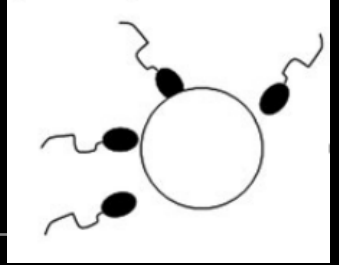


What is Sex?

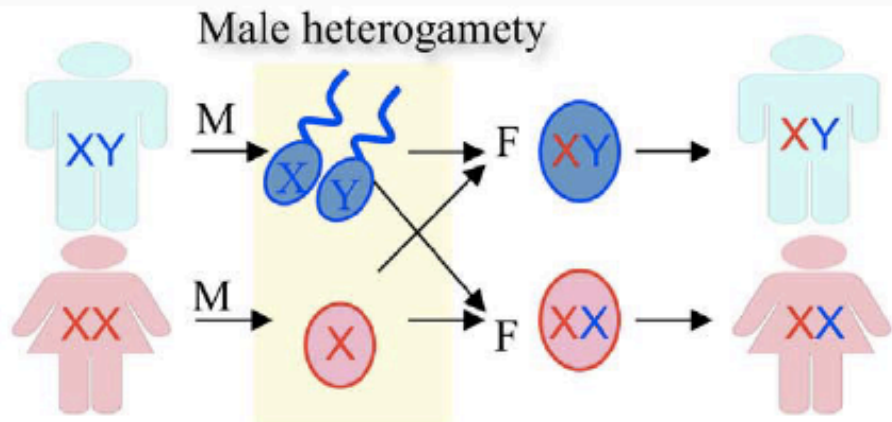


What differentiates the male sex from the female?

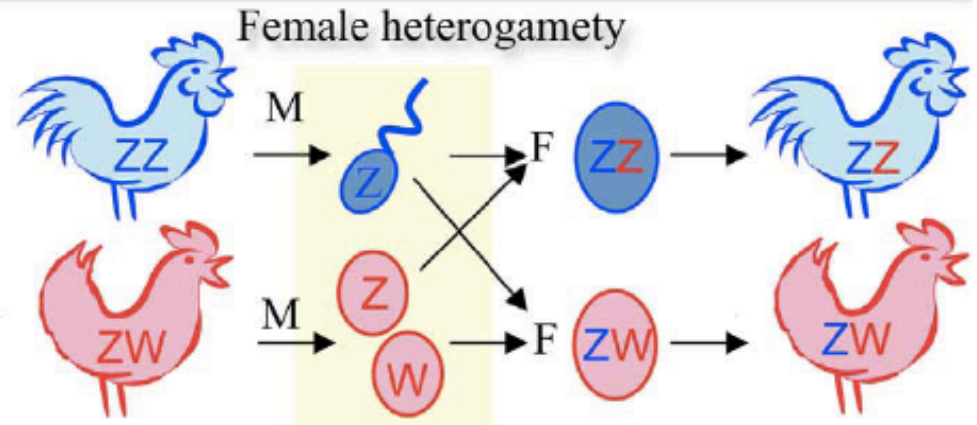
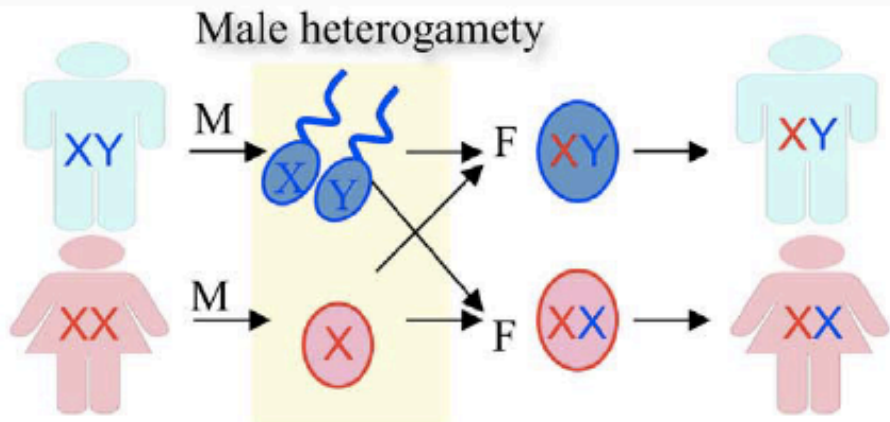
What determines the development of the male sex vs. the female sex?

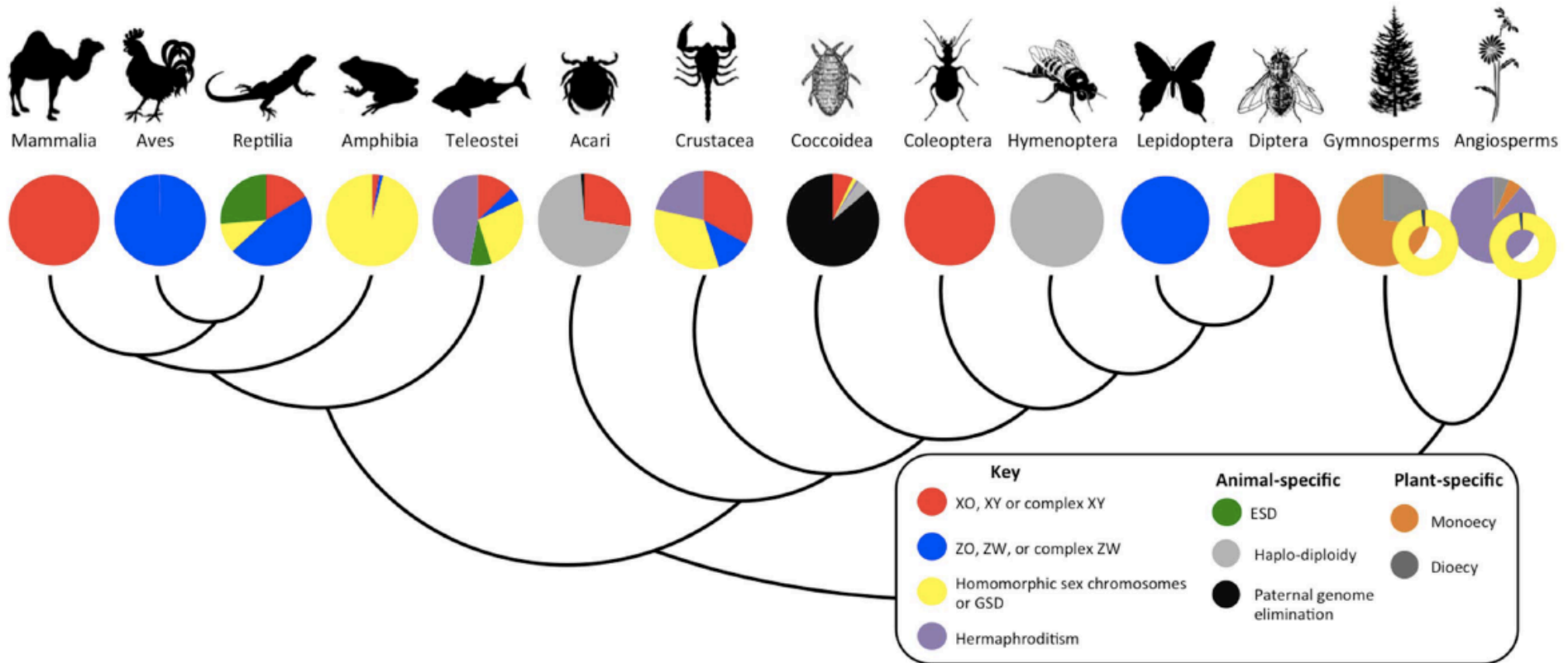
What are some evolutionary consequences of sex with regard to animal behavior?

GENOTYPIC SEX DETERMINATION



GENOTYPIC SEX DETERMINATION

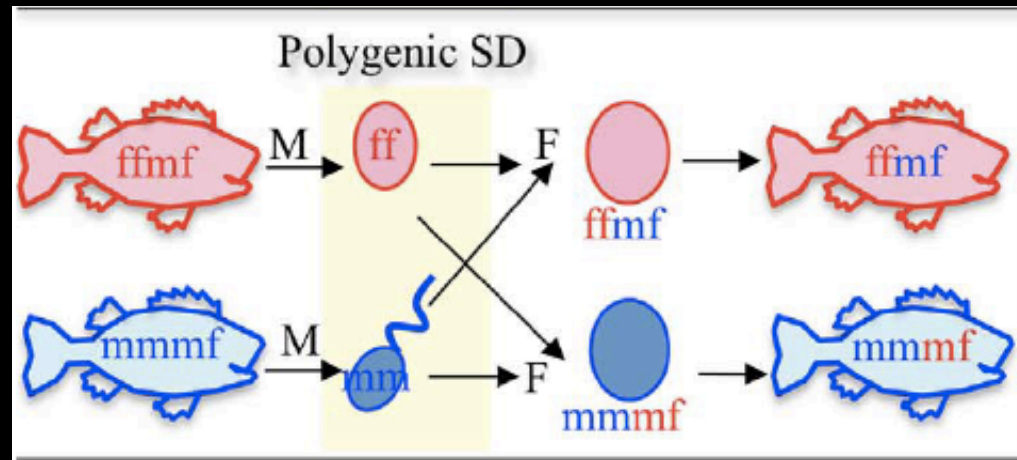




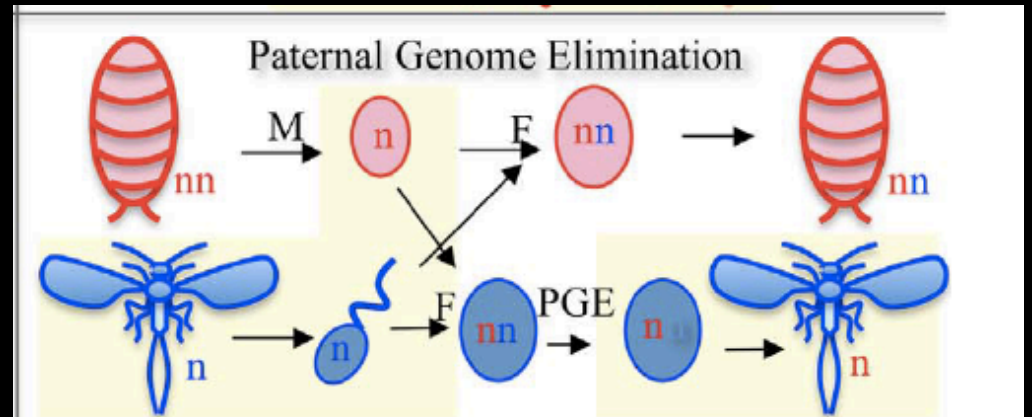
Two theories for the evolution of separate sexes:

- 1) Trade offs
- 2) Avoidance of inbreeding

GENOTYPIC SEX DETERMINATION

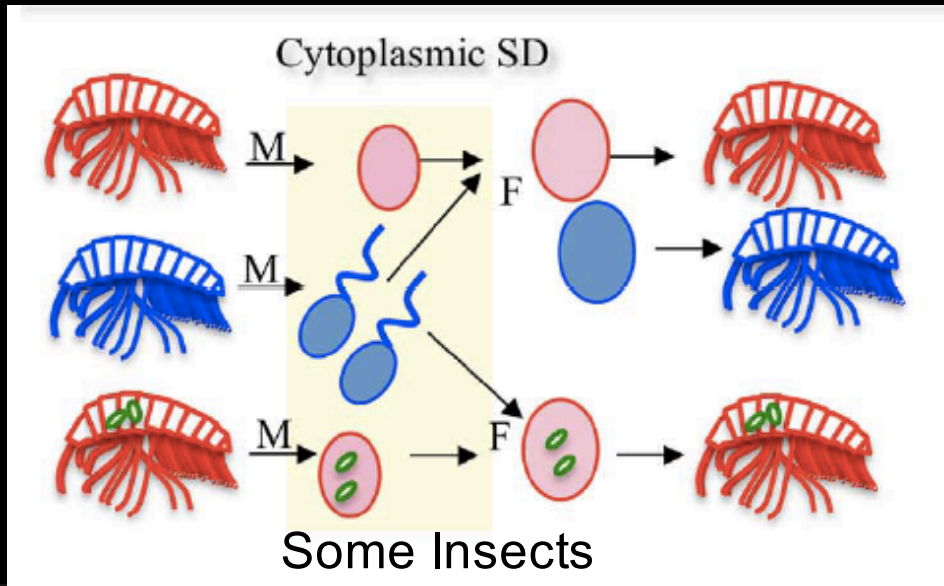


GENOTYPIC SEX DETERMINATION



Scale Insects

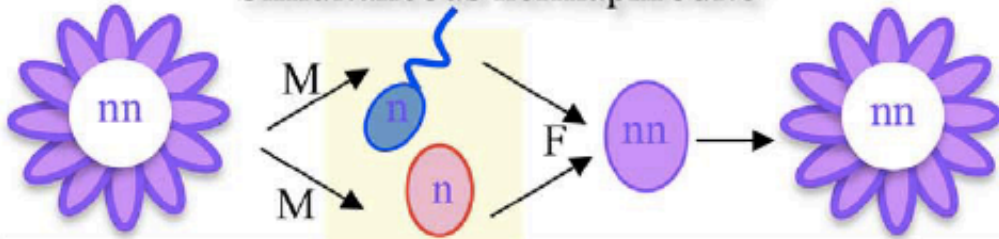
GENOTYPIC SEX DETERMINATION



HERMAPHRODITES

~5% of animal species

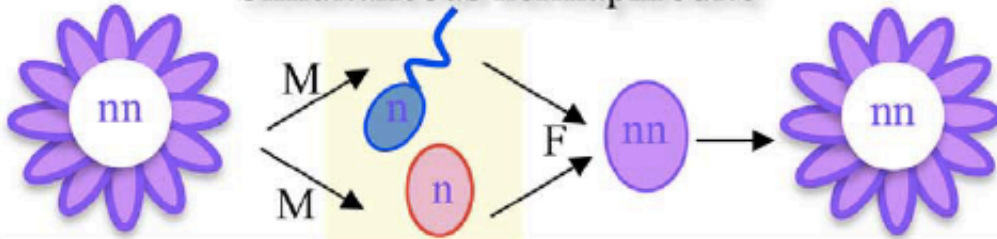
Simultaneous hermaphrodite



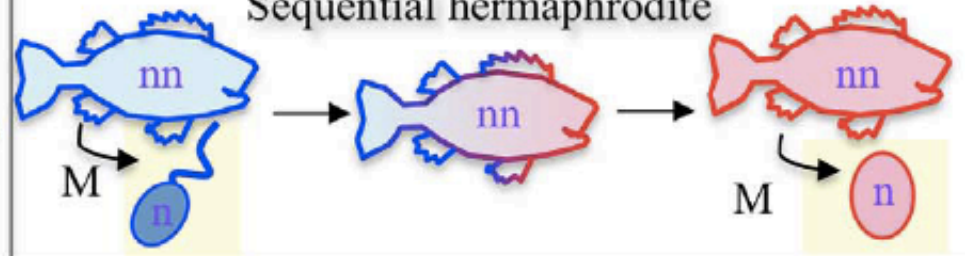
HERMAPHRODITES

~5% of animal species

Simultaneous hermaphrodite



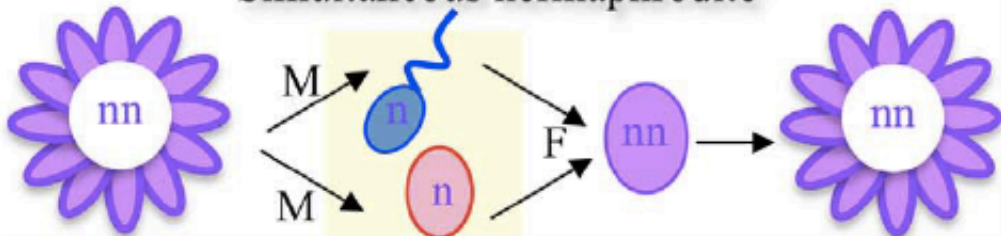
Sequential hermaphrodite



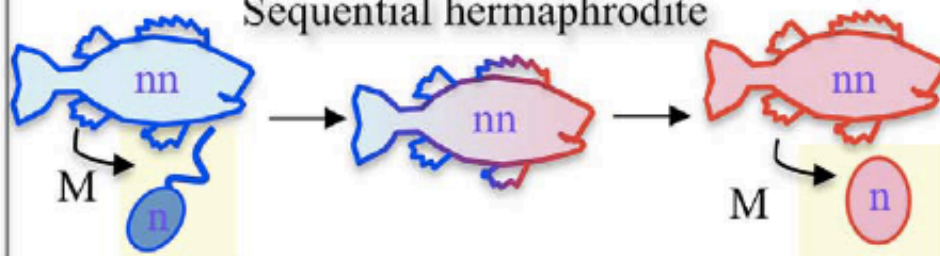
HERMAPHRODITES

~5% of animal species

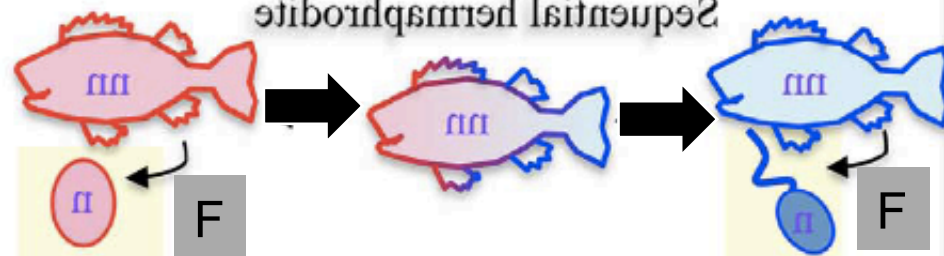
Simultaneous hermaphrodite



Sequential hermaphrodite

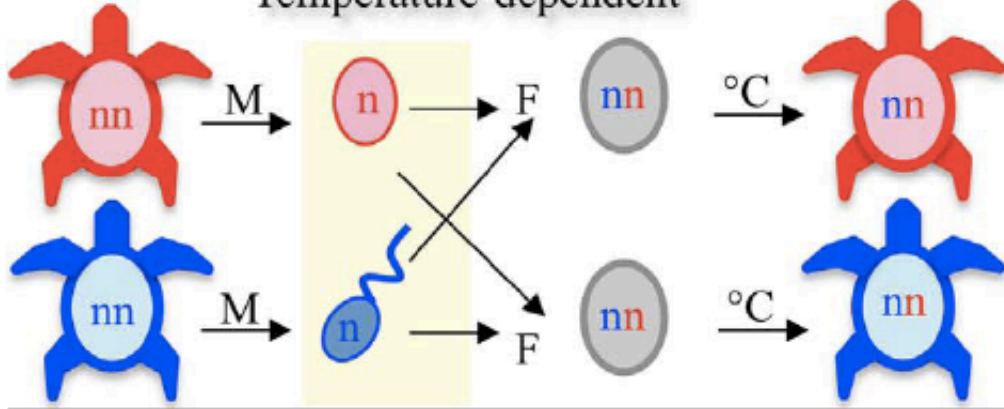


Sequential hermaphrodite

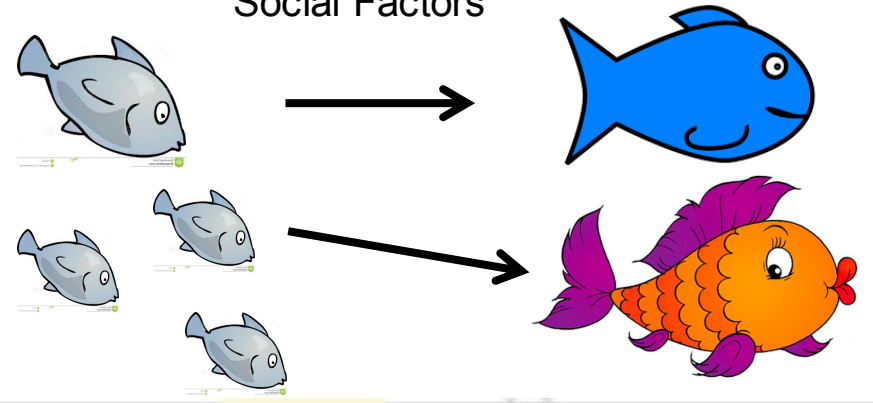


ENVIRONMENTAL SEX DETERMINATION

Temperature-dependent



Social Factors

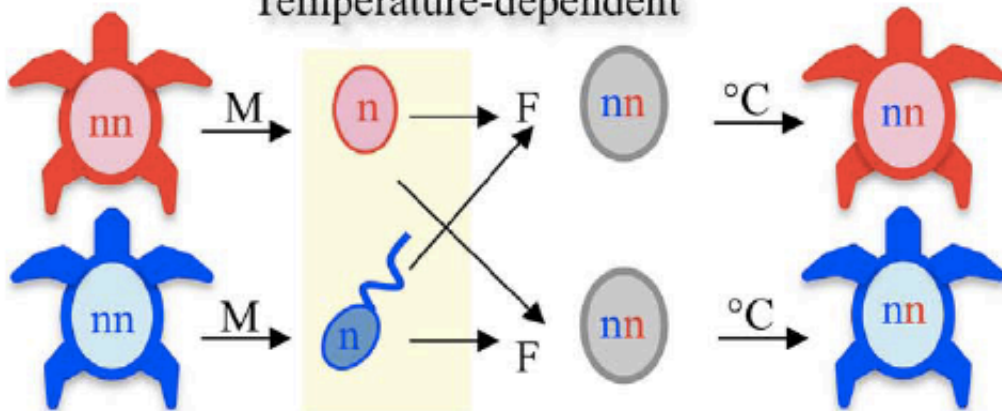


pH
O₂
day length
(consider climate change)

When would you expect ESD to evolve and when would you expect GSD to evolve?

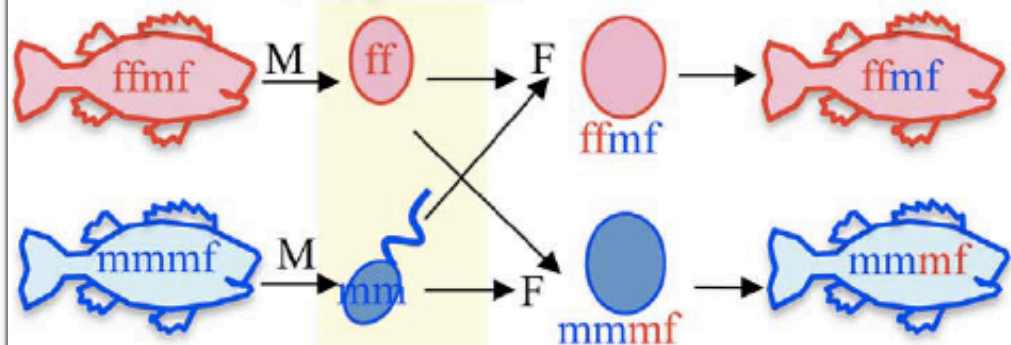
ENVIRONMENTAL SEX DETERMINATION

Temperature-dependent



GENOTYPIC SEX DETERMINATION

Polygenic SD



pH
O₂
day length
(consider climate change)

Asexual reproduction

THE SCIENCES
No Sex Needed: All-Female Lizard Species Cross Their Chromosomes to Make Babies



Male Fish Borrows Egg to Clone Itself

A fish created by spontaneous androgenesis is the first known vertebrate to arise naturally by this asexual reproductive phenomenon.

By Ruth Williams | May 24, 2017



<http://www.the-scientist.com/?articles.view/articleNo/49504/title/Male-Fish-Borrows-Egg-to-Clone-Itself/>

When would you expect ESD to evolve and when would you expect GSD to evolve?

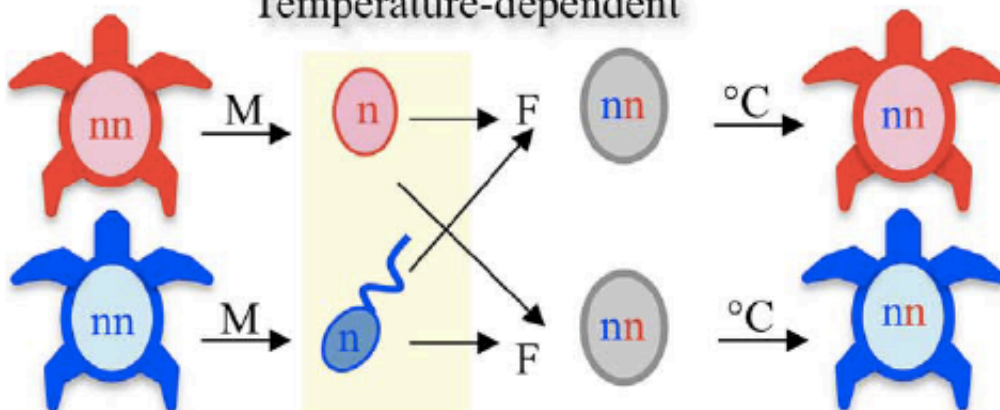
ESD is favored over GSD when specific environments are more beneficial to one sex, selecting for sex-determining mechanisms that match each sex to its best environment

GSD, is thought to be favored when the environment is unpredictable or not variable enough, in which case ESD could produce strongly skewed sex ratios or intersex individuals

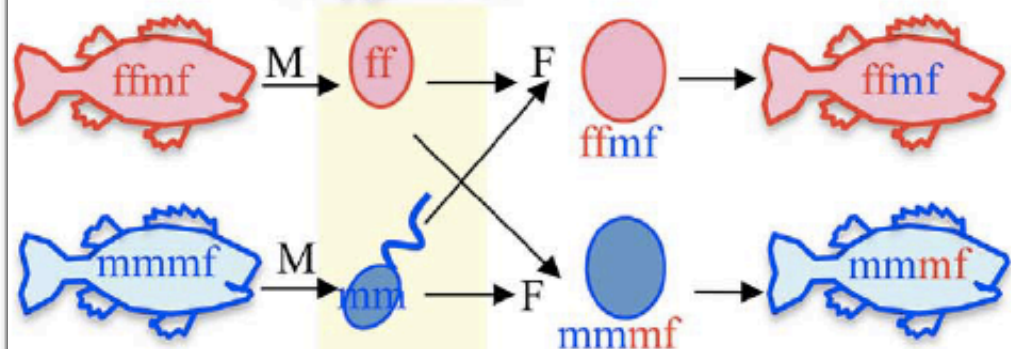
ENVIRONMENTAL SEX DETERMINATION

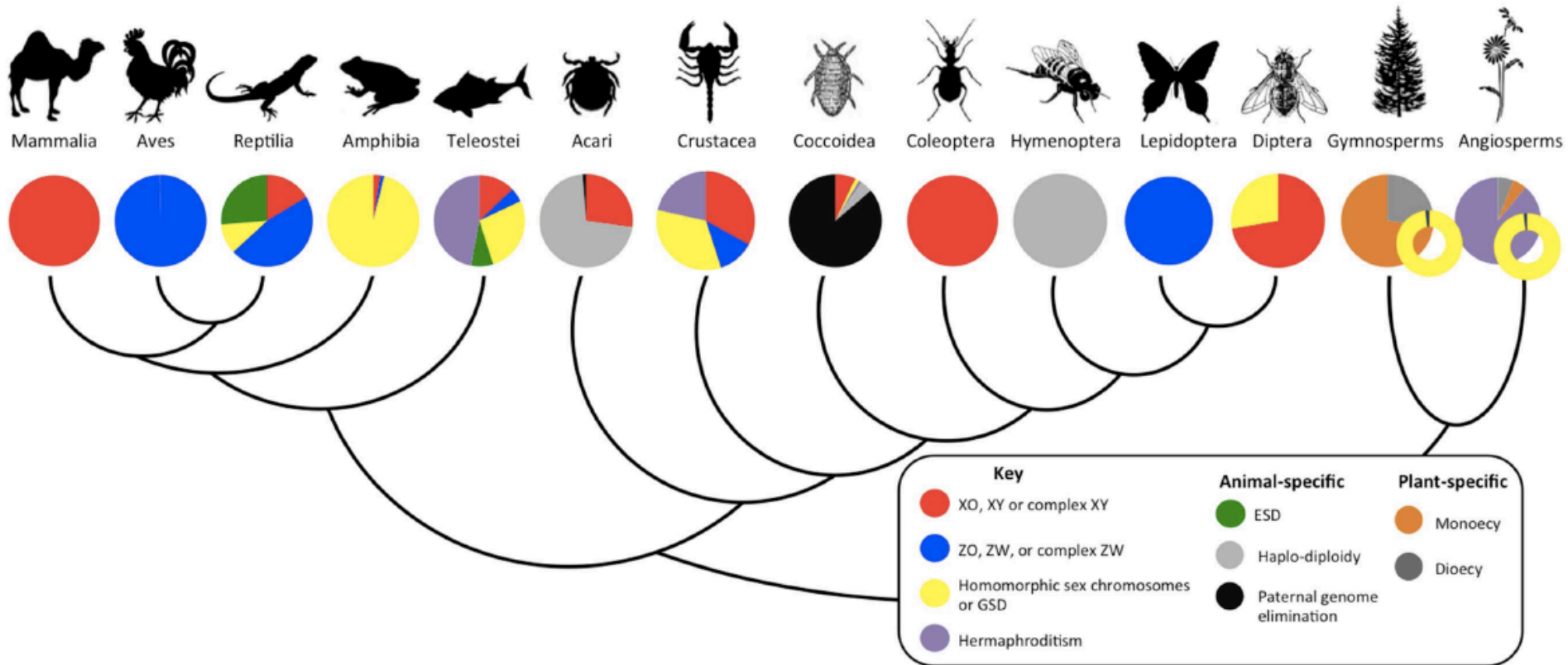
GENOTYPIC SEX DETERMINATION

Temperature-dependent



Polygenic SD

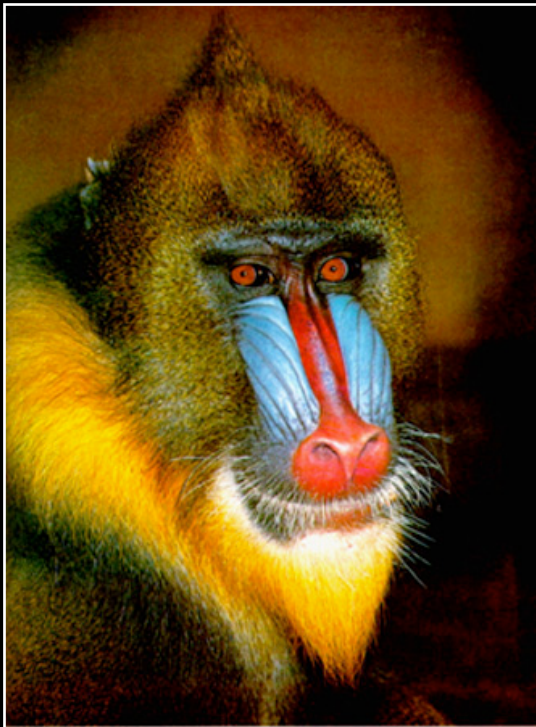




(Darwin as edited by Suzy)

"Sexual selection depends on the success of certain individuals over others of the same sex, in the arena of competition for reproduction; while natural selection depends on the success of individuals of either sex, at all ages, in all arenas of competition for general conditions of life. "

Sexual selection is a special case or a subset of Natural Selection



*"The sexual struggle is of two kinds:
-- in the one it is between the individuals of the same sex, generally the males, in order to drive away or kill their rivals, the females remaining passive;
-- while in the other, the struggle is likewise between the individuals of the same sex, in order to excite or charm those of the opposite sex, generally the females, which no longer remain passive, but select the more agreeable partners."*



"The sexual struggle is of two kinds:

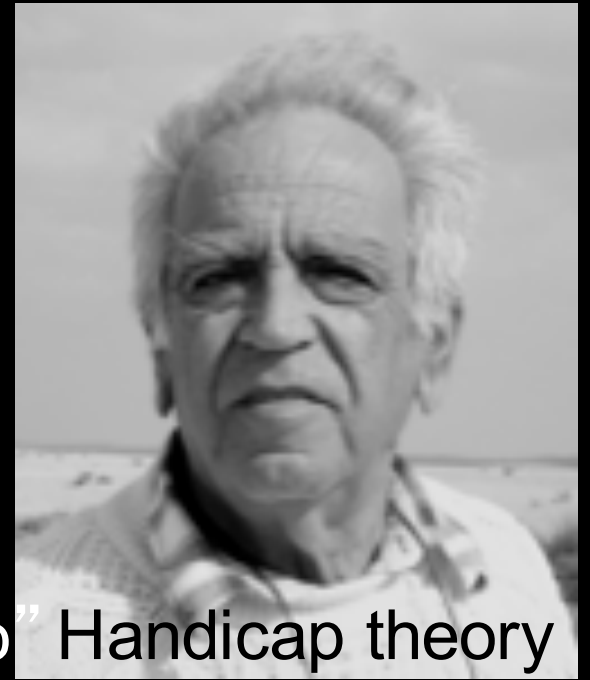
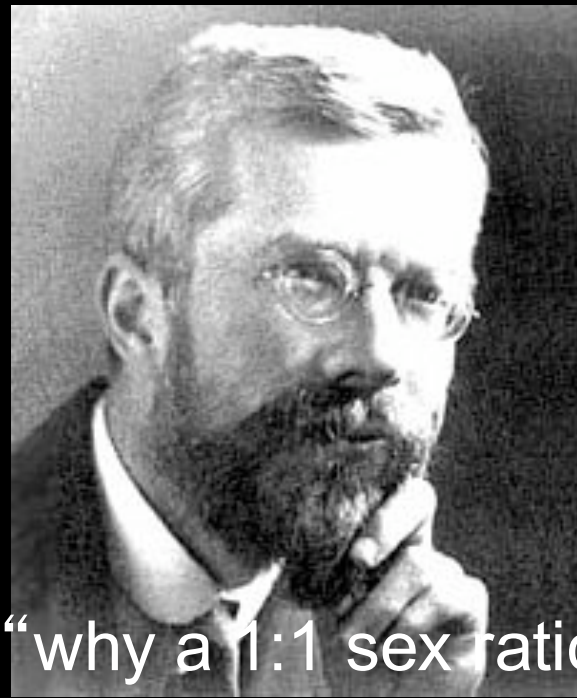
-- in the one it is between the individuals of the same sex, generally the males, in order to drive away or kill their rivals, the females remaining passive.

Male Competition
Intra-sexual selection

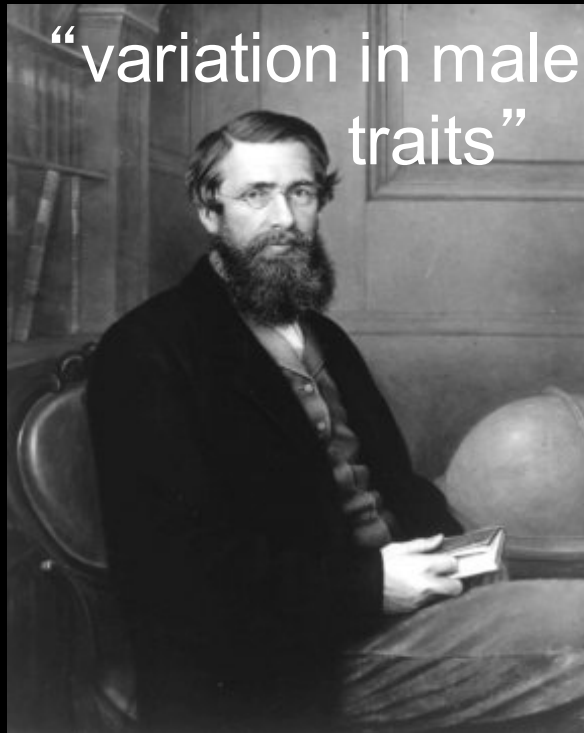
-- while in the other, the struggle is likewise between the individuals of the same sex, in order to excite or charm those of the opposite sex, generally the females, which no longer remain passive, but select the more agreeable partners."

Female Choice
Inter-sexual selection

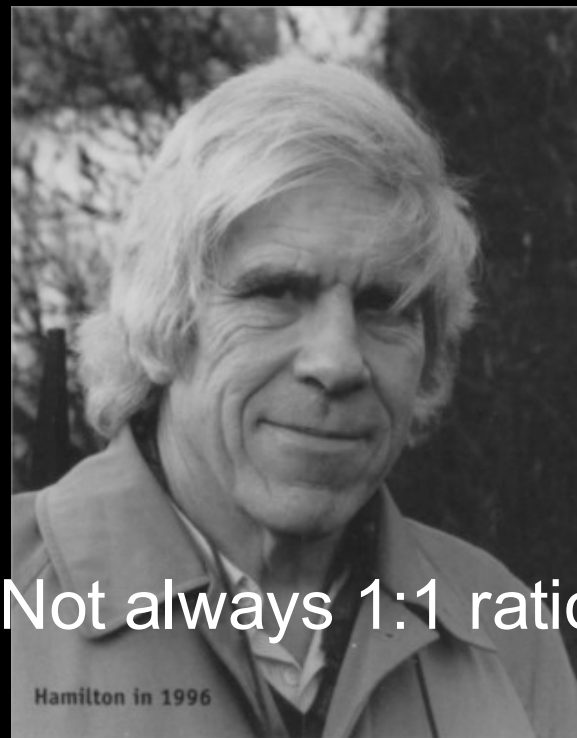




“why a 1:1 sex ratio” Handicap theory



“variation in male traits”



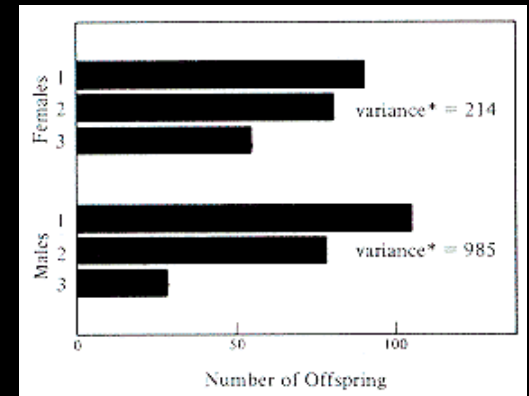
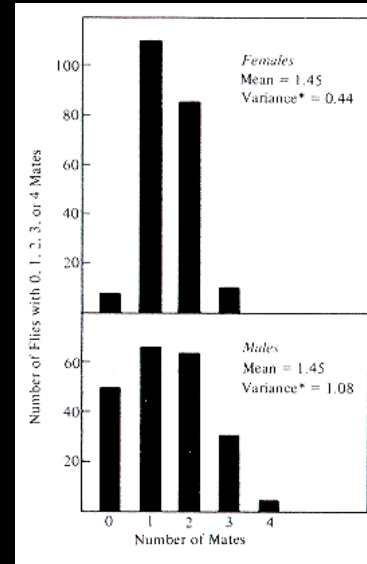
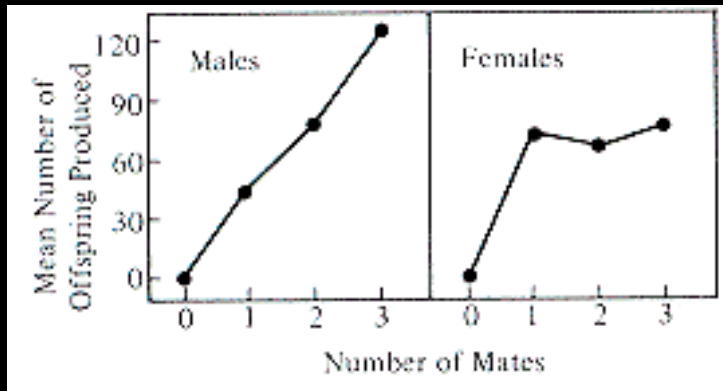
Not always 1:1 ratio

Hamilton in 1996



Parasite load

Bateman's Gradient



Humans: Female versus Male Maximum Number of Children



A Russian woman in the 1700's gave



- ***Mrs. Vassilyev, Russian***, 69 children: sixteen pairs of twins, seven sets of triplets and four sets of quadruplets between 1725 and 1765, in a total of 27 births. 67 of the 69 children born were said to have survived infancy.
- ***Ismail Ibn Sharif Alaouite, sultan of Morocco***, 867 children, 525 sons and 342 daughters with multiple wives and concubines.

Robert Trivers



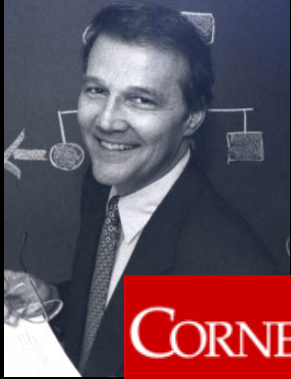
Parental Investment

“Where one parent invests considerably more than the other, members of the latter will compete among themselves to mate with members of the former.”

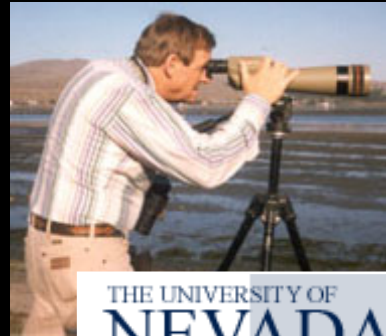
Don't write here

covered very quickly in 2018

Stephen T. Emlen



Lewis W. Oring



Operational Sex Ratio

Reproductive success of males is limited by access to mates.
Ecological factors determine the distribution & availability of females.

Don't write here

covered very quickly in 2018

Amanda Vincent



T.H. Clutton-Brock



“Potential Rate
of Reproduction”

Males can reproduce more rapidly than females.

Don't write here

covered very quickly in 2018

Leigh W. Simmons



G.A. Parker



THE UNIVERSITY OF LIVERPOOL
INVESTING IN KNOWLEDGE

“time out”

The mathematical models require a correction factor
To account for time when individuals are not available to mate.

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