Microevolution & Speciation

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In this lecture topic

- What is microevolution?
- Allele frequencies and evolution – Hardy-Weinberg.
- Sources of genetic variation in alleles.
- What is a species?

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Important stages in the history of Biology

20th century

- Synthetic theory of evolution
  - Population genetics and natural selection based on Mendelian genetics

Huxley
(1887-1975)

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Microevolution

- Evolutionary changes that result from changes in allele frequencies in a population, or in chromosome structure or numbers due to mutation and recombination.

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Incomplete dominance – snap dragons

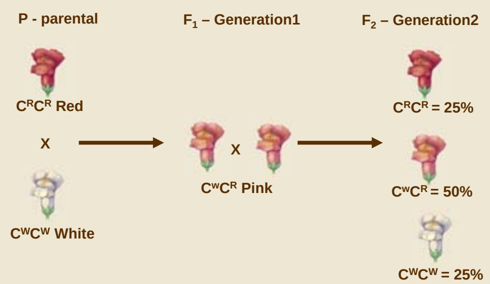

Figure 11.13

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punnet square

where you can see both the recessive and dominant allele in the offspring.

Genotype and allele frequencies

Phenotype	Genotype	Number	Genotype frequency	Total C^R alleles	Total C^W alleles
	C^RC^R	450	450/1000 = 0.45	2x450 = 900	0X450 = 0
	C^RC^W	500	500/1000 = 0.50	1x500 = 500	1x500 = 500
	C^WC^W	50	50/1000 = 0.05	0x50 = 0	2x50 = 100
	Total	1000	0.45 + 0.50 + 0.05 = 1.0	1400 p = 0.7	600 q = 0.3

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Using the Hardy-Weinberg Principle

$p^2+2pq+q^2 = 1$	C^R frequency p=0.7	C^W frequency p=0.3
C^R frequency p=0.7	$C^RC^R = p^2$	$C^RC^W = pq$
C^W frequency p=0.3	$C^WC^R = pq$	$C^WC^W = q^2$

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hardy weinberg equation

state that in a population there is a given set of alleles.

Can predict the mix of alleles for the next generation by frequency of alleles in the first gen.

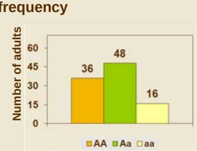
Allele frequencies in populations

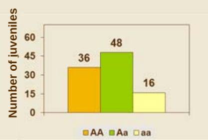
(Each of the 20 adults produces 10 gametes)

Initial allele frequencies in gametes	
A	a
0.6	0.4

- A: 2x36 + 48 = 120/200 = 0.6
- a: 48 + 2x16 = 80/200 = 0.4
- Final = Initial frequency

Final allele frequencies	
A	a
0.6	0.4





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Hardy-Weinberg principle's assumptions

- No natural selection
- No mutation
- No genetic drift – population is large
- Gene flow
- Random mating

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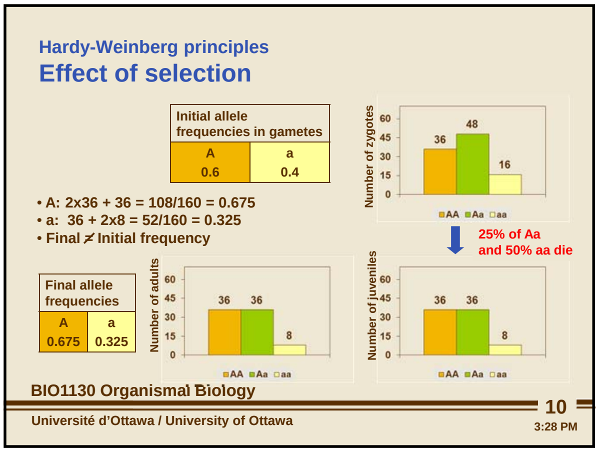
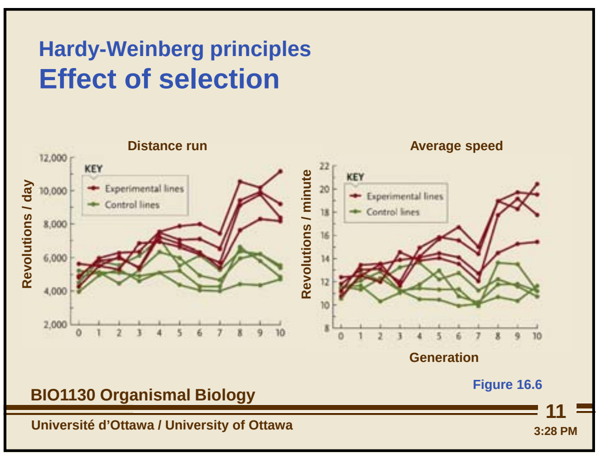
hardy weinburg equilibrium = no microevolution



selection is a case of eliminating some of the alleles because they are

not fit enough and are not passed through. Thus hardy equilibrium is

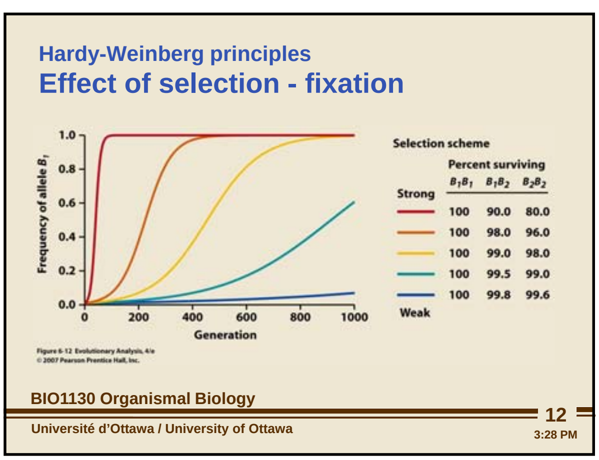
not reached.



active mice breed with their own kind (also active).

altering the genetics of the pool and selective and preventing certain

groups from mating.

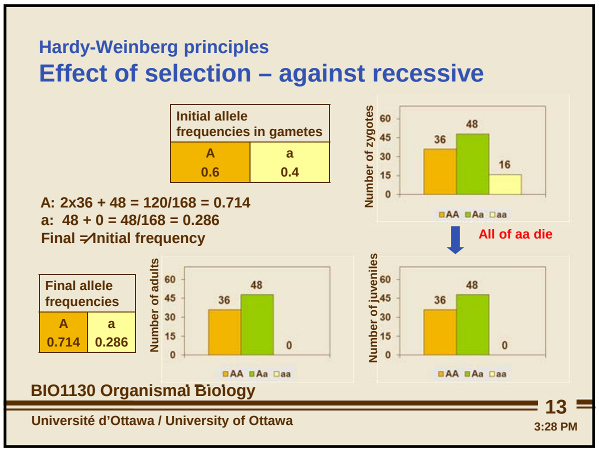


blue- not much change in frequency.

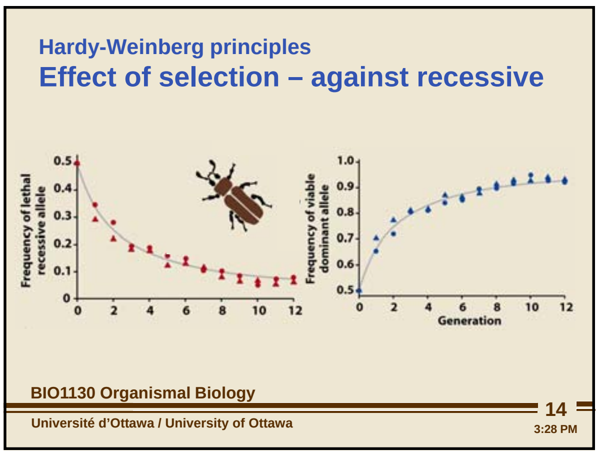
red- can quickly eliminate an allele in a population. -high selection

pressure.

example crops: most alleles are fixed, genetic variability eliminated.



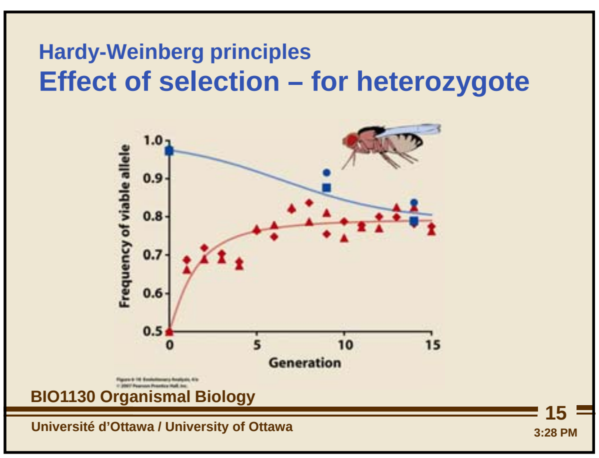
individuals with aa do not pass their alleles on



never remove the gene from population.

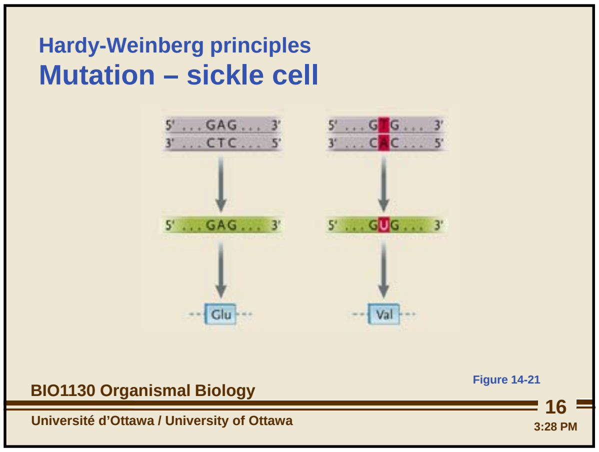
is important because we dont lose the genetic variability from the

population, only reduce the frequency.



heterozygote has an advantage. They are surviving better than the

homozygote.

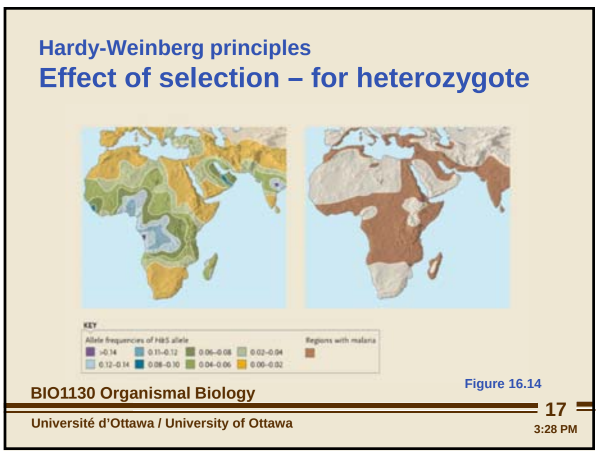


point mutation: one nucleotide changes.

RBC's change their shape.

Heterozygote :some RBC's are normal some of them are sickle

shaped, sickle shaped do not load and transport oxygen.



sickle cell anemia advantageous in areas with most

cases of malaria.

liver will destroy sickle cells.

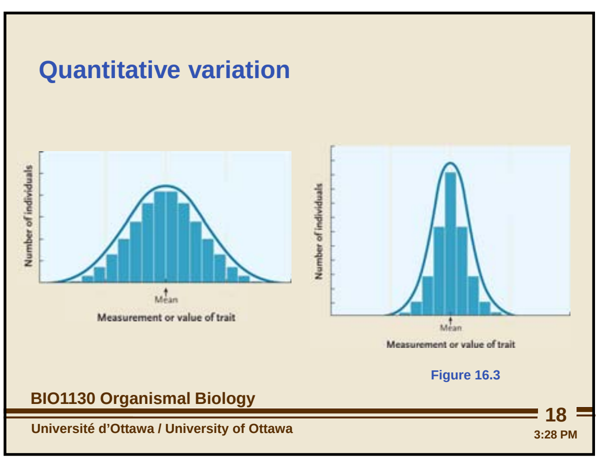
mechanism that destroys sickle cells also destroys

malaria (if it has the disease)

if no sickle cell, liver does not remove

malfunctioning cells.

heterozygous sickle cell is advantageous



most phenotypes are polygenetic

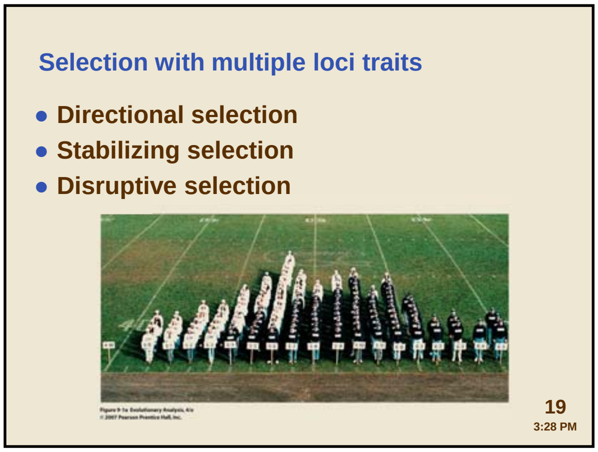
- not just one allele responsible for it.

extremely rare in populations to see a single allele.

cant use H-W with mixed genes.

Use normal curve and Standard deviation by looking at population and

making distribution curve.

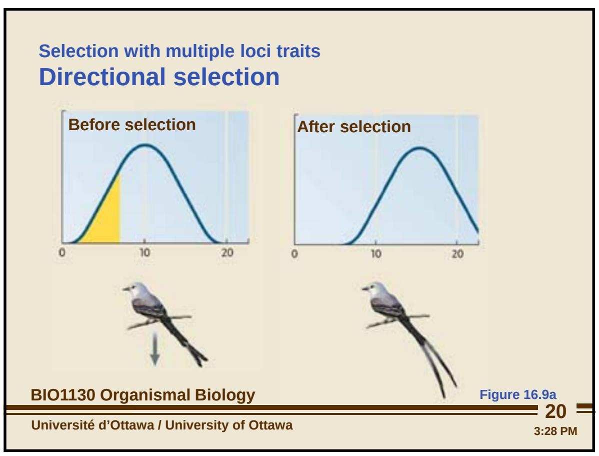


normal distribution with height.

measure characteristic in a population and see if normal distribution is

the same after some # of gen.

if both curves are the same, then no evolution.



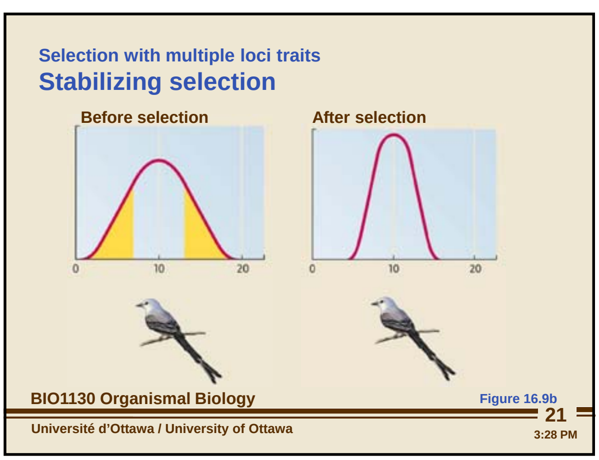
tail on birds show fitness of mail birds. females will generally breed with

birds that have long tails.

the mean has shifted, <-- directional selection

shifts traits away from existing mean to the favoured extreme. it is very

common.



getting rid of variation around the mean trait.

individuals express intermediate phenotypes

have the highest relative fitness. by

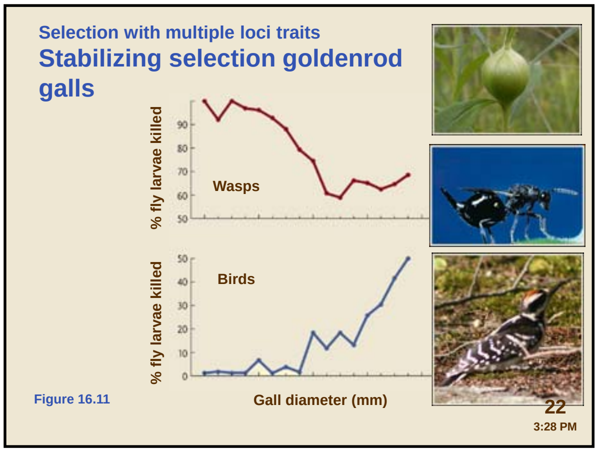
eliminating phenotypic extremes, stabilizing

selection reduces genetic and phenotypic

variation and increases frequency of

intermediate phenotypes. Most common

type of natural selection.



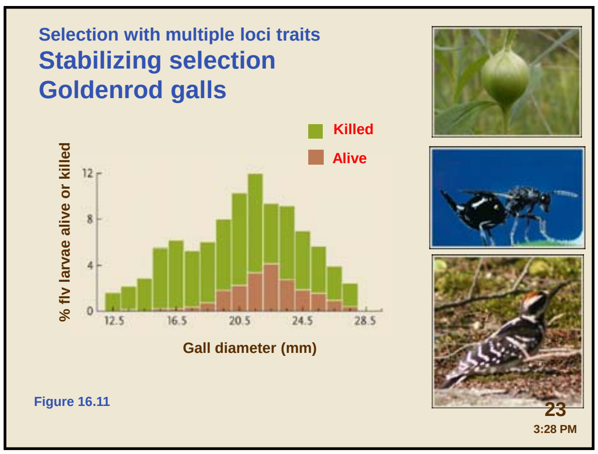
wasps can best attack the maggots while they are inside the small galls.

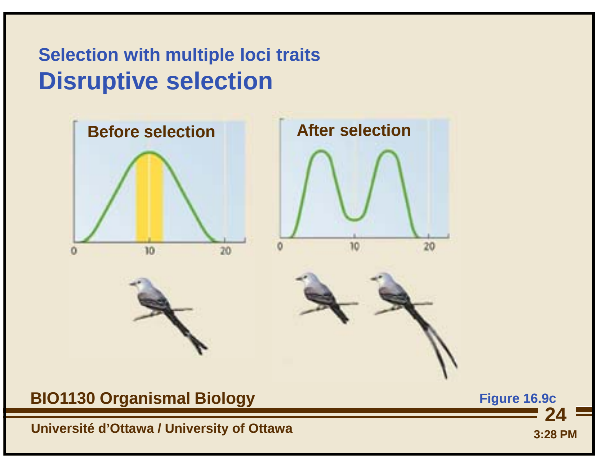
when the Galls are big, woodpeckers attack the maggots.

small galls and big galls are removed from population.

optimum gall size- too big for wasp, too small for birds.

stabilizing selection around intermediate gall size.





stabilize and go remove the middle of the distribution curve.

potential for new organism or species. when extreme phenotypes have higher relative fitness than the intermediate phenotype. alleles producing extreme phenotypes become more common promoting polymorphism. less common.

Selection with multiple loci traits

Disruptive selection

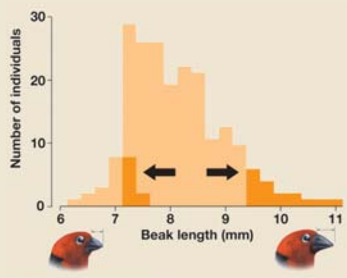


Figure 16.12

Darwin's finches.

beak size becomes correlated with seed size. full range of beak sizes because all types of seeds were available. 3 year Drought took place and the smallest and biggest birds with beaks survived. the middle died.

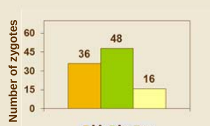
Hardy-Weinberg principle's assumptions

- No natural selection
- No mutation
- No genetic drift – population is large
- Gene flow
- Random mating

Hardy-Weinberg principles

Effect of mutation

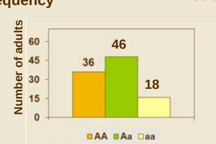
Initial allele frequencies in gametes	
A	a
0.6	0.4

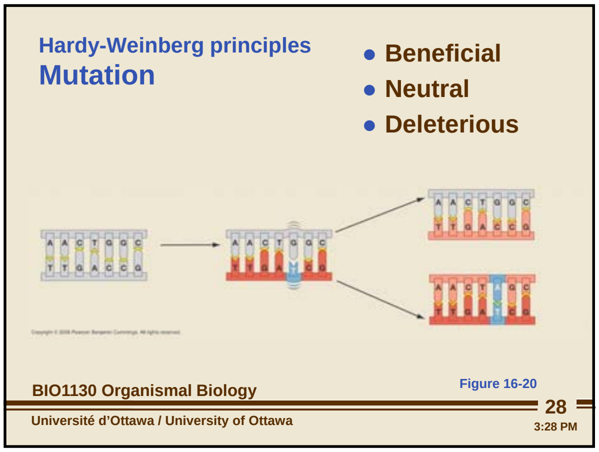


A: 2x36 + 46 = (118) 118/200 = 0.59
a: 46 + 2x18 = (92) 92/200 = 0.41
Final $\neq$ Initial frequency

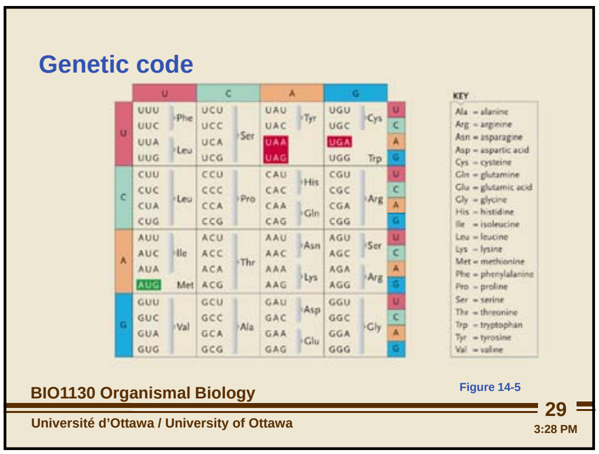
A into a 1/100

Final allele frequencies	
A	a
0.6	0.4



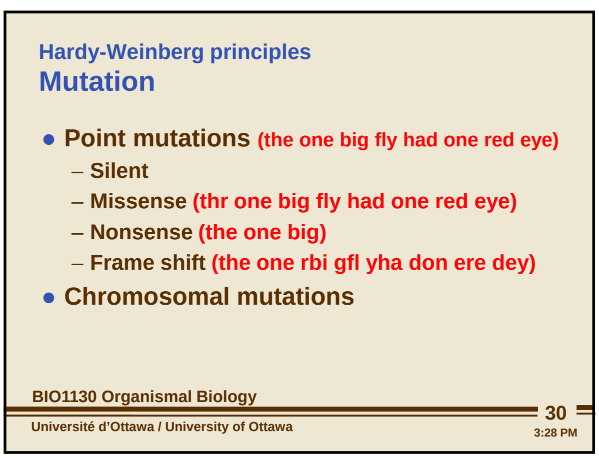


mutations are primarily neutral/ have no effect.



many codons code for same amino acids

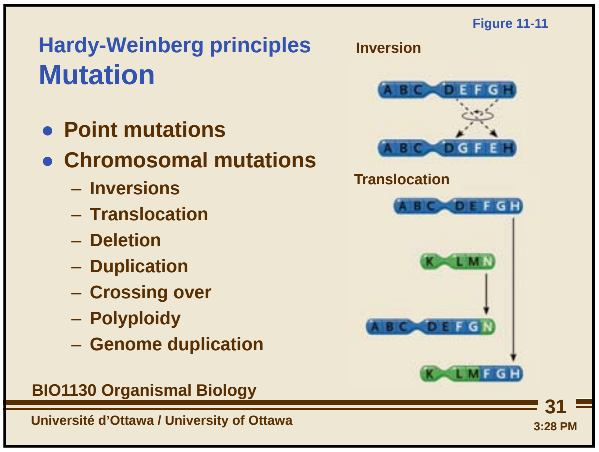
many occur from chromosomial rearrangements



nonsense: codon turns into termination codon. not going to get the full sequence.

frame shift: reading is out of order causing everything else to be out of order as well.

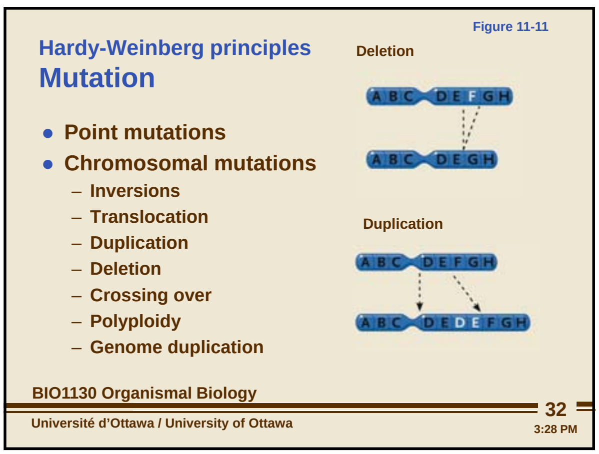
silent: no affect



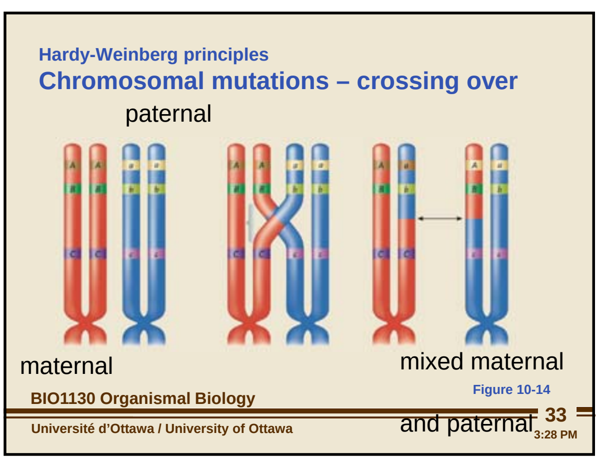
when the pact breaks, most of the time it is fixed perfectly, but

sometimes it is not and causes inverse mutation.

translocation: break on 2 separate chromosomes



deletion: things get lost.



ends break and arms are exchanged.

genetic information material is swapped between chromosomes.

Hardy-Weinberg principles

Chromosomal mutations – polyploidy

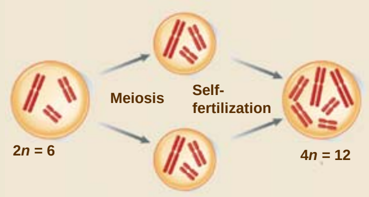


Figure 18-24

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miosis has failed. doubling of chromosome number. Gametes fuse, double chromosomes. (polyploidy)

Hardy-Weinberg principles

Chromosomal mutations – polyploidy

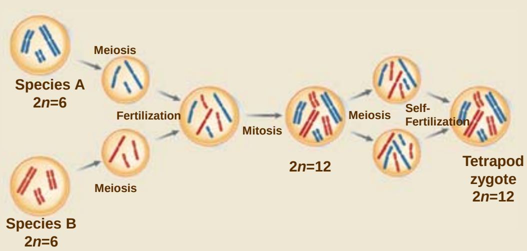

Figure 18-25

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Hardy-Weinberg principle's assumptions

- No natural selection
- No mutation
- No genetic drift – population is large
- Gene flow
- Random mating

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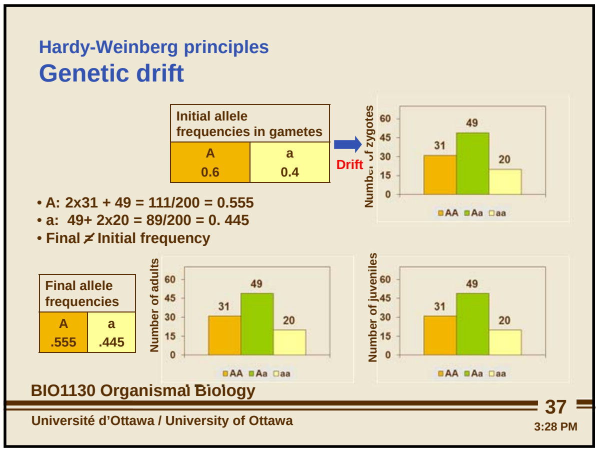
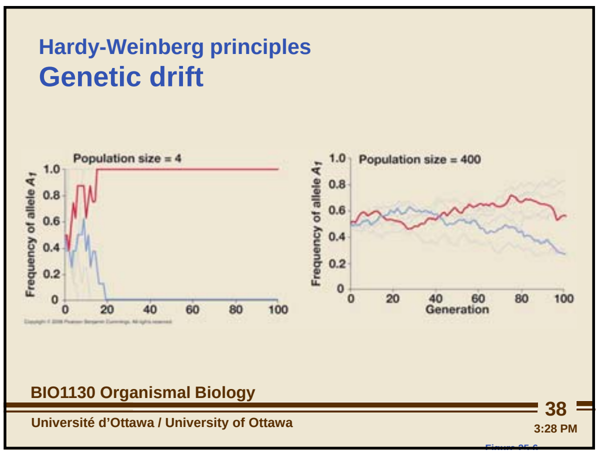
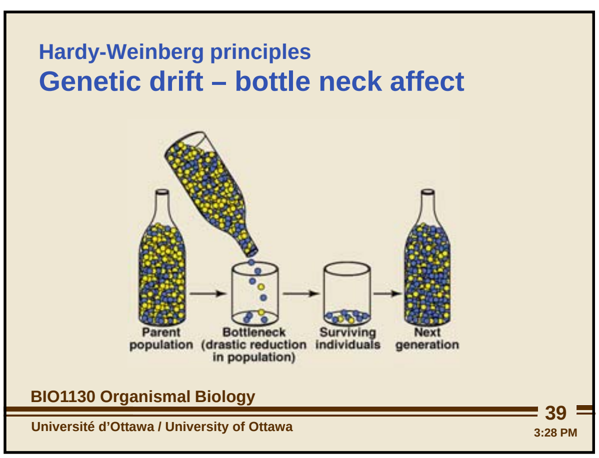


didnt get accurate sample of the population that was there.



loss of genetic variation when we subset a population.

big pop- dont lose the variation



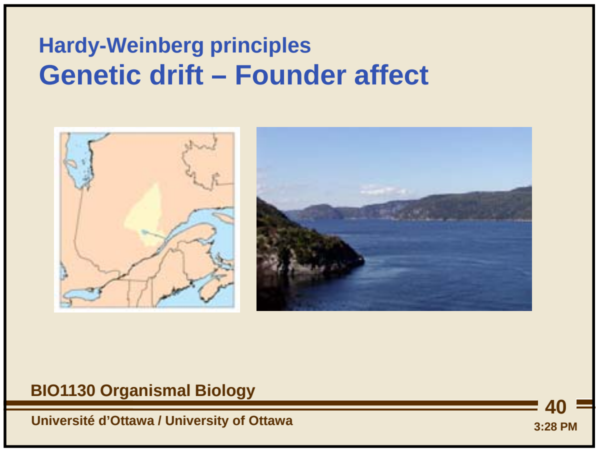
next gen. only a subset of genetic variation that was there.

bottleneck effect is the dramatic reduction of the population.

(elephant seal, american buffalo)

stressful factor such as disease, hunting etc... dramatically

reduces population. This reduces genetic variation

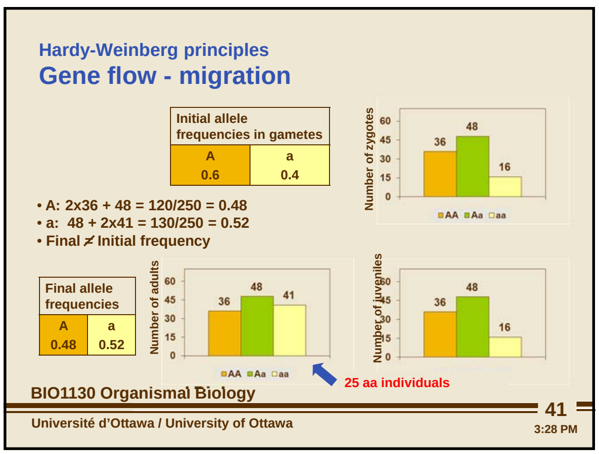


bottleneck effect, smaller population is in its original location.

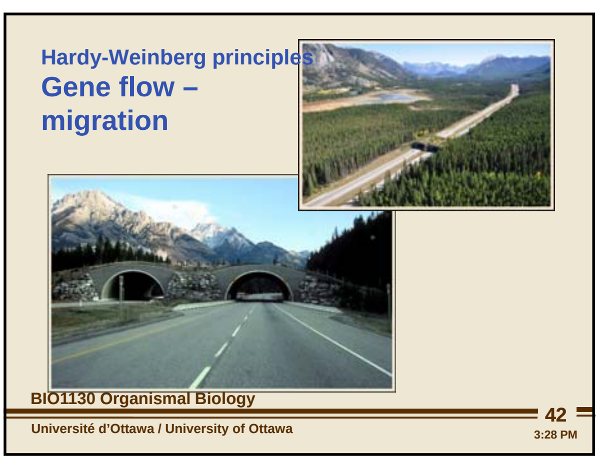
Founder effect, smaller population is isolated from other groups, can react differently to the new environment

(new spiders in NYC after sandy)

consequence of founding: genetic disorders because of loss of genetic variation... (this area in quebec, entire population made from 600 individuals) when a small population recolonizes. only carry small sample of parent genetic variation. chance of some alleles may be missing.



new genes added to the population that gets integrated but doesnt add up properly, Thus, no HW equilibrium



from fragmented habitat. isolation of population, cause bottleneck effect. conservation tries to reconnect these fragmented habitats causing migration of organisms causing genetic variability of 2 population becomes genetic variability of 1 population.

(Y to Y project)

Hardy-Weinberg principle's assumptions

- No natural selection
- No mutation
- No genetic drift – population is large
- Gene flow
- Random mating

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Hardy-Weinberg principles

Nonrandom mating - Inbreeding

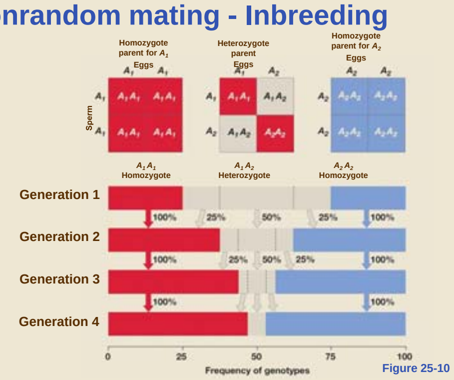

Figure 25-10

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consequence of inbreeding: after 5 or 6 generation of inbreeding, the

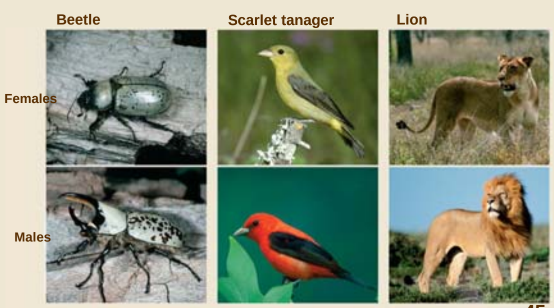
Heterozygocity disapears.

no microevolution

individuals that are genetically related mate with each other.

Hardy-Weinberg principles

Nonrandom mating - Sexual dimorphism



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sexual dimorphism- differences in males and females is visibly clear.

Females have limited number of eggs that they can produce... same

with insects and animals. she invests alot of energy and time.

male produces sperm little or no energy for ever that want to reproduce

forever, females have to decide carefully to pick a male for best sperm.

males have signals and reactions that try to say they have the best

sperm. (dances, fights, fitness). After that, the females can tell which

male is the most fit for mating.

Microevolution

Hardy-Weinberg principles

Nonrandom mating - sexual selection

- Sexual selection
  - On males – female choice
  - On males – competition
    - Combat
    - Sperm competition
    - Infanticide

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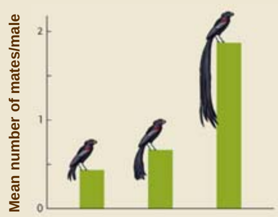
Hardy-Weinberg principles

Sexual selection female choice



riflebird

Tail feathers

Figure 16-13

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birds with long tails are more likely to mate with females.

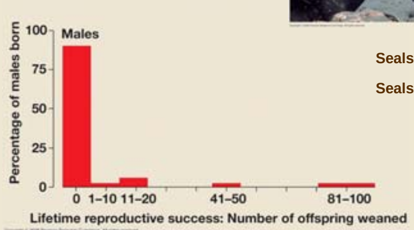
were not going to get HW equilibrium because most of the same trait is

passed on to next generation (long tails), selective advantage.

this is non-random mating.

Hardy-Weinberg principles

Sexual selection Male competition - combat



Seals V1

Seals V2

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<-- elephant seals.

1 male mating with almost all of females.

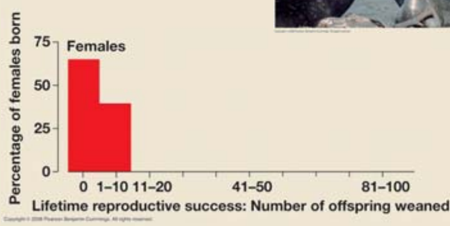
males fight each other to show they are the most fit and deserve to

mate.

Hardy-Weinberg principles

Sexual selection

Male competition - combat



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Hardy-Weinberg principles

Sexual selection

Male competition – sperm competition

Copulatory wheel

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male scrapes and cleans out the females seminal vesicle full of sperm from another organism and puts his inside to make sure his sperm is fertilized. indirect male competition.

Hardy-Weinberg principles

Sexual selection

Male competition – infanticide

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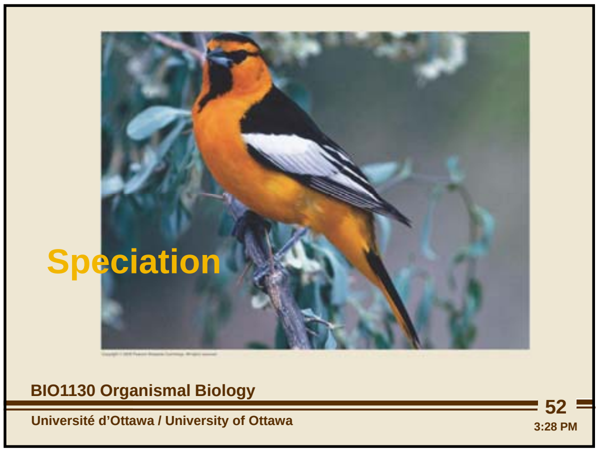
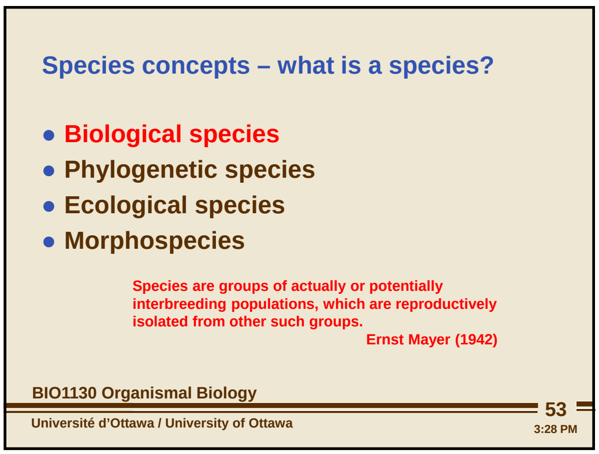
1 dominant male with 5-6 females <-- social structure.

male is not related to the others. when the new dominant male replaces the old one, it kills any cubs that were tied to the old male and replaces them with his own.

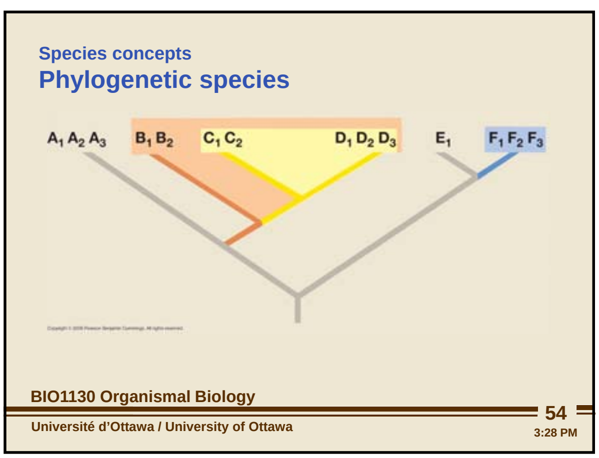


aprox 8.7 million different types of organisms living on Earth.
found constant algorithm across the Linneaus class system. K P C O F G S.
7 million undiscovered.

will take couple of thousand years to identify 7 million because it took 200 some years since taxonomy to identify 1.3 million.



some mechanism that prevents them from breeding with each other.
name of specie can be a problem: commodity called canola, was called rape seed and they used that for lamp oil, car engines etc... now it was said it was toxic to humans because of acid it contained. Canada food couldn't use it because it was banned to use it as food commodity so they requested name change for this new substance.
biological species definition excludes bacteria and archea. ex: e-coli is not valid under biological. cant use fossils.



end of the cladistic ex: D1D2D3 can be seen as phylogenetic species.
Cladogram can never stop branching.
question is where do we stop branching?
DEFINITION: species as a group of organisms bound by a unique ancestry.

Species concepts

Morphospecies

Figure 18.4

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distinguished based on morphology.

Species concepts

- Biological species
- Phylogenetic species
- Ecological species*
- Morphospecies

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ecological species: sloppy form of species. species grouped together based on environment/geographic. not considered as a concept.

Subspecies: species that can breed but are isolated from each other.

i.e wolfs are ancestors of dogs but were considered different.

(interbreed)

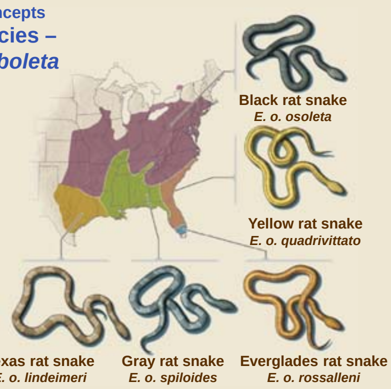
isolating mechanism drives a population to become a separate species but there is still an opportunity for breeding.

sub species- - - -

Species concepts

Ring species – *Elaphe oboleta*

Figure 19.12



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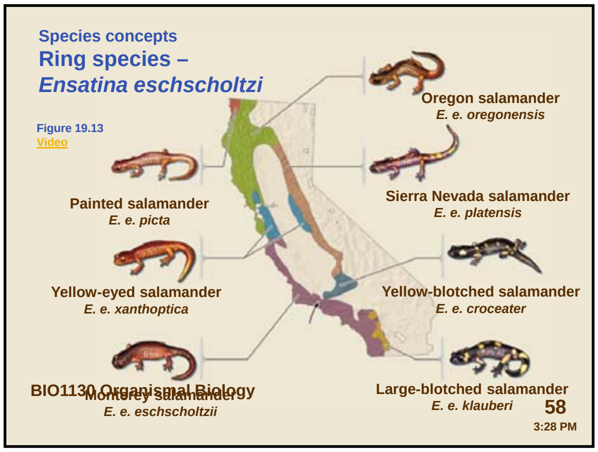
slowly change in functionality and appearance as they adapt to different environments. if joined, they can still interbreed.



isolation between the physical barrier caused subspeciation.

one side the salamanders acquired camouflage which blended them

into their environment so they could survive and produce offspring.

on the other side, salamanders changed in color showing they are

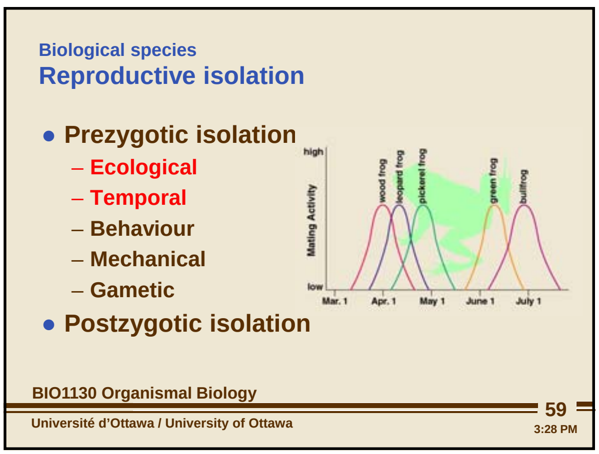
poisonous (advertise with bright colouration). these are less likely to

survive compared to the others

the 2 groups have changed so much they are about to become different

species. gradual change, divergence and isolation at play.

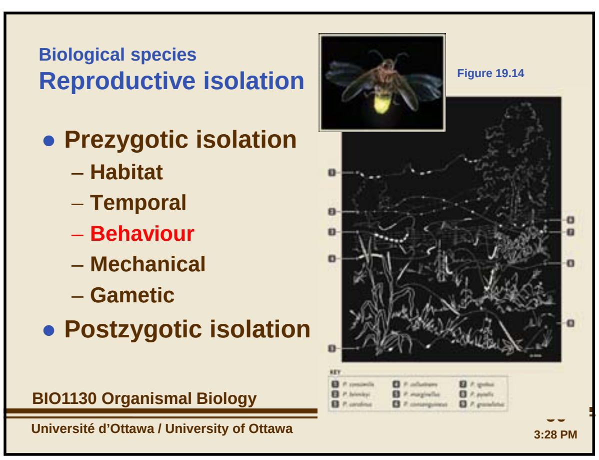
can interbreed, hybrid does not have colouration that will help it survive.



ecological: ecologically could not come into contact with each other

thus cannot mate. different environment.

Temporal: reproductive cycle at different times of the year or day.



flash intermittent signals,specie specific. Each specie has different

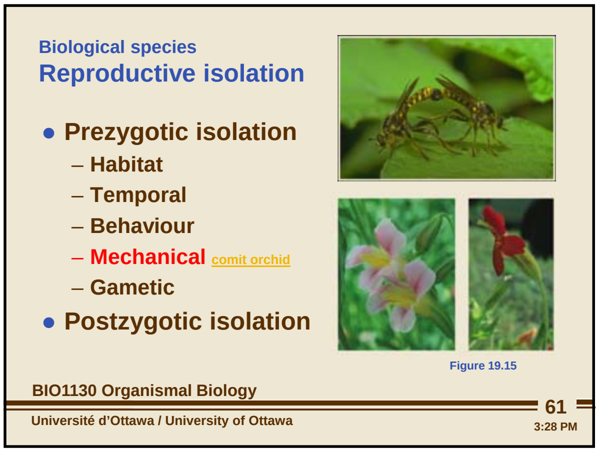
signals. Females only look for the right signal so only same specie

come together.

problem: some females pretend to be from other species by sending

their own signals (not their own language) to lure in the male and eat

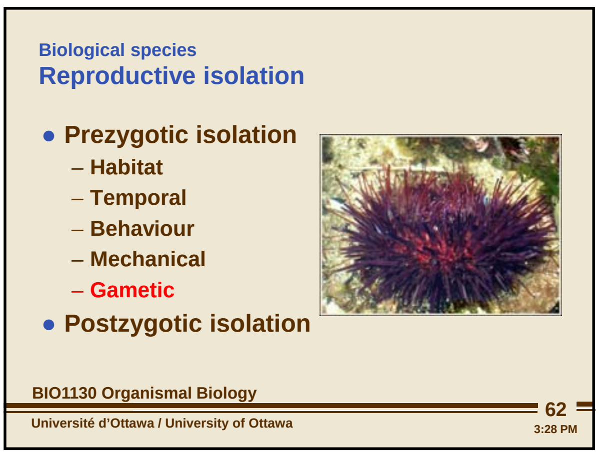
them to receive protein. they will then call in for their male specie.



differences in the structure of copulatory organs

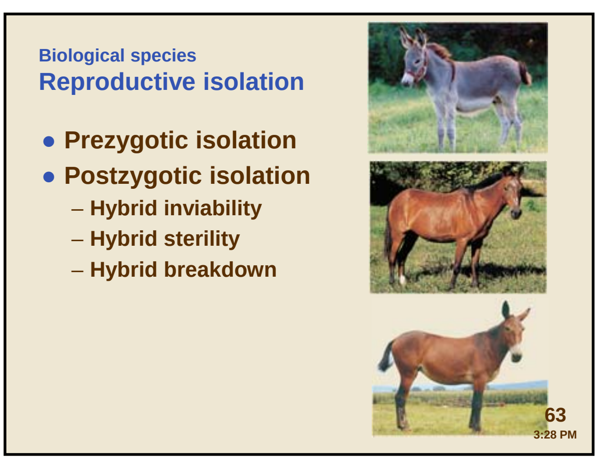
prevent successful mating between individuals of

different species



eggs that will not be fertilized by any sperm. Can only recognize the

specie sperm and then fertilize.



hybrid invialibily: egg will never develop. egg and sperm may fertilize

but will not undergo maturation. usually die as embryos or early stage

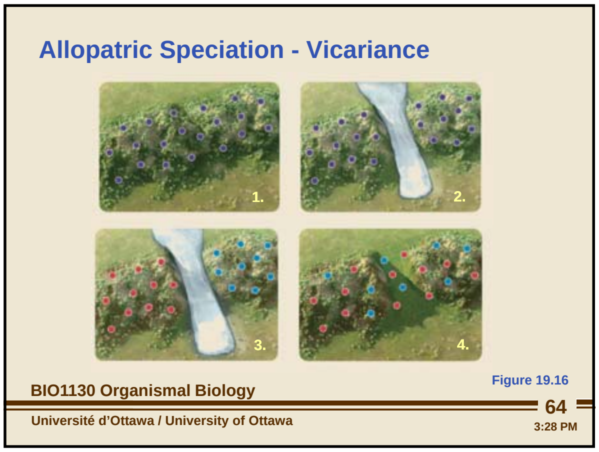
in life. development instructions from parents may be incompatible.

sterility: mules are sterile, can never reproduce. parent species differ in

the number or structure of chromosomes which cannot pair properly

during meiosis.

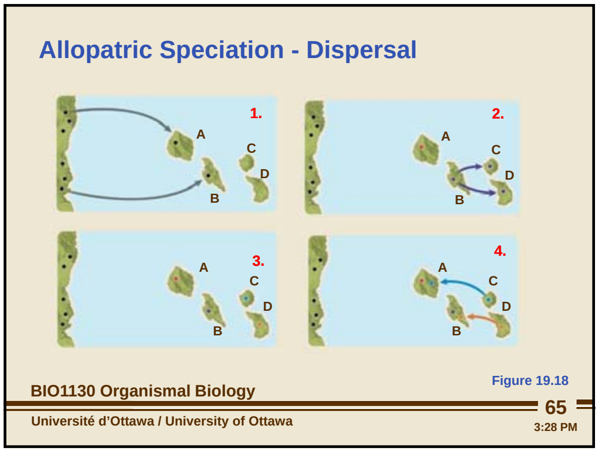
breakdown: Salamanders, hybrids, missing vital information to survive



allopatric: environment separation and over time will lead to different speciation. once barrier is removed, cannot reproduce.

after separation of gondwana- mammals in Africa and birds evolved in south America

happens in 2 steps. 1) geographic isolation (pop geographically isolated from the rest) 2) reproductive isolation. in their new group they reproduce, experience mutation and natural selection and genetic drift, may accumulate genetic differences that isolate them reproductively.

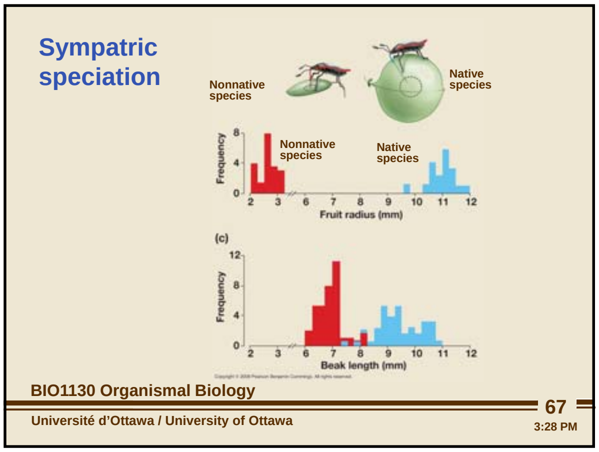


population moves to different area and evolves into different specie.

survivor of the last ice age.

lives on top of highest mountain peeks that poke through the ice.

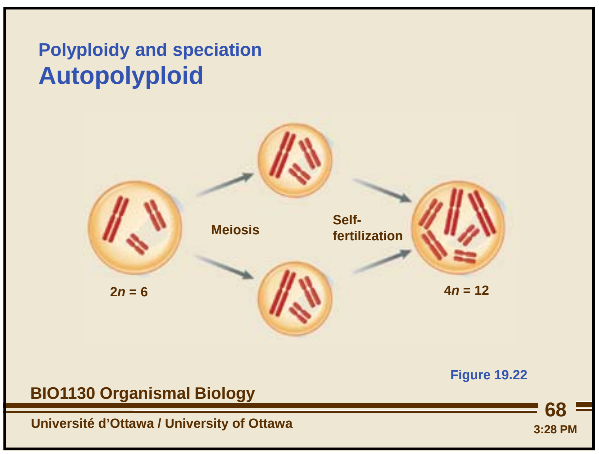
adapted to temperature. If its body temperature raises above 7 degrees it will cook and die. can still function below 5-15 degrees and will not freeze. They are isolated on mountains, each mountain has different specie of this insect.



when a nonnative specie accidently was introduced, it fed on small seeds whereas the natives fed on large seeds.

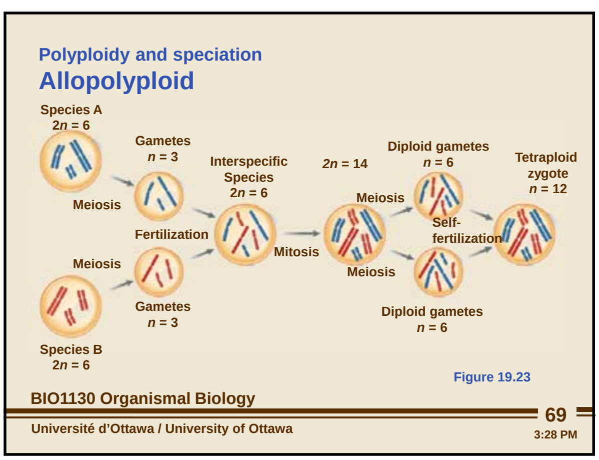
can be a type of reproductive isolating mechanism.

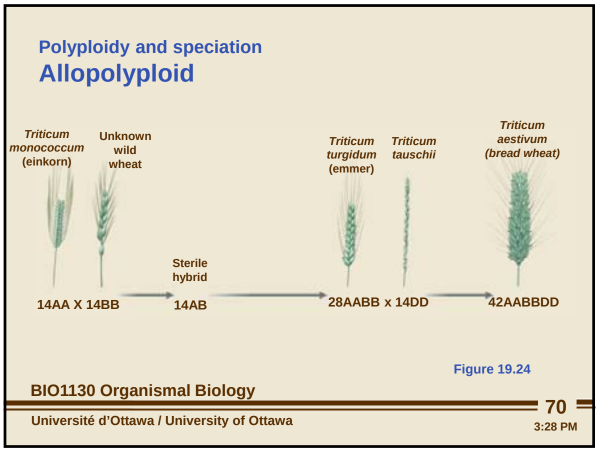
cannot replicate with one another even when they are sharing the same environment at the same time. as well as with food.



meiosis doesnt produce haploid gametes.

joins to make poliploid cell.





polyploid from 3 different species of Triticum.

3rd specie was never found and is missing

alloploid did not disperse its seeds rather than using wind.