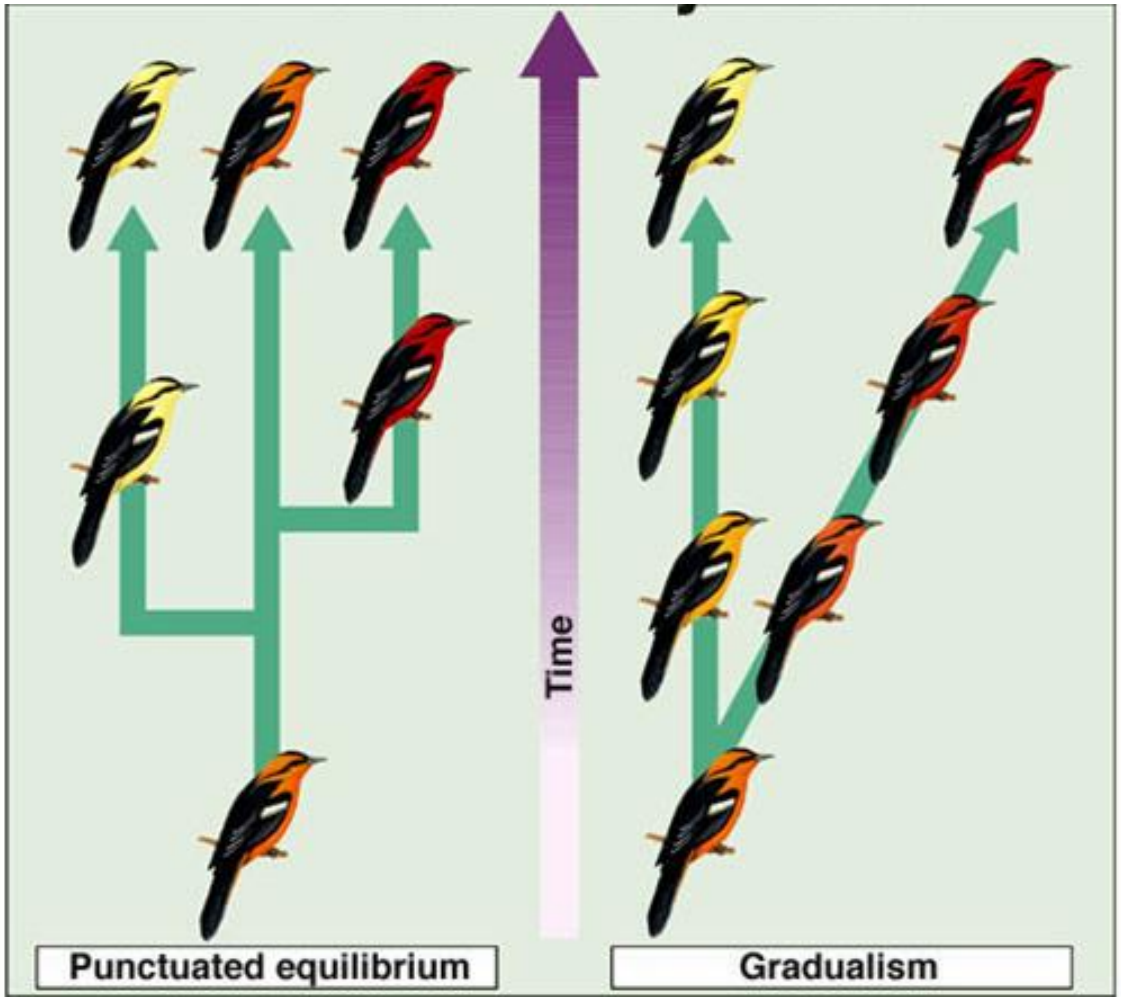
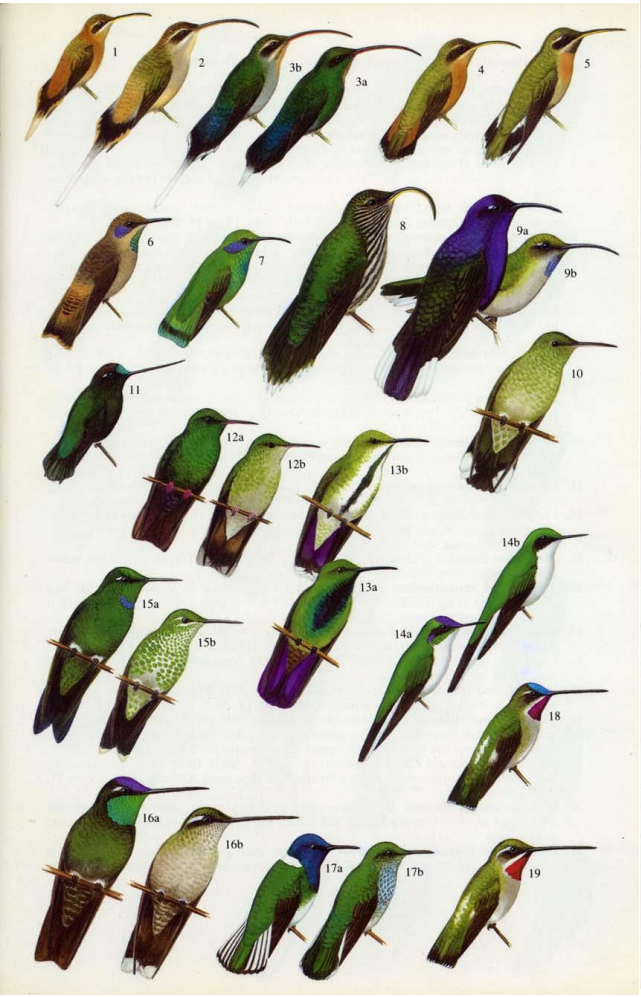
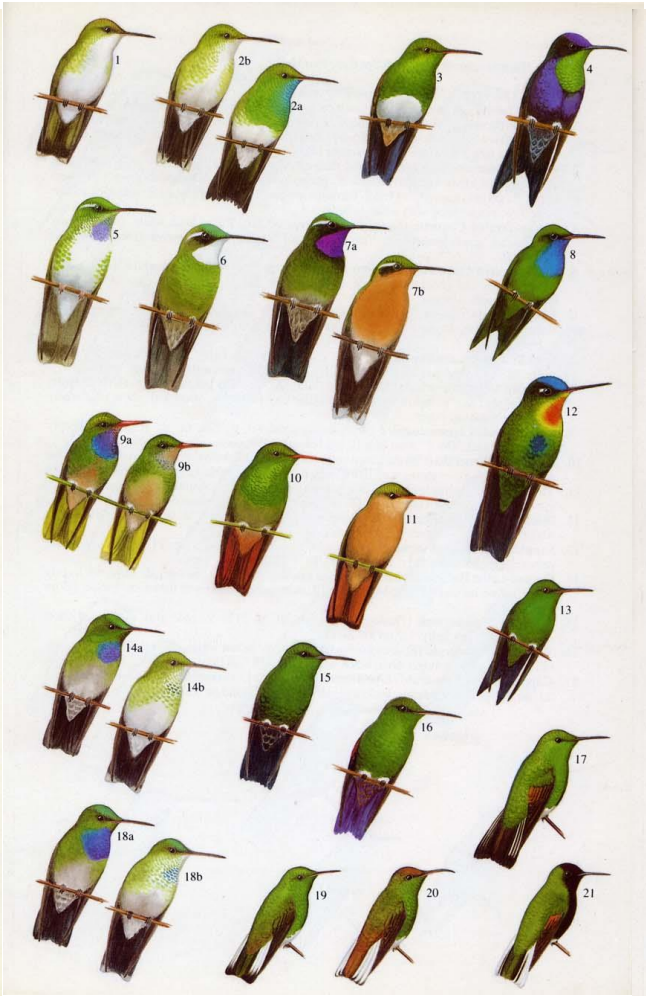
NOTES – CH 24:
The Origin of Species



Species





Hummingbirds of Costa Rica

- **SPECIES**: a group of individuals that mate with one another and produce fertile offspring; typically members of a species appear similar

  (exceptions: males vs. females; young vs. mature)

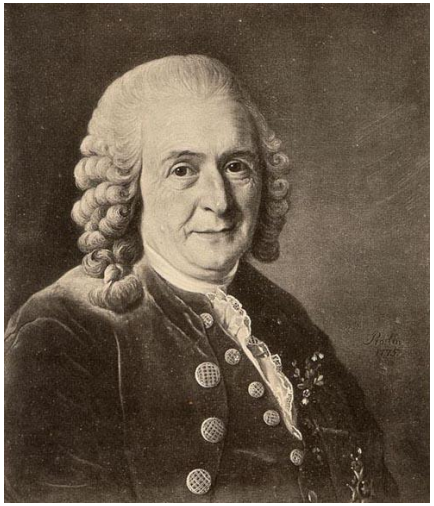
the "biological" species concept defines a species as "a population or group of populations whose members have the potential to interbreed to produce <u>viable, fertile offspring</u>."

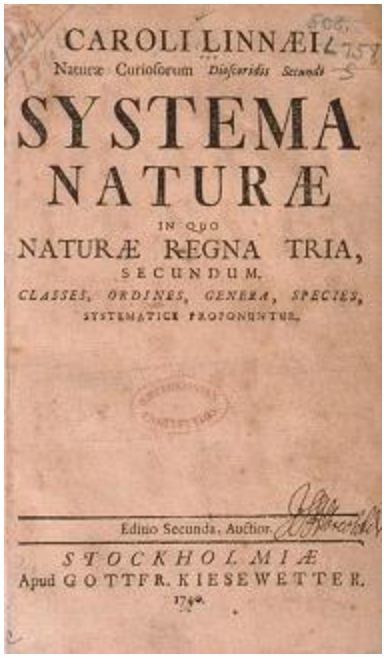
Same species of ant!!!

2 different species of meadowlarks!

Classification of species…

- **<u>Carolus Linnaeus</u>**: Swedish biologist; <u>developed system of classification</u> in the 1700's based on appearances ("morphological" definition of species)





Levels of Classification:	**Example – dogs!**
Kingdom	Animalia
Phylum	Chordata
	(subphylum: Vertebrata)
Class	Mammalia
Order	Carnivora
Family	Canidae
Genus	Canis
Species	*Canis familiaris*

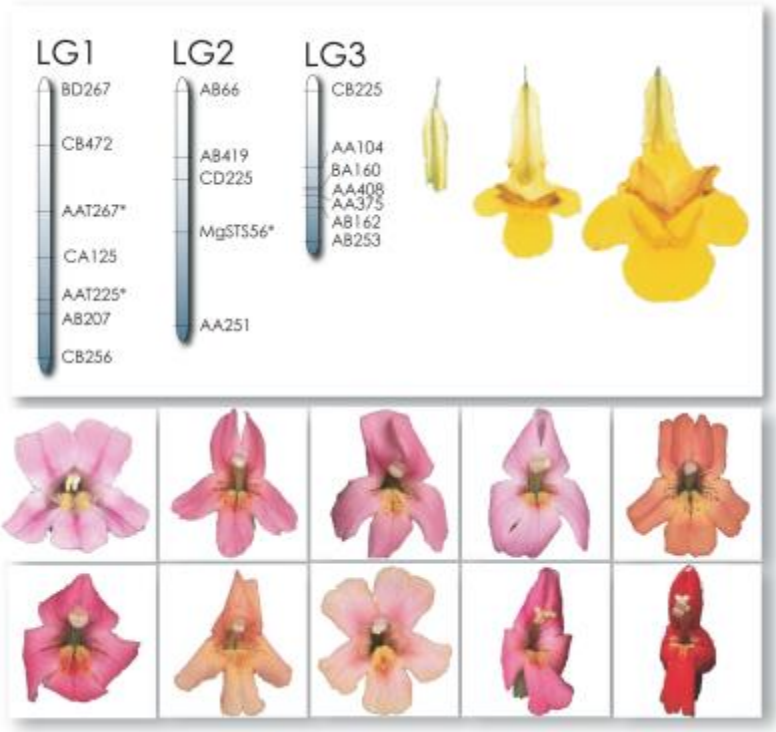
*__SPECIATION__: the process by which one species splits into two species, which thereafter evolve as distinct lineages ***(i.e. they cease to interbreed!!)***

Bullfrog
(Rana catesbeiana)

No dorsolateral ridges

Green Frog
(Rana clamitans melanota)

Dorsolateral ridges that do not reach the groin

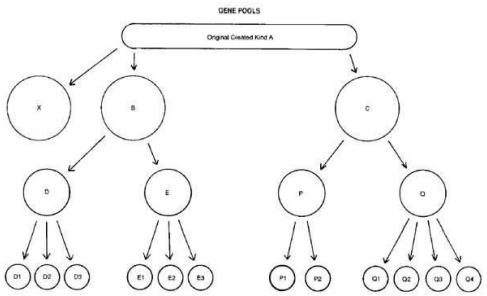


SPECIATION…

2 critical requirements for speciation to occur are:

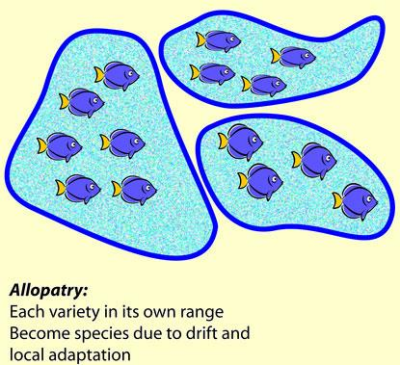
(1) ***<u>separation of the gene pool</u>*** of the ancestral species into two separate gene pools (gene flow sufficiently reduced), and

(2) over time, allele and gene frequencies may change due to natural selection (**<u>genetic divergence</u>**!)

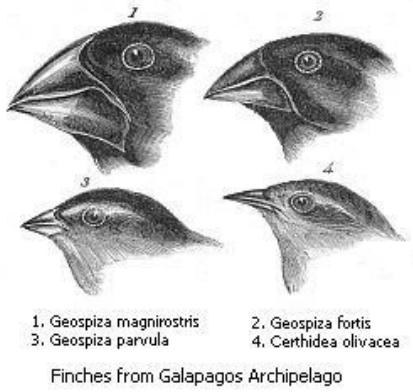


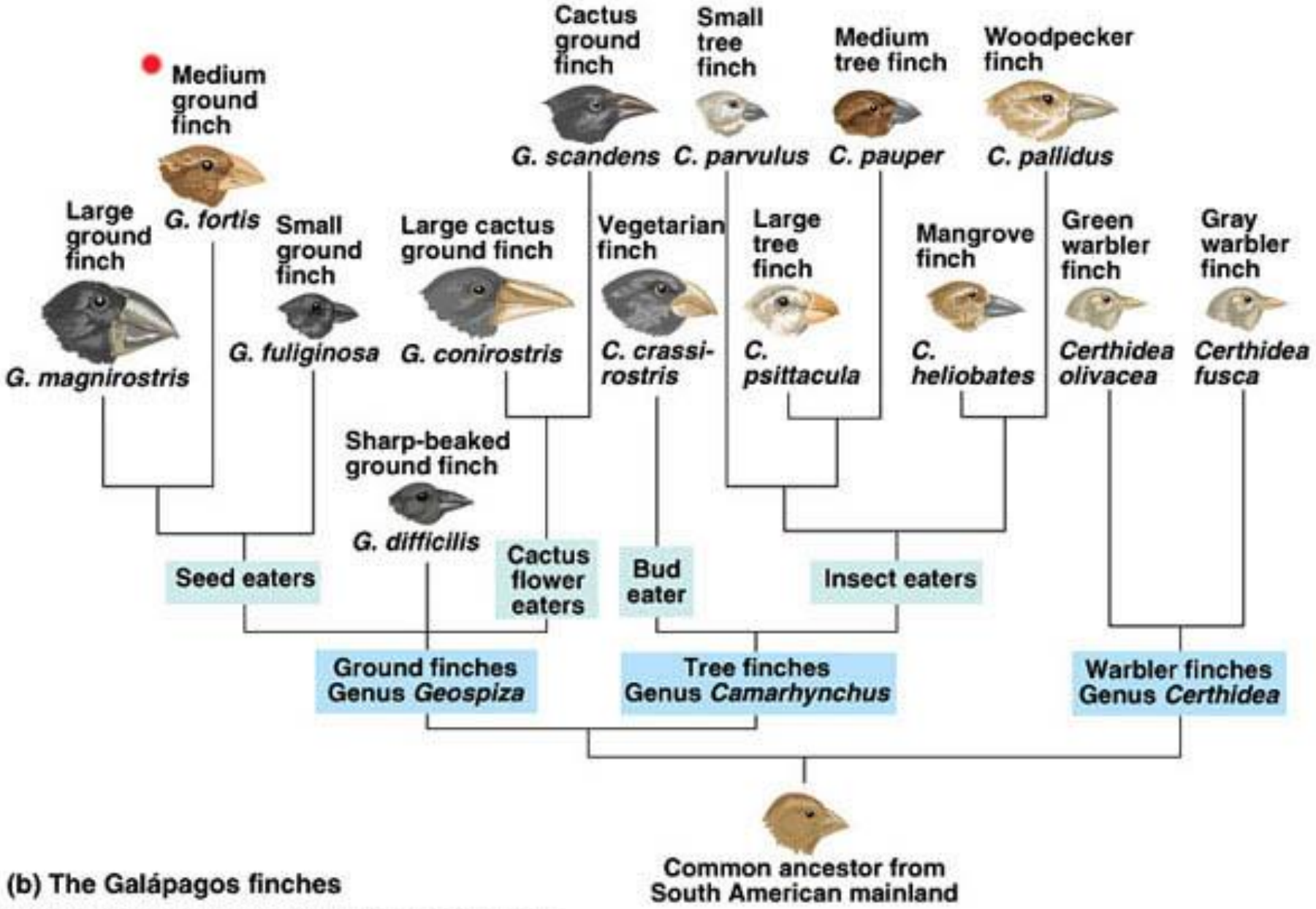
Two Modes of Speciation:

1) **ALLOPATRIC SPECIATION**: (a.k.a. "geographic speciation"); **a population is separated geographically**, either by a natural barrier or when some individuals leave a population and found a new population



- Example: finches of the Galapagos Islands

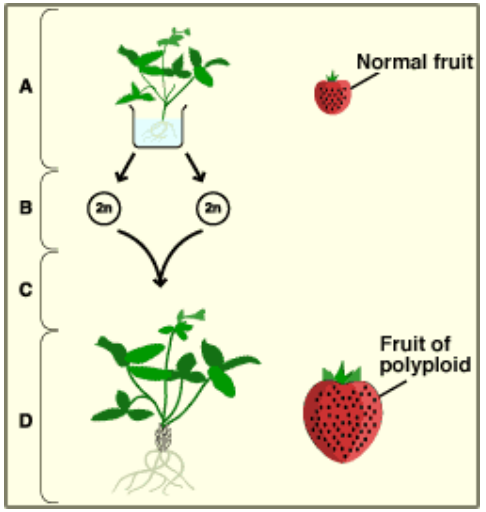




(b) The Galápagos finches

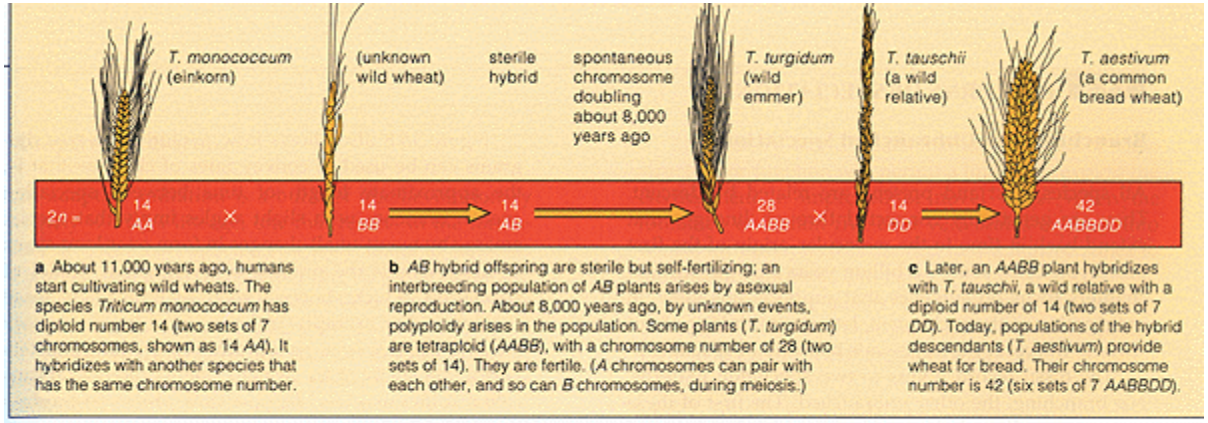
Two Modes of Speciation:

2) SYMPATRIC SPECIATION: a gene pool is divided without geographic separation…HOW?



➔ **POLYPLOIDY**: an increase in the # of chromosomes (common in plants)

➔ precise selection of habitat or mating site by individuals (animals)



a About 11,000 years ago, humans start cultivating wild wheats. The species *Triticum monococcum* has diploid number 14 (two sets of 7 chromosomes, shown as 14 *AA*). It hybridizes with another species that has the same chromosome number.

b *AB* hybrid offspring are sterile but self-fertilizing; an interbreeding population of *AB* plants arises by asexual reproduction. About 8,000 years ago, by unknown events, polyploidy arises in the population. Some plants (*T. turgidum*) are tetraploid (*AABB*), with a chromosome number of 28 (two sets of 14). They are fertile. (*A* chromosomes can pair with each other, and so can *B* chromosomes, during meiosis.)

c Later, an *AABB* plant hybridizes with *T. tauschii*, a wild relative with a diploid number of 14 (two sets of 7 *DD*). Today, populations of the hybrid descendants (*T. aestivum*) provide wheat for bread. Their chromosome number is 42 (six sets of 7 *AABBDD*).

Figure 15.6 Presumed sympatric speciation in wheat through polyploidy and hybridizations. Wheat grains 11,000 years old have been found in the Near East. Diploid wild wheats still grow there.

Sympatric speciation

Divergence occurs despite lack of geographic isolation

POLYPLOIDS:

Organisms with extra sets of chromosomes; can result in sympatric speciation in one generation

The origin of a polyploid individual is usually a mistake in meiosis or mitosis

Autopolyploidy vs. allopolyploidy

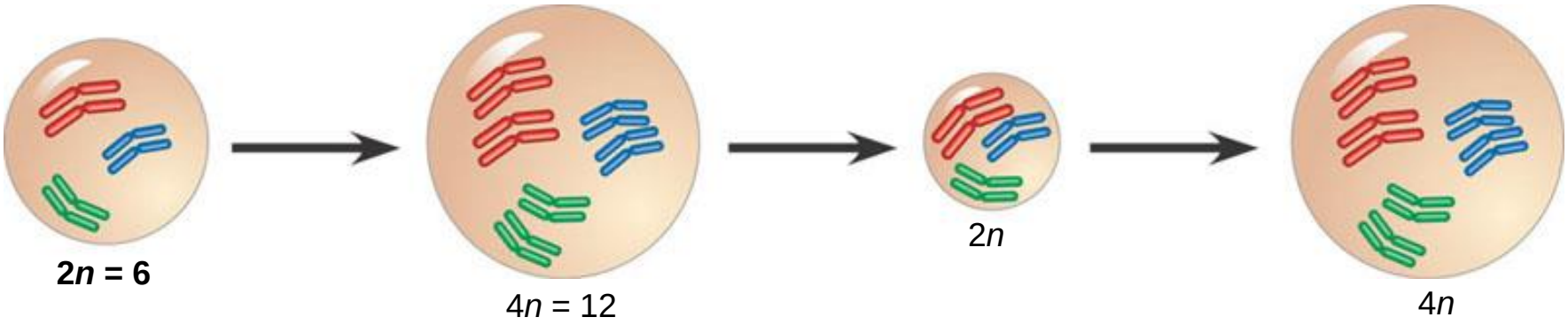
Sympatric speciation

An autopolyploid = an individual that has > two chromosome sets, <u>all from a single species</u>

Failure of cell division in a cell of a growing diploid plant produces a tetraploid branch.

Gametes produced by flowers on this branch will be diploid.

If offspring are viable and fertile, it is a new biological species.



Sympatric speciation

An allopolyploid = an individual with > two chromosome sets, derived from different species

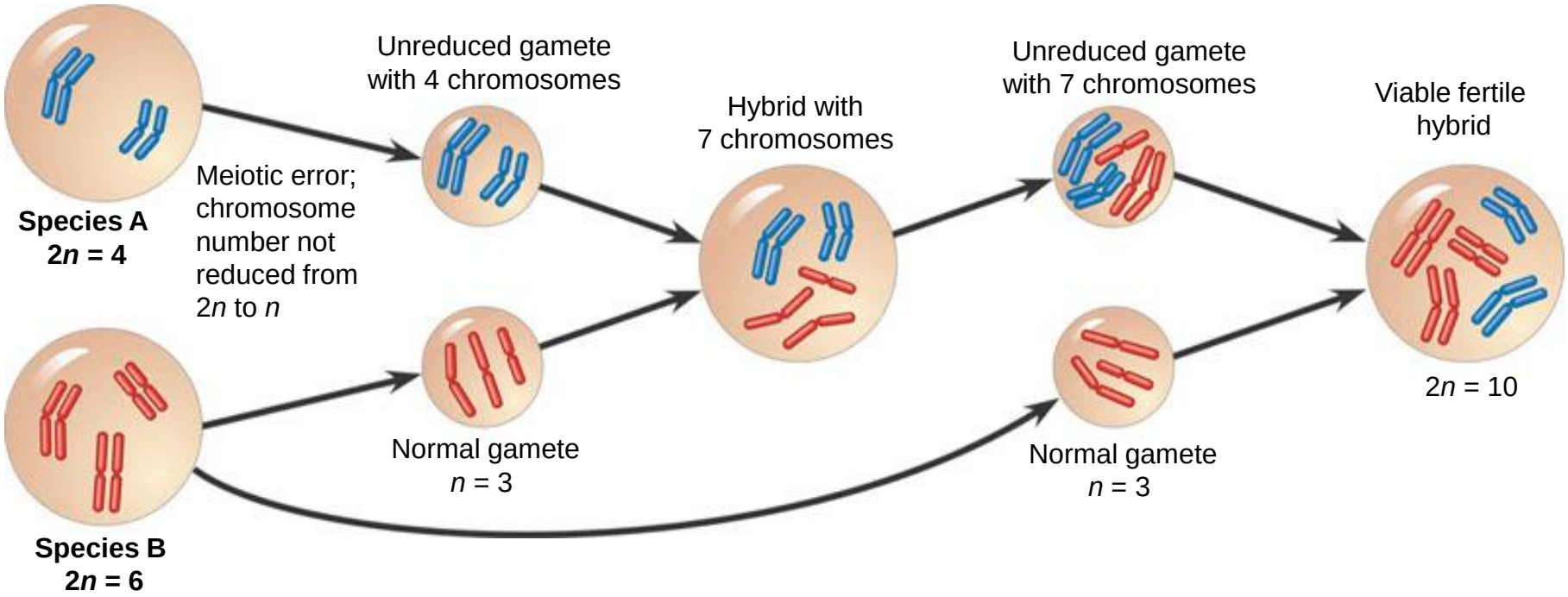
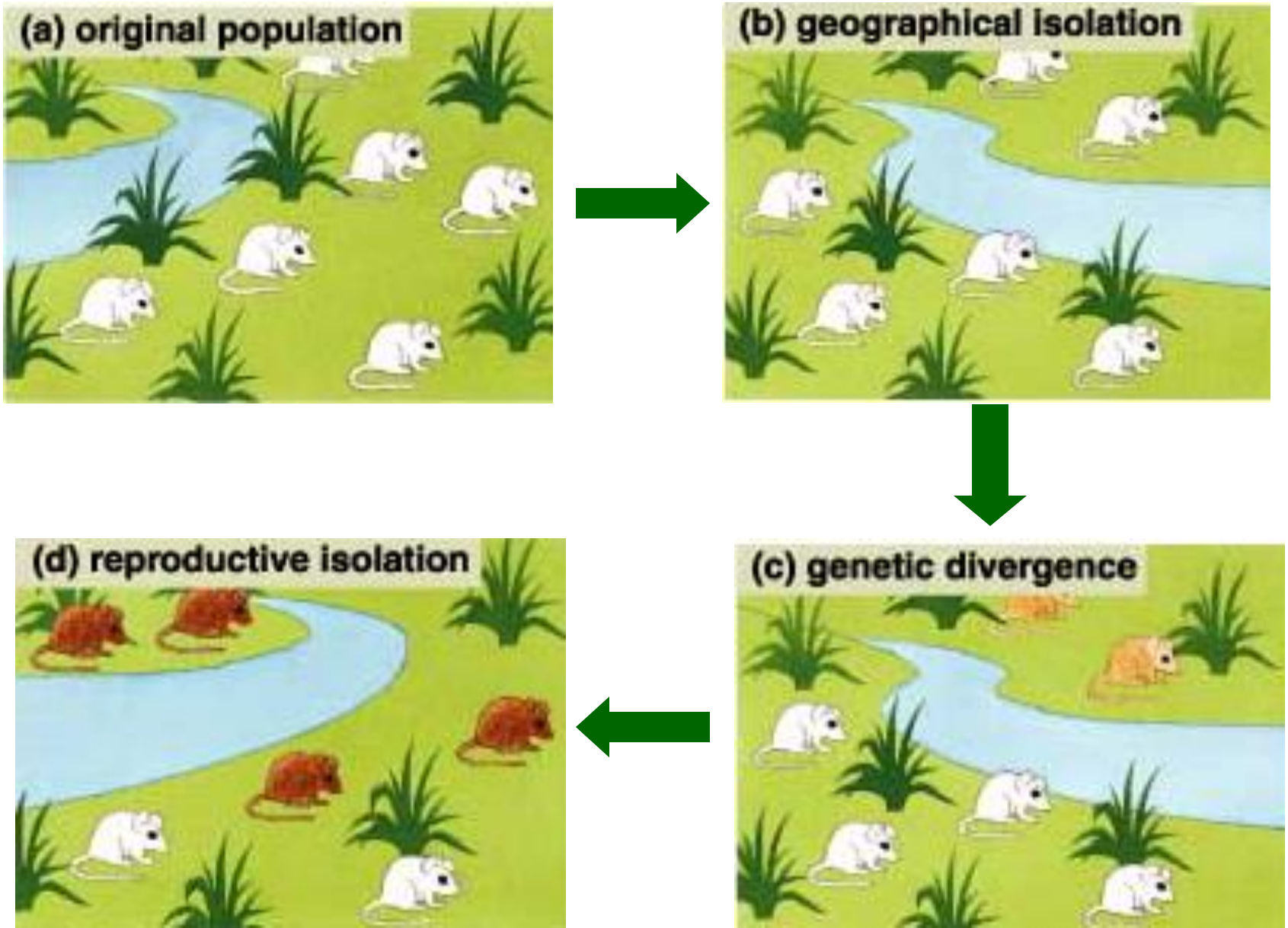


Figure 24.9

Polyploidy is especially common in plants

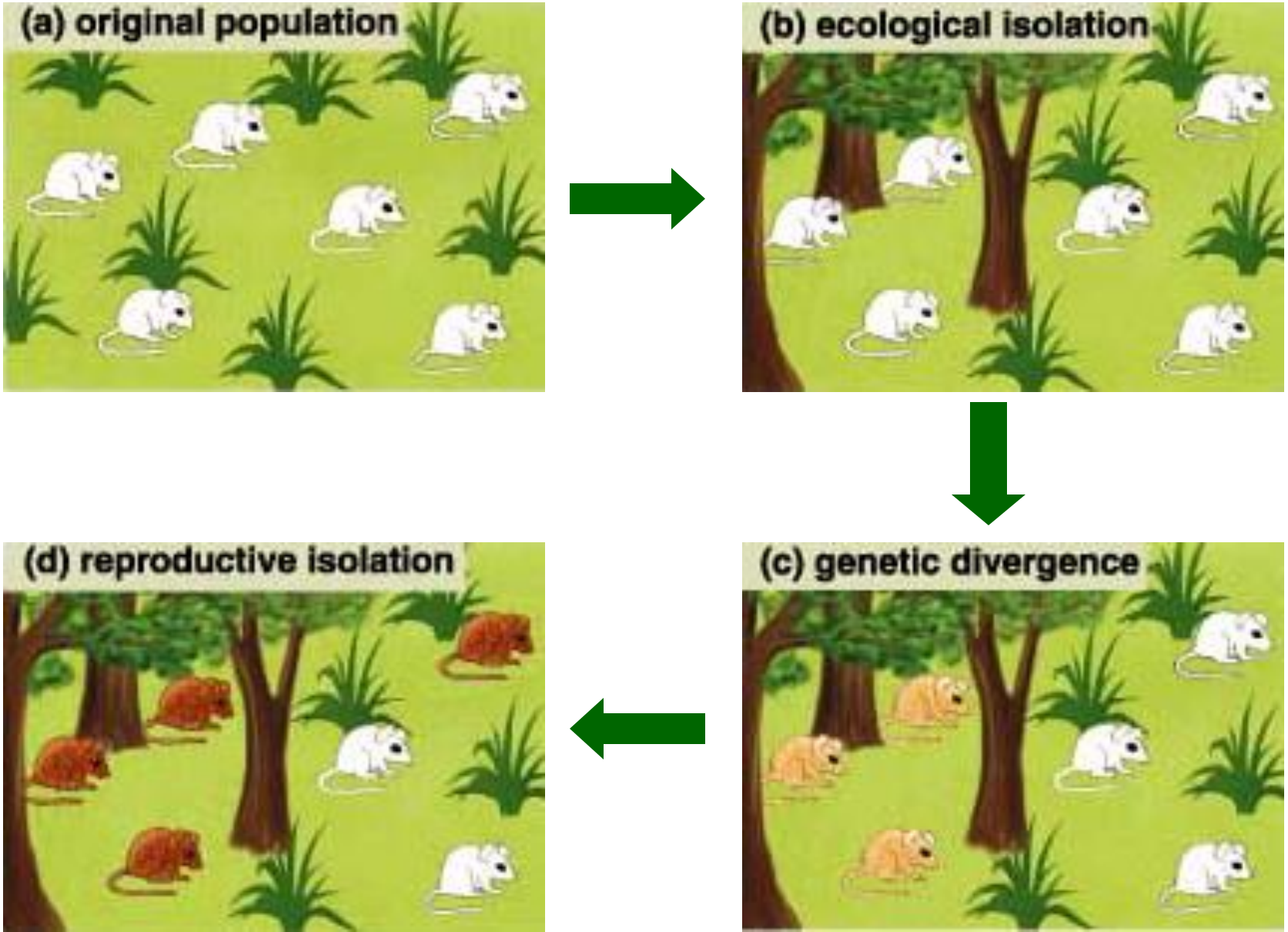
Allopatric speciation

Divergence occurs in geographic isolation

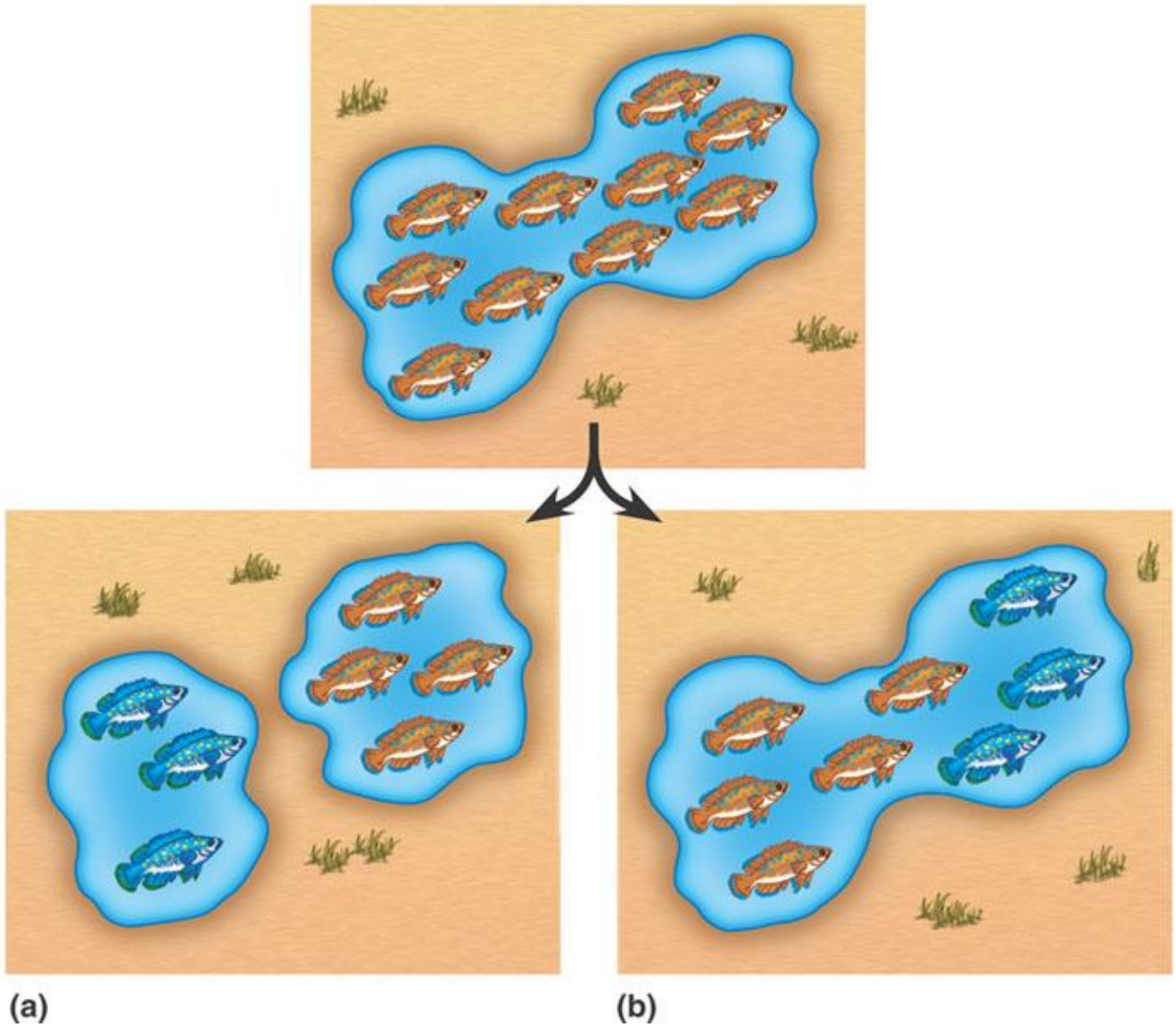


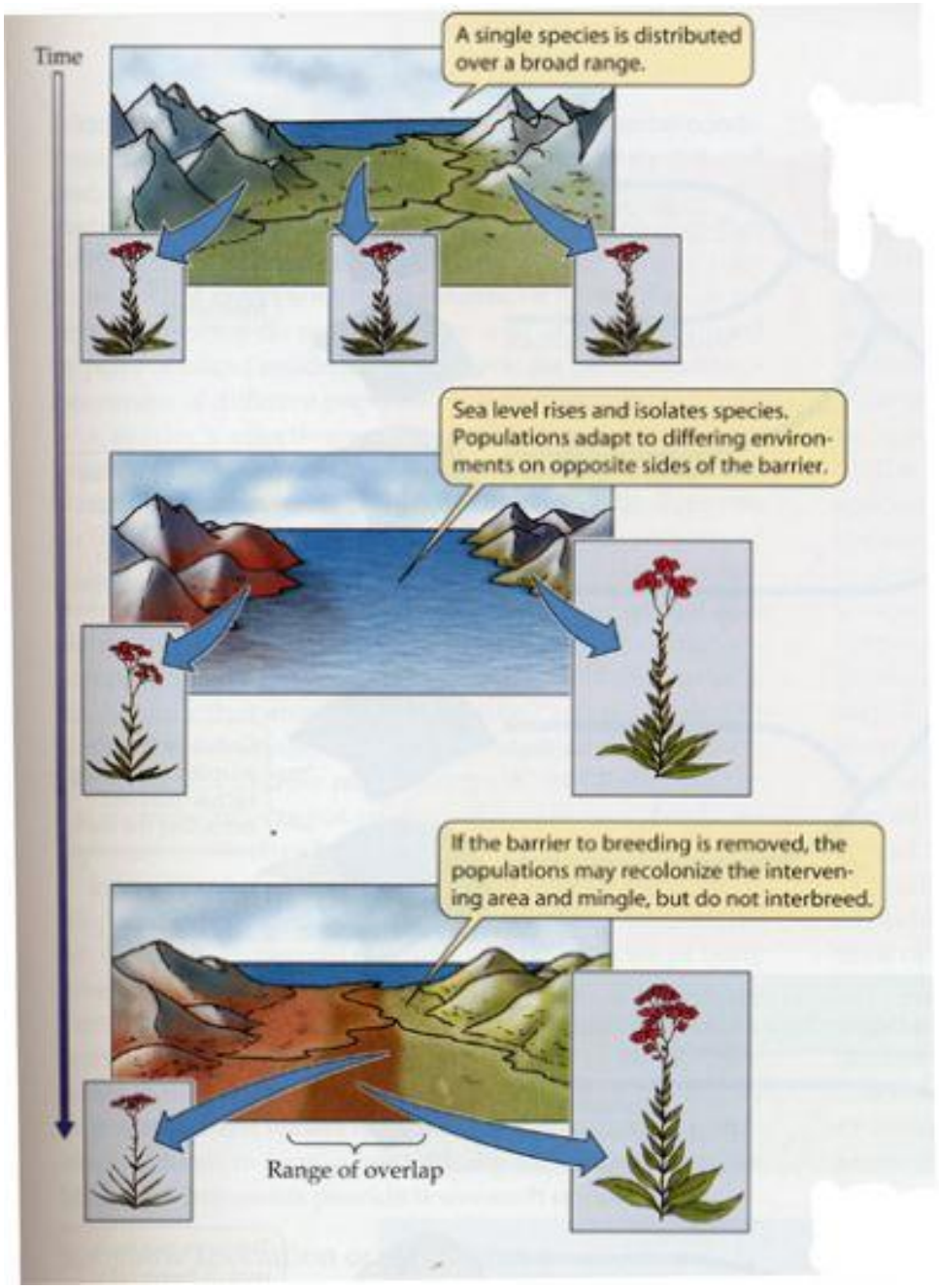
Sympatric speciation

Divergence occurs despite lack of geographic isolation



Allopatric vs. sympatric speciation





What type of speciation is occurring?

Explain.

REPRODUCTIVE ISOLATING MECHANISMS:

- **Prezygotic Barriers (operate before mating)**

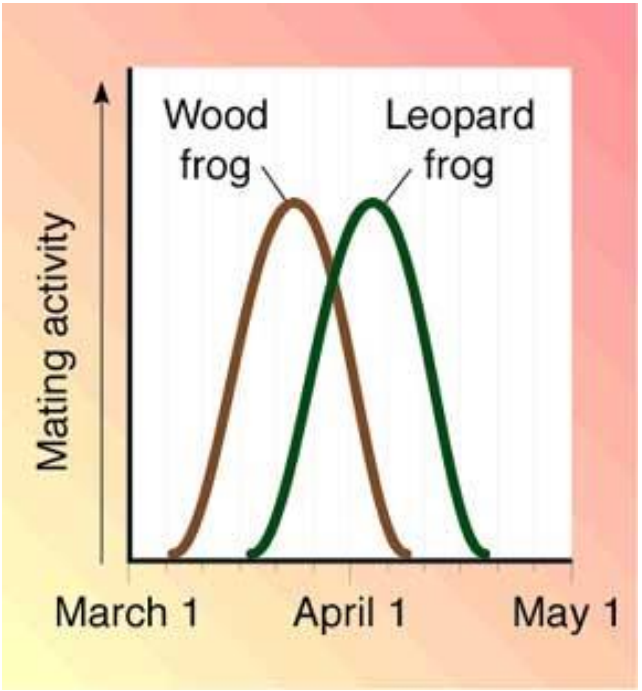
> Habitat Isolation

> Behavioral Isolation

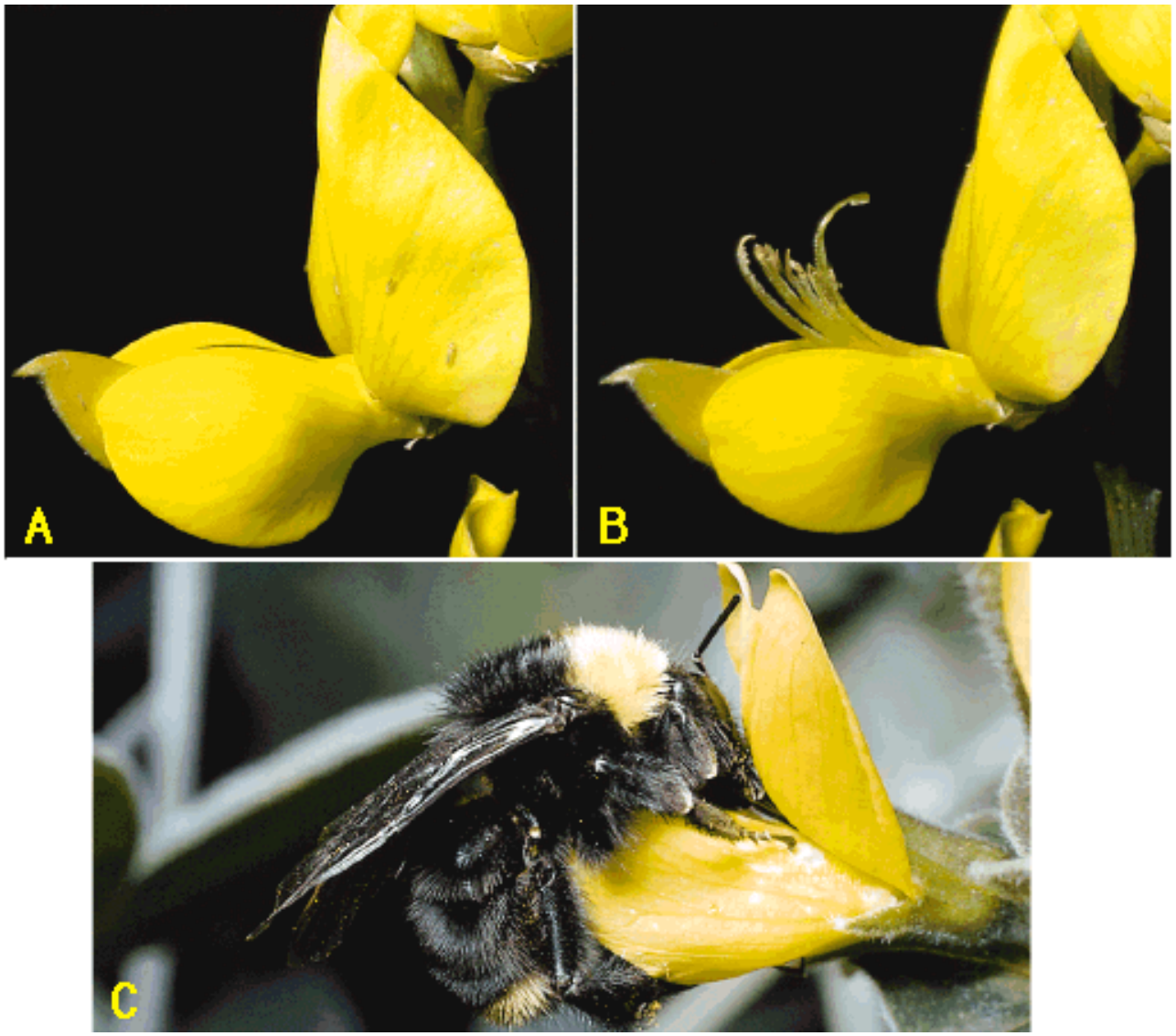
> Temporal Isolation

> Mechanical Isolation

> Gametic Isolation



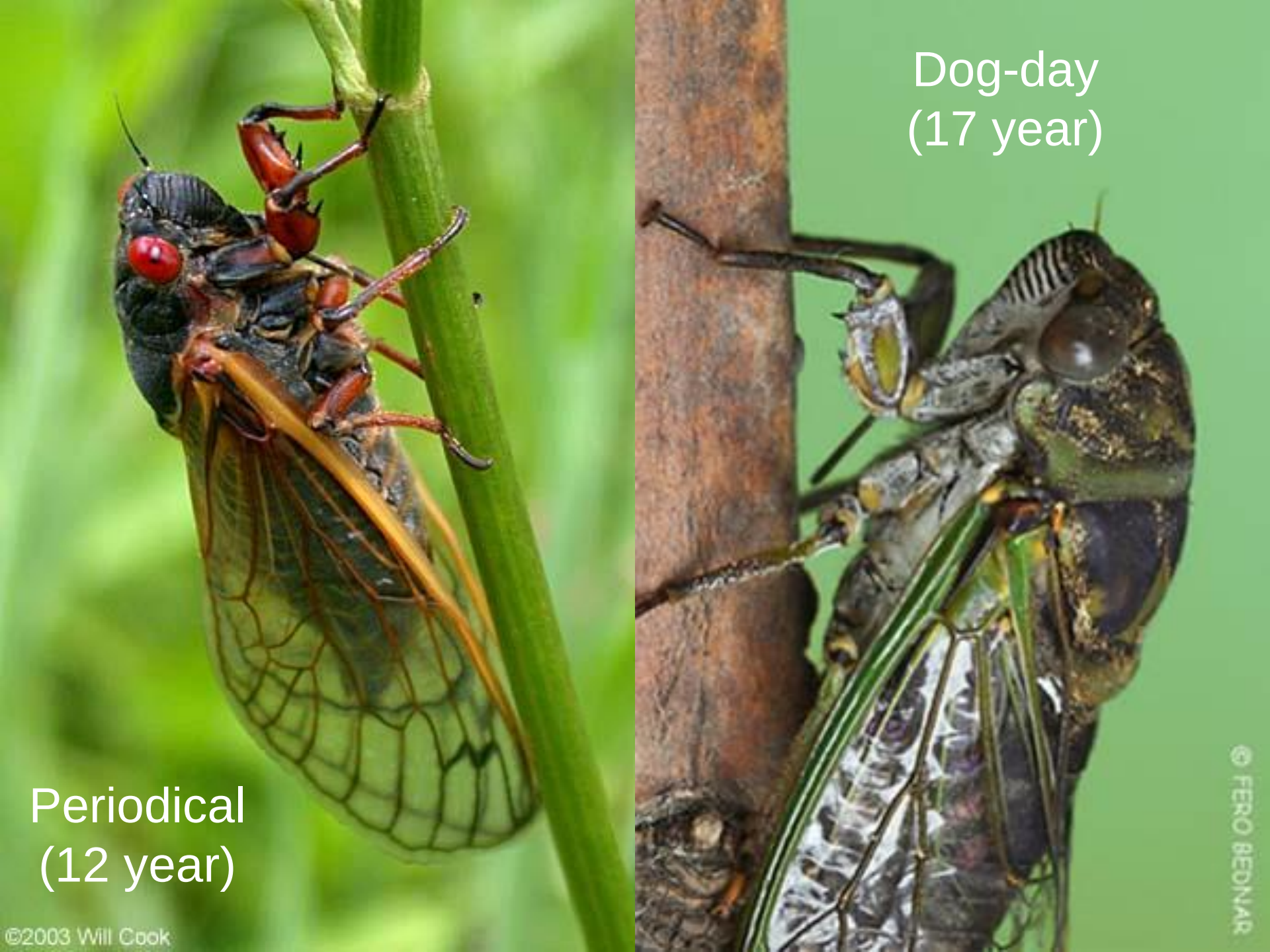
Mechanical Isolation

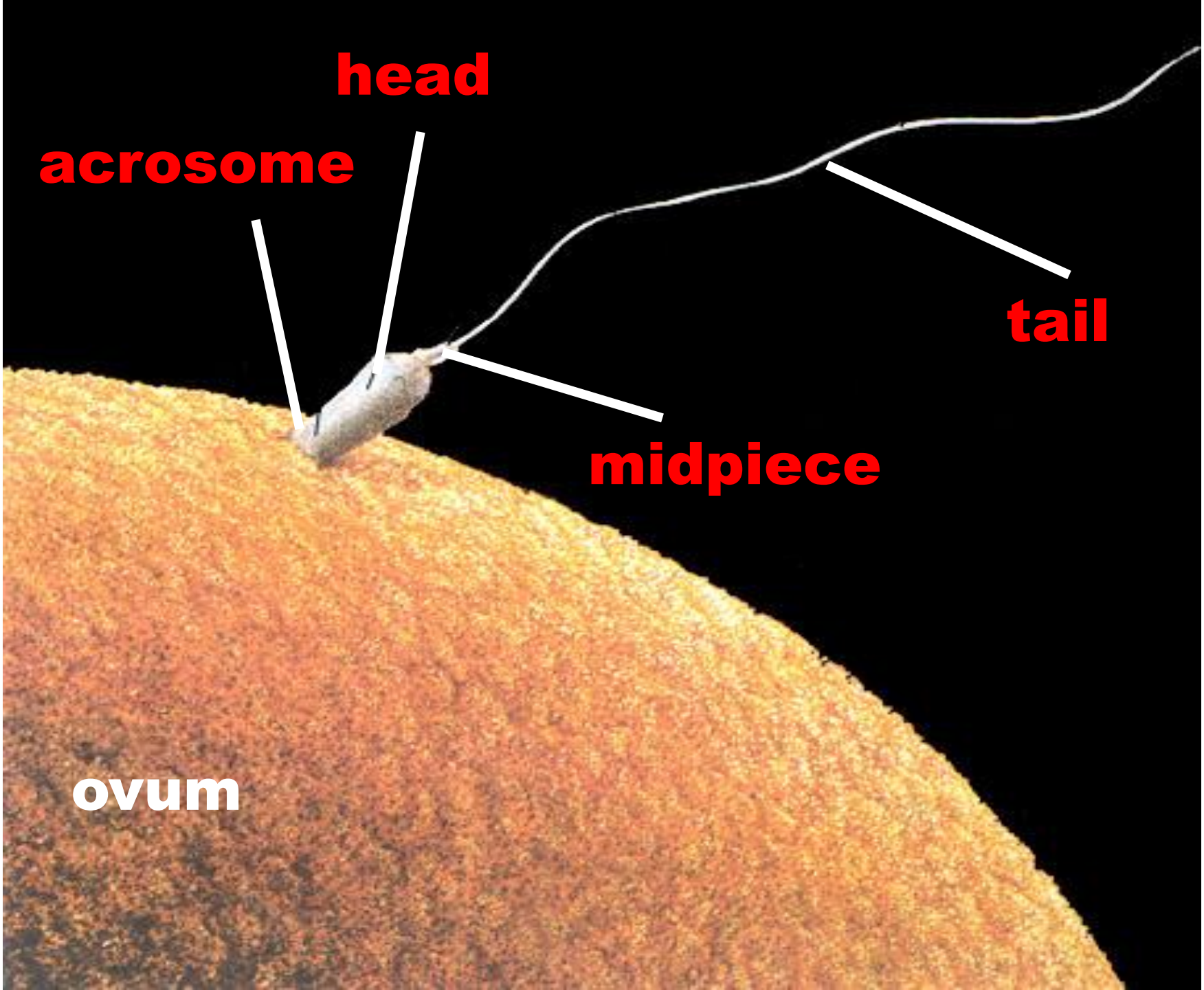


Galapagos Islands

Blue-footed boobies

Red-footed booby


Periodical
(12 year)
©2003 Will Cook
Dog-day
(17 year)
© FERO BEDNAR


head
acrosome
tail
midpiece
ovum

REPRODUCTIVE ISOLATING MECHANISMS:

• Postzygotic Barriers (operate after mating):

> Hybrid zygote abnormality

> Hybrid Infertility (Reduced Hybrid Fertility)

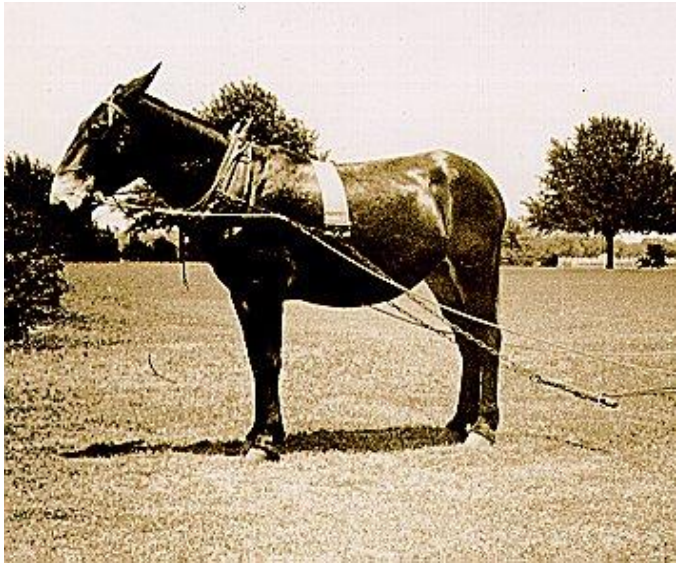
> Low Hybrid Viability (Reduced Hybrid Viability)

> Absence or Sterility of one sex

> Hybrid Breakdown

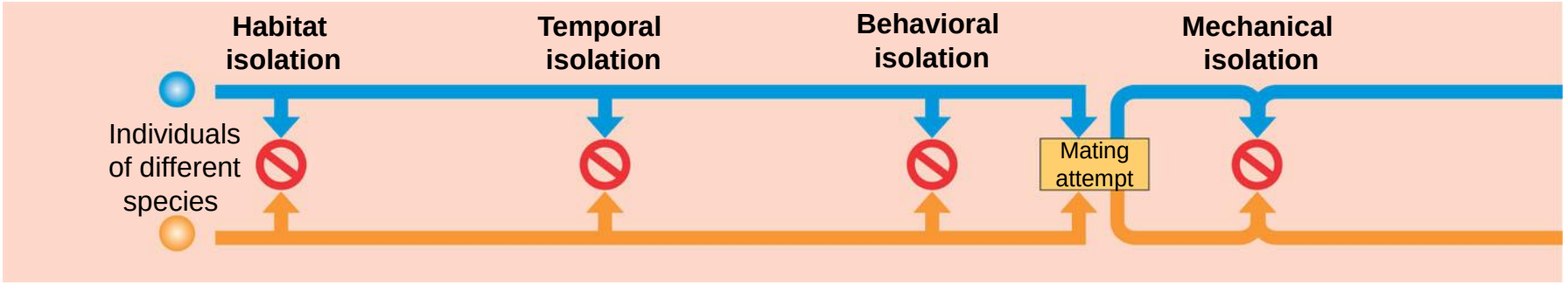
x

=



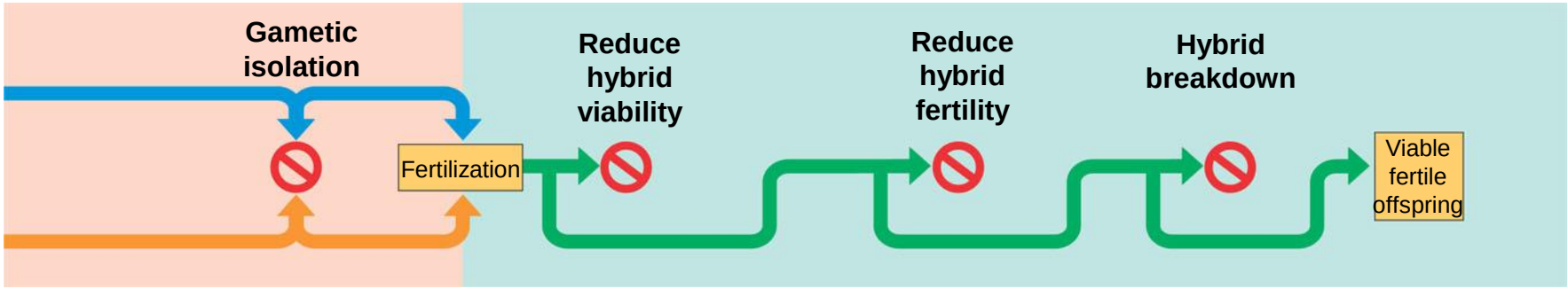
sterile

Reproductive Barriers



HABITAT ISOLATION **TEMPORAL ISOLATION** **BEHAVIORAL ISOLATION** **MECHANICAL ISOLATION**

Reproductive Barriers



GAMETIC ISOLATION

REDUCED HYBRID VIABILITY

REDUCED HYBRID FERTILITY

HYBRID BREAKDOWN

The Tempo of Speciation…

*the fossil record reveals that at certain times in some lineages, speciation rates have exceeded extinction rates…the result: **ADAPTIVE RADIATION**

ADAPTIVE RADIATION: gives rise to a large number of daughter species

-likely to occur when a population colonizes an environment that has relatively few species

-often evident on islands (islands have many ecological opportunities for new species)

Case study of adaptive radiation: the HAWAIIAN ISLANDS!

***1,000 species of flowering plants** (more than 90% of these are "endemic" – found nowhere else)

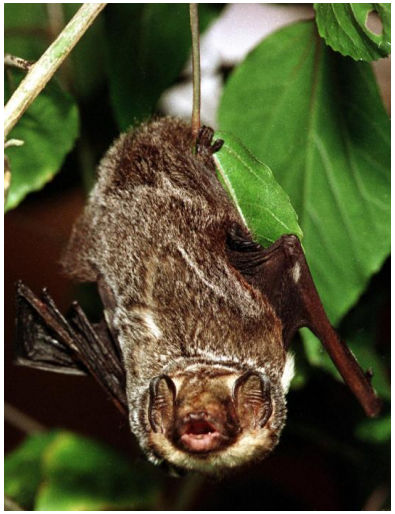
***10,000 species of insects** (believed to have evolved from only 400 immigrant species)

***1,000 species of land snails**

Case study of adaptive radiation: the HAWAIIAN ISLANDS!

***more than 100 bird species**
(believed to have evolved from only 7 immigrant species)

***no amphibians or reptiles** (until humans introduced them)

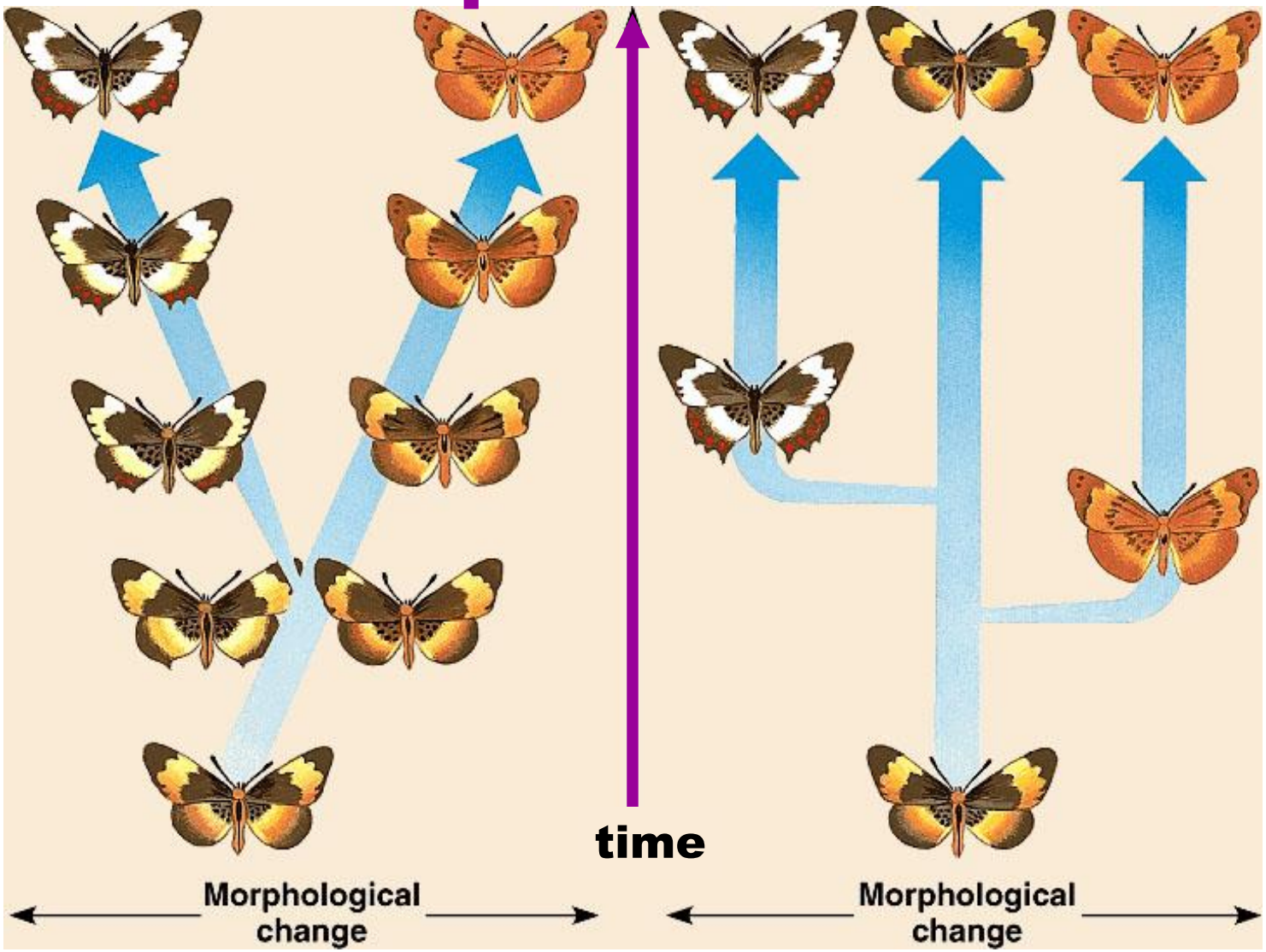


***only one mammal species**: **a bat**
(until humans introduced more)

Tempo of Evolution: Gradualism vs. Punctuated Equilibrium

- **Gradualism Model**: species descended from a common ancestor gradually diverge more and more in morphology as they acquire unique adaptions
- **Punctuated Equilibrium Model**: a new species changes most as it buds from a parent species, and then changes little for the rest of its existence

Tempo of Evolution

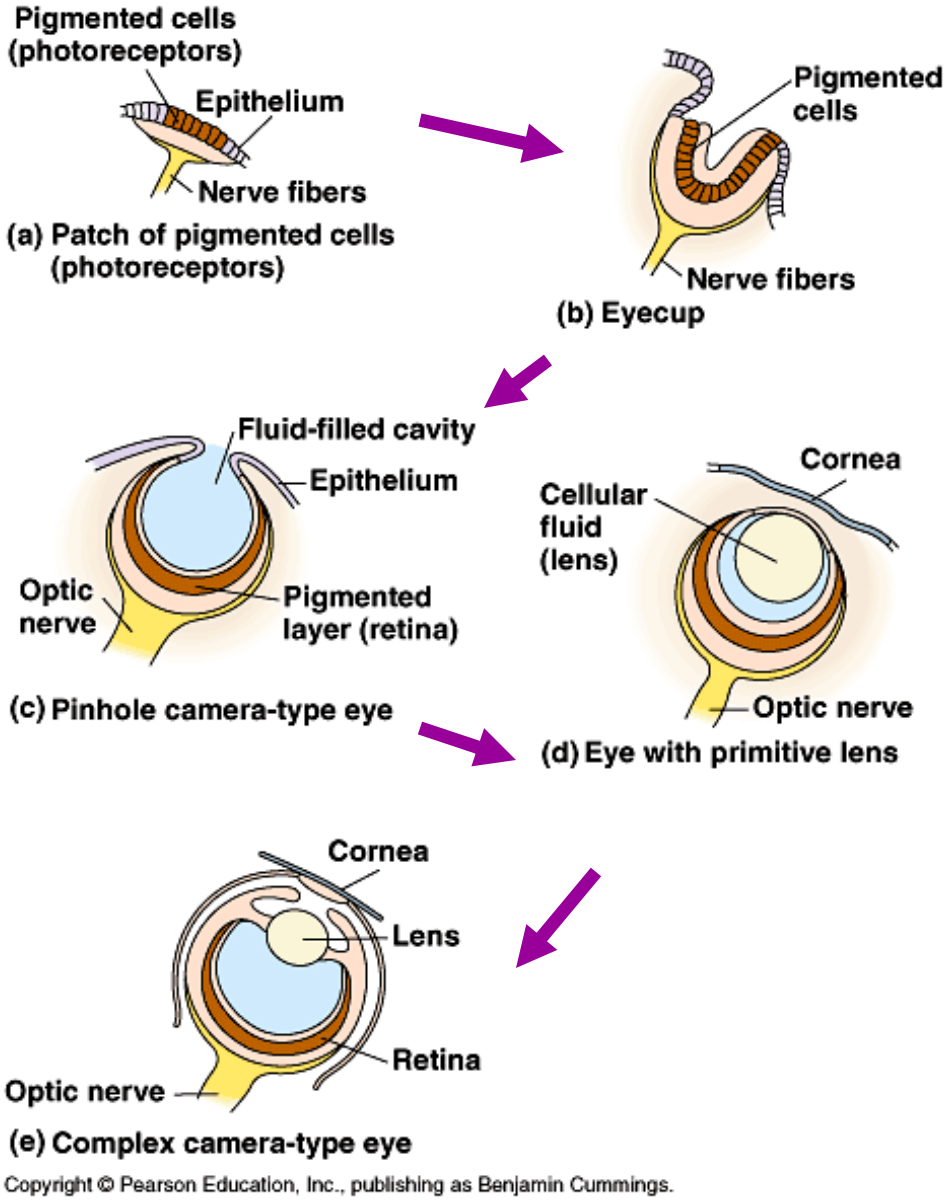


Gradualism

Punctuated Equilibrium

Evolutionary Novelties

Evolutionary novelties usually arise as modifications of existing traits



Evolution is not "goal oriented"

Evolution is a genetic response to the interaction between the individuals of a population and their current environment (which includes other individuals)

Natural selection can only act on the phenotypic variation present, and selection can only cause evolutionary change if phenotypic variation results (at least in part) from genetic variation

Evolution is not “goal oriented”

Therefore, even if female tigers in a population would prefer blue males, blue tigers will never evolve if the population lacks variation that includes blue fur

He’s not blue, but he’s better than nothing!

YES! But he exists only in my dreams.