In the news

First superfast muscles in mammals help bats catch prey

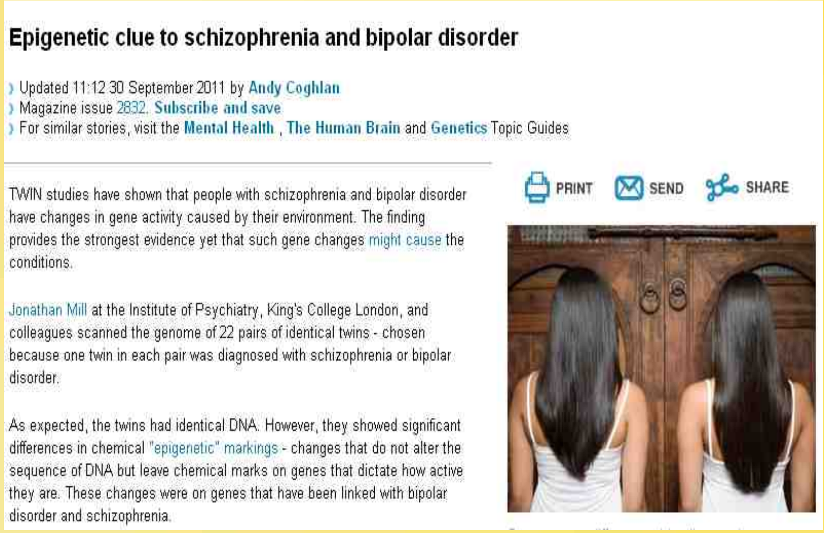
By Leila BattisonScience reporterDaubenton's bats produce a terminal buzz of up to 190 calls per second

Bats are able to locate their prey using echolocation produced by a special kind of "superfast" muscle, scientists have found.
These specially adapted muscles can contract 100 times quicker than most of the muscles in human bodies.

As the bat approaches its prey target, the frequency of calls increases up to about 190 calls per second, creating what is known as the "terminal buzz".
Such rapid contractions made these "superfast muscles", a type of muscle which has previously only been seen in the sound-making organs of rattlesnakes, the humming Oyster Toadfish, and many songbirds.

In the news

Epigenetic clue to schizophrenia and bipolar disorder
scanned the genome of 22 pairs of identical twins - chosen because one twin in each pair was diagnosed with schizophrenia or bipolar disorder.


Epigenetic clue to schizophrenia and bipolar disorder

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TWIN studies have shown that people with schizophrenia and bipolar disorder have changes in gene activity caused by their environment. The finding provides the strongest evidence yet that such gene changes might cause the conditions.

Jonathan Mill at the Institute of Psychiatry, King's College London, and colleagues scanned the genome of 22 pairs of identical twins - chosen because one twin in each pair was diagnosed with schizophrenia or bipolar disorder.

As expected, the twins had identical DNA. However, they showed significant differences in chemical "epigenetic" markings - changes that do not alter the sequence of DNA but leave chemical marks on genes that dictate how active they are. These changes were on genes that have been linked with bipolar disorder and schizophrenia.

the most significant differences, with variations of up to 20 per cent in the amount of methylation, were in the promoter "switch" for a gene called ST6GALNAC1, which has been linked with schizophrenia
One gene, called ZNF659, showed over-methylation in people with schizophrenia and under-methylation in those who were bipolar, suggesting that the conditions might result from opposing gene activity
"We know these disorders are related, and there are clinical features shared by both," says Mill. "But our scan suggests there are some genes that might be overactive in one disease and underactive in the other."

In the news

'Autistic' mice created – and treated
...they engineered mice to lack a gene called Cntnap2, which had already been implicated in autism. Cntnap2 is the largest gene on the genome, clocking in at 2.5 million bases, and is responsible for regulating brain circuits involved in language and speech.
were less vocal and less social, grooming was "wild almost to the point of self-injury", says Geschwind. These three symptoms are the ones normally used to diagnose autism in humans.
Next, Geschwind and his team tested a drug approved by the US Food and Drug Administration to treat repetitive behaviour and aggression in people with autism. Risperidone, originally used to treat psychosis, worked on the mice in much the same way it does in humans.

The treated mice were less hyperactive, but still avoided interaction with others. "[The drug] didn't touch the social behaviours,"

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Ethology: topics

1) Roots of ethology: from Darwin to behavourism
2) Classical ethology: perception, elementary reactions, pre-wired learning, Behavioural ecology approach: optimalisation, game theory
3) Neural and genetic control of behaviour (biological rhythms, CPG, simpler networks)
4) Genetics and evolution of behaviour, evolution of communication
5) Spatial navigation, cognition
6) Evolution of social behaviour, cooperation and conflict
7) Parental investment, Systems of reproduction

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Outline

Illustrate

- That genetic variaton does exist
- Natural or artificial selection are efficient

Communication

- Theoretical background
- Reconstruction of steps of changes (How?)
- Understanding the causes (Why?)

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Behaviour genetics

Behaviour has been shaped by evolution (Darwin)
Should have heritable components

Can be studied by comparing

•Species (species-specific behaviour, hybrids)

•Populations (natural populations, genetic selection)

•Individuals (individual variations, isolating mutants)

Recently:

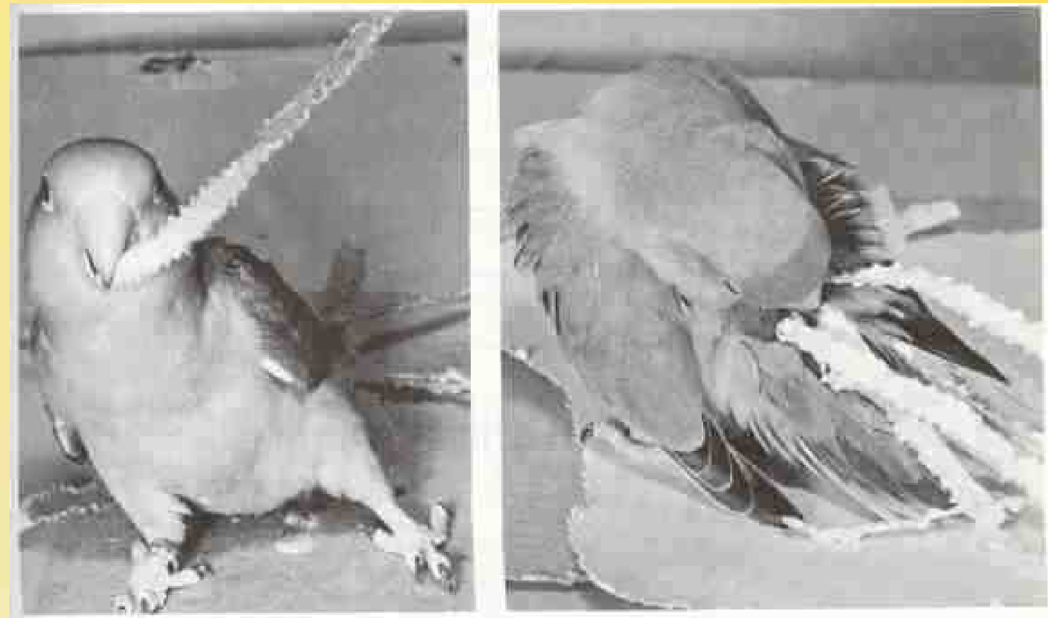
•Tracing natural selection (identified lineages by DNA)

•Identification of genes and their function (mapping, knocking out, switching on and off, expression patterns)

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Species hybrids

Carrying of nest material in lovebirds



4 **Lovebird, *Agapornis roseicollis*,** the species that transports nest material in its feathers. Photograph courtesy of William Dilger.

Agapornis roseicollis: short strips tucked into feathers on the back

Agapornis fisheri: long strip in the bill

Peter Kabai
www.behav.org
peter.kabai@gmail.com

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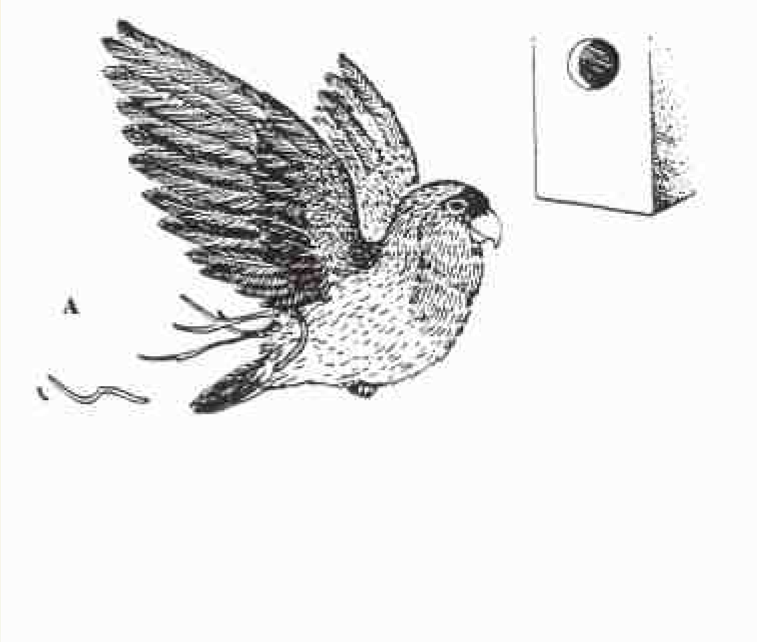


Hybrid lovebird

Hybrids tuck strips into feathers, but lose them when flying

One action is missing: shaking the strips into feathers

Following lots of unsuccessful attempts hybrids learn

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Hybrids

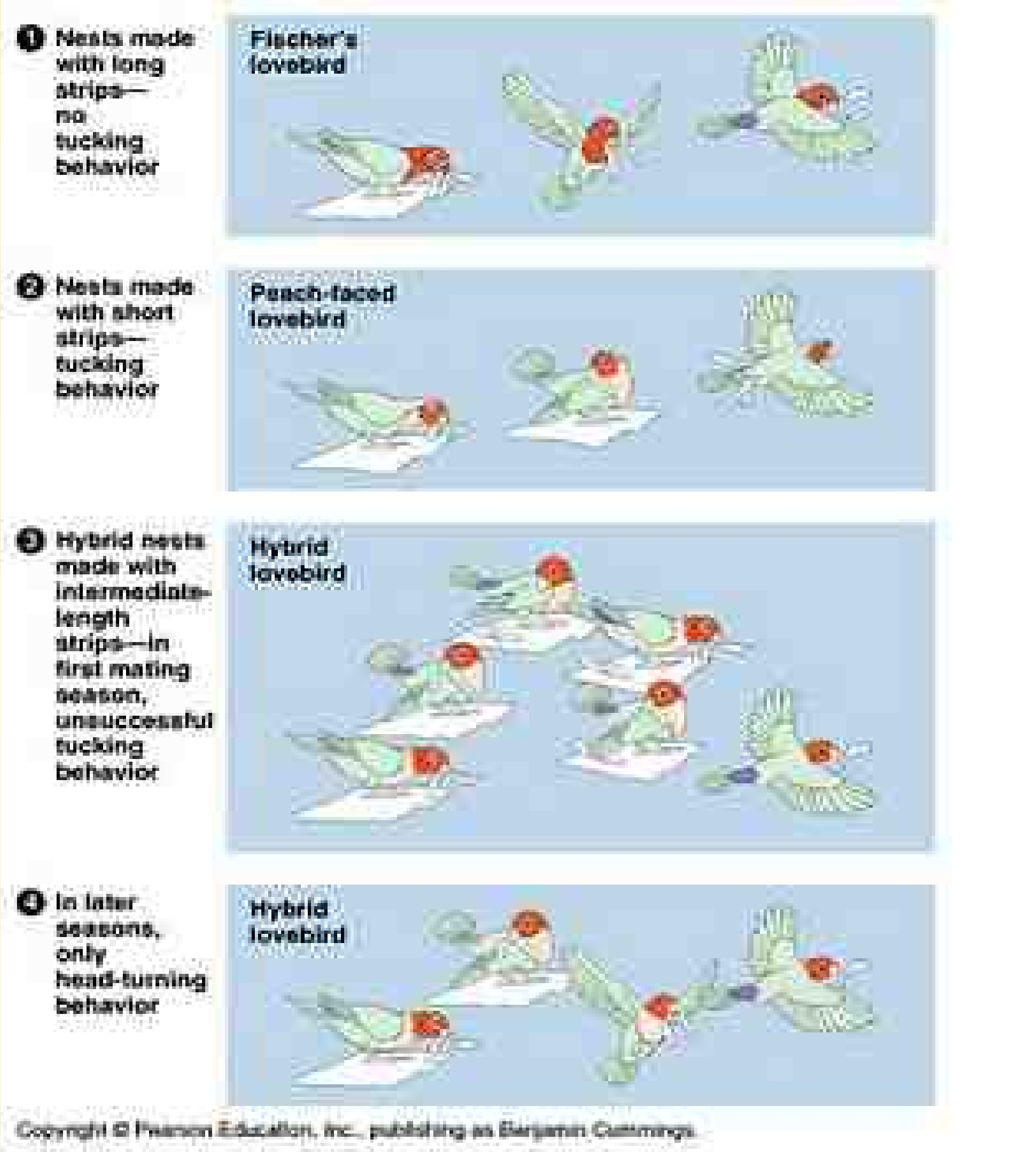
Learn to carry strips in bill, however,

they still turn their head back

Behaviour is built from elements

Unlearned behaviour is modified by experience

Some elements can not be changed or dropped



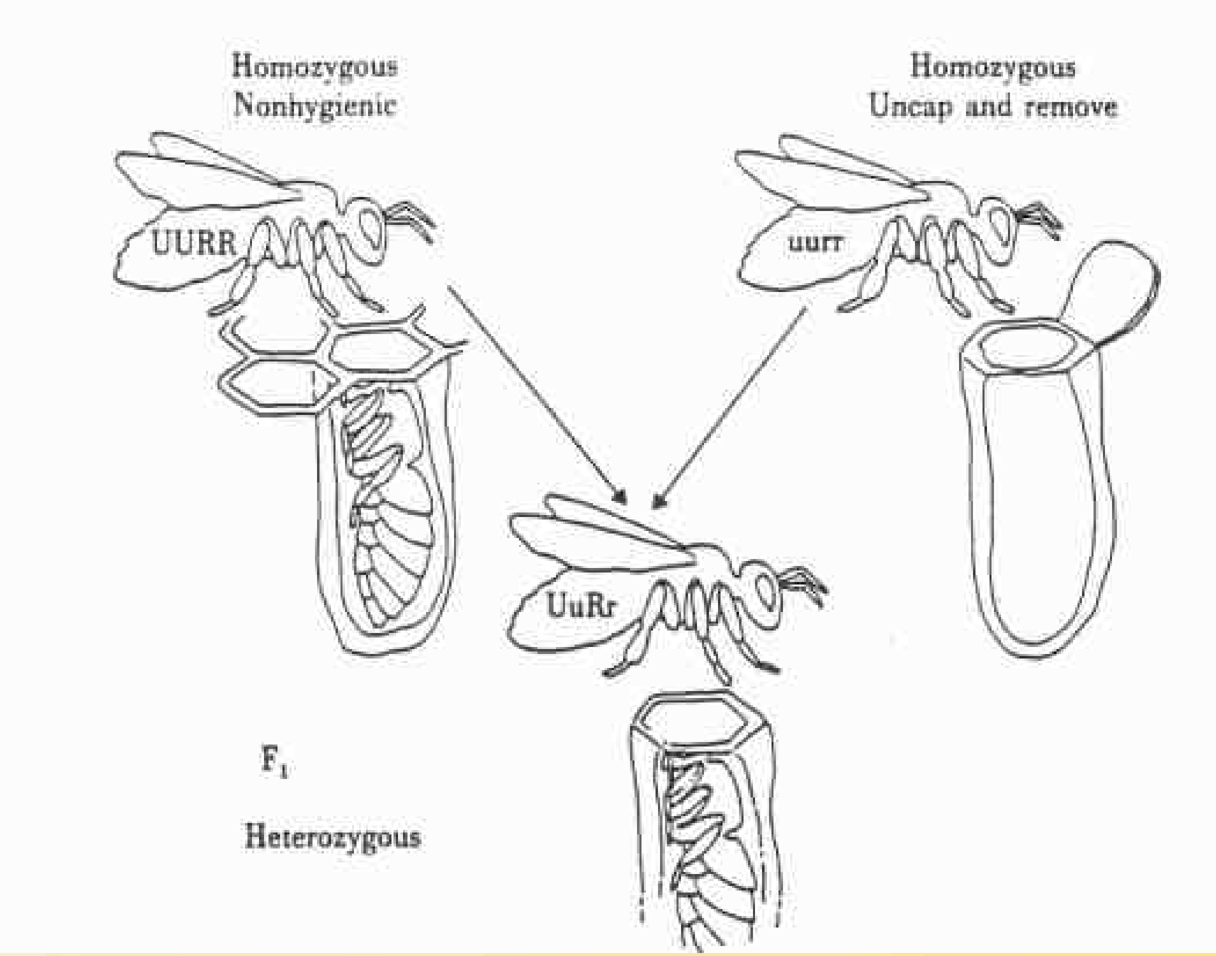
Comparing populations

Bacillus larvae infection kills larvae

Hygienic bee

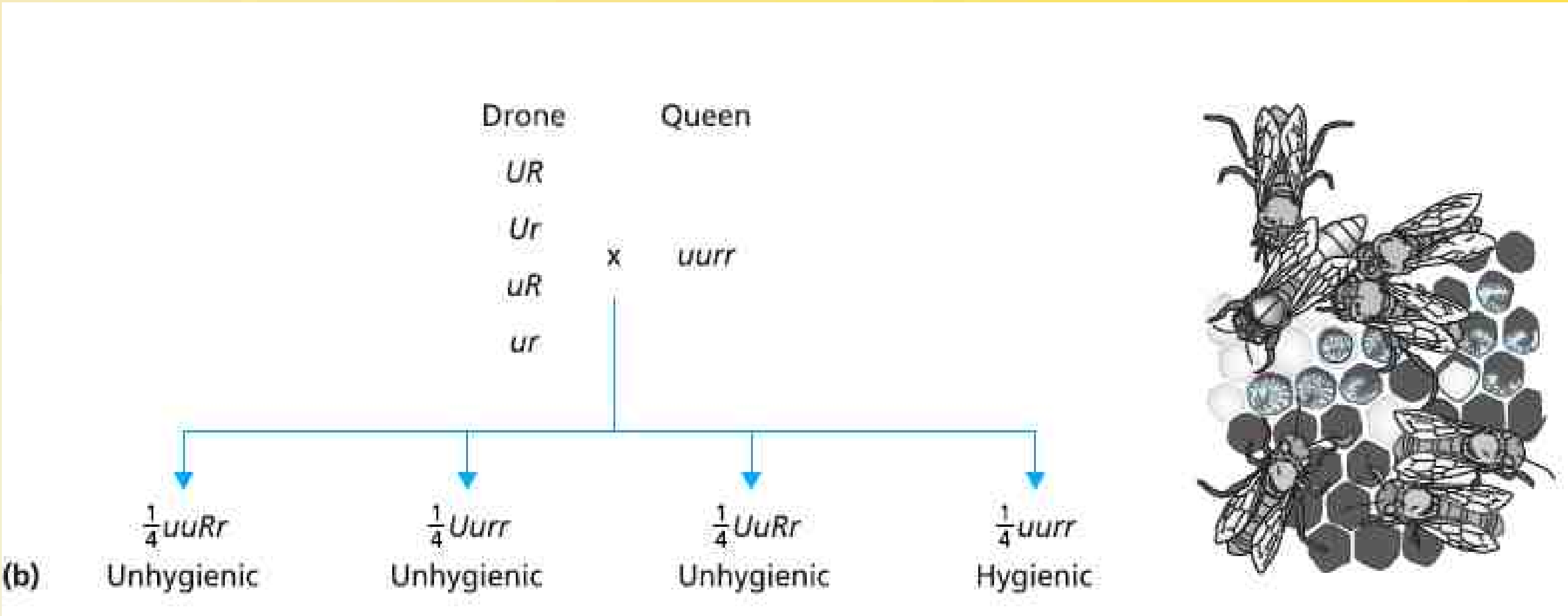
1. uncap the cell
2. remove larva

Nonhygienic: dead larvae are not removed



F1 hybrid is nonhygienic

Peter Kabai
www.behav.org
peter.kabai@gmail.com



¼ hygienic (Rothebuhler, 1964)

A closer look at backcross

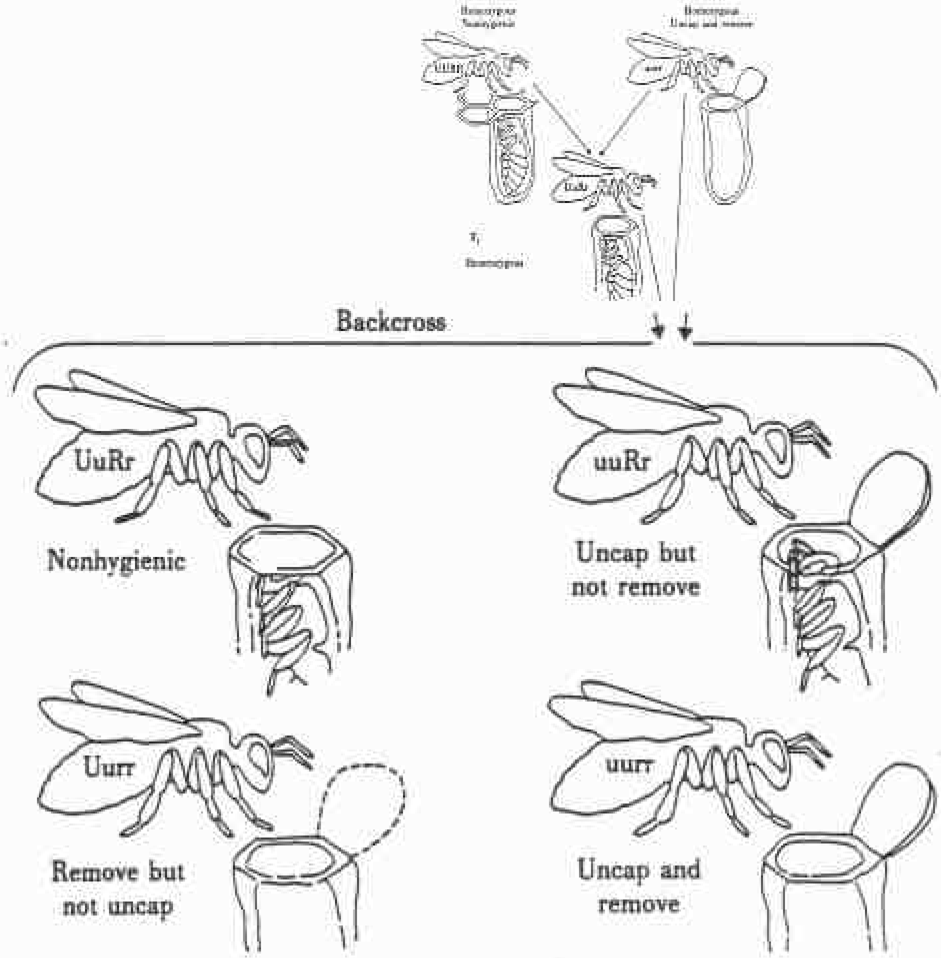
¼ nonhygienic

¼ uncap but not remove

¼ remove but not uncap

¼ uncap and remove

2 genes, 2 alleles ?



2 genes, 2 alleles ???

Gramacho and Spivak (2003) Behav Ecol Sociobiol (2003) 54:472–479

Compared behaviour and olfaction (electroantennogram) of hygienic and nonhygienic bees

Hygienic finds dead larvae faster, perceives odour better

Uncappers have higher olfactory threshold

2 genes, 2 allels ???

1) Work sharing (Arathi and Spivák, 2001, Anim. Behav.)

Four colonies: 0, 25, 50, 100% hygiyenic bees
many hygienic (50-100%): most bees only uncap, others remove
few hygienic: uncap and remove

Conclusion: hygienic behaviour is influenced by social environment

2) 3 loci (Oxley et al. 2010) explaining 30% of variance

2 loci in uncapping

1 locus in rremoval

+ 4 candidate genes:

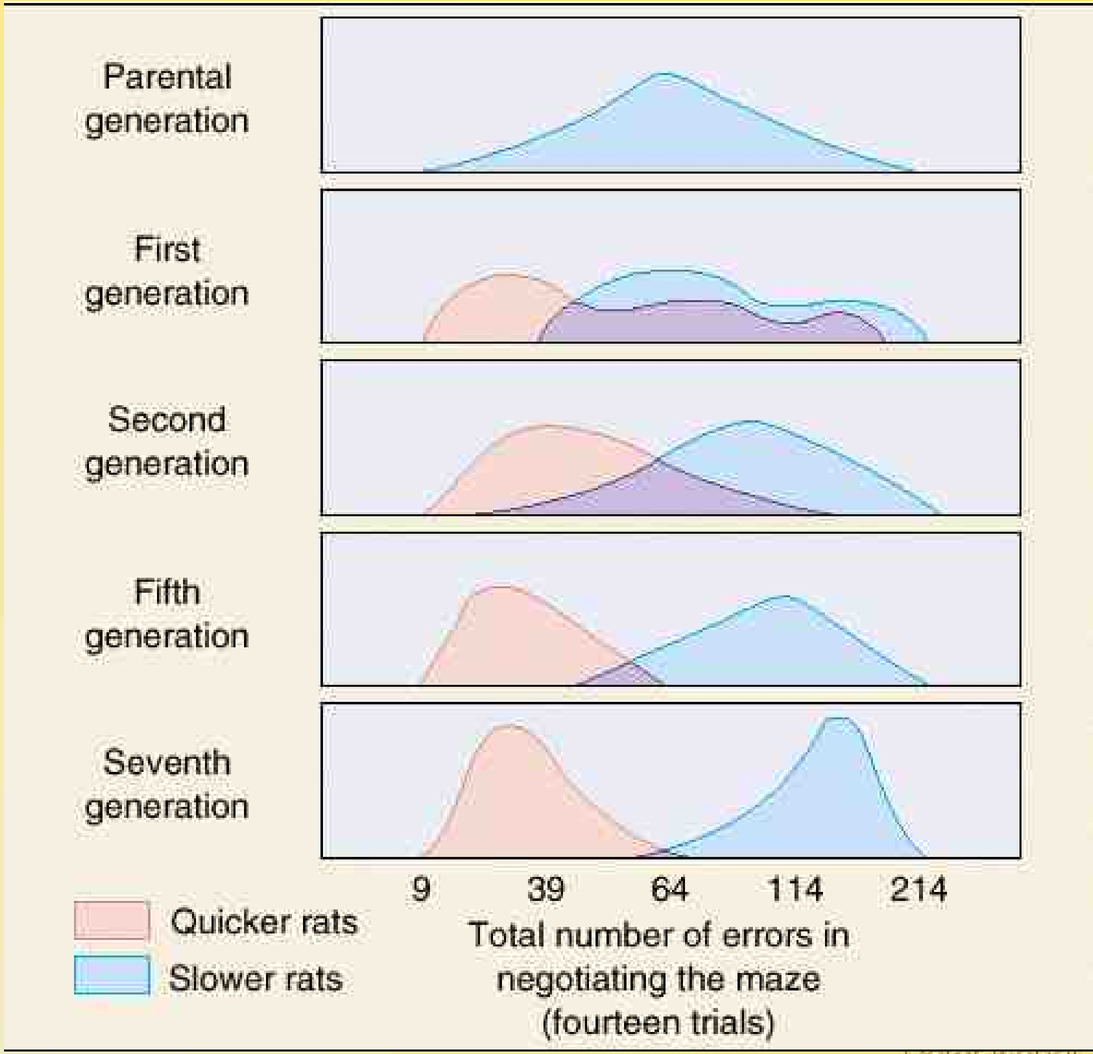
olfaction, learning, social, circadian

(larvae were killed by pin) ->

Genetic selection for behaviour

Tryon 1940
Selection for performance in multiple T-maze

by generation 7 significant difference between „maze bright” and „maze dull” lines



Peter Kabai
www.behav.org
peter.kabai@gmail.com

Genetic selection for behaviour

Tryon interpretation: difference in „general learning ability”

However, when setup was modified (e.g. Negative reinforcement) differences vanished or even were reversed)

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Gene x environment interaction

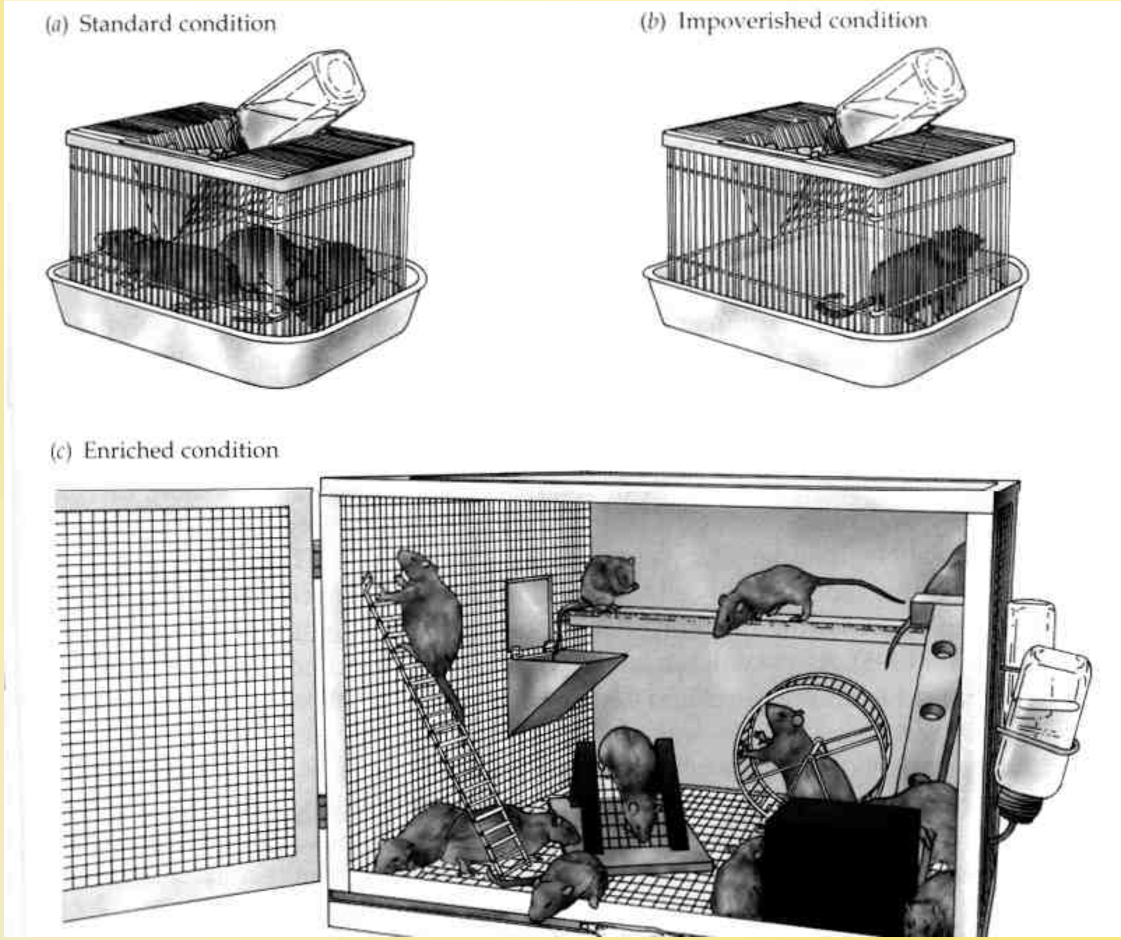
Cooper and Zubeck, 1958.

3 treatments of both lines

a) Standard

b) Restricted environment

c) Enriched environment



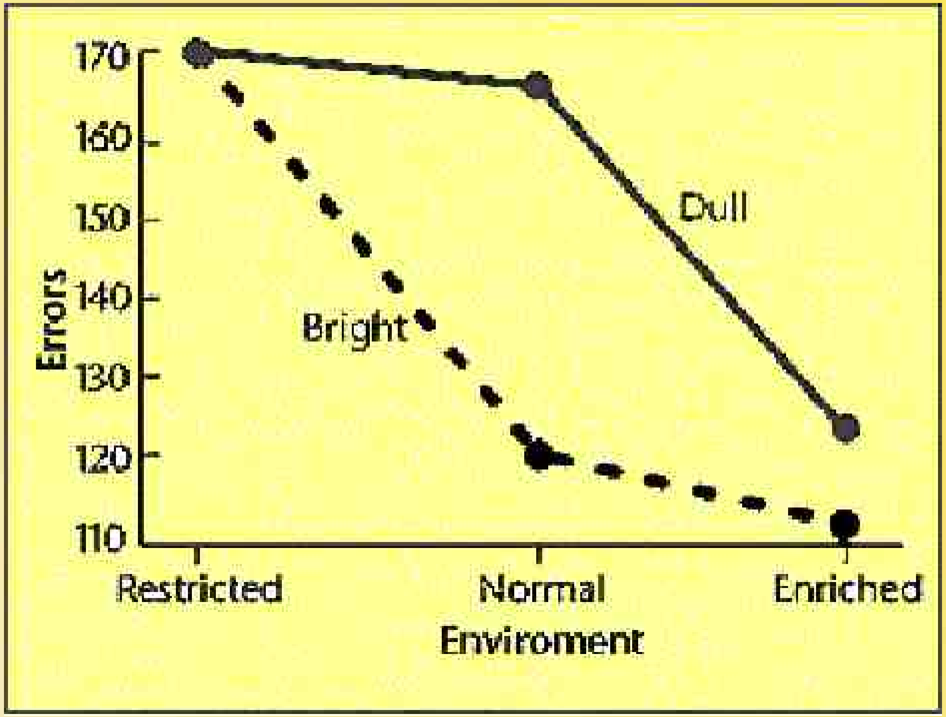
Peter Kabai
www.behav.org
peter.kabai@gmail.com

Artificial selection for behaviour

Bright rats behave dull if reared in impoverished environment

Dull rats enlighten in enriched

Interaction between genes and environment



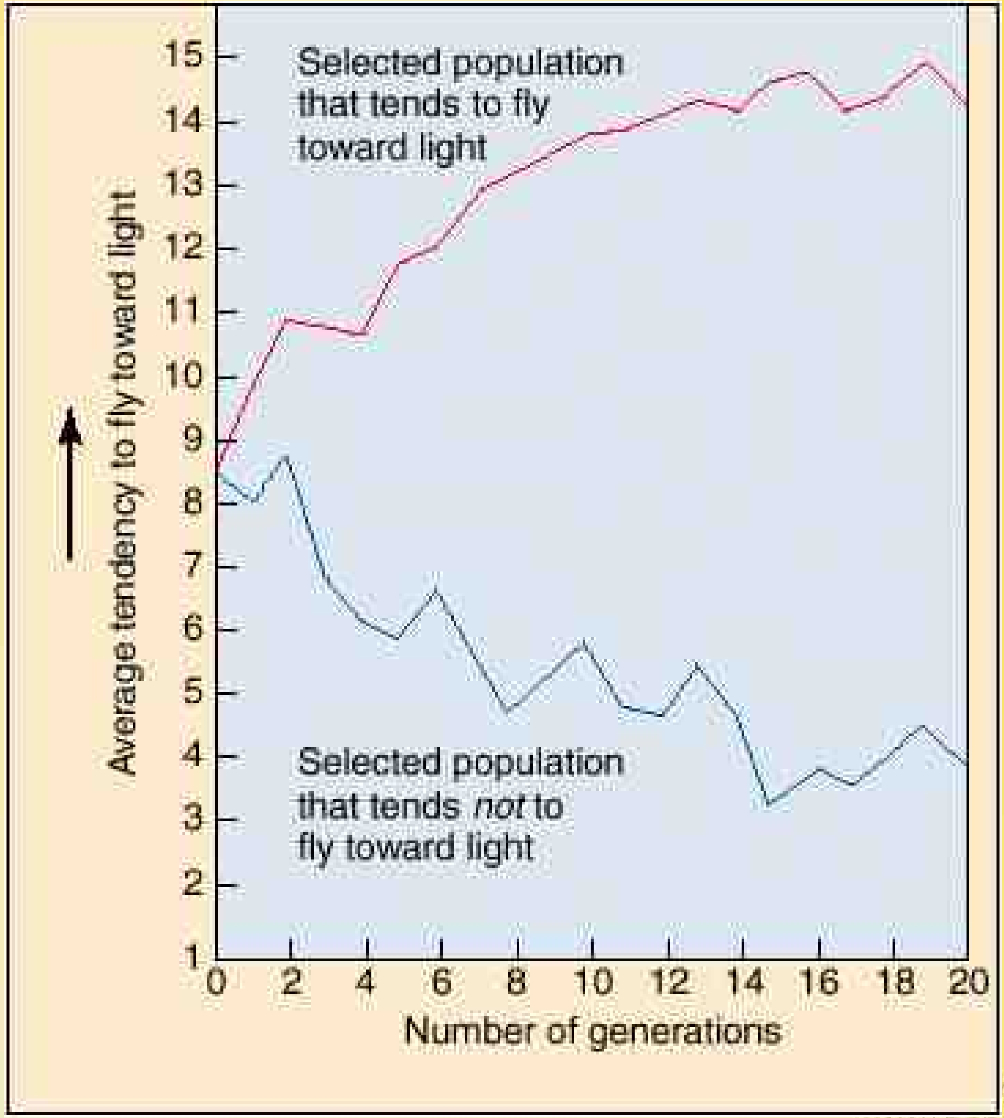
Alcohol preference of bright rats is stronger than that of a strain selected for alcohol preference! Amit and Smith, 1992, Psychopharm

Novelty seeking, stress, neophoby? Emotionality, important in us too

Peter Kabai
peter.kabai@gmail.com

Artificial selection for behaviour

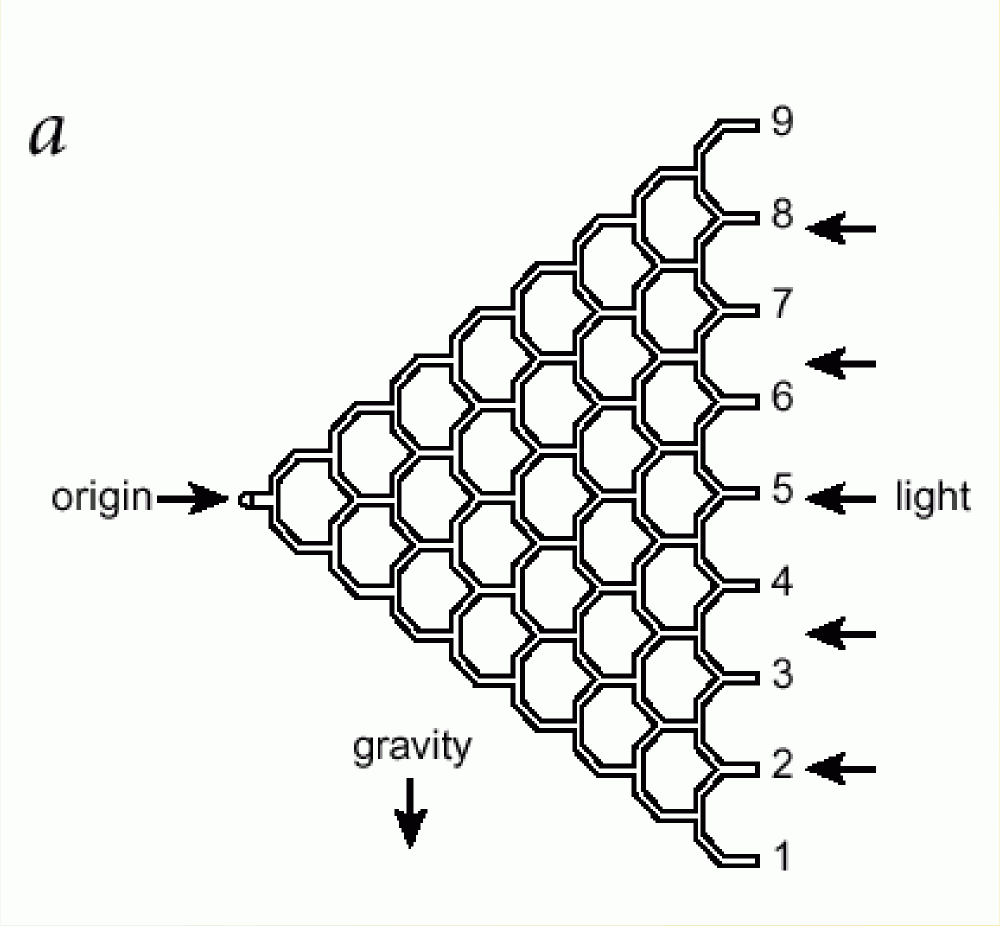
Drosophila (phototaxis, geotaxis, courtship, motor activity, learning ability and much more)

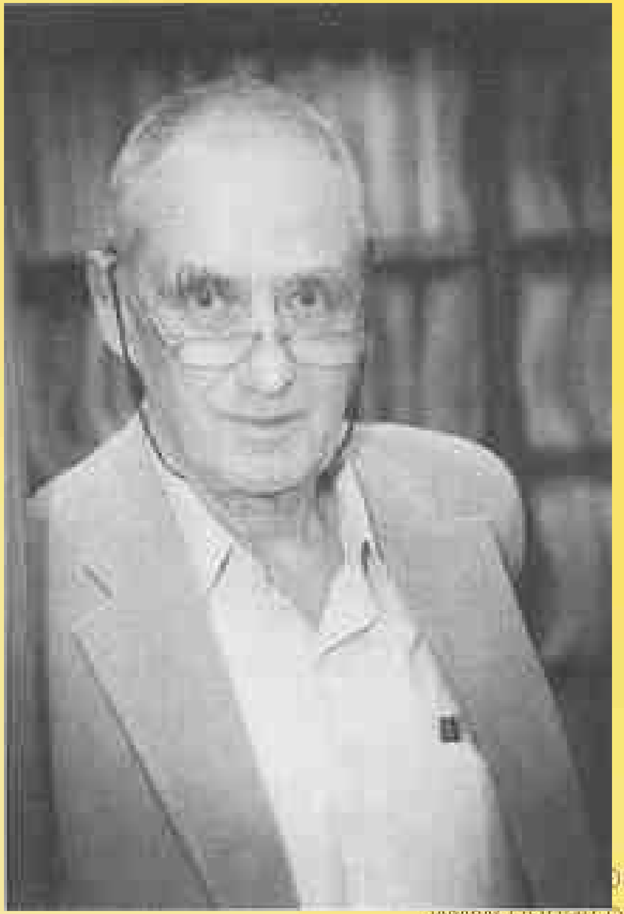


Kabai
www.behav.org
peter.kabai@gmail.com

Artificial selection for behaviour

Geotaxis Jerry HIRSCH 1922 - 2008





Artificial selection for behaviour

Geotaxis: Toma, … Jerry Hirsch… (2002) Nature Genetics

Genexpression patterns in the 2 lines were different: after lots of filtering: 3 major genes in geotaxis

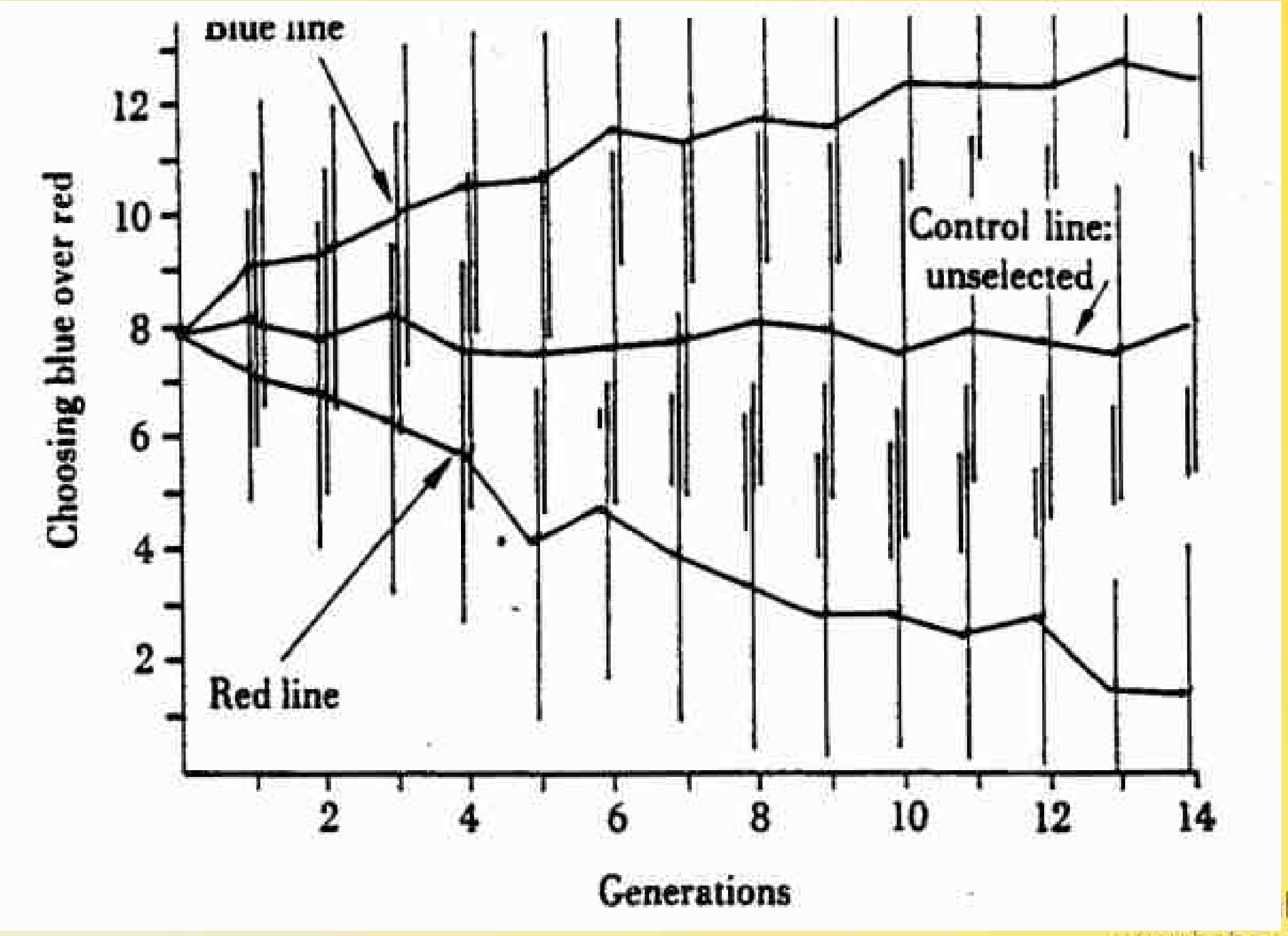
Two genes in circadian rhythm (*cryptochrome* 9 és a *Pigment-dispersing factor)*
One gene for nervous development (*Pendulum)*

Debate between Benzer and Hirsch:
Benzer: one gene – one behaviour
Hirsch: should be more complex

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Artificial selection for behaviour

Selection for colour preference in Japanese quail (J.K. Kovach)



bai
www.behav.org
peter.kabai@gmail.com

Directing and stabilising selection

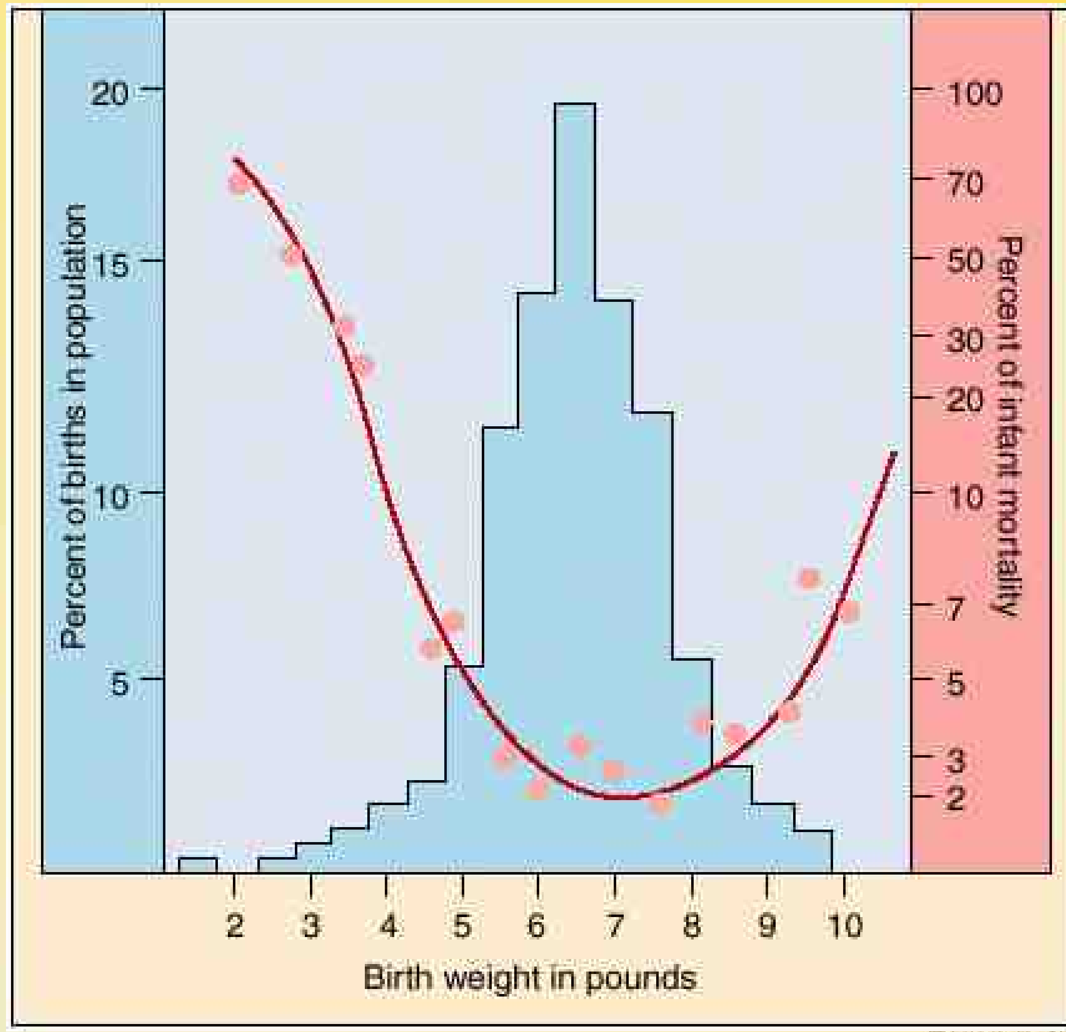
Directing selection

1. Trait in population changes in one direction

Body and brain size in homo lineage increased

Stabilising selection trait does not seem to change

Traits should change in synchrony
Evolution is slow...



Reasons of genetic variation

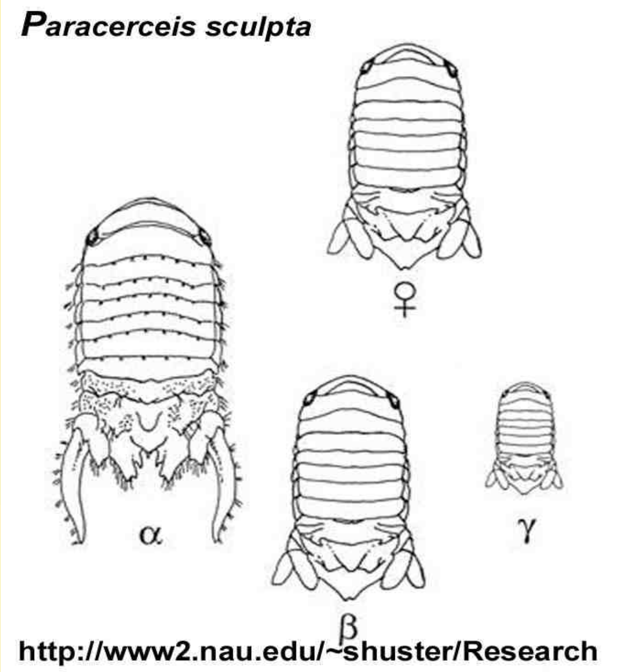
1) (New mutations constantly arise – but are wiped out by cleansing selection)

2) Distinct alternative tactics

3) Phenotype can be controled by opposing genetic factors, more than one optima

4) Environment may change, adaptation can be slow

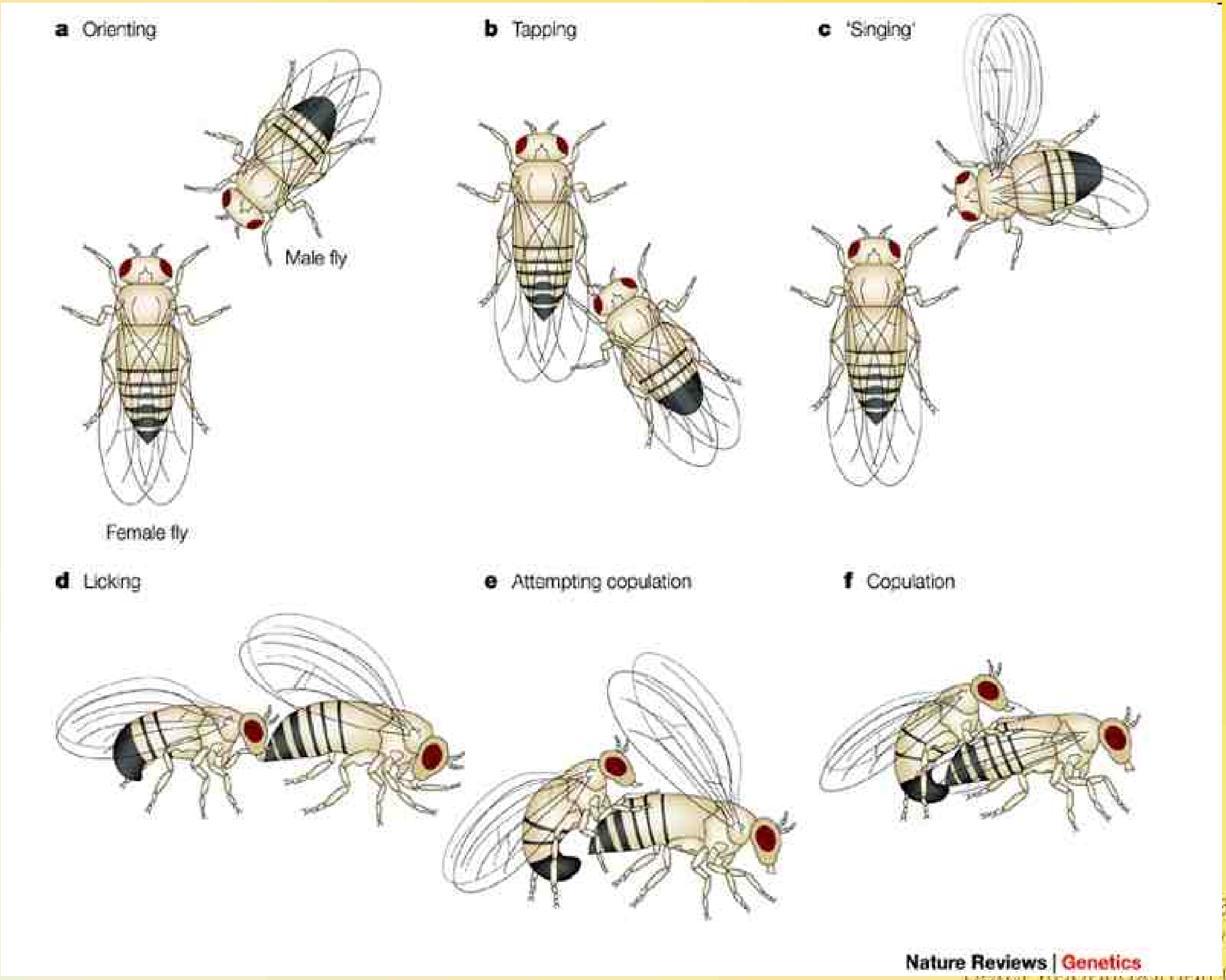
5) Different phenotypes in a group can be beneficial e.g. ADHD: hunters among farmers (Williams and Taylor 2006.)



Peter Kabai
www.behav.org
peter.kabai@gmail.com

Isolation of mutants

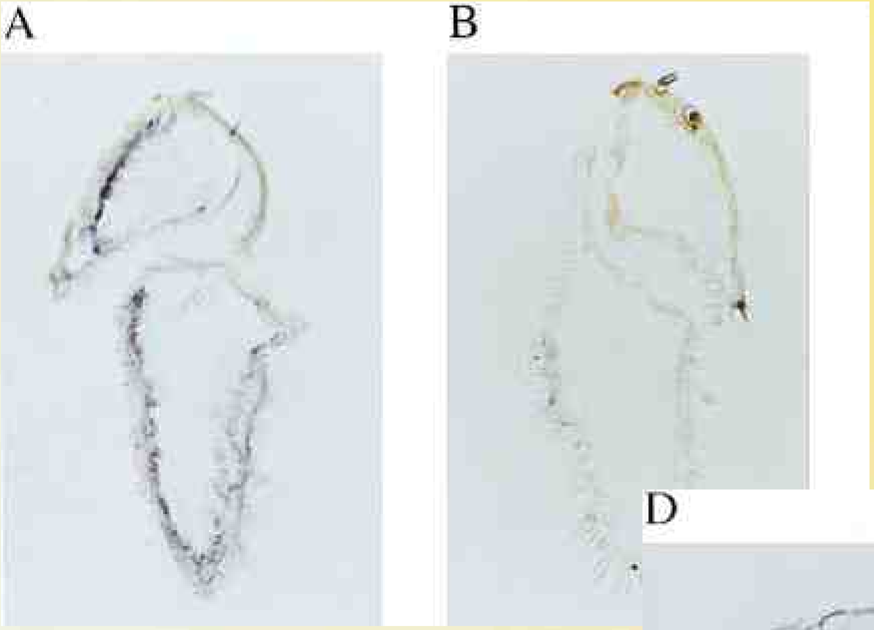
Drosophila:
- hundreds of behavioural mutants (circadian, learning, courting etc. stb.)

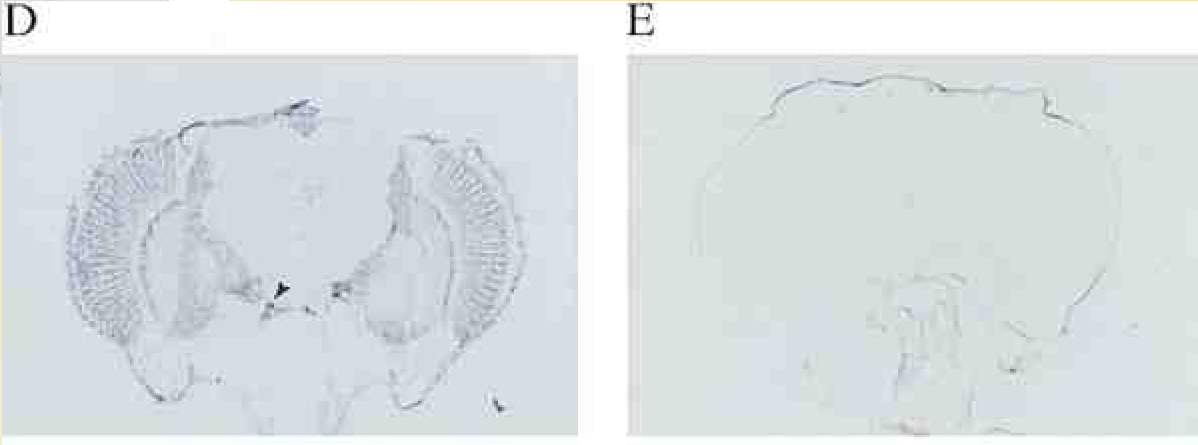


Behavioural mutants

Qtc (quick to court): males court virgin females and even males. Geneproduct in antennae (A) and CNS (D).

Gainesa et al (2000) Genetics **154:** 1627–1637





Behavioural mutants

Dissatisfaction (dsf)

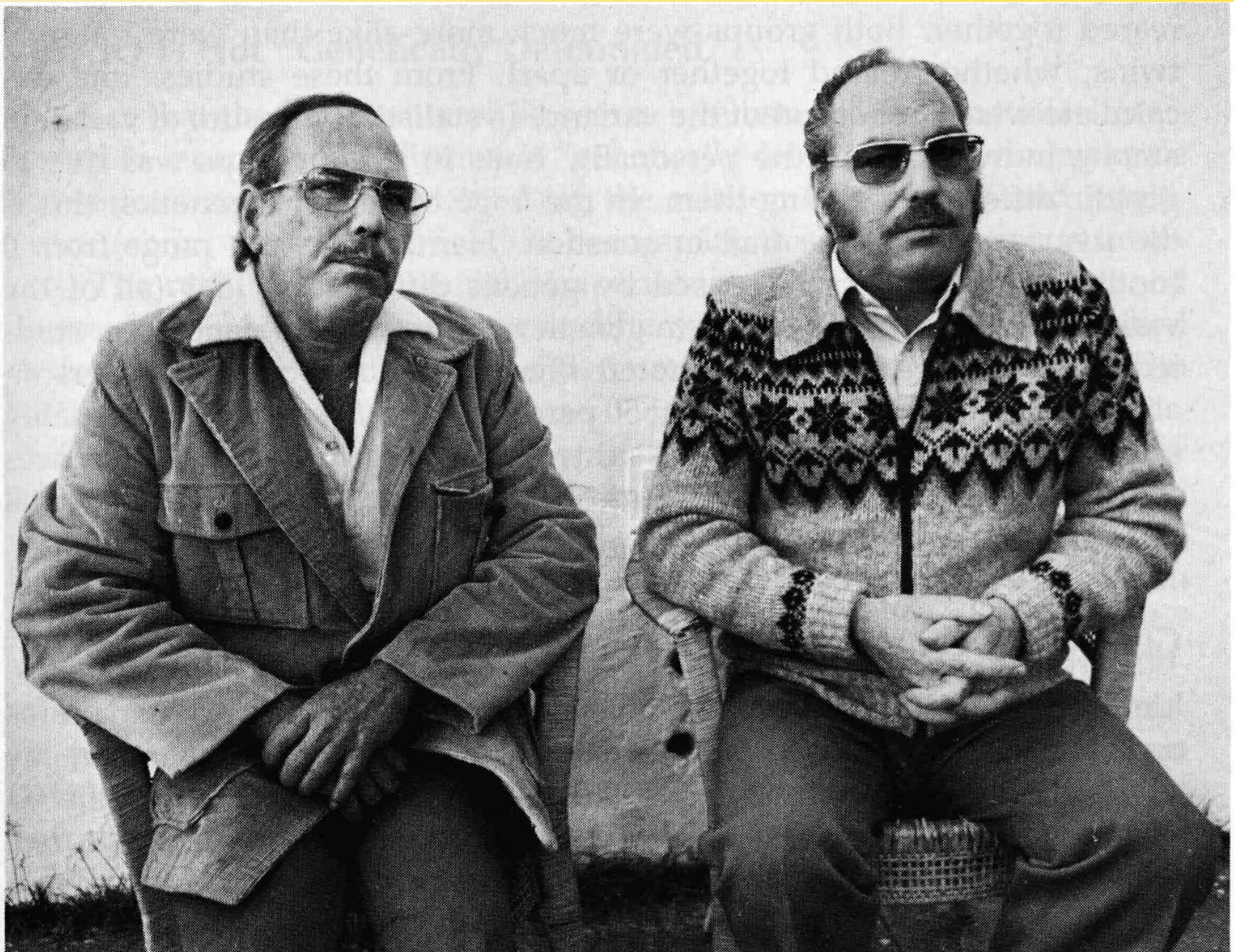
male: bisexual
female: does not respond to him

Mechanism: demage in sex.specific abdominal neurons

Figure: 5 dsf males circling

Heritability of traits in humans

- .



Heritability

Genetic variance / all variance

All variance: degree of difference among individuals in a population

Genetic variance: genetic difference among individuals

H = 0: no genetic variation in the given phenotype (suntan)

H = 1: genetic differences explain phenotypic variance (albinism)

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Intelligence quotient runs in families

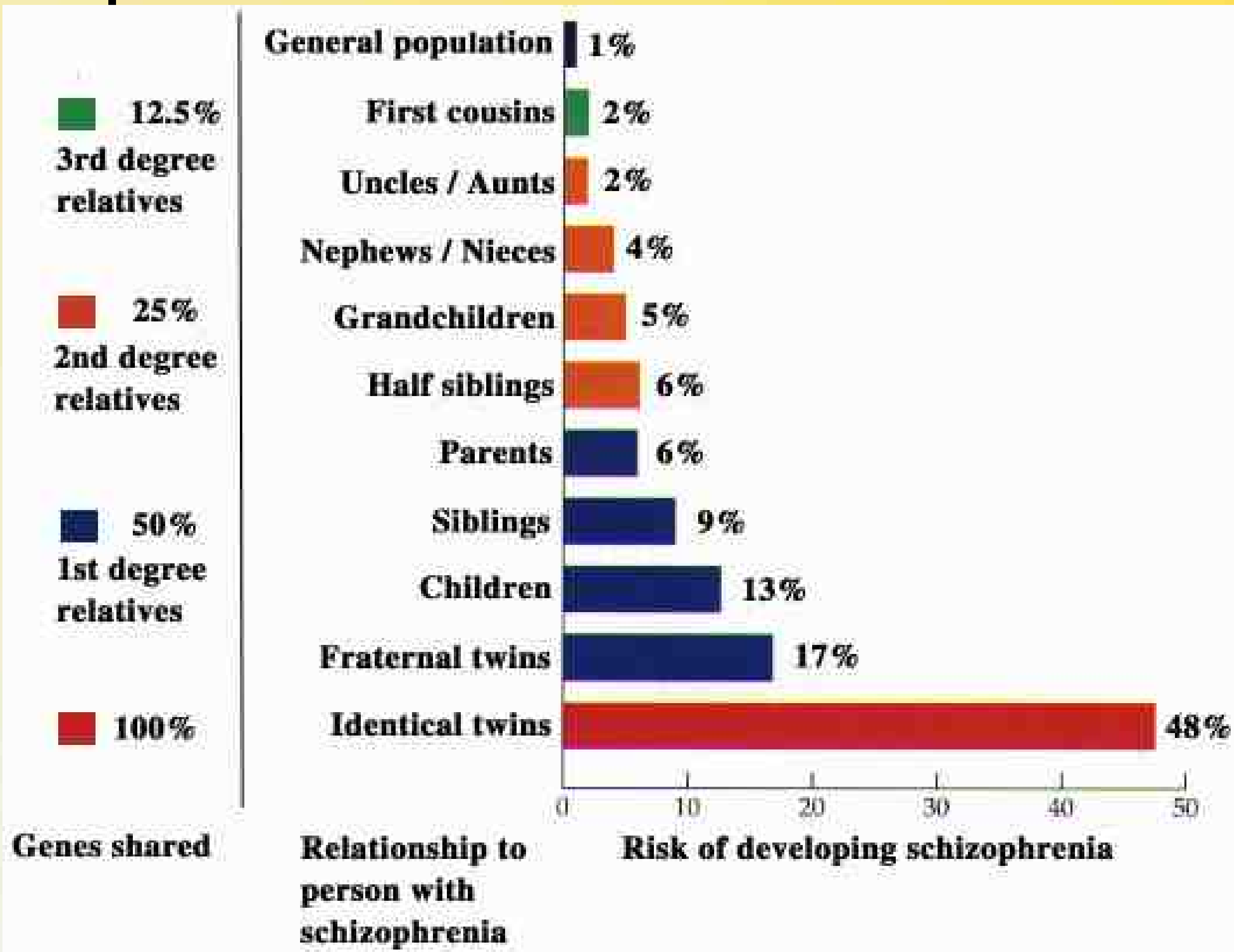
TABLE 1 Familial correlations for IQ scores: Predicted values based on the genetic differences hypothesis and the actual correlations

Category	Predicted correlation	Actual median correlation	Number of studies
Identical (MZ) twins reared together	1.0	0.85	34
Identical (MZ) twins reared apart	1.0	0.75	5
Fraternal (DZ) twins reared together	0.5	0.58	41
Siblings reared together	0.5	0.45	69
Parent-genetic offspring	0.5	0.39	32
Parent-adoptive offspring	0.0	0.18	6

Sources: Bouchard and McGue [137]; Bouchard [134]

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Schizophrenia



In the news of 2011

Epigenetic clue to schizophrenia and bipolar disorder
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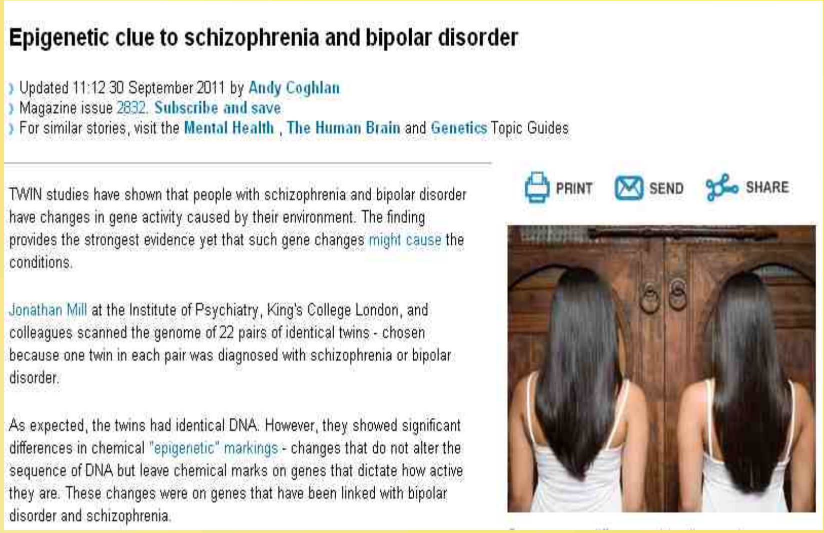

Epigenetic clue to schizophrenia and bipolar disorder

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As expected, the twins had identical DNA. However, they showed significant differences in chemical "epigenetic" markings - changes that do not alter the sequence of DNA but leave chemical marks on genes that dictate how active they are. These changes were on genes that have been linked with bipolar disorder and schizophrenia.

the most significant differences, with variations of up to 20 per cent in the amount of methylation, were in the promoter "switch" for a gene called ST6GALNAC1, which has been linked with schizophrenia
One gene, called ZNF659, showed over-methylation in people with schizophrenia and under-methylation in those who were bipolar, suggesting that the conditions might result from opposing gene activity
"We know these disorders are related, and there are clinical features shared by both," says Mill. "But our scan suggests there are some genes that might be overactive in one disease and underactive in the other."

Heritability of personal traits

personality trait	heritability
well being	0.48
social potency	0.59
achievement	0.39
social closeness	0.40
stress reaction	0.53
aggression	0.44
control	0.50
harm avoidance	0.55
positive emotionality	0.40
negative emotionality	0.55

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Evolution of behaviour

How?

Microevolutionary changes

Reconstruction of evolutionary steps

by comparing species

Why?

Microevolutionary changes

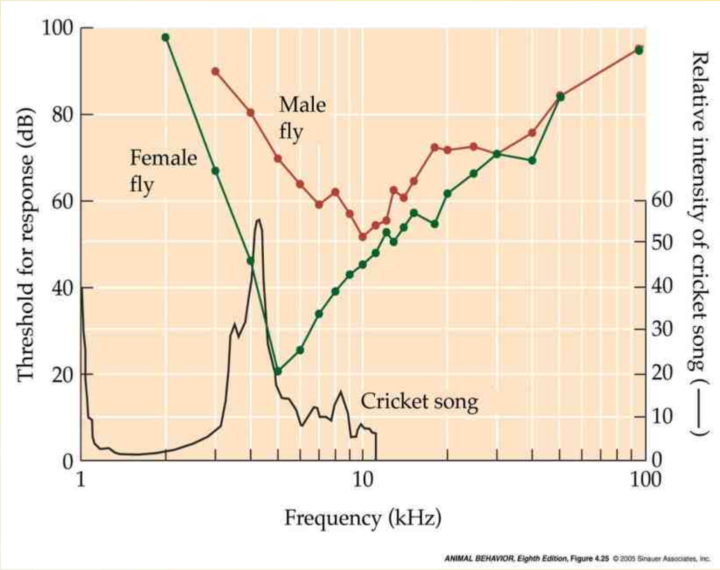
Understandig selection mechanisms

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Detecting microevolution

Females of *Ormia* fly sensitive to cricket song

Finds male crickets and injects eggs into it.



Microevolution

Ormia fly invaded Hawaii from North America
Marlene Zuk (2006) on Kauai Island (Hawaii)
found that :
1991-2001 number of males dropped dramatically
30% of males were infected.
By 2001 majority of males did not chirp

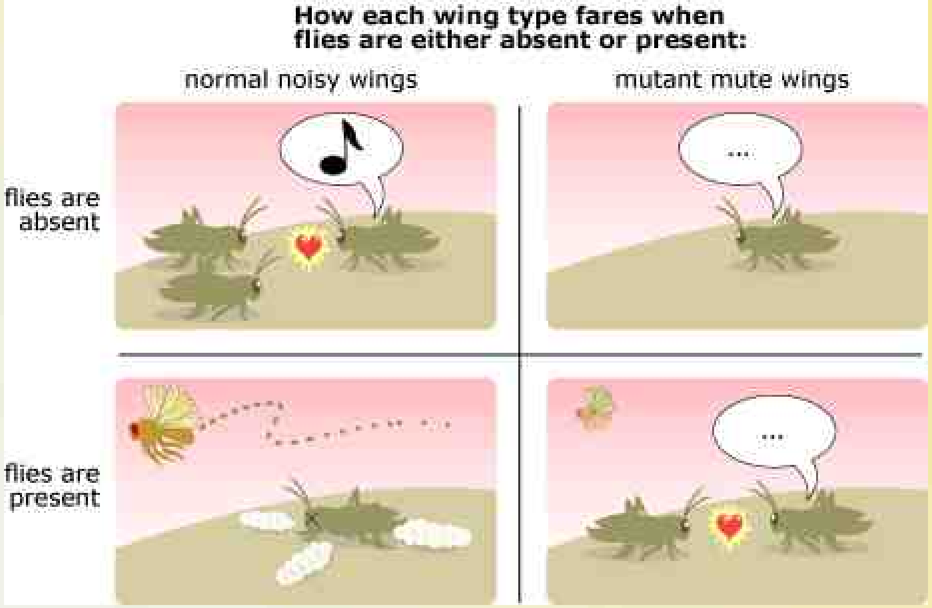
→ microevolution in 20 years!

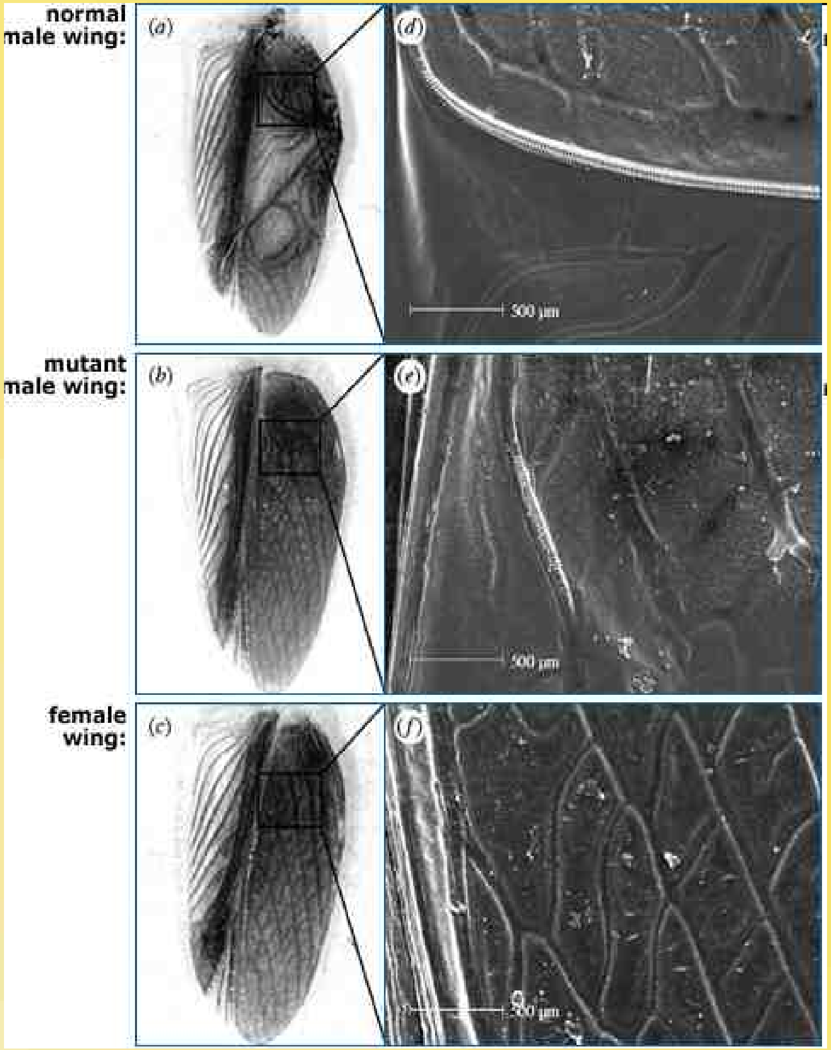
Peter Kabai
www.behav.org
peter.kabai@gmail.com

Wing of silent male (b) similar to female's (c)

Point mutation on chromosome X

Tinghitella (2008) Heredity





Heavy parasitic load: advantegious to remain silent

Chirping is risky but probably pays when most males are silent

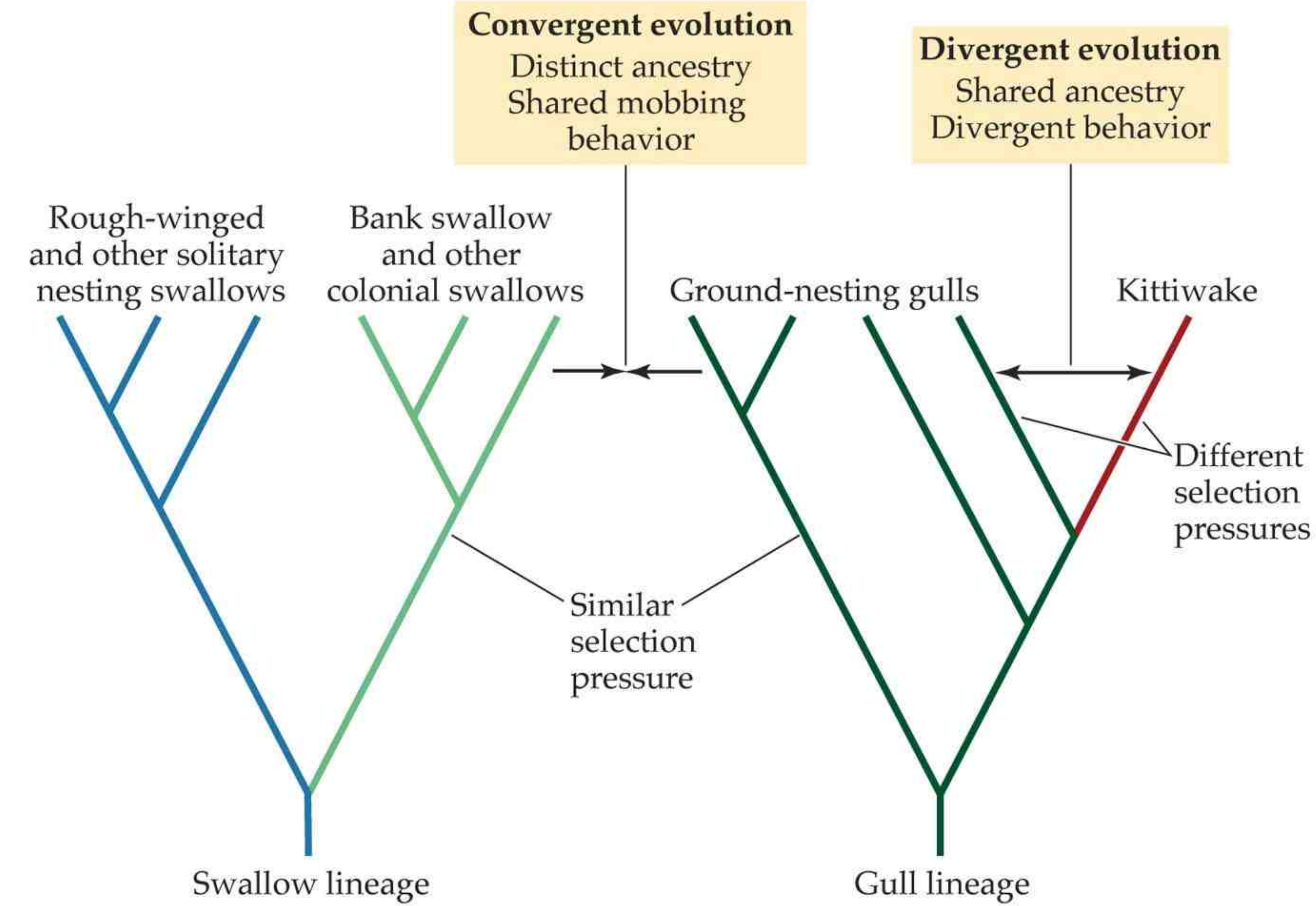
Comparing species: Mobbing behaviour of colonial, ground-nesting gulls

ANIMAL BEHAVIOR, Eighth Edition, Figure 6.1

Not all gulls nest on the ground

ANIMAL BEHAVIOR, Eighth Edition, **Figure 6.6**

6.7 The logic of the comparative method



Comparing species: reconstruction

Courtship in Phasanidae (pheasants)

Cockerrels have long conspicuos tale

Displaying tale during courtship.

What could be the steps leading here?

Peter Kabai
www.behav.org
peter.kabai@gmail.com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X


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Corder


countingsheep.typepad.com/ photos/traveling_sh...

- Cockerels in some Phasanidae species point at food items and call (head down, tale up)
- Females approach, male mounts

Peter Kabai
www.behav.org
peter.kabai@gmail.com

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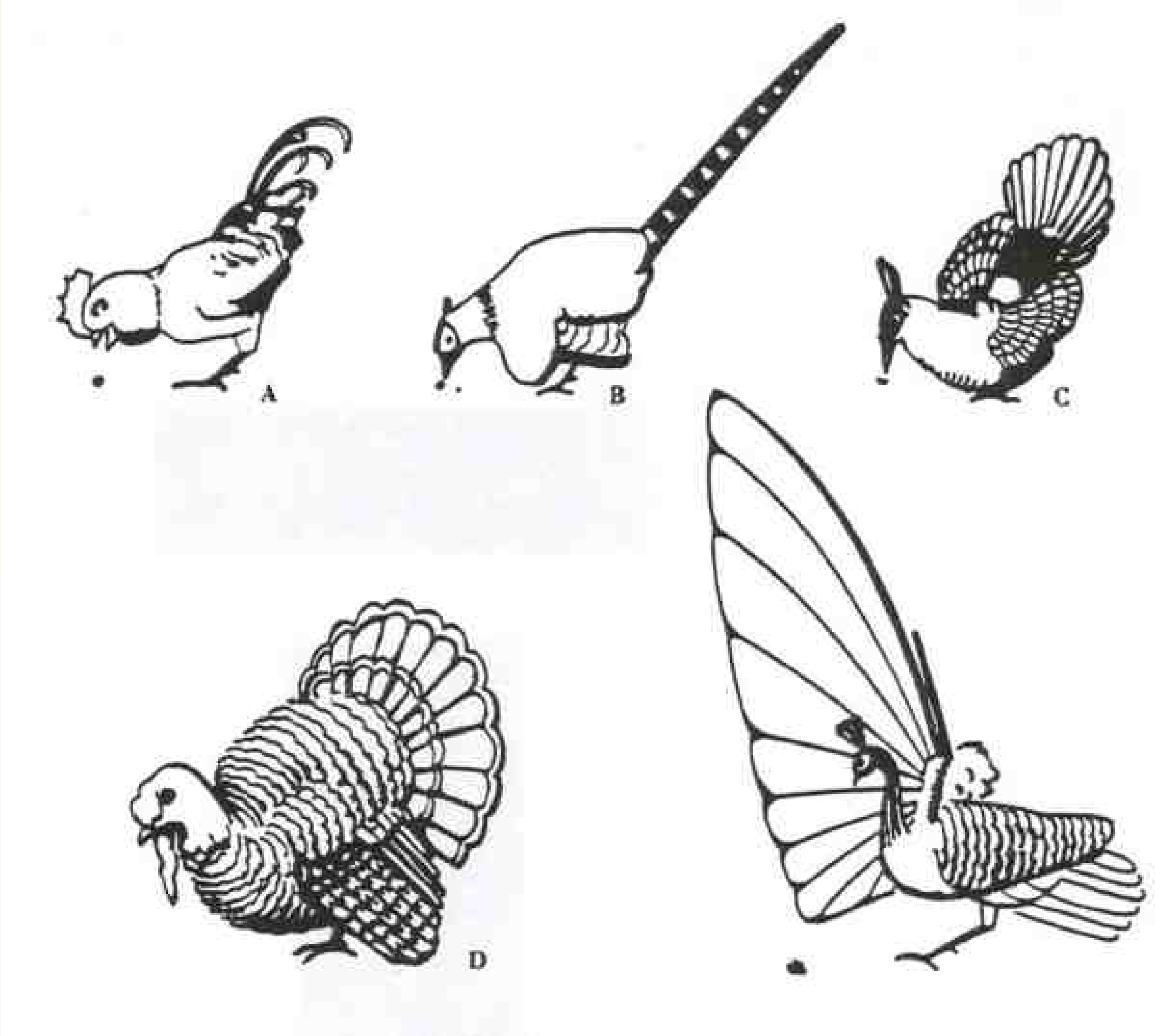
Some species:

- Do not point at food
- Spread tail feather and bow

Reconstruction of possible evolutionary steps



Ritualisation:

Act with direct function exegerated and serves as signal.

Peter Kabai
www.behav.org
peter.kabai@gmail.com

Dance flies (Empididae) courtship behaviour

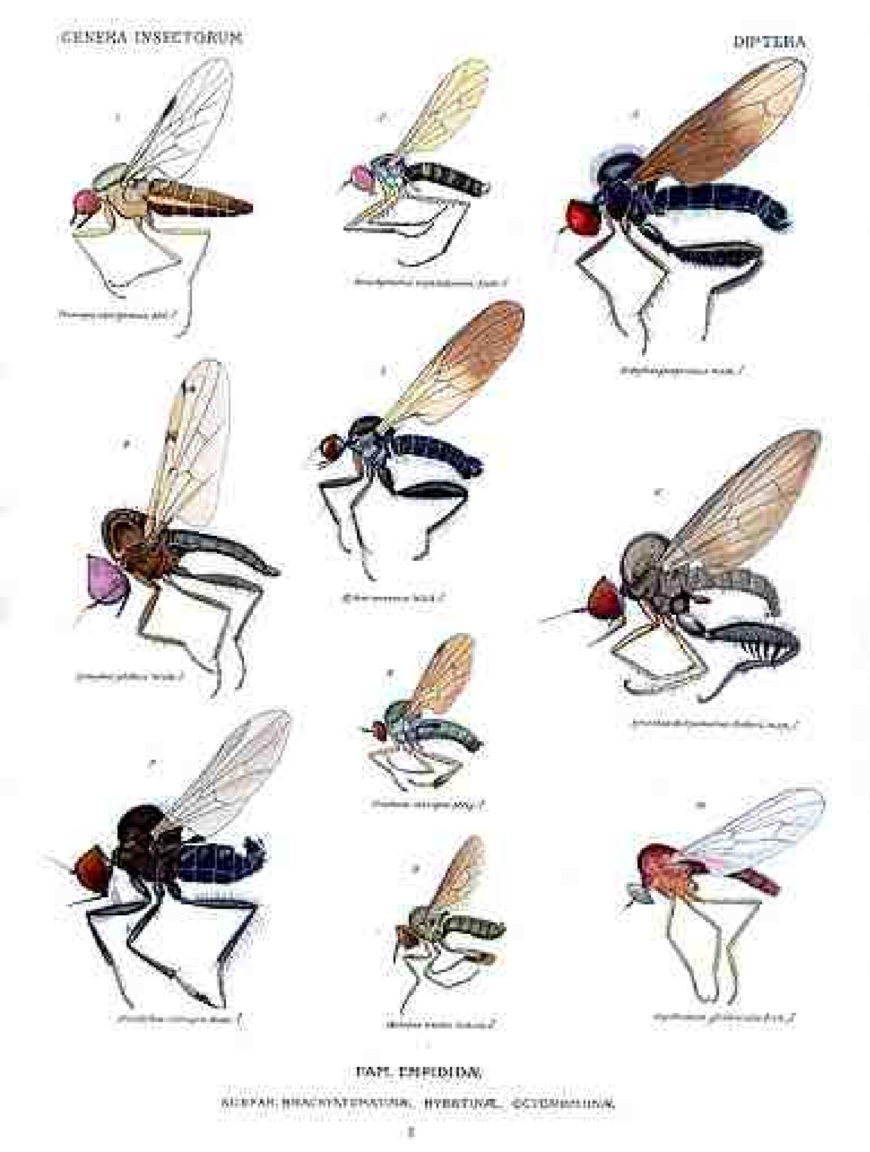
Cca. 3,000 species (predatory).

Variable courtship patterns

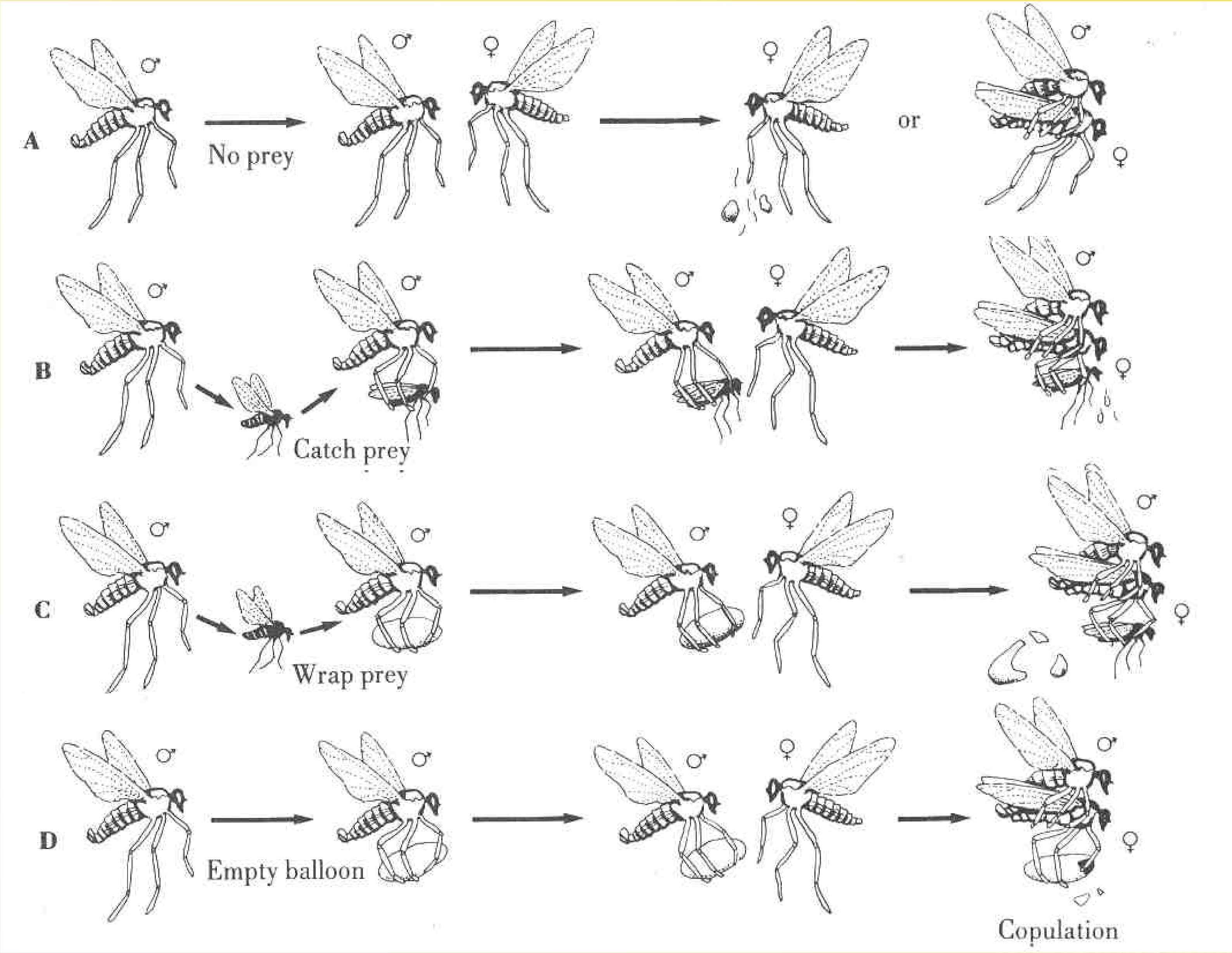
One strange species: male prepares a silk baloon and hand it over to female before mating.

Function?

Origin?



Courtship of dance flies (Kessel, 1955)



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