

Behavior genetics

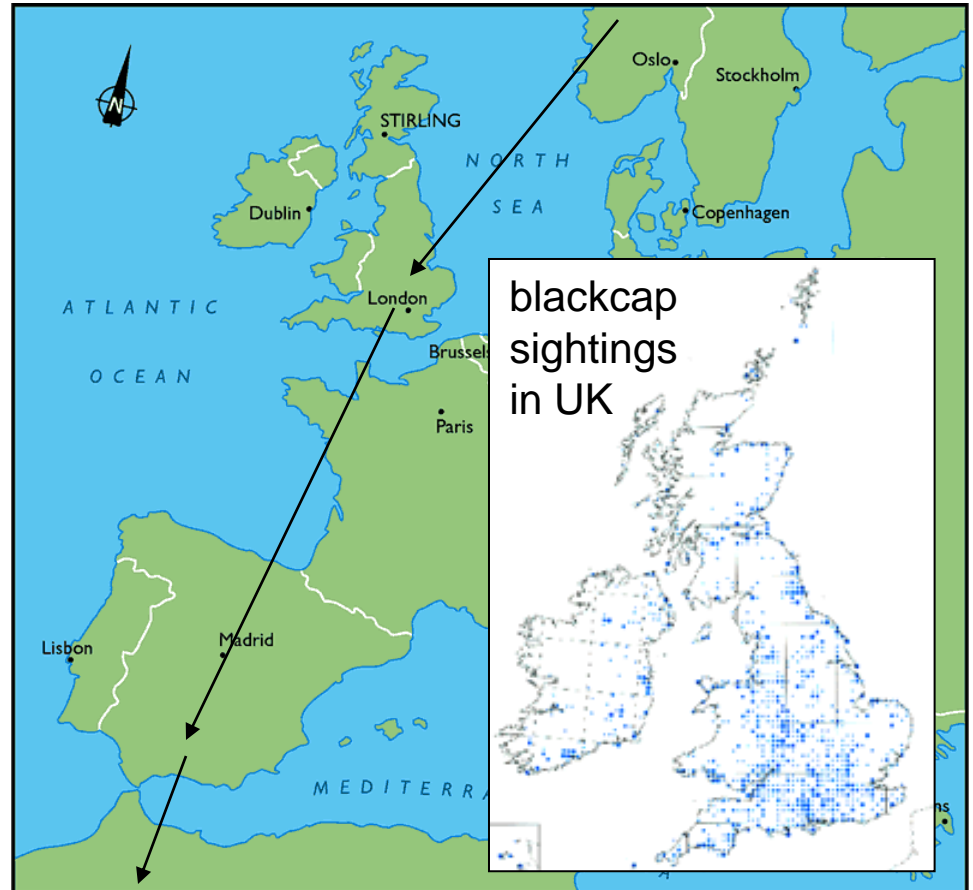


Migration of blackcap warblers

blackcap



Banding studies suggest UK blackcaps had different origin

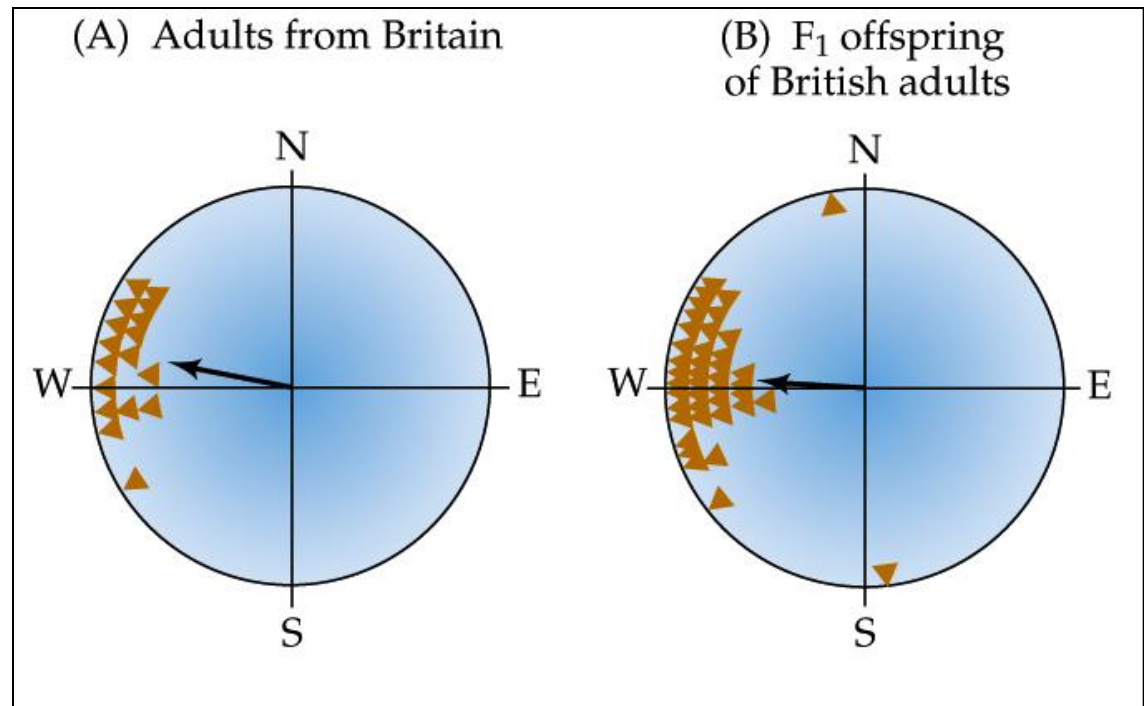
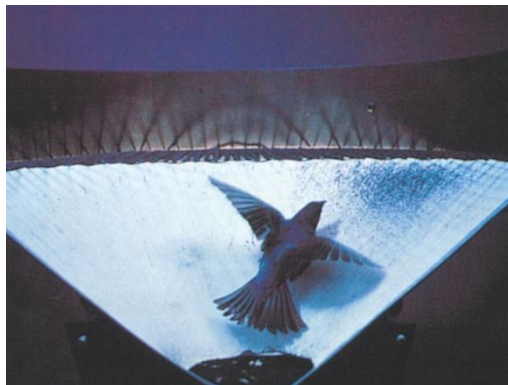
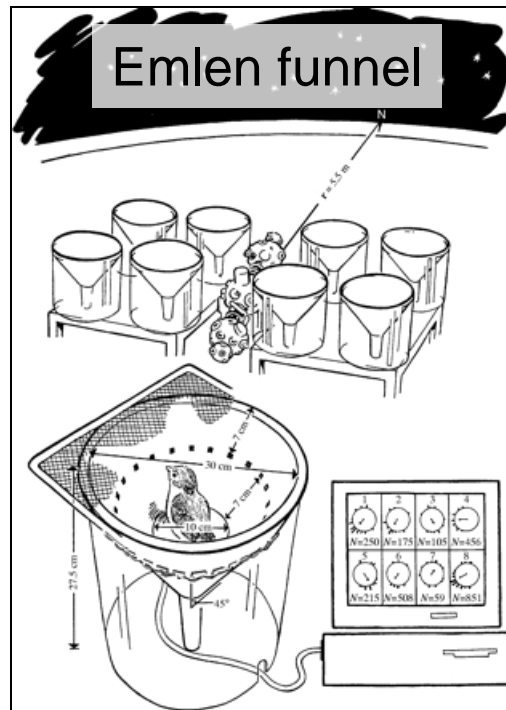


Possible explanation for winter sightings?

Migration of blackcap warblers



Migration of blackcap warblers



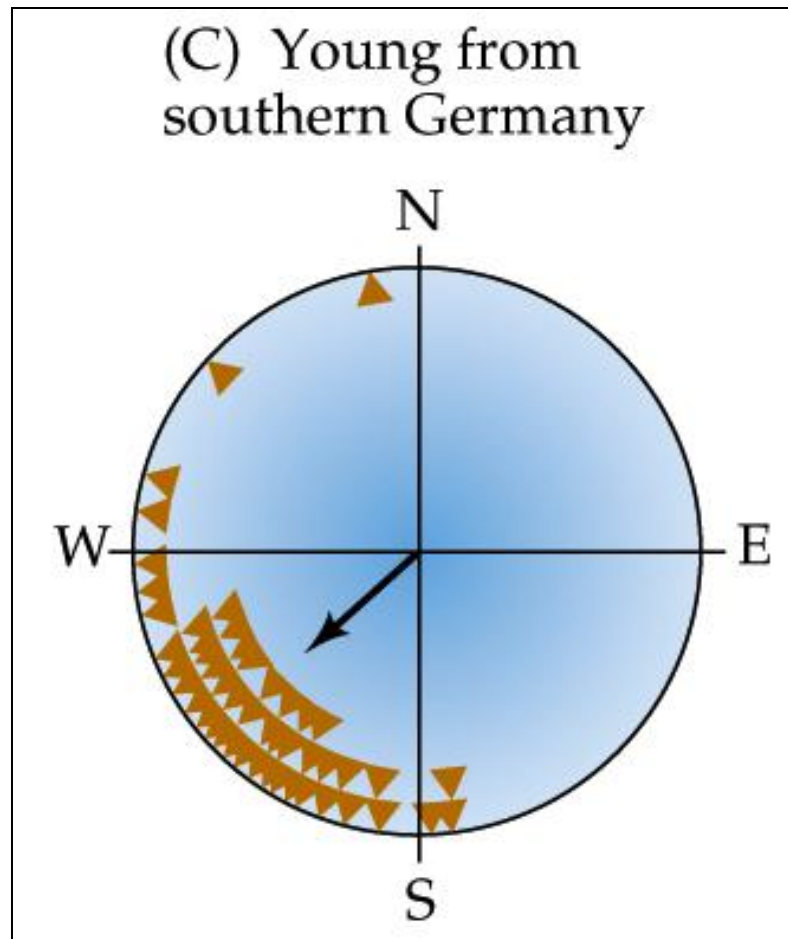
Migration of blackcap warblers

Why migrate to UK instead of Africa?



Migration of blackcap warblers

Novel migration route possibly
due to relaxed genetic control?



Migration of blackcap warblers

NW German migrants in 1960: 0%

NW German migrants in 1990: ~10%

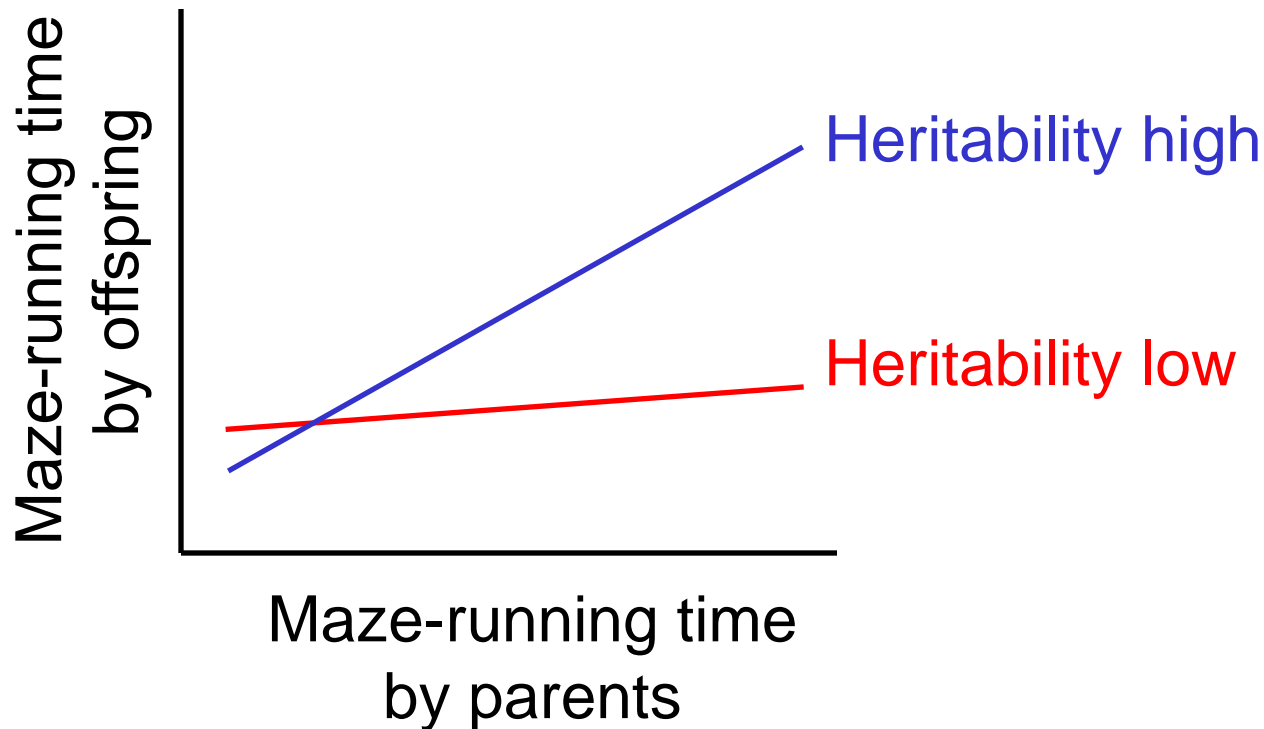
How did this spread in the population?



Evidence of genetic basis of behavior

1. Parent-offspring similarity
2. Hybridization studies
3. Field experiments

Parent-offspring similarity



Heritability: a primer

$$h^2 = V_A/V_P$$

varies between 0 and 1

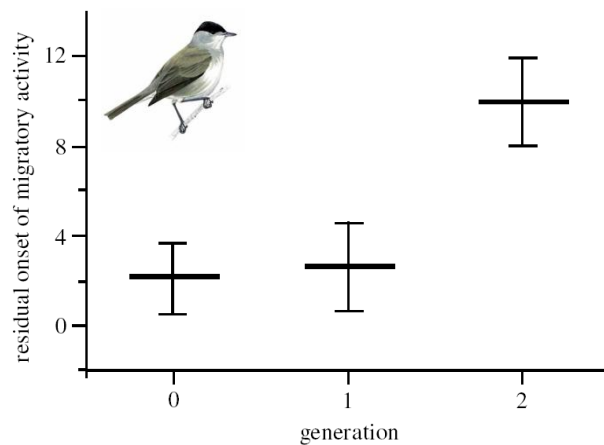
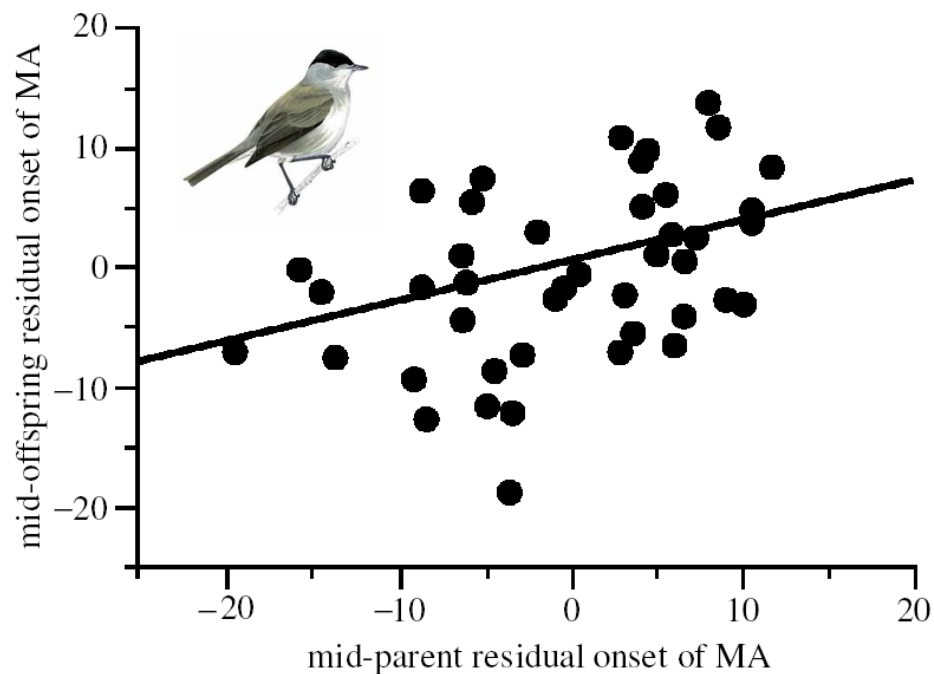
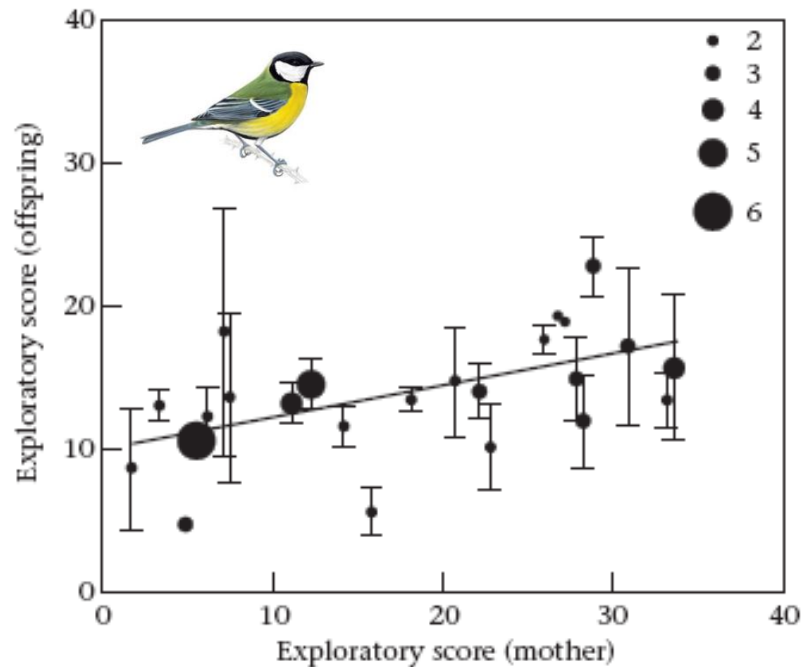
$$\frac{V_a}{2V_p} = \frac{1}{2}h^2$$

One parent - offspring formula

$$\frac{V_a}{V_p} = h^2$$

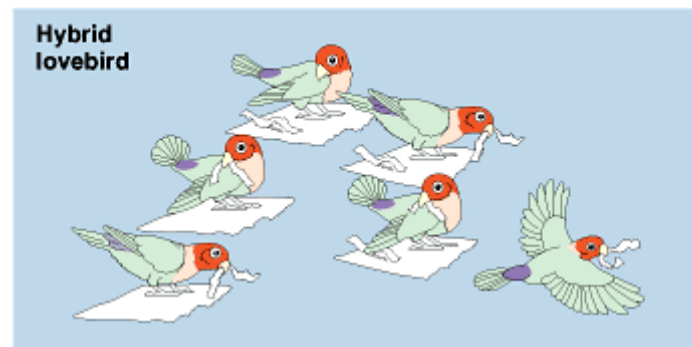
Mid-parent offspring regression

Parent-offspring similarity



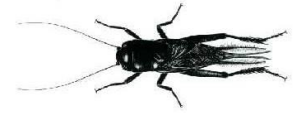
Hybridization

Hybrid phenotypes



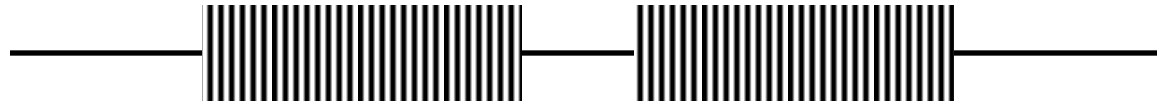
Hybridization

Song patterns in crickets

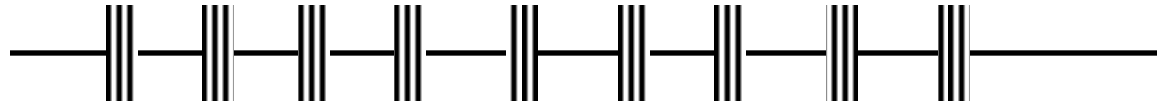


Teleogryllus sp.

commodus



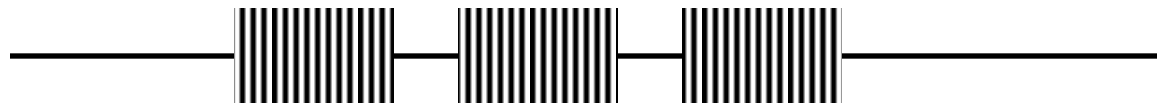
oceanicus



commodus x
oceanicus (F1)



commodus x
F1 backcross

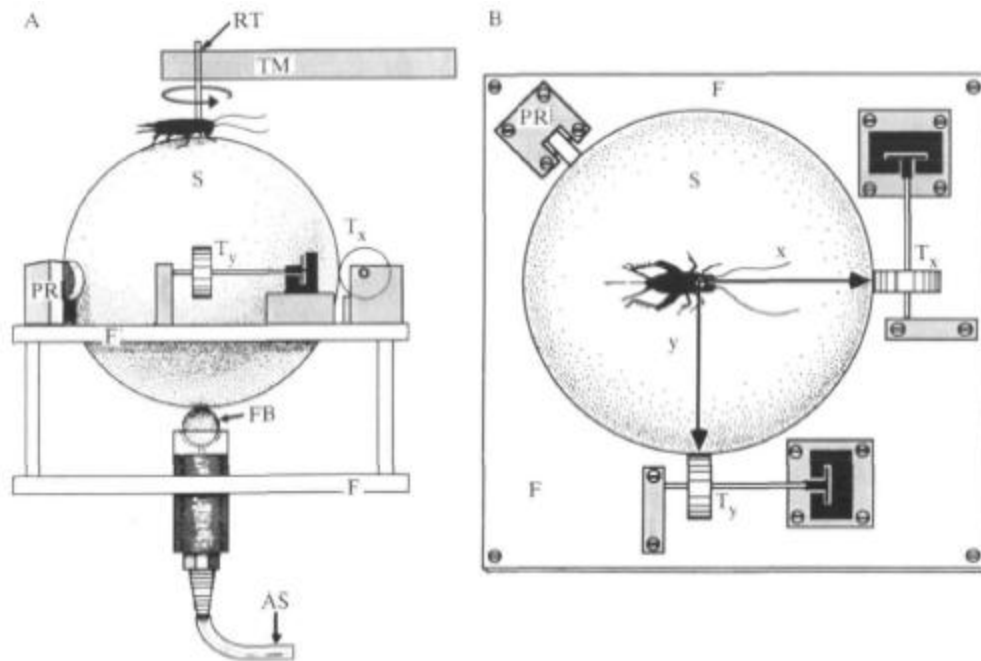


oceanicus x
F1 backcross

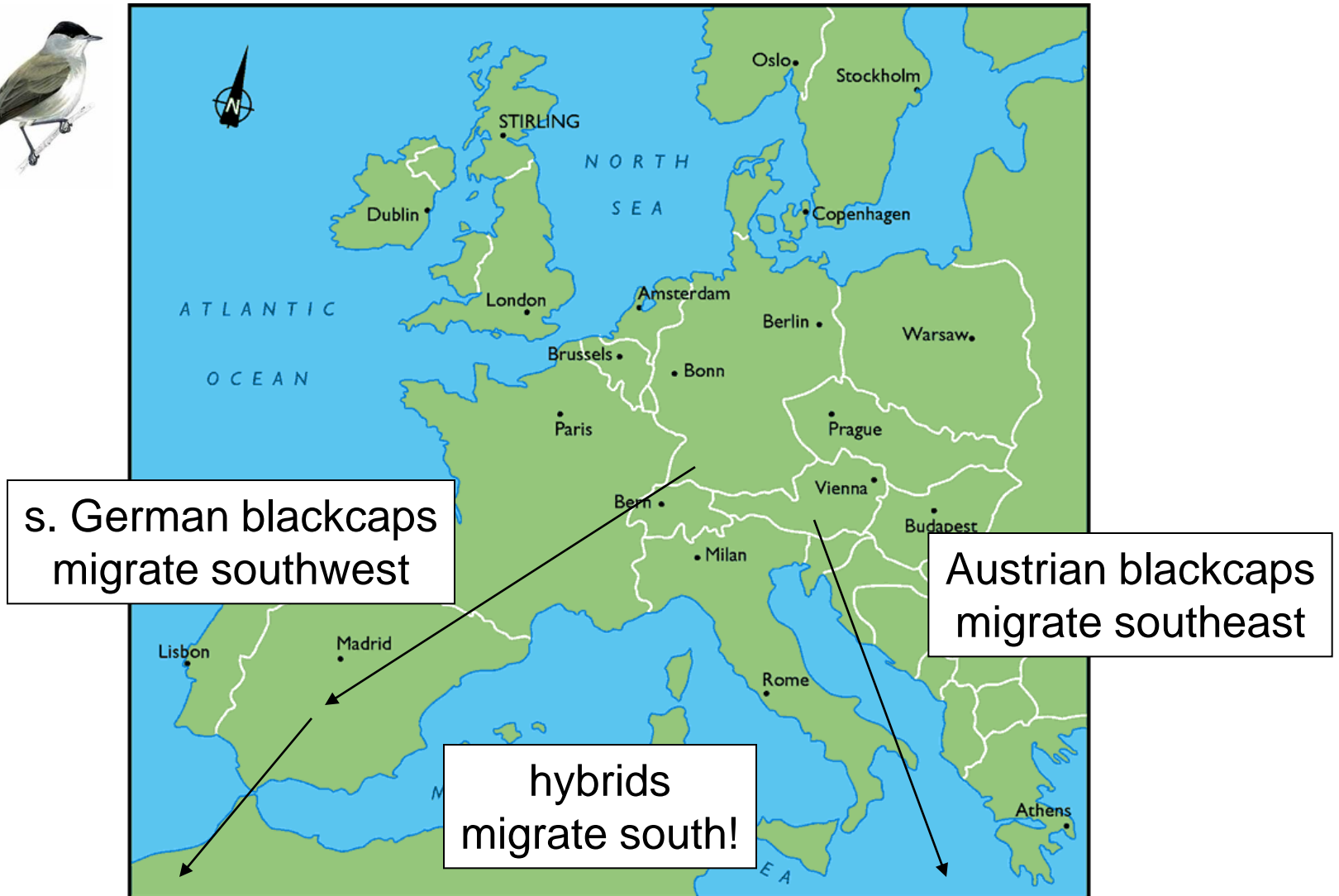


Hybridization

F1 females prefer F1 male song

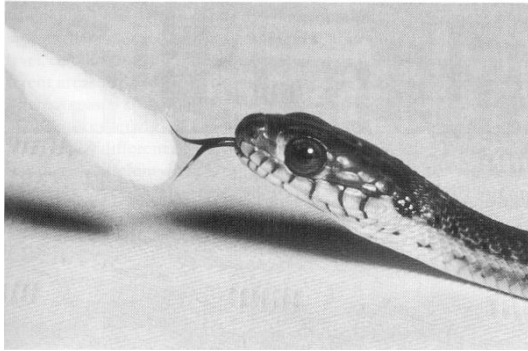


Hybridization

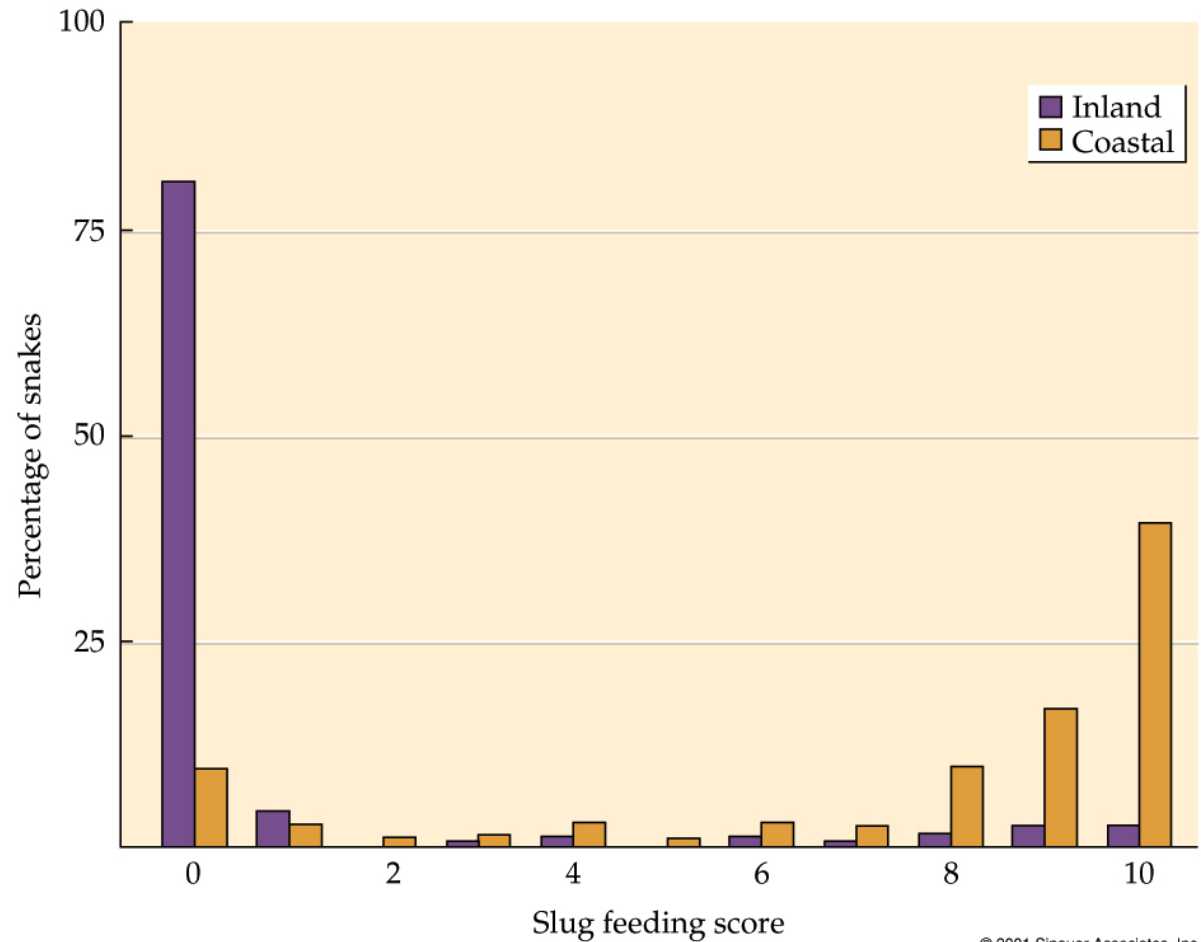
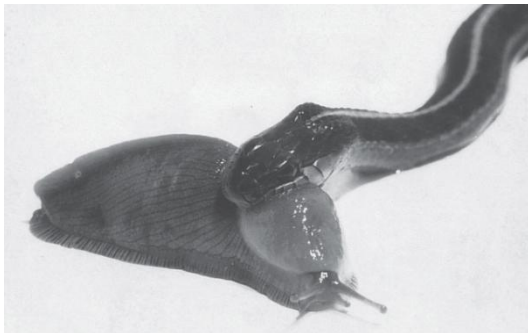


Testing for genetic effects

Common garden experiments
Reciprocal transplant experiments → Discussed in readings

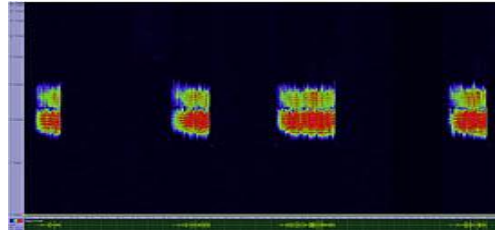


Food preferences
in garter snakes



A natural common garden experiment

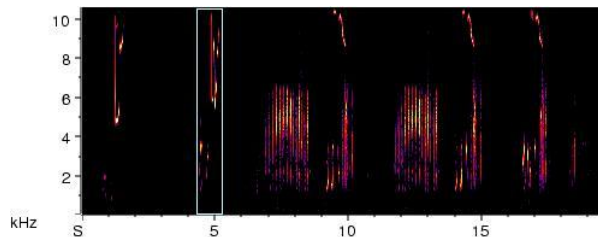
Avian brood parasitism



chipping
sparrow



brown-headed
cowbird



Testing for genetic effects

Island of Mallorca

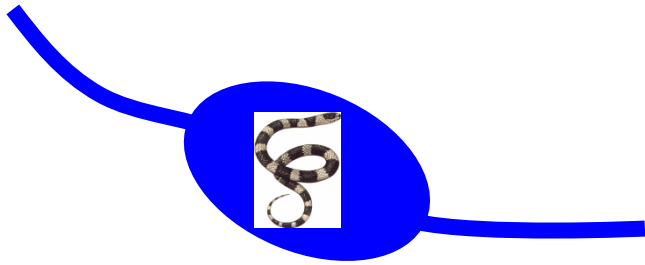
Mallorcan midwife toad



viperine snake

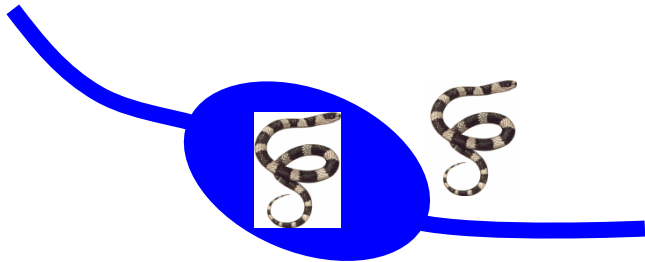


Testing for genetic effects

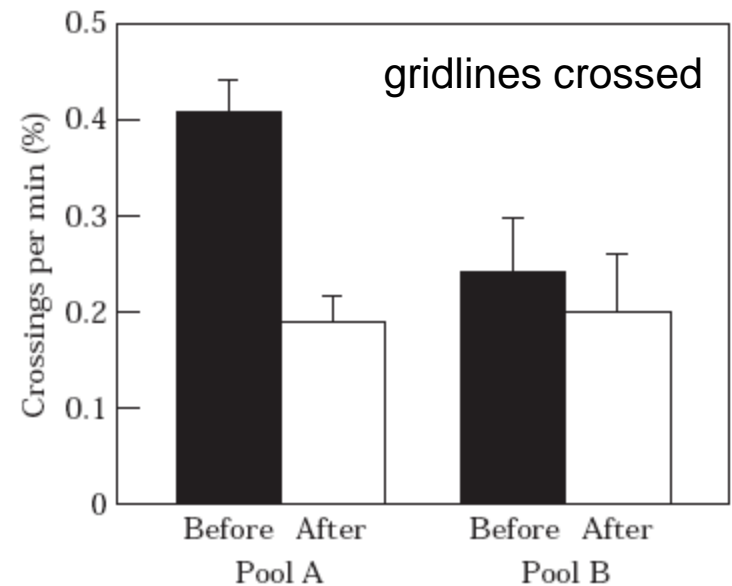
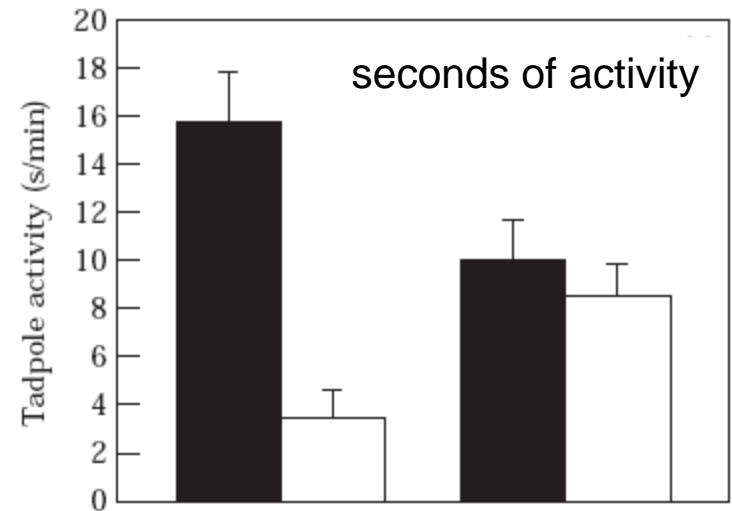


Pool A = snakes absent

Pool B = snakes present



Is this sufficient evidence of a heritable anti-predator response?



Testing for genetic effects



Test subjects: predator
naïve tadpoles

Behavioral change following addition of chemical cue

	water→cue	water→cue	water→cue	water→cue
swimming	No change	No change	No change	Decreased!
immobile	No change	No change	No change	Increased!
				
	Asiatic <i>Elaphe rufodorsata</i>	English <i>Natrix natrix</i>	Spanish <i>Natrix maura</i>	Mallorcan <i>Natrix maura</i>

Testing for genetic effects

Conclusions?

Recognition retained in absence of selection pressure
Recognition is heritable (presumably genetic)

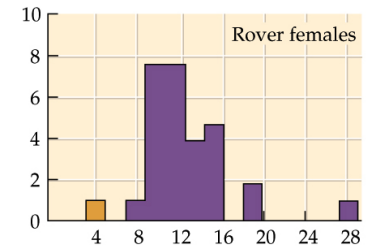
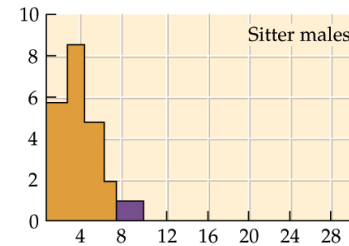
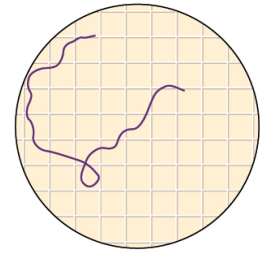
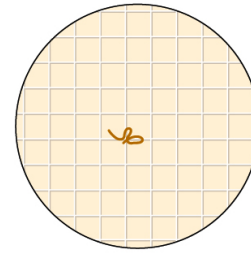
	water→cue	water→cue	water→cue	water→cue
swimming	No change	No change	No change	Decreased!
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	Asiatic <i>Elaphe rufodorsata</i>	English <i>Natrix natrix</i>	Spanish <i>Natrix maura</i>	Mallorcan <i>Natrix maura</i>

Genetic control of behavior

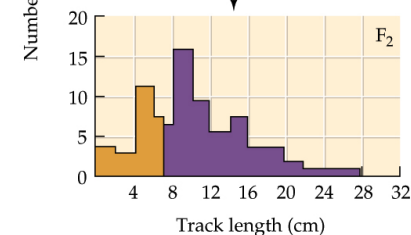
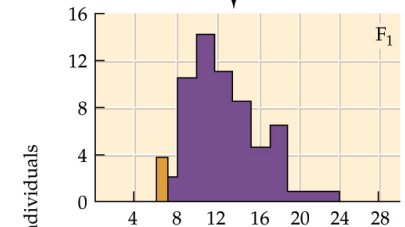


Single locus behavioral traits

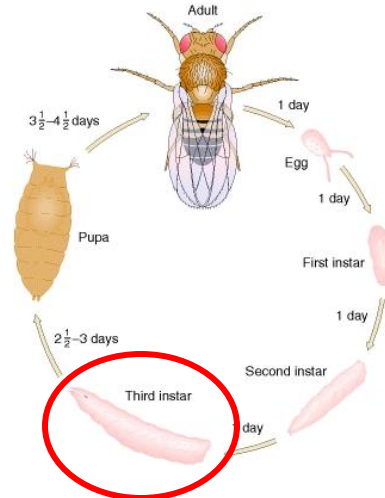
- Foraging of larvae regulated by *for* gene in *Drosophila*
- Two behavioral phenotypes: sitter and rover



×

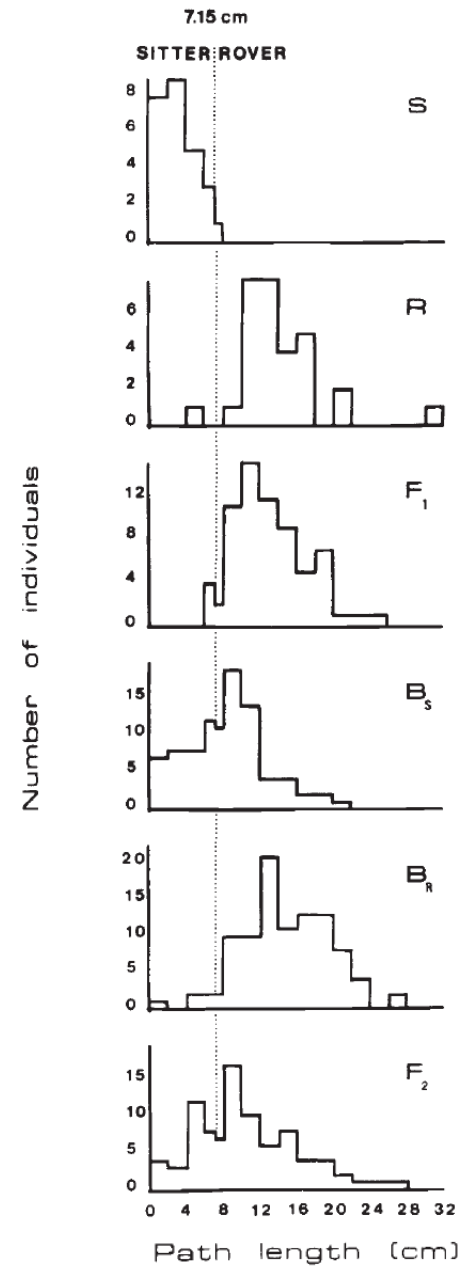
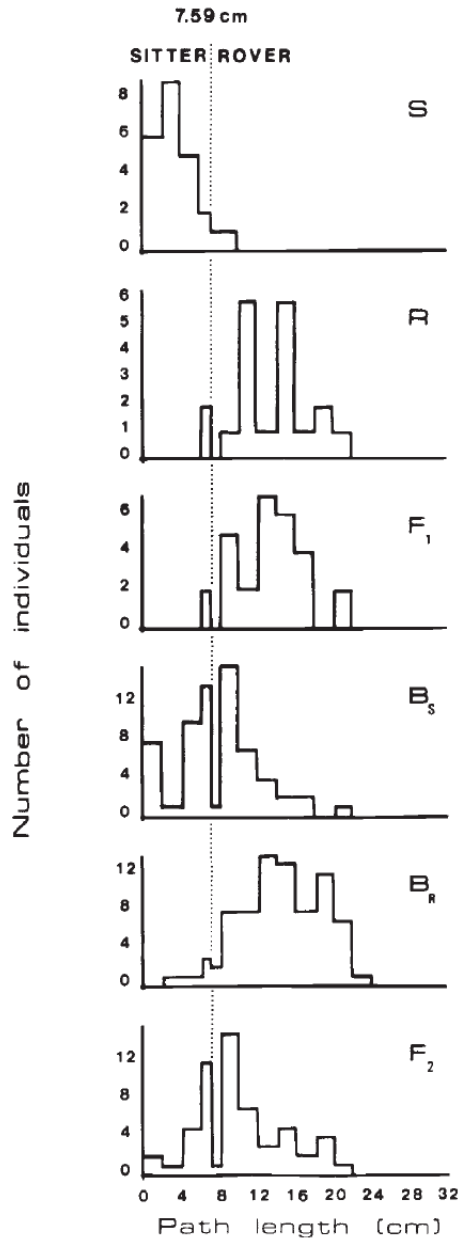


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Autosomes or sex chromosomes?



Polygenic behavioral traits

Honeybee larvae infected with American foulbrood



Hygienic behavior
consists of two
components:
uncap and remove



Polygenic behavioral traits

Hygienic bees × unhygienic bees = unhygienic F1

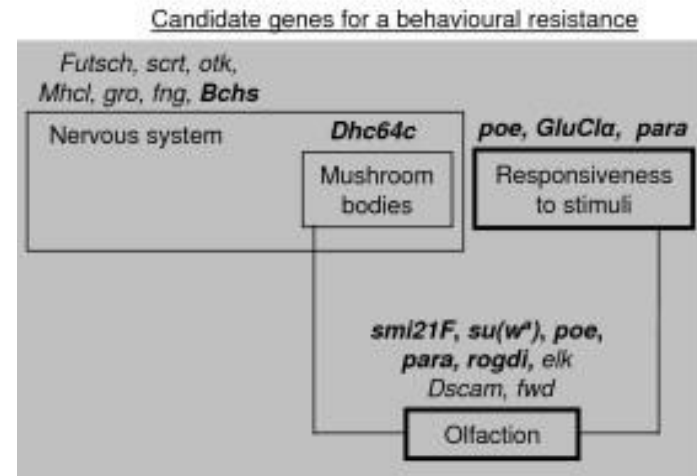


Dihybrid cross results in

- Hygienic bees that uncap and remove
- Bees that uncap, but not remove
- Bees that don't uncap, but will remove
- Unhygienic bees

What can we conclude?

More recent research suggests that several more genes may be involved



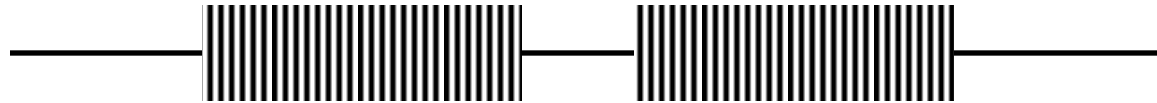
Polygenic behavioral traits

Phenotype of hybrids, backcrosses suggest polygenic inheritance

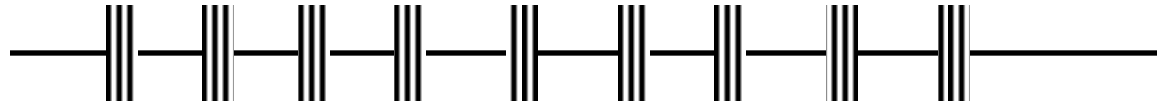


Teleogryllus sp.

commodus



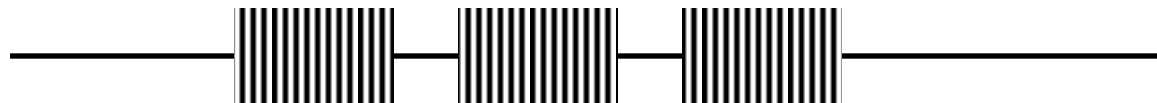
oceanicus



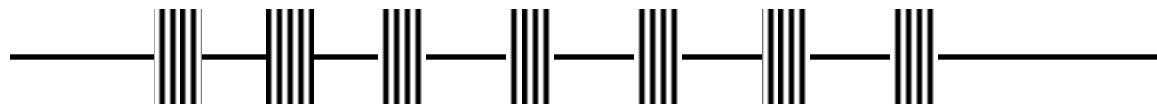
commodus x
oceanicus (F1)



commodus x
F1 backcross

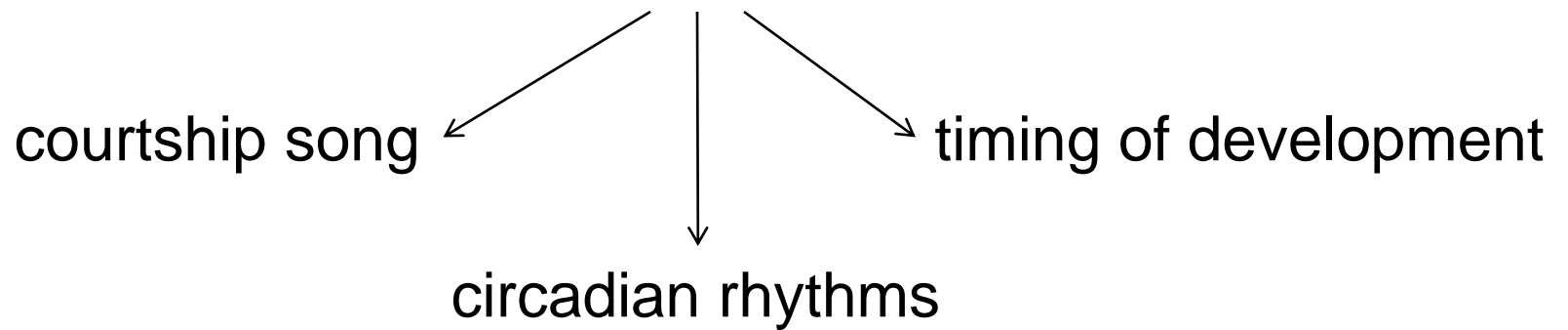
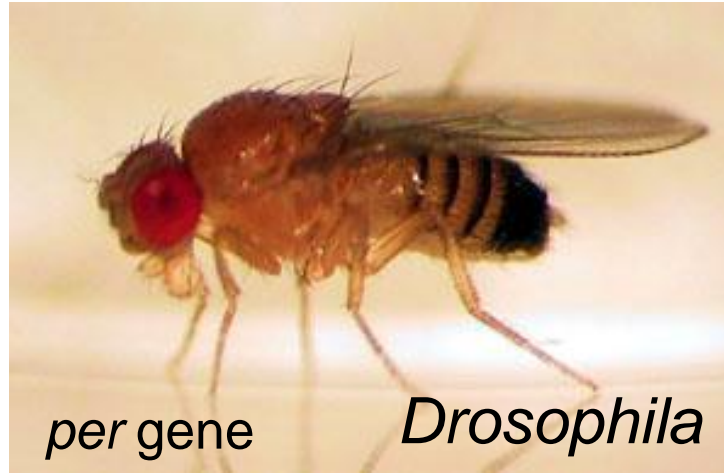


oceanicus x
F1 backcross



Recall our earlier mention of blending inheritance

Pleiotropic genes



Genes to behavior



pup odor integrated in hypothalamus

fosB activated in POA

FosB protein produced

FosB production alters POA neural circuits

result is maternal care

Inactivated *fosB* allele disrupts maternal behavior



How to identify genetic basis of behavior?

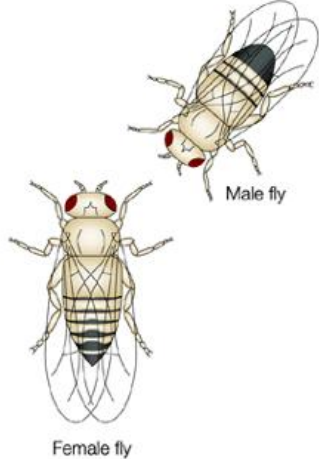
Forward genetics: identify genetic basis of phenotype
Reverse genetics: identify phenotype of particular gene



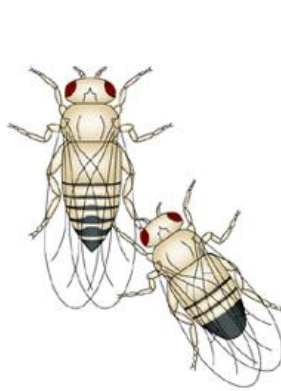
Classical forward genetics

Expose animals to mutagen → Isolate behavioral mutants → Locate using genetic marker

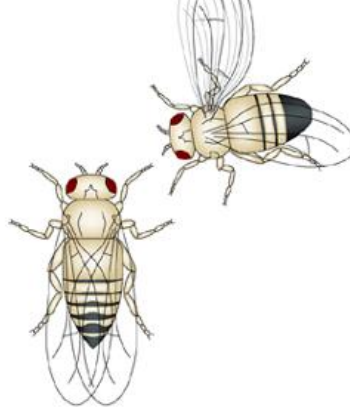
a Orienting



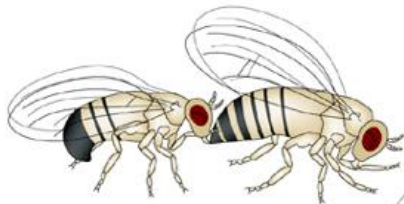
b Tapping



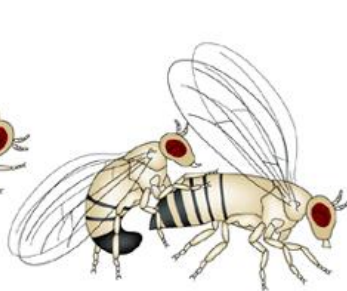
c 'Singing'



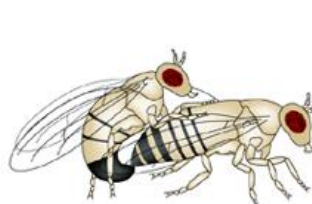
d Licking



e Attempting copulation



f Copulation



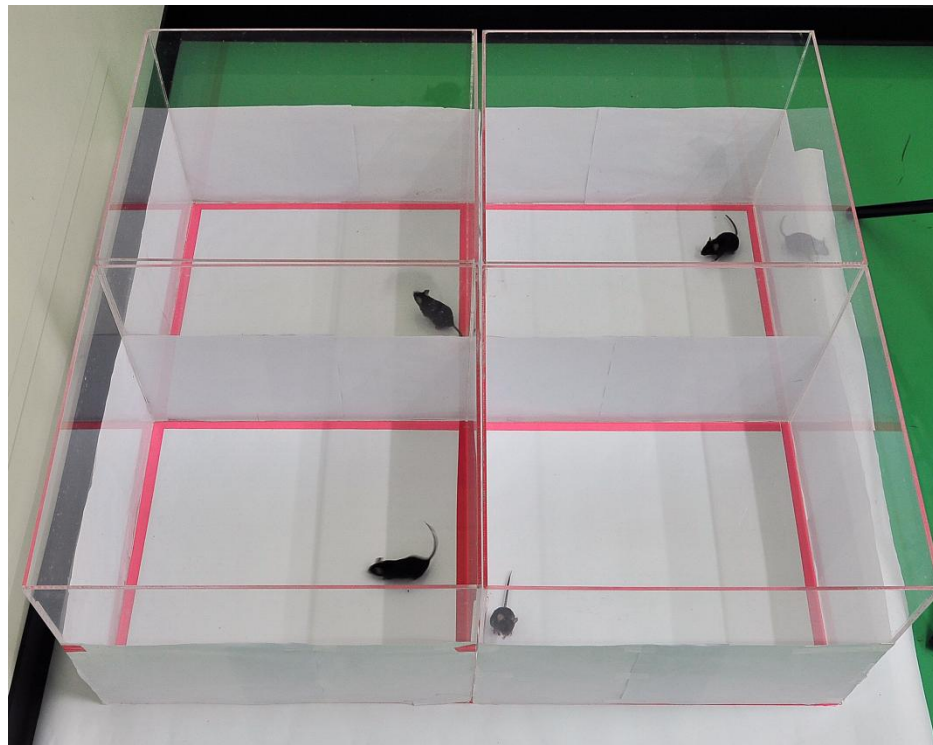
Drosophila courtship mutants include *fruitless*, *dissatisfaction*, *cacophony*, and *stuck*



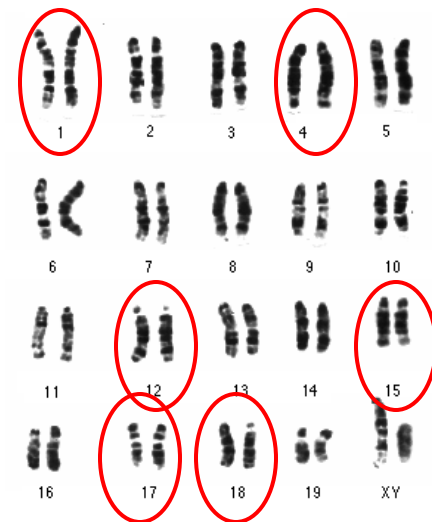
Jeff Hall '67

Quantitative trait loci (QTL) mapping

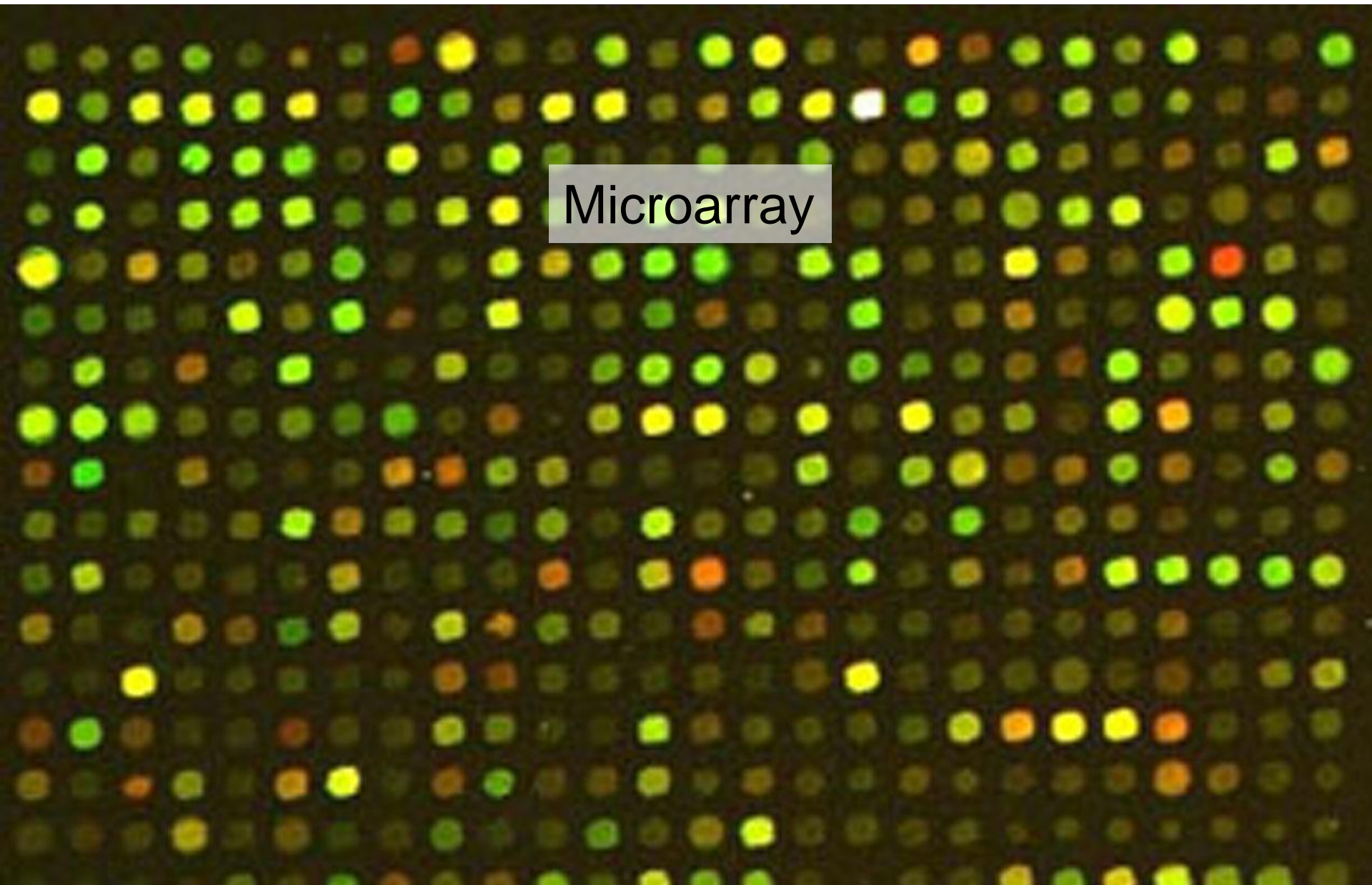
Polygenic behavioral traits follow continuous distribution
QTL co-occur with behavioral trait, inheritance can be traced



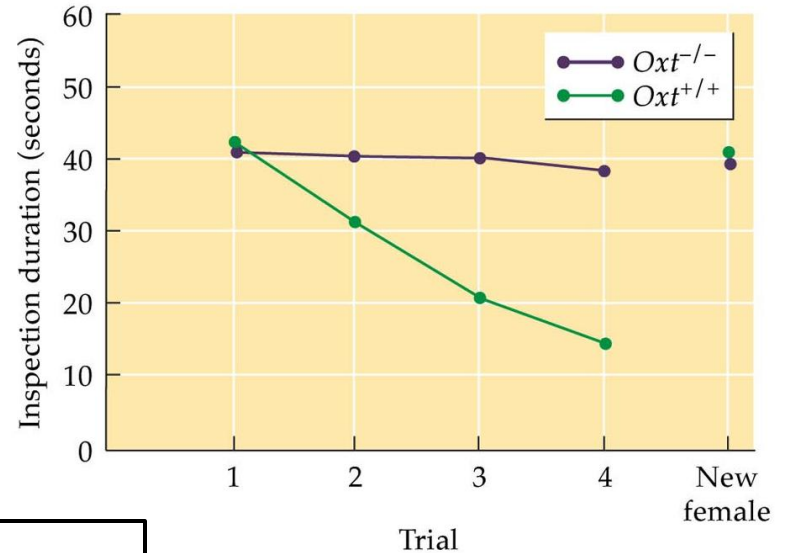
Results of QTL mapping for
fear in open-field tests



Reverse genetic approaches



Reverse genetic approaches



WT mother implanted with
blastocyst (contains both
WT and knockout cells)



FI includes chimera and WT offspring

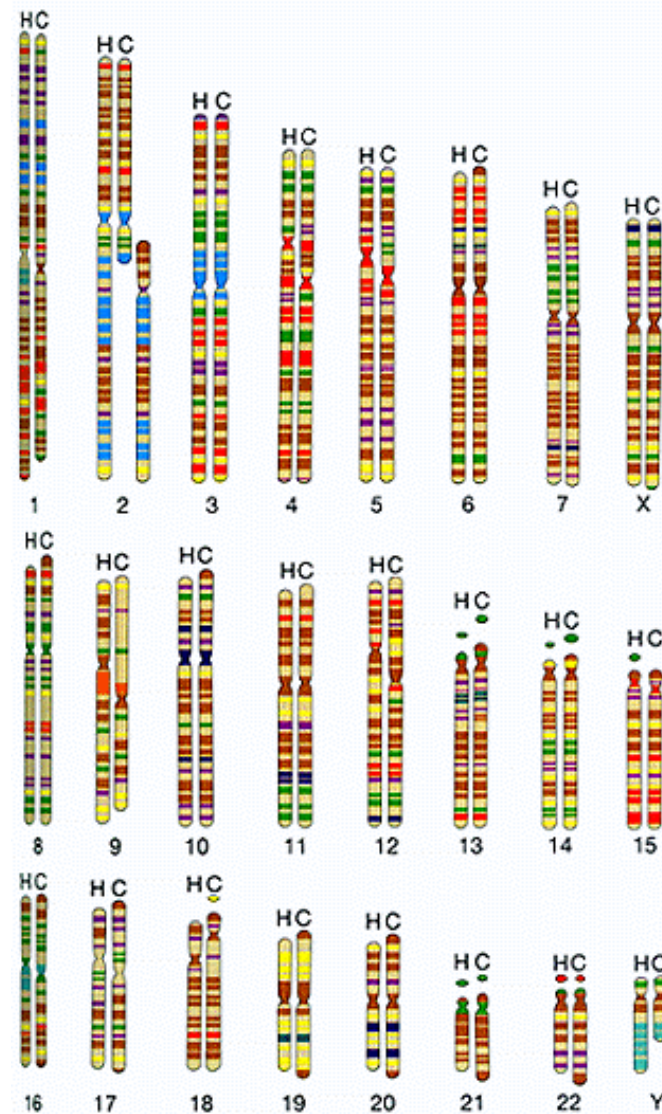


Selective breeding yields all knockout offspring



Social amnesia in mice

Genes or gene expression?



Behavior and gene expression

Age polyethism in honeybees



nurses: first 2-3 weeks



foragers: next 2-3 weeks

How to separate confounding effects of age and behavior?

Behavior and gene expression

