

Behavior genetics

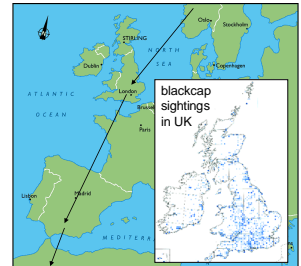


Migration of blackcap warblers

blackcap



Banding studies suggest UK blackcaps had different origin

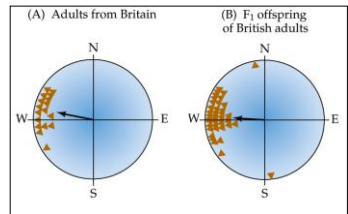
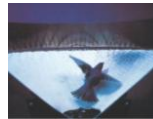


Possible explanation for winter sightings?

Migration of blackcap warblers



Migration of blackcap warblers



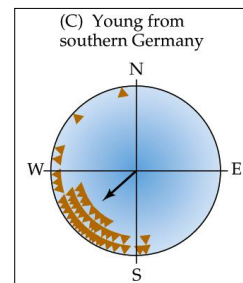
Migration of blackcap warblers

Why migrate to UK instead of Africa?



Migration of blackcap warblers

Novel migration route possibly due to relaxed genetic control?



Migration of blackcap warblers

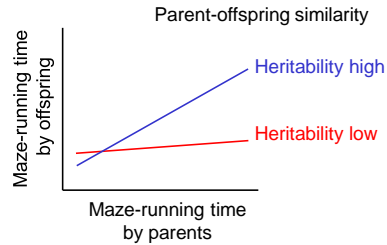
NW German migrants in 1960: 0%
NW German migrants in 1990: ~10%

How did this spread in the population?



Evidence of genetic basis of behavior

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



Heritability: a primer

$$h^2 = V_A/V_P$$

varies between 0 and 1

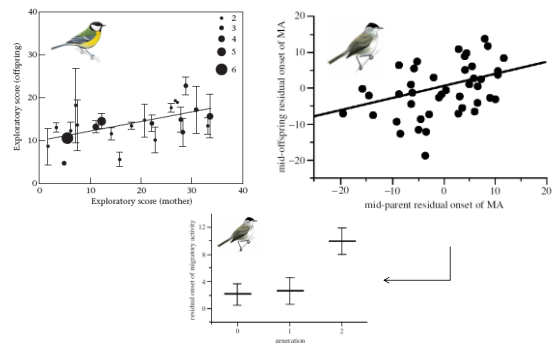
$$\frac{V_a}{2V_p} = \frac{1}{2}h^2$$

One parent - offspring formula

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

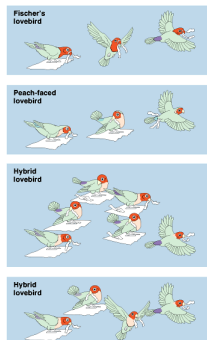
Mid-parent offspring regression

Parent-offspring similarity



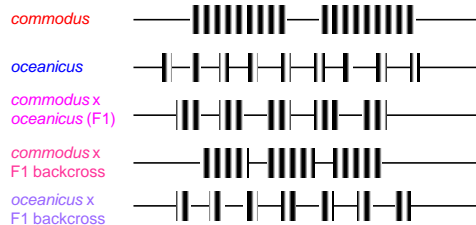
Hybridization

Hybrid phenotypes



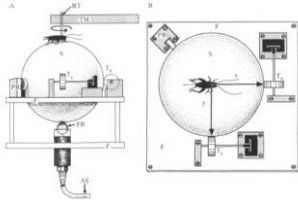
Hybridization

Song patterns in crickets

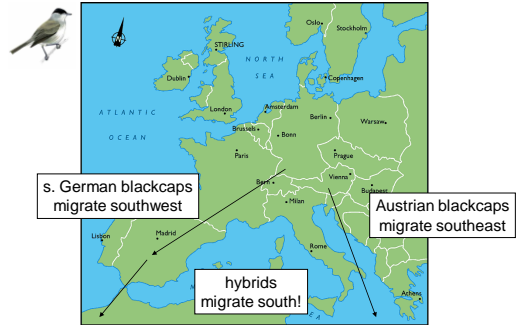


Hybridization

F1 females prefer F1 male song



Hybridization



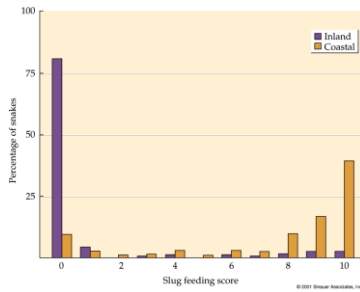
Testing for genetic effects

Common garden experiments
Reciprocal transplant experiments

Discussed in readings

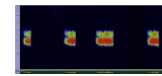


Food preferences in garter snakes



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

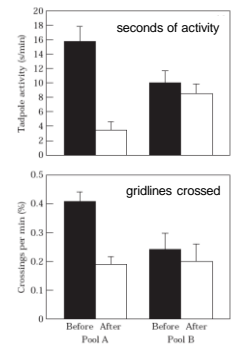


Pool A = snakes absent

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!
				
	Asianic <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)

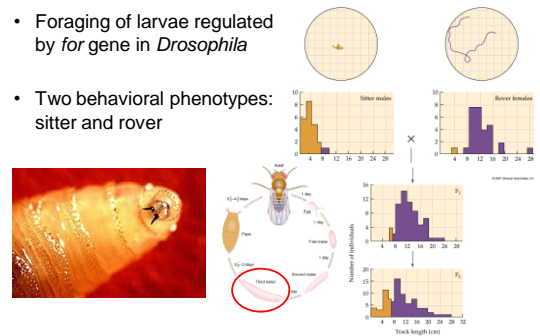
	water→cue	water→cue	water→cue	water→cue
swimming	No change	No change	No change	Decreased!
immobile	No change	No change	No change	Increased!
				
	Asianic <i>Elaphe rufodorsata</i>	English <i>Natrix natrix</i>	Spanish <i>Natrix maura</i>	Mallorcan <i>Natrix maura</i>

Genetic control of behavior

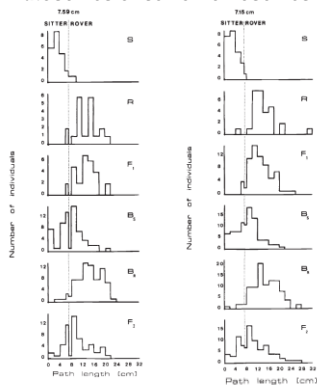


Single locus behavioral traits

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



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

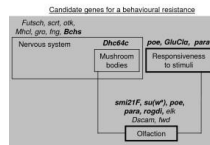


Dihybrid cross results in

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

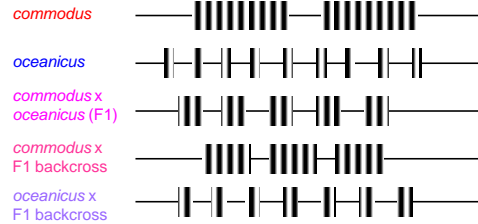
What can we conclude?

More recent research suggests that several more genes may be involved



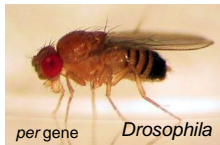
Polygenic behavioral traits

Phenotype of hybrids, backcrosses suggest polygenic inheritance



Recall our earlier mention of blending inheritance

Pleiotropic genes



courtship song → timing of development
circadian rhythms

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



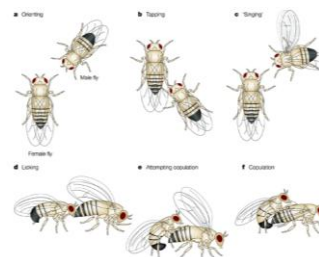
How to identify genetic basis of behavior?

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



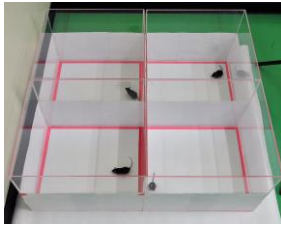
Drosophila courtship mutants include *fruitless*, *dissatisfaction*, *cacophony*, and *stuck*



Jeff Hall '67

Quantitative trait loci (QTL) mapping

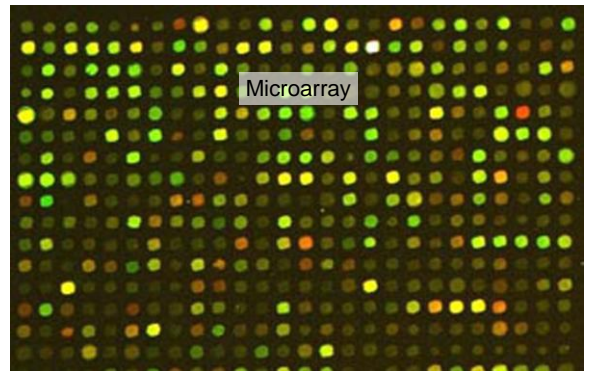
Polygenic behavioral traits follow continuous distribution
QTL co-occur with behavioral trait, inheritance can be traced



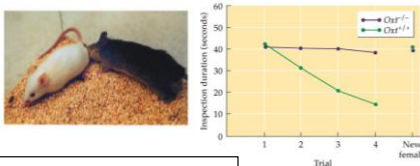
Results of QTL mapping for fear in open-field tests



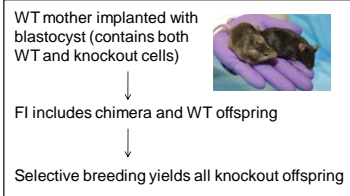
Reverse genetic approaches



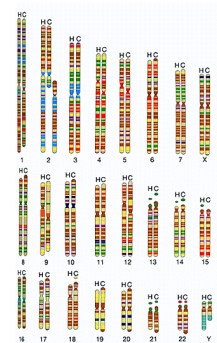
Reverse genetic approaches



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

