society: In the shortest society, the average man is about 143 cm tall (about 4 feet, 8 inches) and the average woman about 135 cm (~4'5"); in the tallest society, the average man is about 180 cm tall (~5'11"), and the average woman about 165 cm (~5'5"). But in every society the average man is taller than the average woman, usually by about 10%. From Rogers and Mukherjee (1992).

Sexual dimorphism

- Apparently non-adaptive differences
  - シカなどの角
  - 魚・両生類の体色
  - 鳥の飾り羽根





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.

Sexual dimorphismの謎

- If long tail feathers can improve the survival of fecundity, why do only males have them?
- How could enormously long tail feathers improve the survival or the fecundity of birds?

アカエリホウオウ

http://www.charliesbirdblog.com/~charlie/JNB11jan06/red-collwidow.jpg

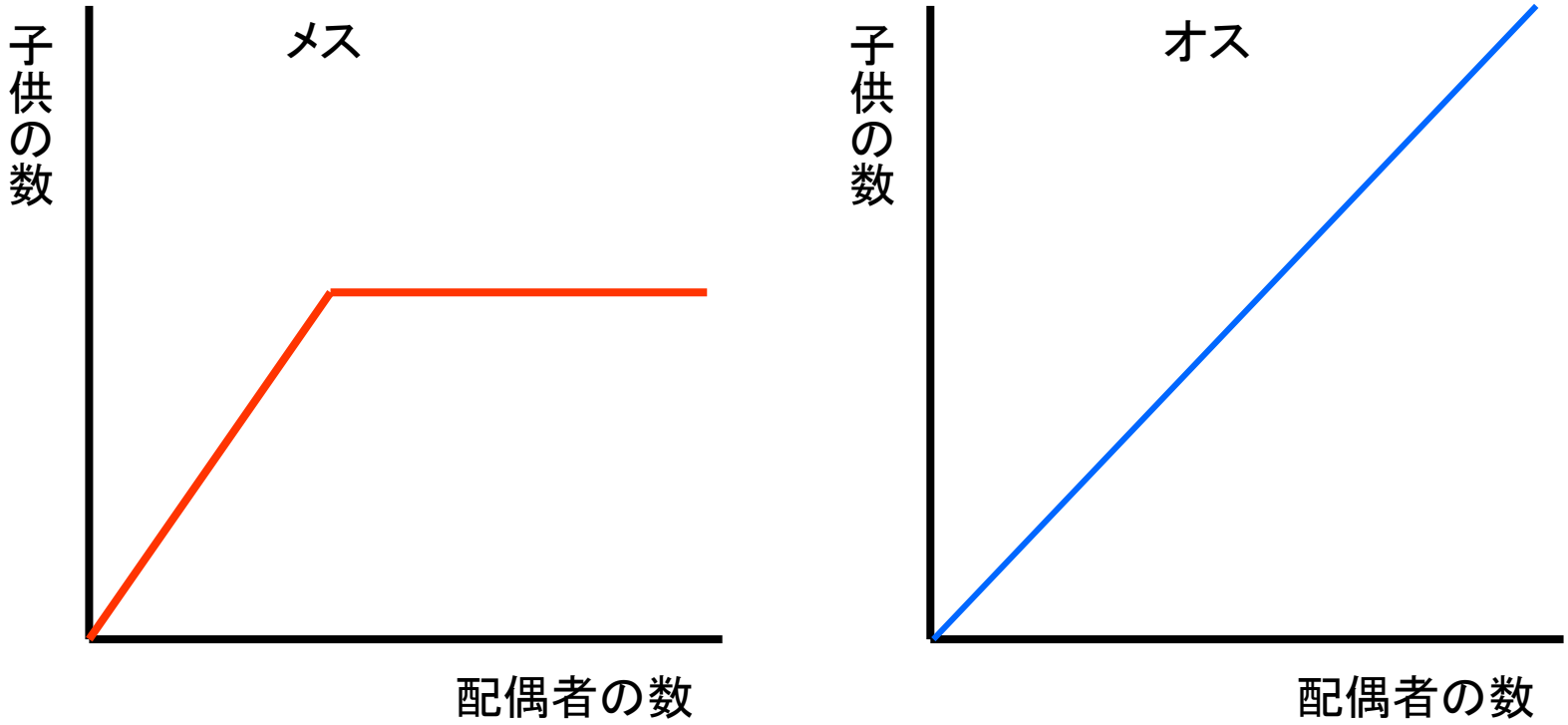
Darwin’s idea

- As Darwin himself was the first to recognize, sex provides a solution to the puzzle of sexual dimorphism.
- Darwin realized that individuals vary not only in their success at surviving and reproducing, but also in their success at persuading members of the opposite sex to mate.

Asymmetries in sexual reproduction

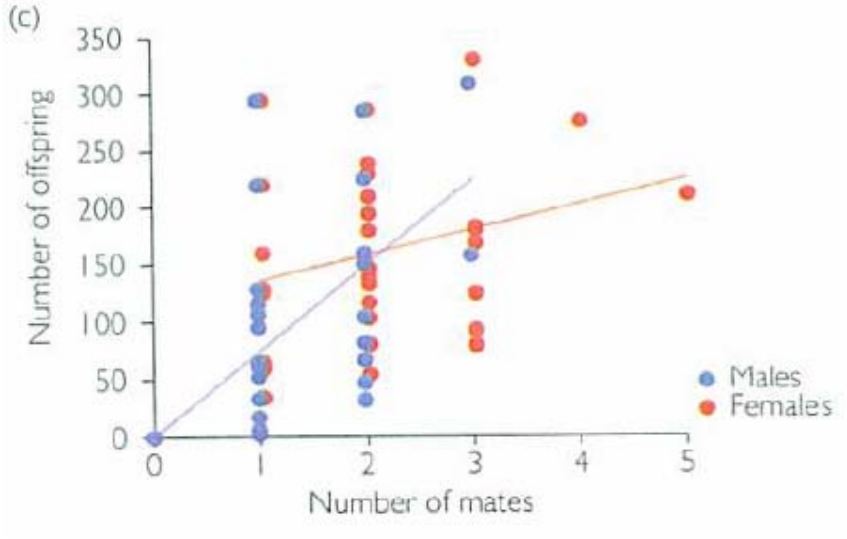
- Parental investment:
  - Eggs or pregnancies are more expensive than ejaculates.
- An example:
  - The orangutan mothers (ca 40kg) will carry the fetus for 8 months, give birth to a 1-kg baby, nurse it for ca 3 months, and continue to protect it until it reaches the age of 7 or 8.
  - The father (ca 70kg) produces only a few gram of semen.

Bateman’s principle

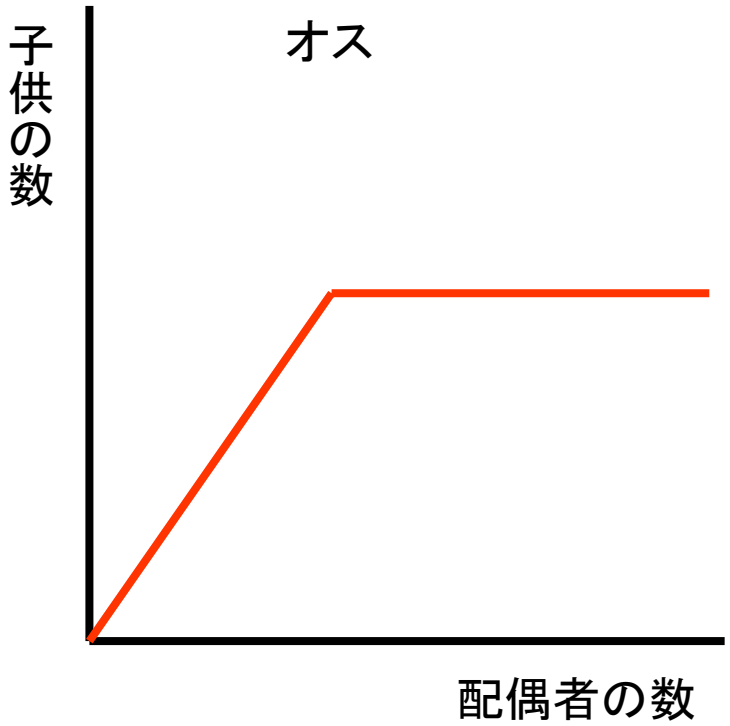


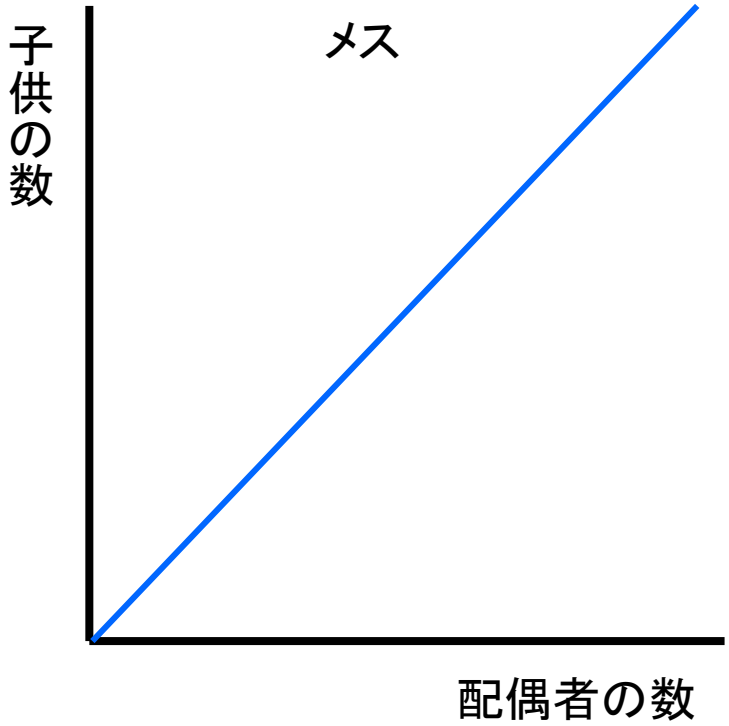
Bateman (1948) tested this prediction in lab populations of the fruit fly, and found that number of mates had a larger effect on RS of males than on RS of females.

Rough-skin newts *Taricha granulosa*



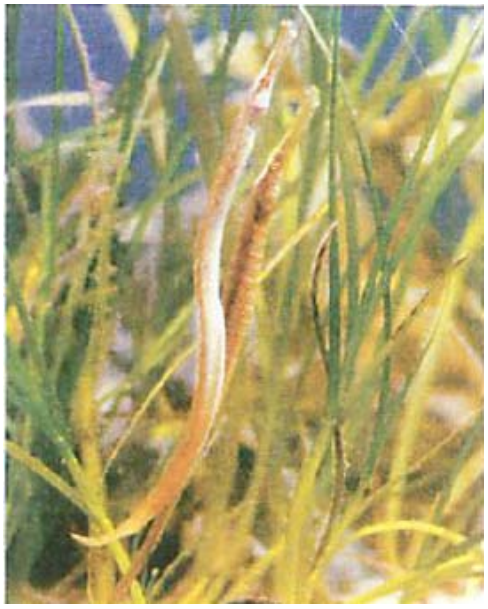
Question

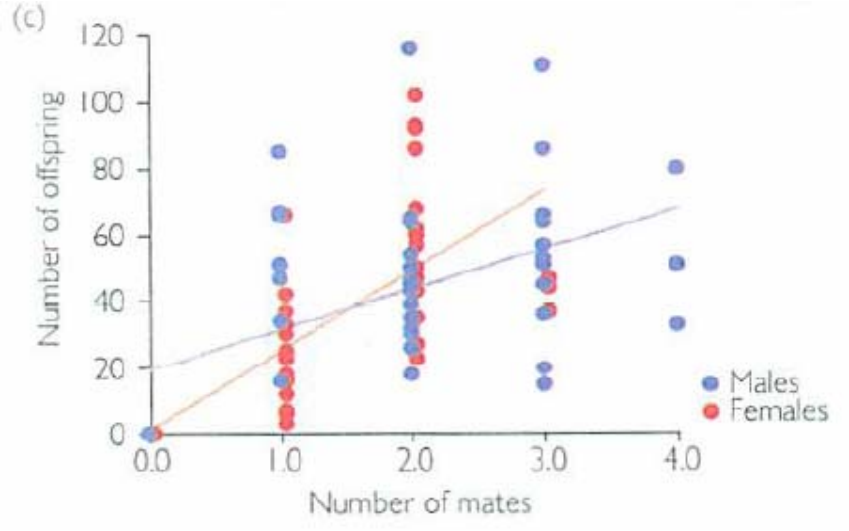




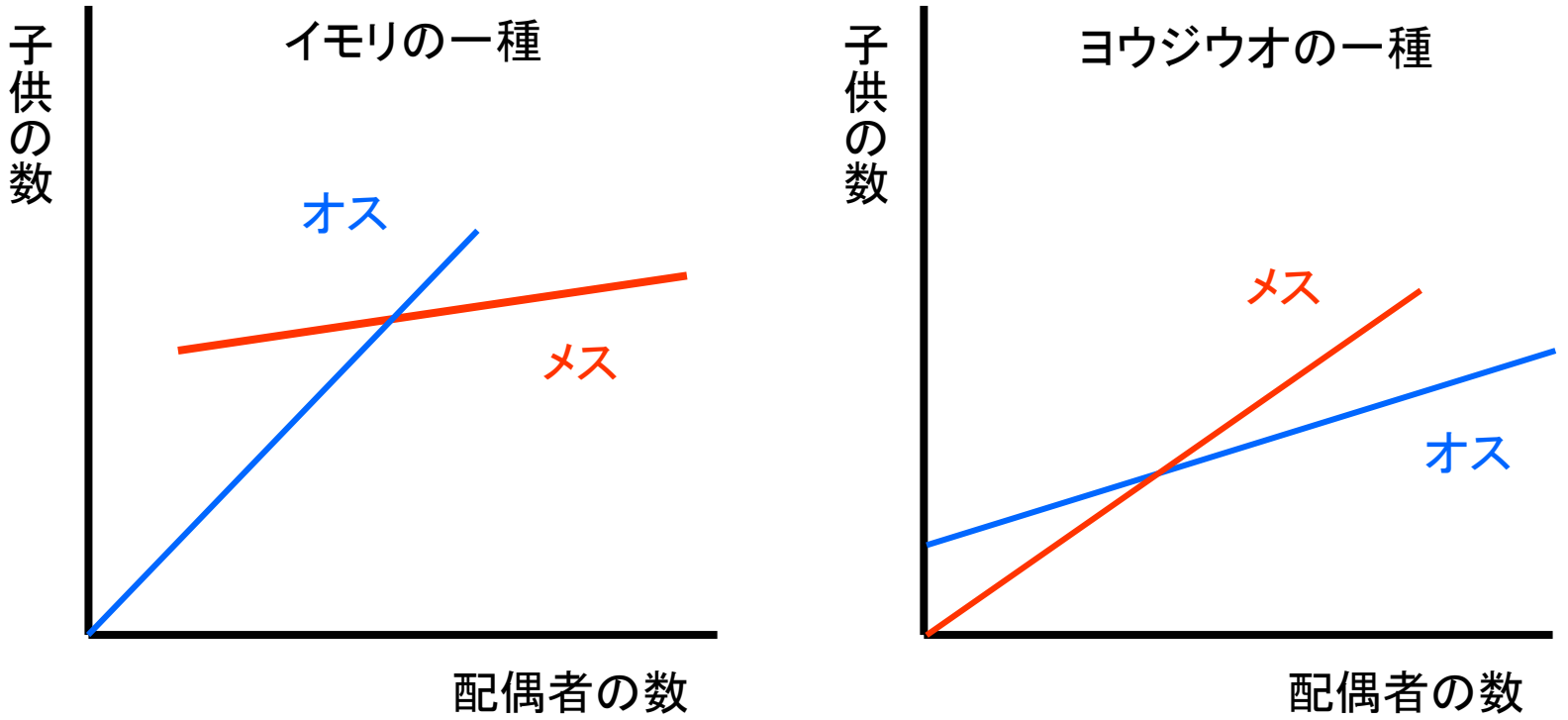
Batemanの原理が逆転するのは、どんな場合だろうか？

Broad-nosed pipefish *Sygnathus typhle*





Evidence for Bateman’s principle



Asymmetries in sexual reproduction in rough-skinned newts and broad-nosed pipefish

Behavioral consequences of asymmetric limits on fitness

- Male-male competition (intrasexual selection)
  - Males may fight amongst themselves, head-to-head, claw-to-claw, or antler-to-antler.
  - Males may advertise for mates by singing, dancing, or showing off bright colors.
- Female choice (intersexual selection)
  - Females choose the male with the best display.

Galapagos marine iguanas

Fig 11.9 Natural selection on body size in Galapagos marine iguanas

- Maximum size at which iguanas were able to maintain their weight
  - メスはこの上限以下だが、オスの多くはこの上限をこえている
- Survival rates of marked individuals of different sizes
  - 大型個体は生残率が低い（とくにオス）

⇒ オスの大型個体の存在は自然淘汰では説明が困難

Fig 11.9 Natural selection on body size in Galapagos marine iguanas

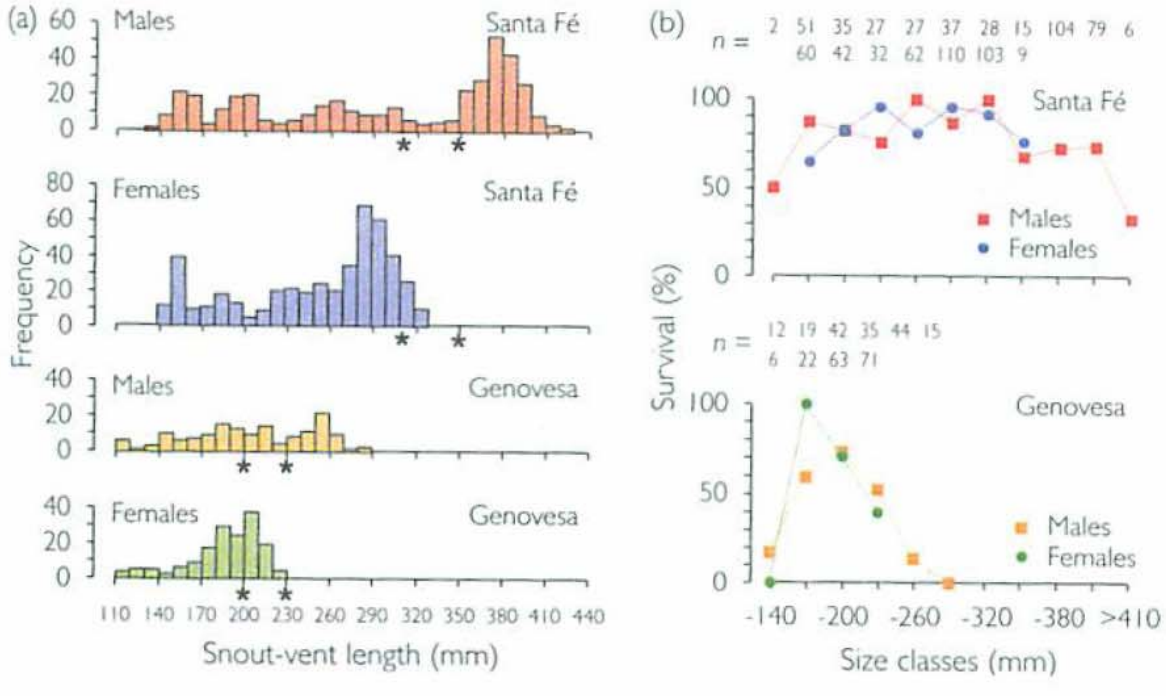


Figure 11.9 Natural selection on body size in marine iguanas (a) Size distributions of male and female marine iguanas on two different Galápagos Islands, Genovesa and Santa Fé. Asterisks mark the maximum sizes at which iguanas were able to maintain their weight in two different years (1991–1992 and 1992–1993). From Wikelski et al. (1997). (b) Survival rates of marked individuals of different sizes (snout–vent length, mm) from March 1991 to March 1992 on Genovesa and from February 1990 to February 1992 on Santa Fé. The sample sizes, or number of individuals in each group, are given by *n*. From Wikelski and Trillmich (1997).

Parental investment in marine iguanas

- Each female
  - digs a nest on a beach away from the basking and feeding areas,
  - buries her eggs,
  - guards the nest for a few days,
  - lays a clutch of 1-6 eggs/year,
  - into which she puts ca 20% of the body mass.
- Males
  - provide no parental care at all,
  - The cost of producing ejaculates is paltry.

Fig 11.11 Mating success in marine iguanas

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- There is extreme variation among males:
  - 45 in No 59, 10 in No 65, … 0 in 8 individuals.
- Because:
  - only some males manage to claim territories,
  - some males manage to maintain their claims for a longer period than others,
  - some territories and territory holders are more attractive to females than others.

Fig 11.11 Mating success in marine iguanas

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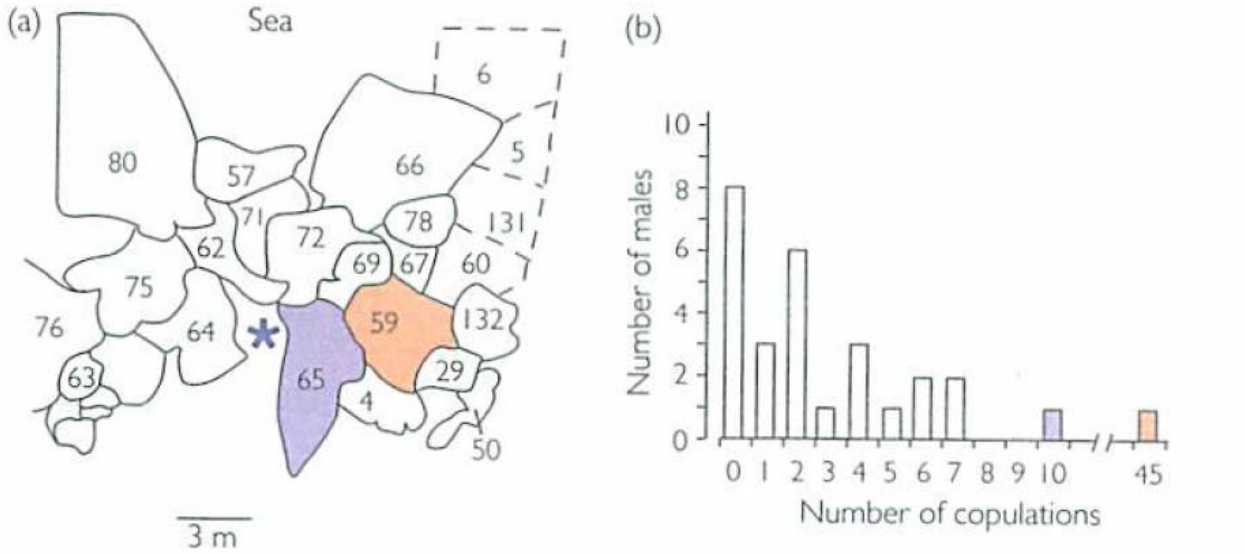

Figure 11.11 Mating success in male marine iguanas (a) A cluster of iguana mating territories on Camaaño Islet, Galápagos. Lines show boundaries of mating territories on January 16, 1978; numbers identify territory owners. As the scale bar for this map shows, mating territories are only a few square meters in size. The dark blue asterisk indicates where Krisztina Trillmich sat to watch the iguanas. (Camaaño Islet has only 880 m of shoreline and supports a population of nearly 2,000 iguanas.) From Trillmich (1983). (b) Histogram showing variation in number of copulations obtained by male iguanas on mating territories shown in (a). Note the break in the horizontal scale; the most successful male, iguana 59, got more than four times as many copulations as any of his rivals. The histogram includes only males that claimed a territory for at least a short time during the mating season. From Trillmich (1983).

Sexual selection differentials

Table 11.1 Sexual selection differentials for male body size in marine iguana colonies on Santa Fé and Genovesa

Body size is given as snout–vent length (SVL). The standardized selection differential (see Chapter 9) is the difference between the average body size of all males that copulated at least once and the average body size of all males that tried to copulate, expressed in standard deviations of the distribution of body sizes of all males that tried to copulate. (The standard deviation is the square root of the variance.) Both standardized selection differentials are positive ($P < 0.05$), indicating that males that got to copulate were larger on average than males that tried to copulate. From Wikelski and Trillmich (1997).

	N	Average size (mm SVL)	Standard deviation	Standardized selection differential
Santa Fé				
Males that copulated	253	401	13	0.42
All males that tried to	343	390	26	
Genovesa				
Males that copulated	25	243	26	0.77
All males that tried to	147	227	21	

まとめ

- 性淘汰には2つのタイプがある
  - 性内淘汰：通常はオス間競争
  - 性間淘汰：通常はメスによる選択
- 性淘汰は非適応的な性的2型を進化させる
  - 「美しい」オス
  - 「選ぶ」メス