Sexual conflict and the emergence of sexual equality and monogamy

Professor Keith Kendrick

Sexual conflict and the emergence of sexual equality and monogamy

Sex is only the beginning of the war to promote your genes

What are the other biological battlegrounds where male and female mammals fight to promote their own genes ?

- The male reproductive organs

- The female reproductive organs

-

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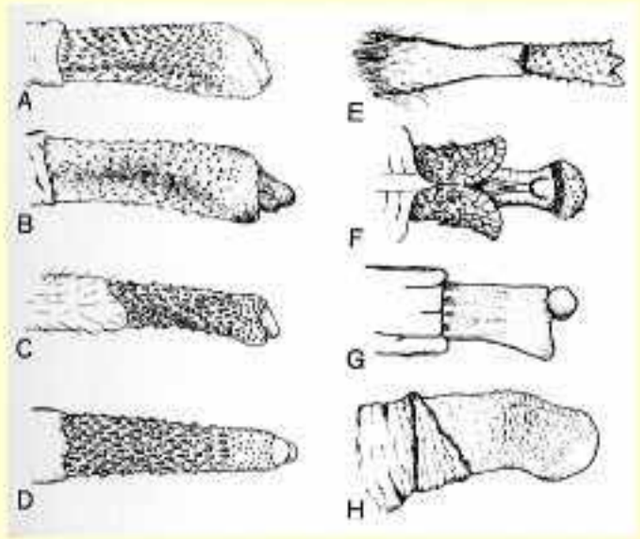
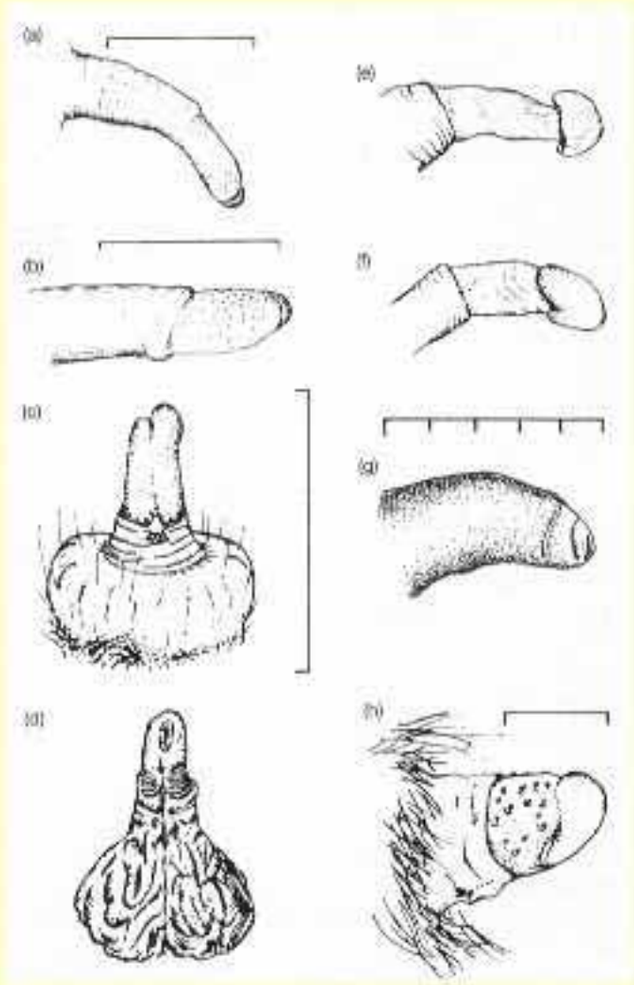
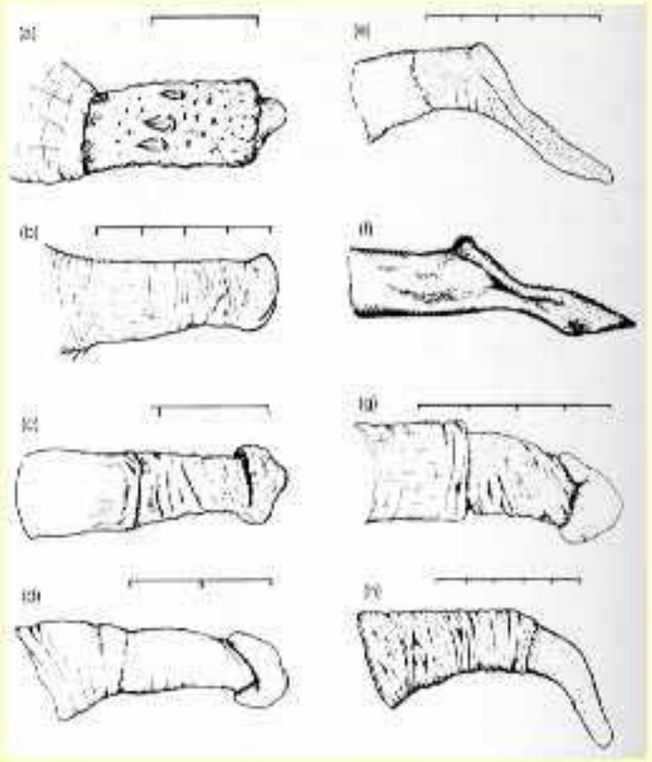
- Male and female genomes

What is a penis for ?

Do size and complexity matter ?







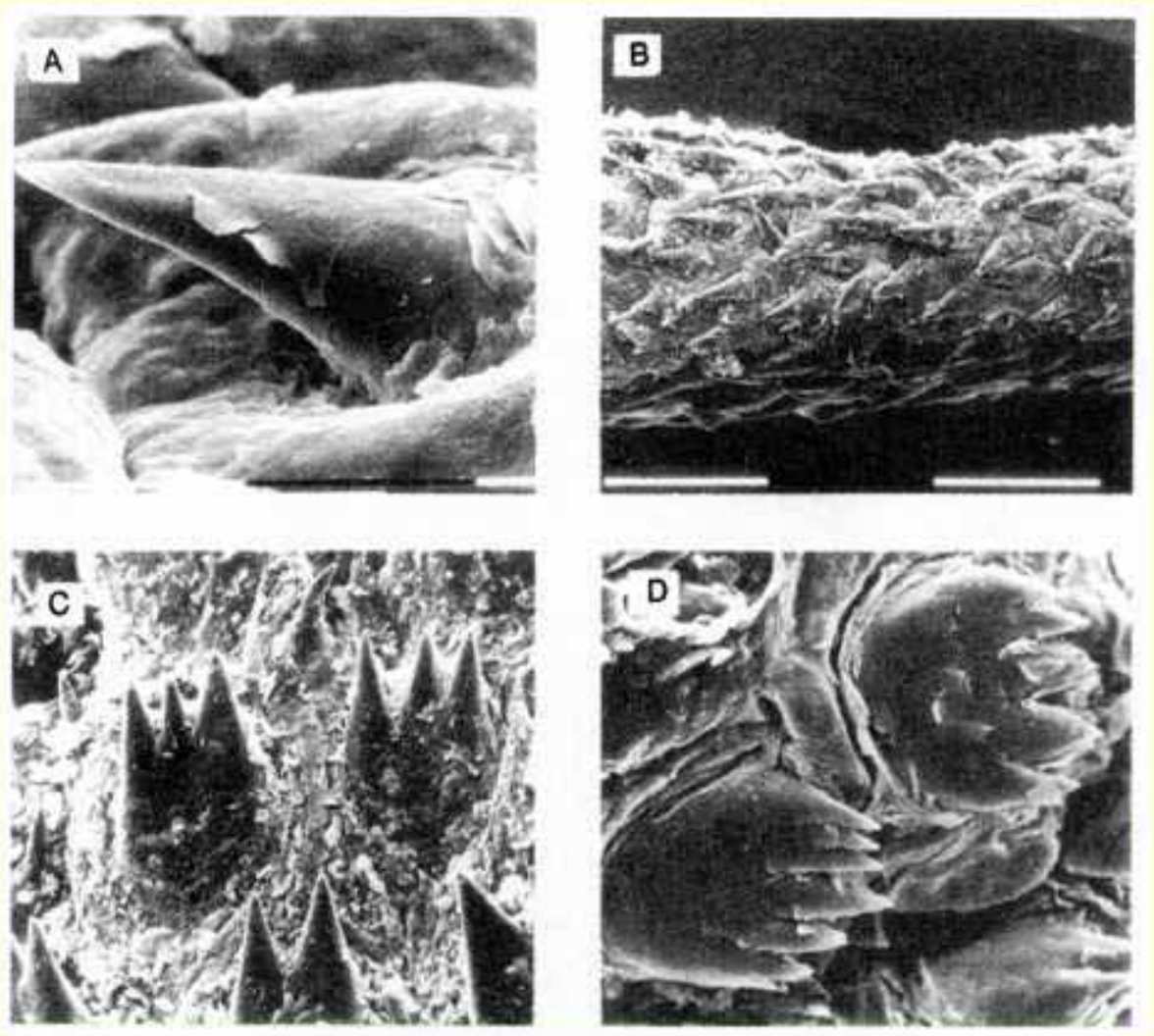
Dispersed mating system

Monogamous mating system

Multi-male/multi-female mating system

What is a penis for ?

'The taxonomists friend !'



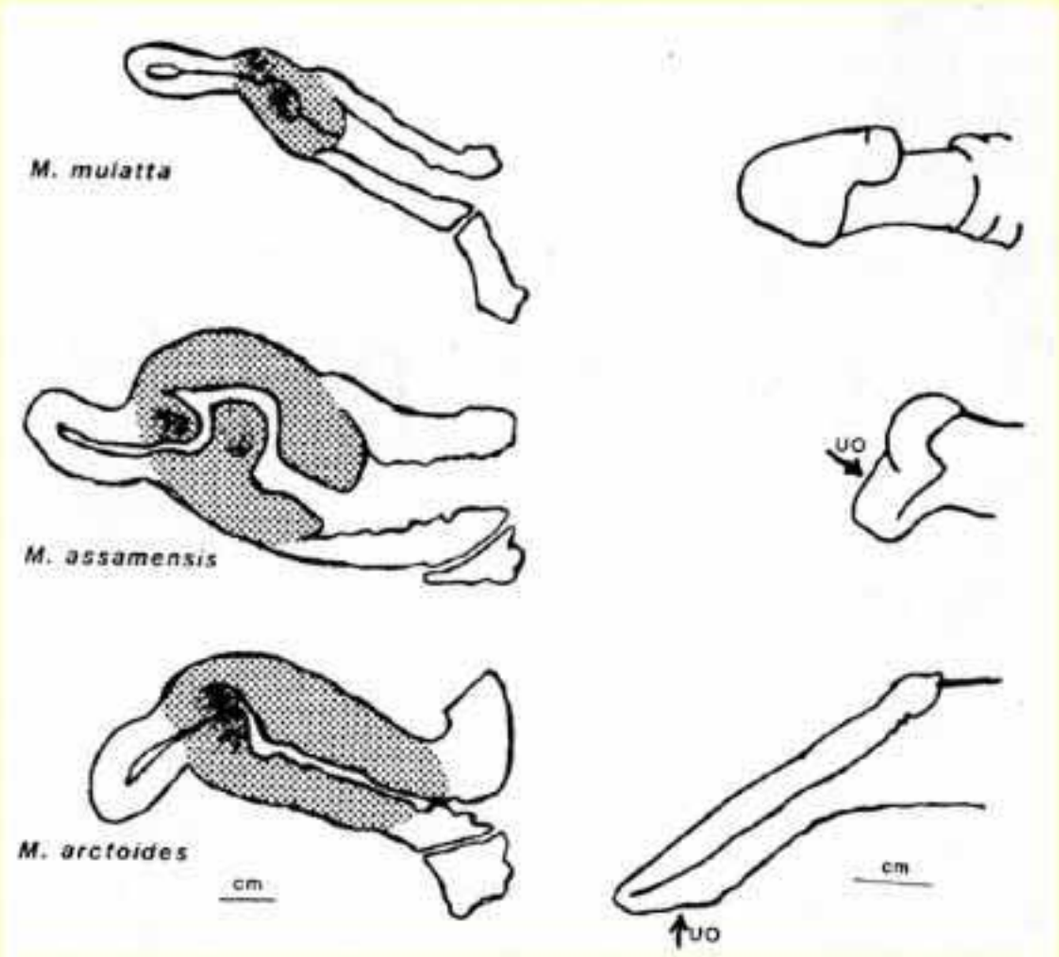
'It is very remarkable, considering that the organs have the same rather limited functions to perform, how varied the male genitalia are in their morphology'
Hill (1972)

But what is a penis really for ?

- Getting sperm into the female's reproductive tract ?

  - Significant appendages are not essential !

- Unique keys designed to fit female locks ?



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- Mechanical diggers ?
- 'Macho' mammals ?
- Adaptations to female choice ?

The size and complexity of the penis are indeed related to how many males a female would expect to have sex with

Dixson (1987)

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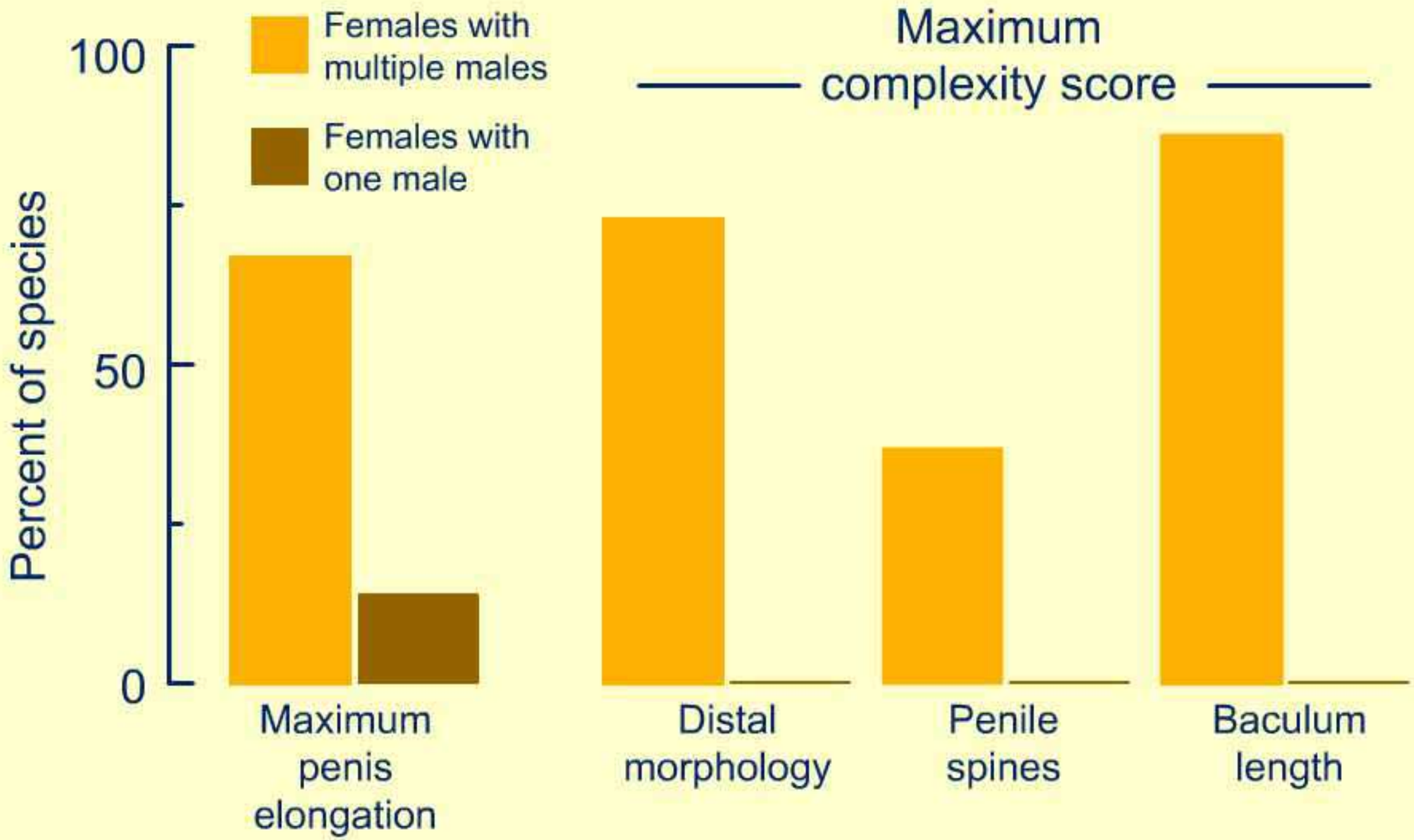
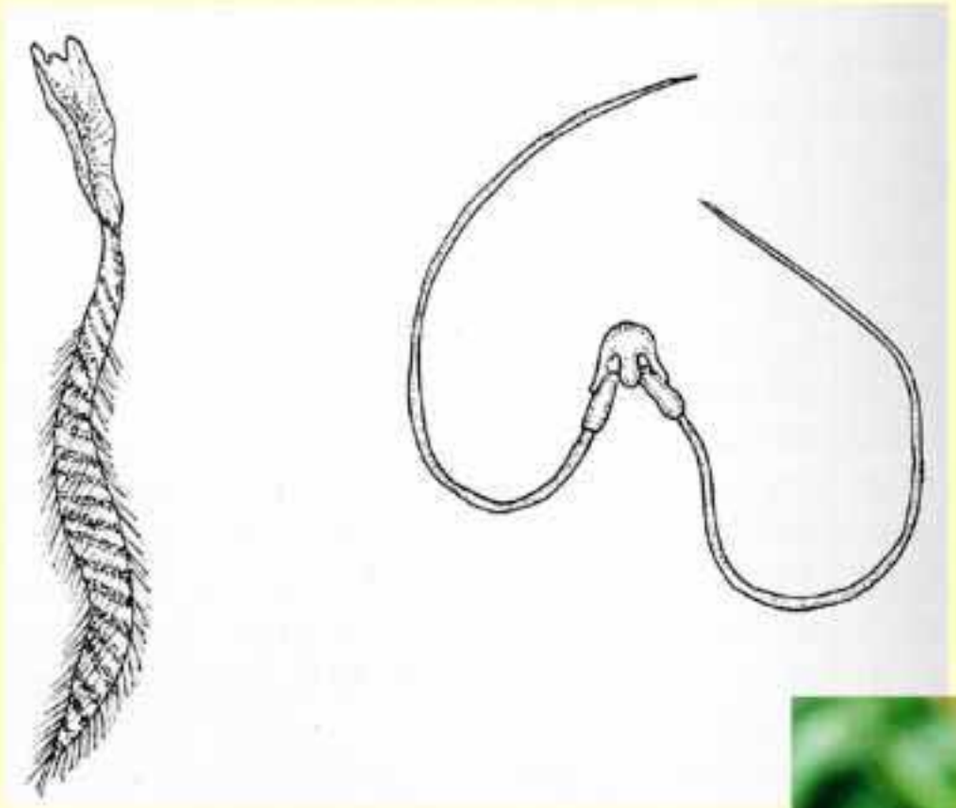


So maybe it is all down to female choice !

Sperm design

Co-operative sperm

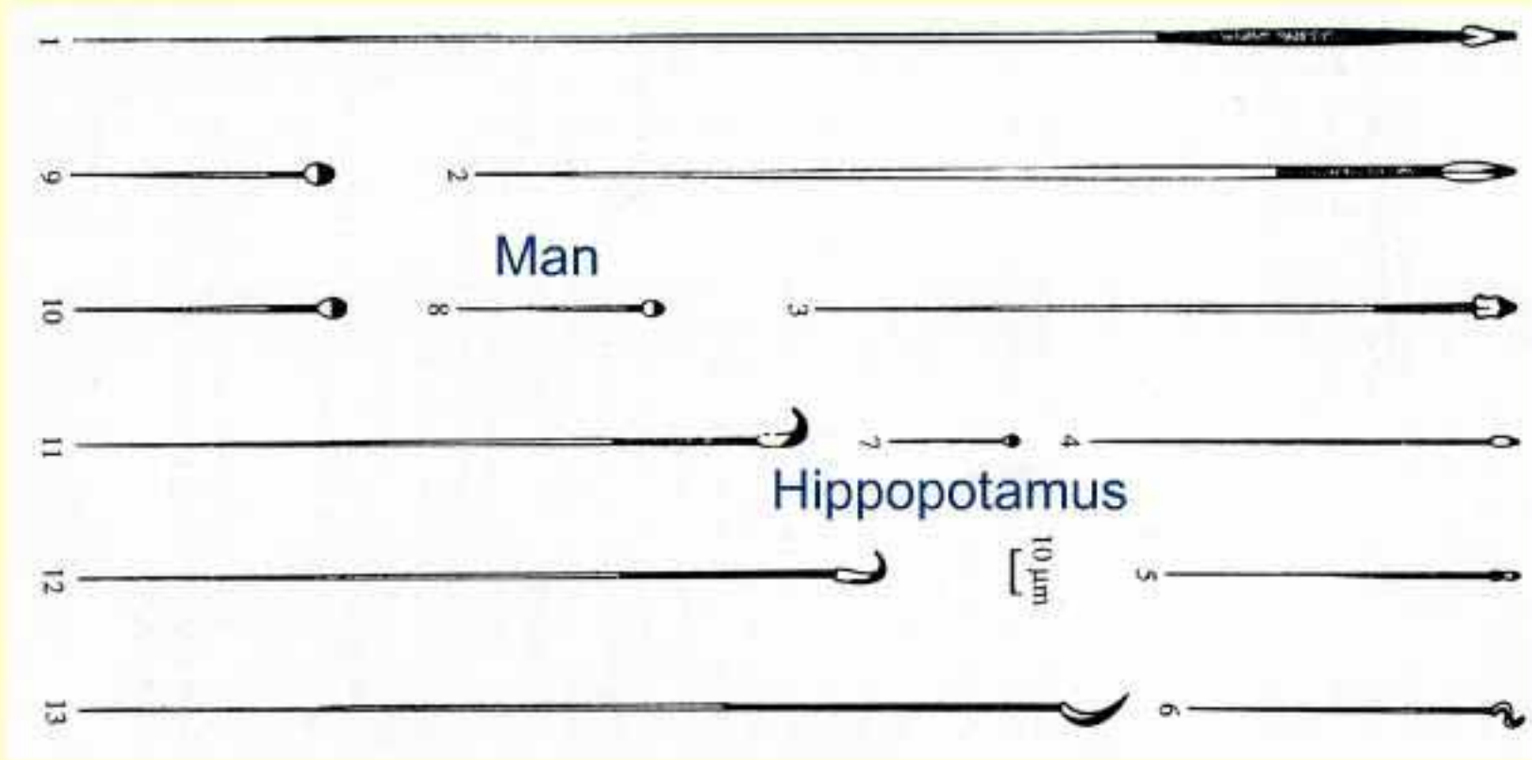
Giant helper sperm (spermatozeugma) produced by some molluscs

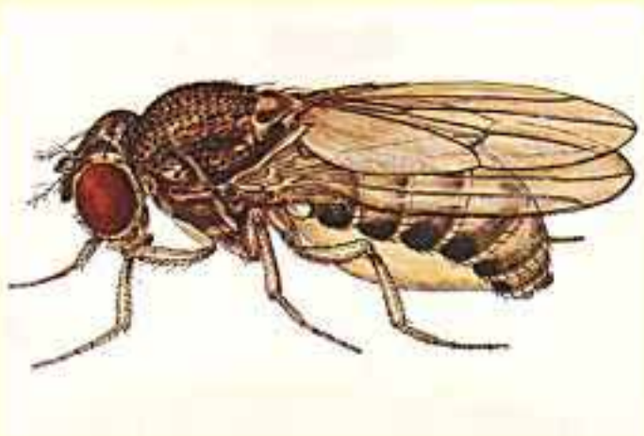


Binary sperm of the Virginia opossum

Sperm design

Sperm length

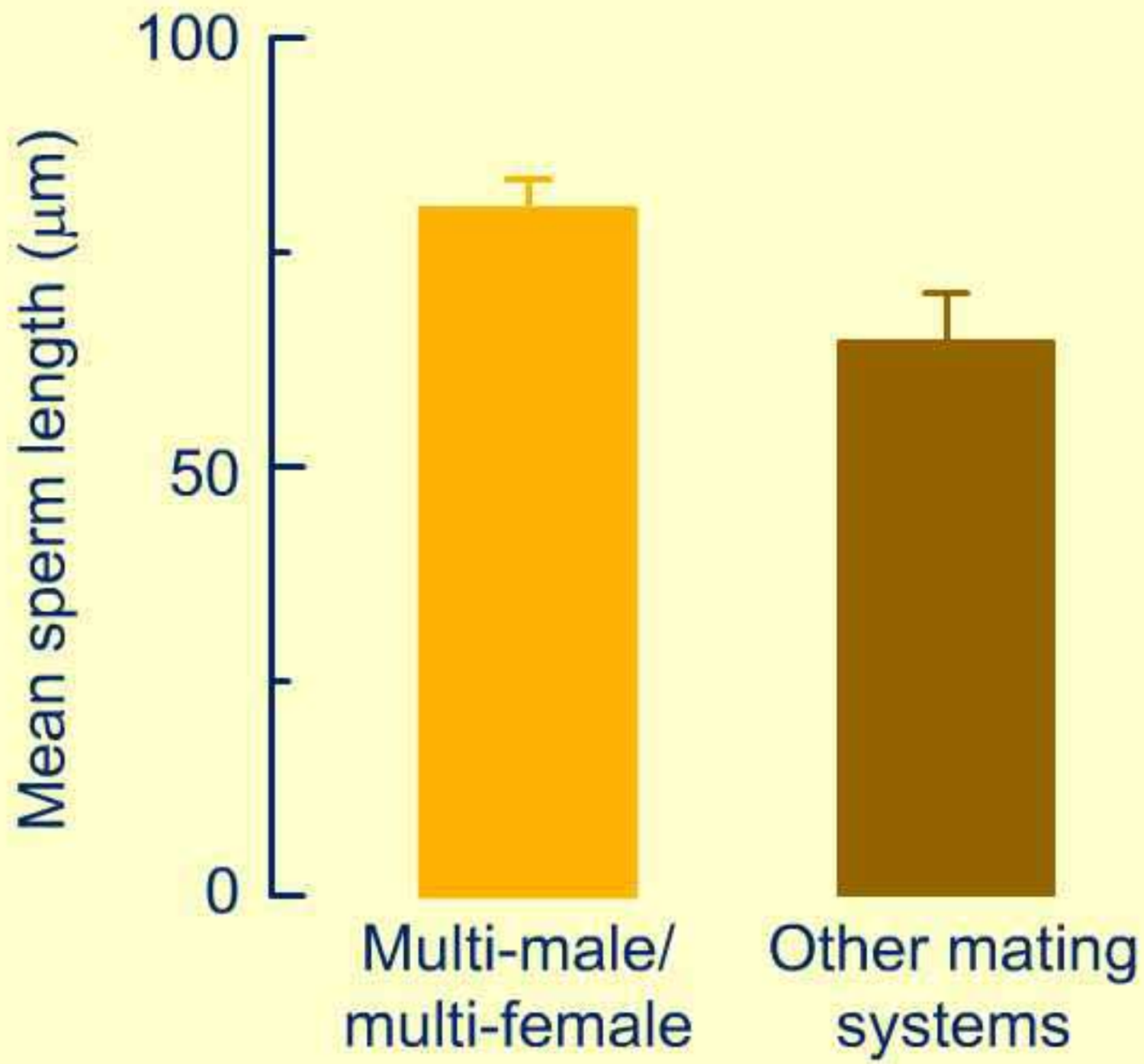




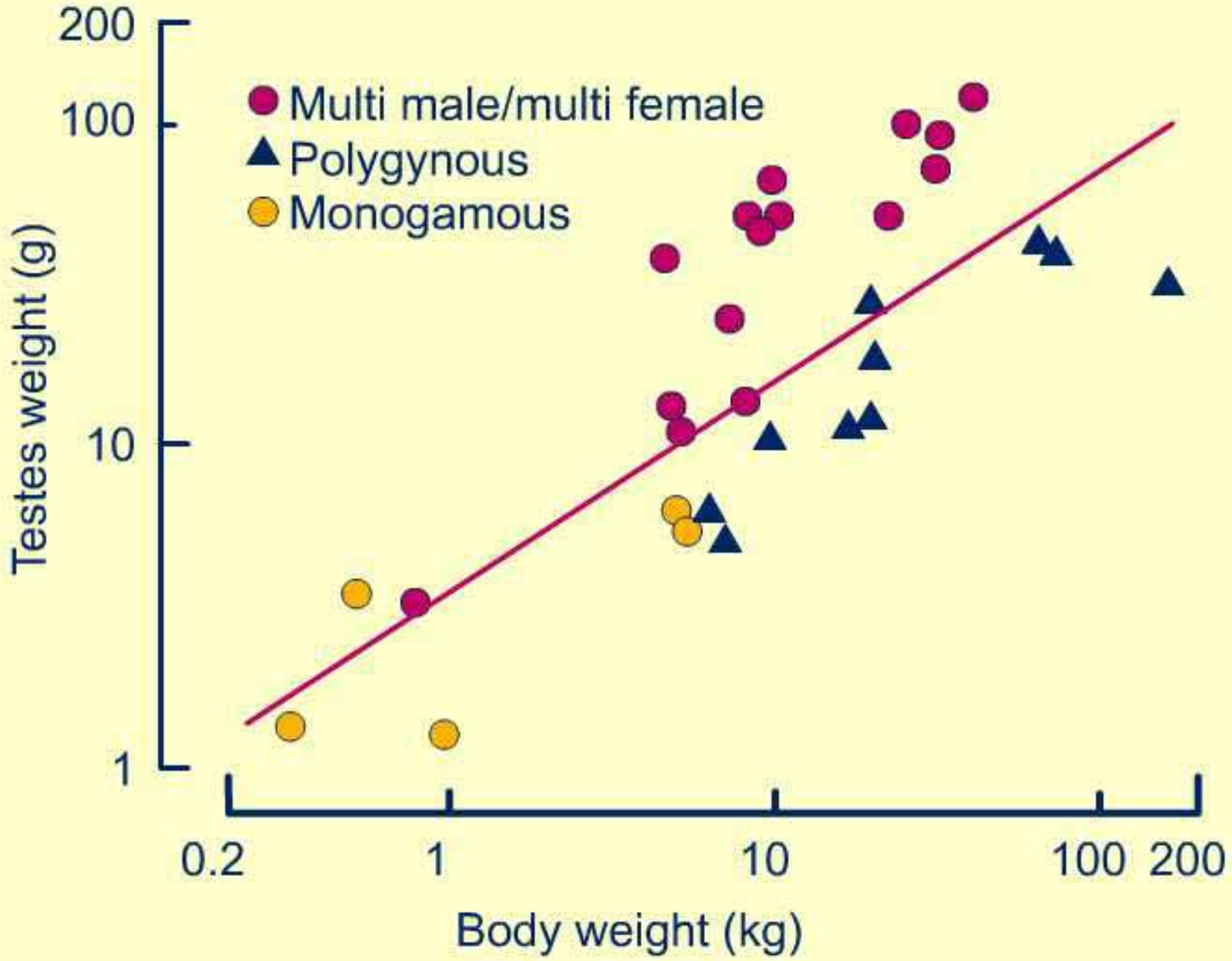
Drosophila bifurcata:
Sperm length is 20 times its' body length !

Sperm design

Sperm length in primates



Sperm storage and production



The numbers game - 50,000,000 sperm is enough, but you need more to beat the competition !

Summary

- You need a penis for coercion and rooting out the competition !
- The more partners females want, the bigger and more sophisticated it gets
- The greater the competition.....
    - The more sperm you store and produce during sex
    - The longer are your sperm
- Monogamy reduces everything !

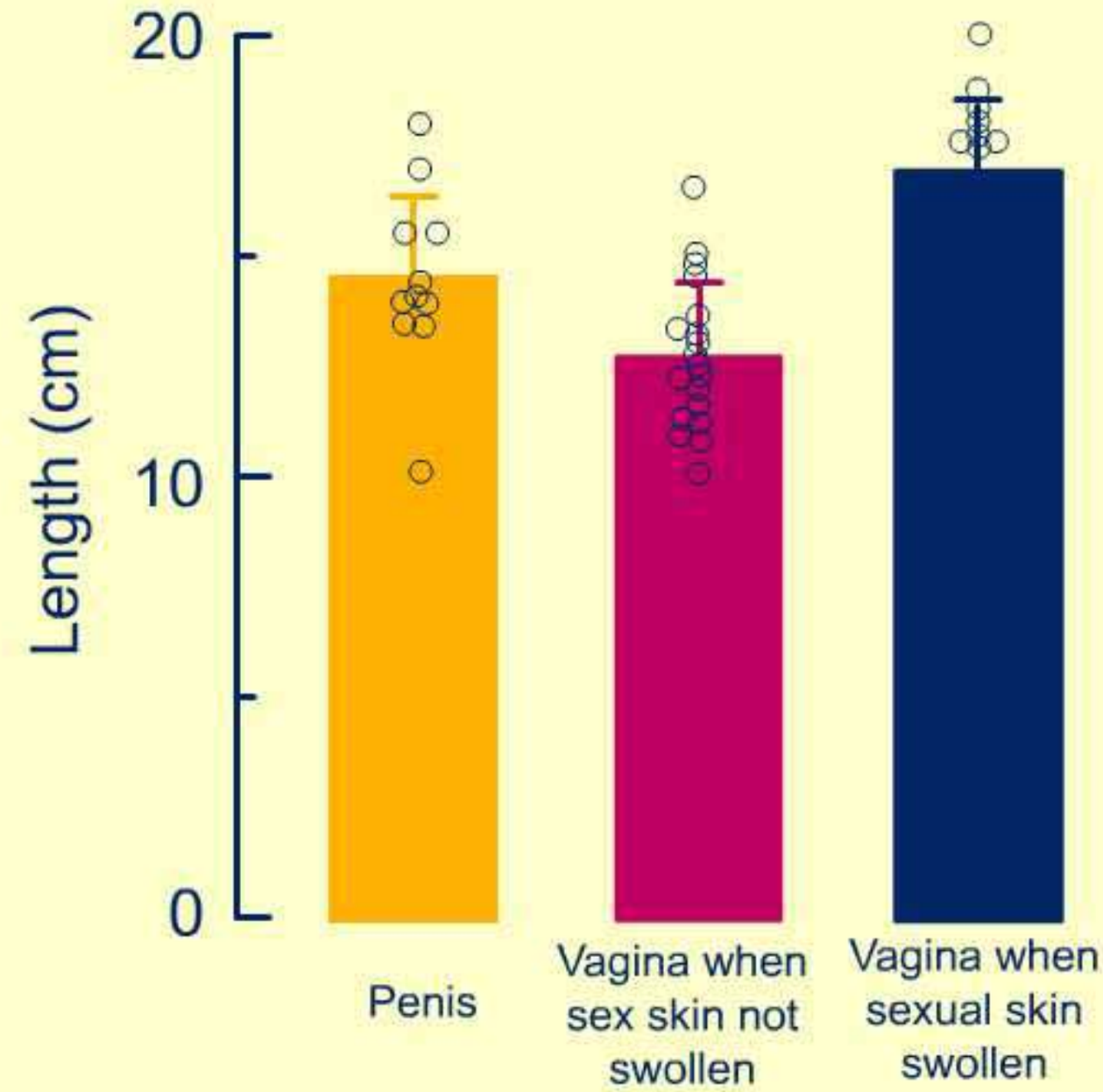
Can females control which sperm fertilise their eggs ?

The female reproductive tract is not sperm friendly !

Animals - The Inside Story
BBC

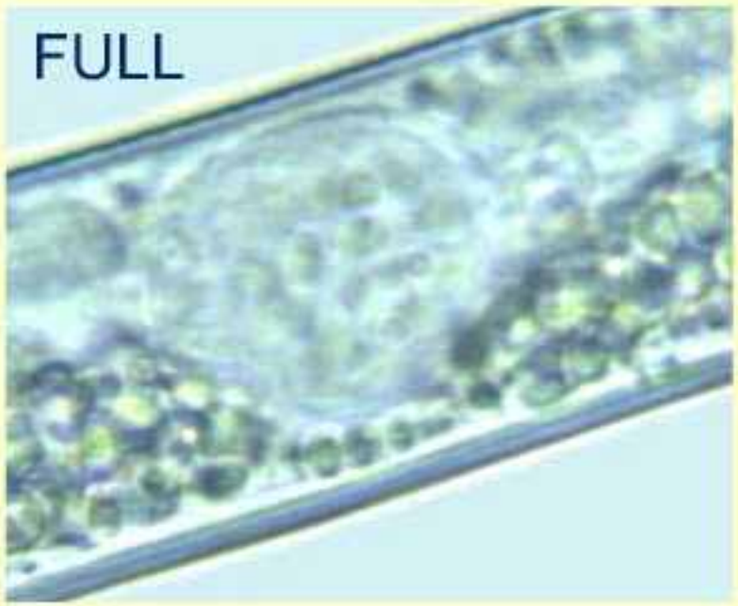
Can females control which sperm fertilise their eggs ?

Length of vagina varies during menstrual cycle
(Dixson 1994)



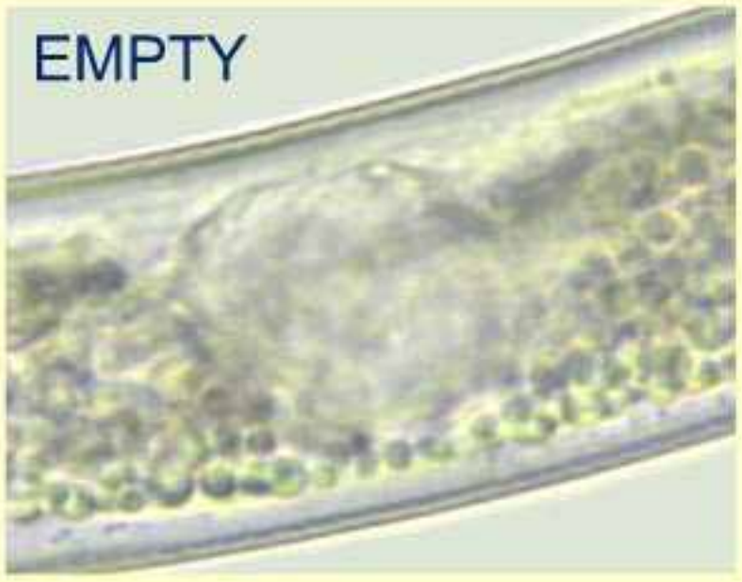
Can females control which sperm fertilise their eggs ?

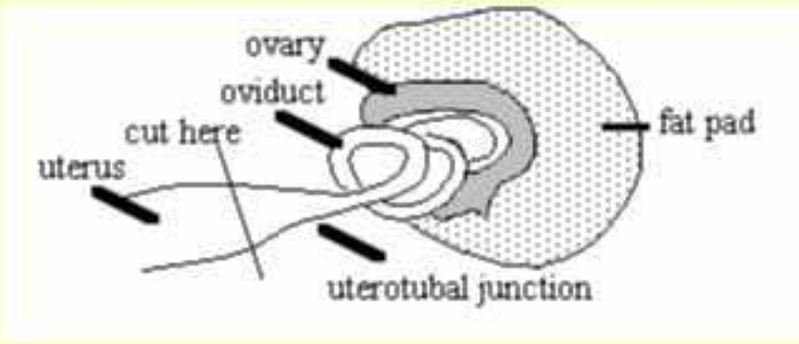
The last-man advantage



nematode spermatheca

Tarantula spermatheca

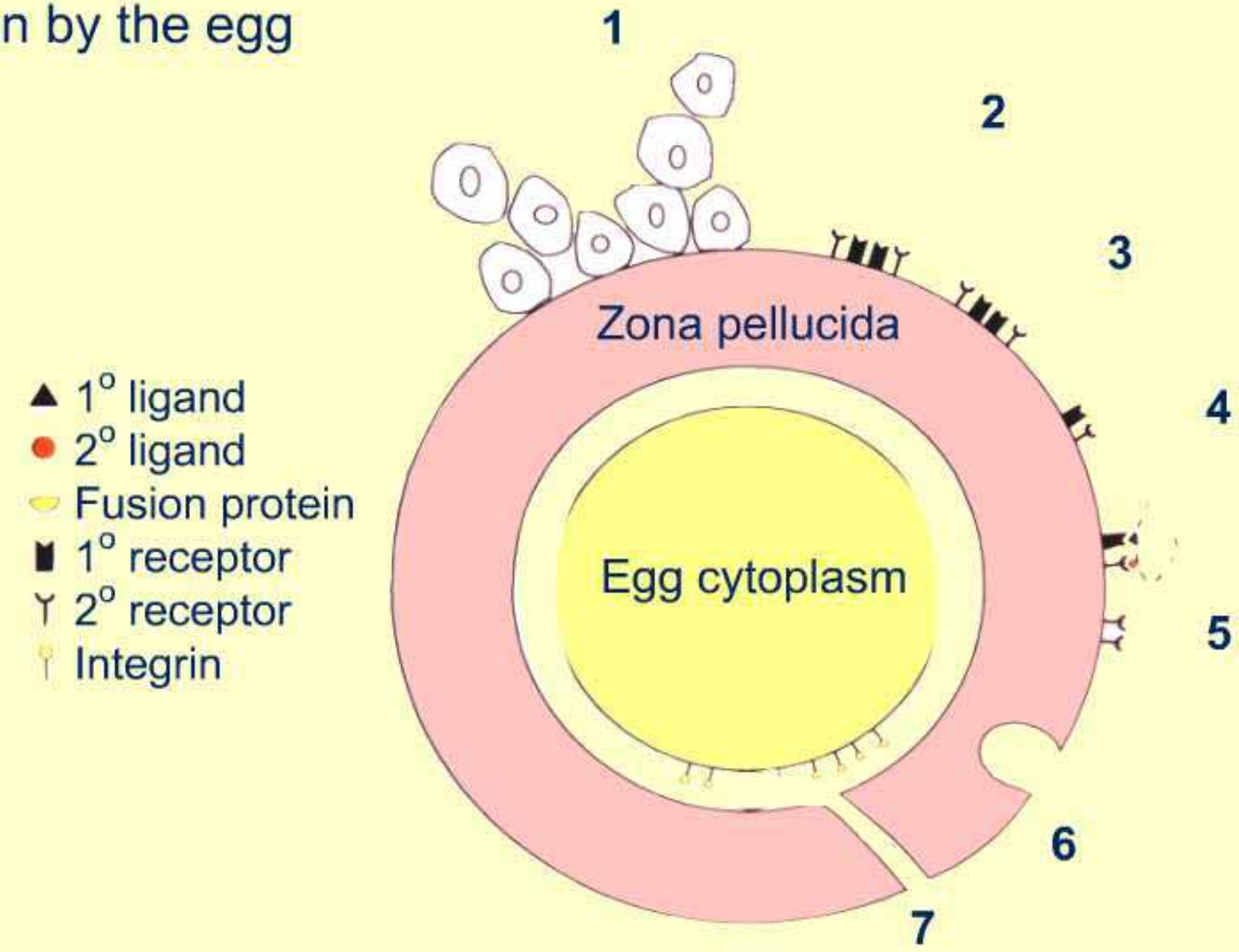




Uterotubal junction

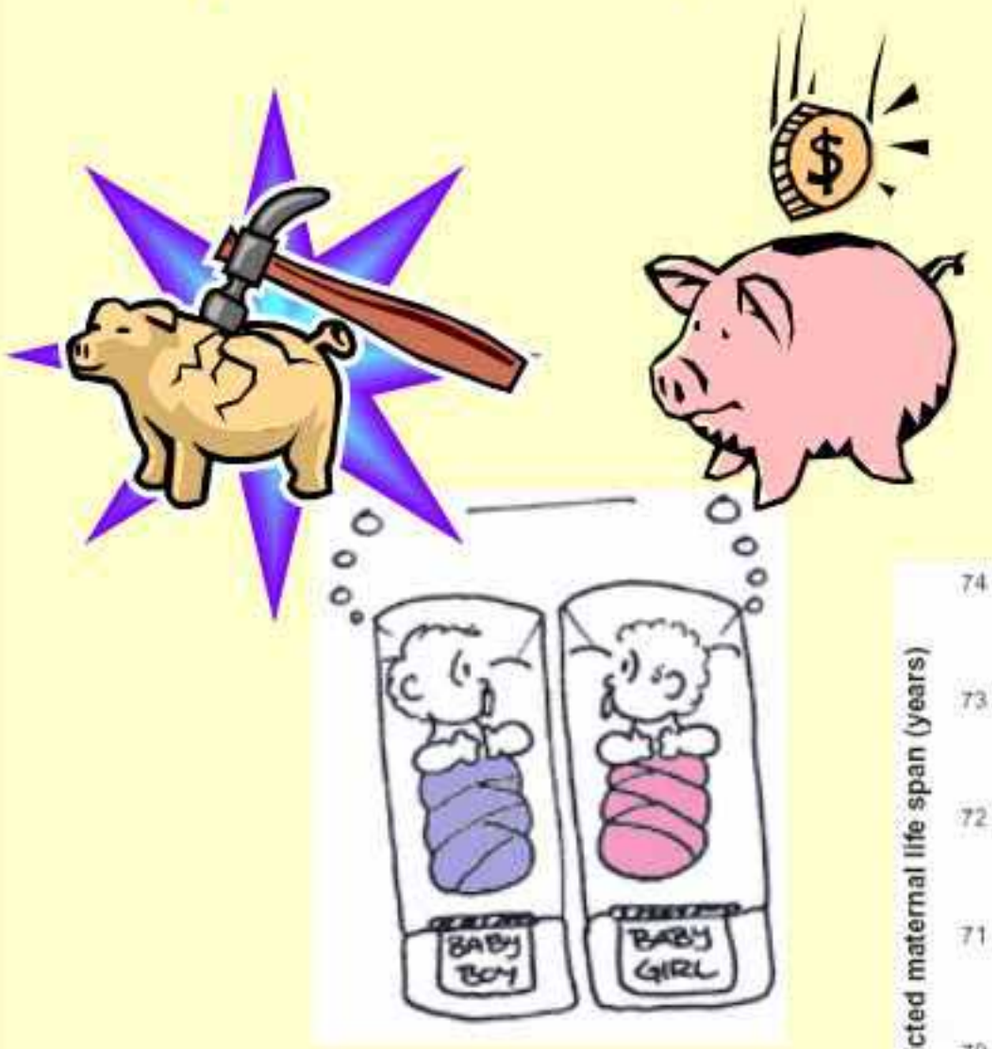
Can females control which sperm fertilise their eggs ?

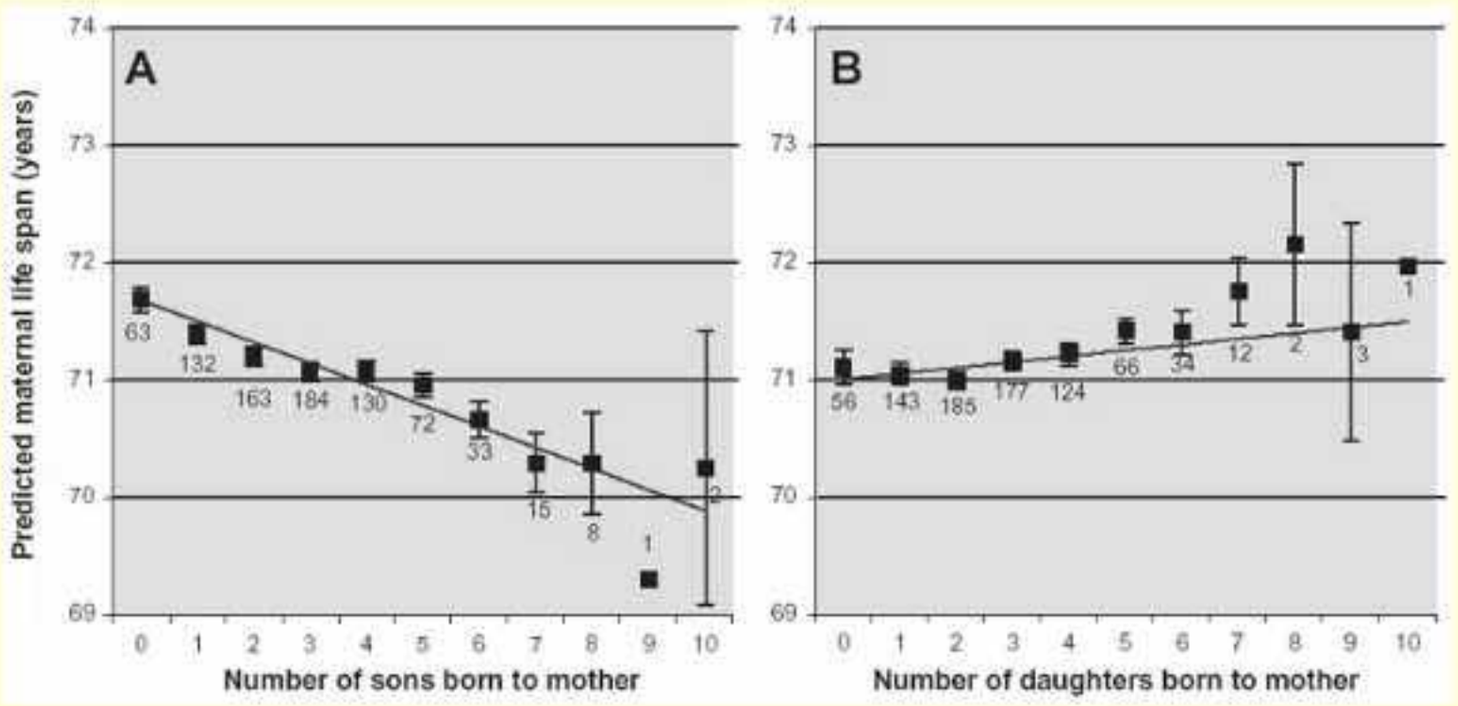
Selection by the egg



Can females control which sperm fertilise their eggs ?

Boys are more expensive than girls - the 'Trivers-Willard' model





Helle *et al* 2002

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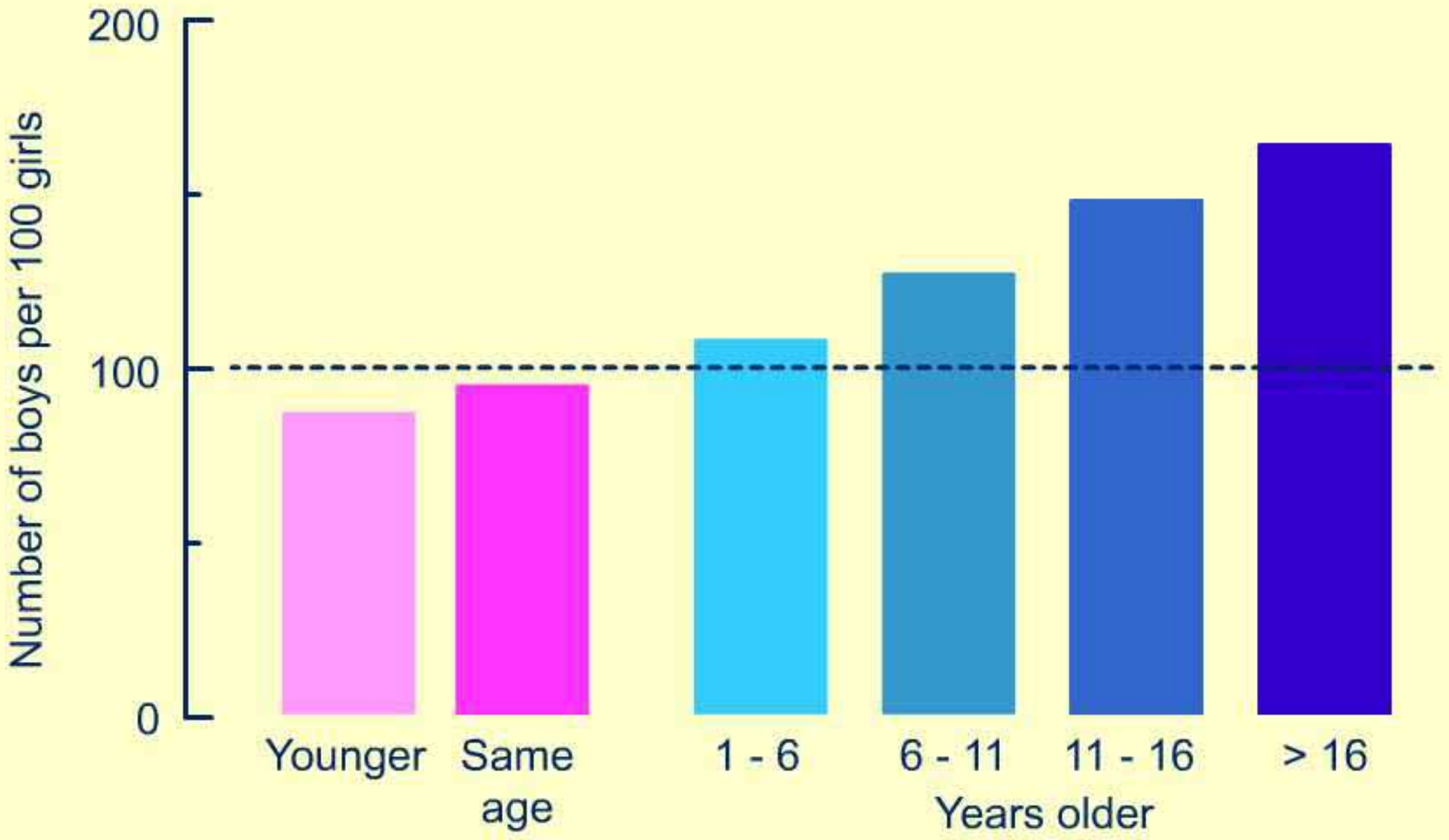

Summary:

- Whatever their mating arrangements, females make it difficult for male sperm to get to their eggs

Battles fought between male and female genomes

- You need genes from both mother and father

- 'Imprinted' genes in mammals

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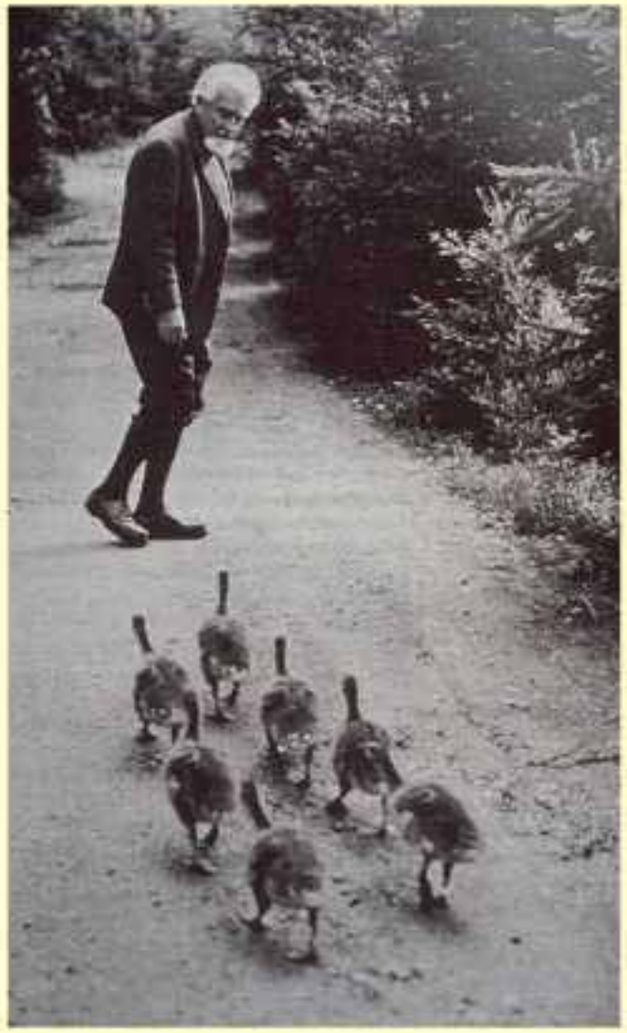

Imprinting in ducklings

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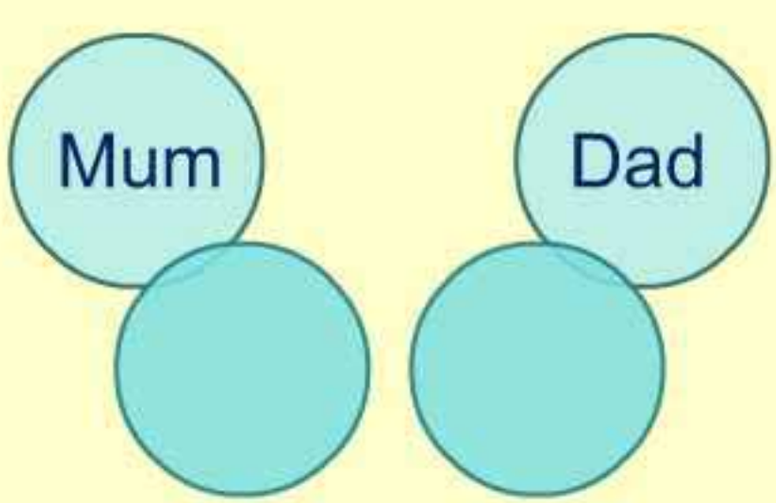
Bi-allelic (normal)

-



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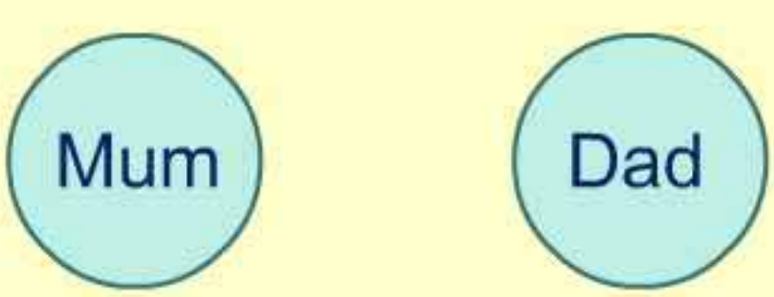

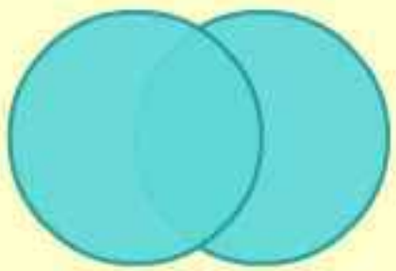

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Mono-allelic (Imprinted)

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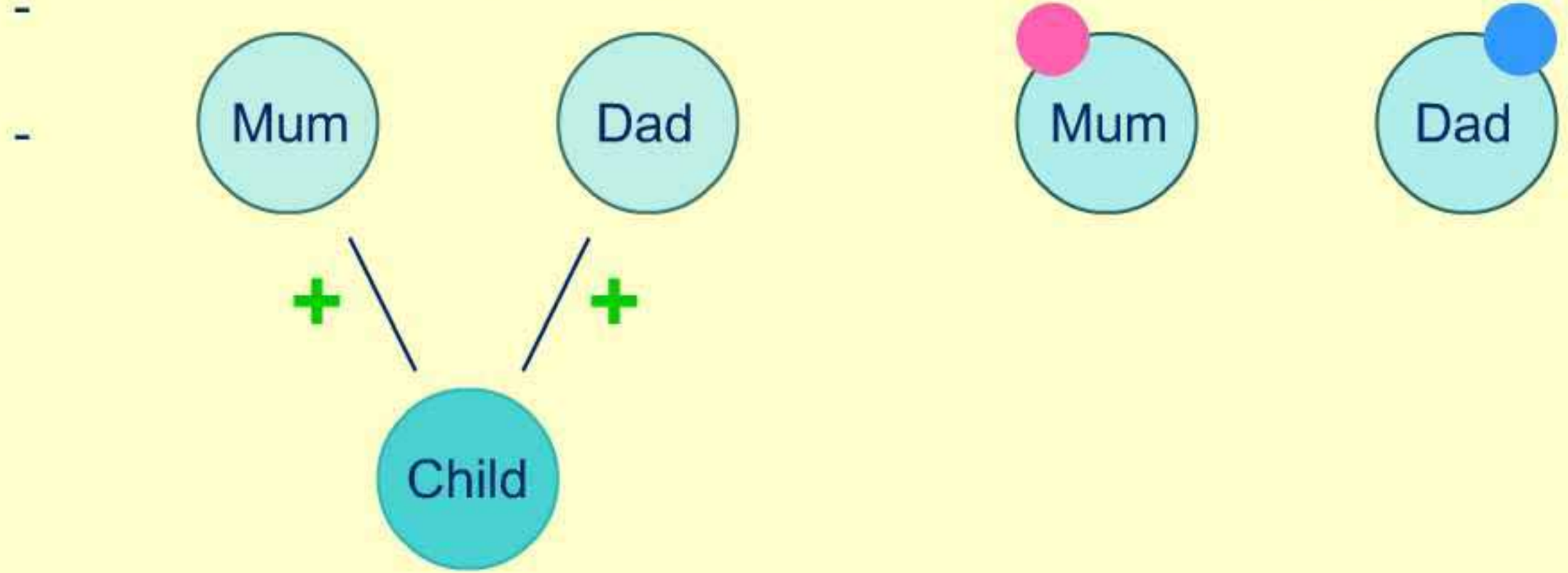

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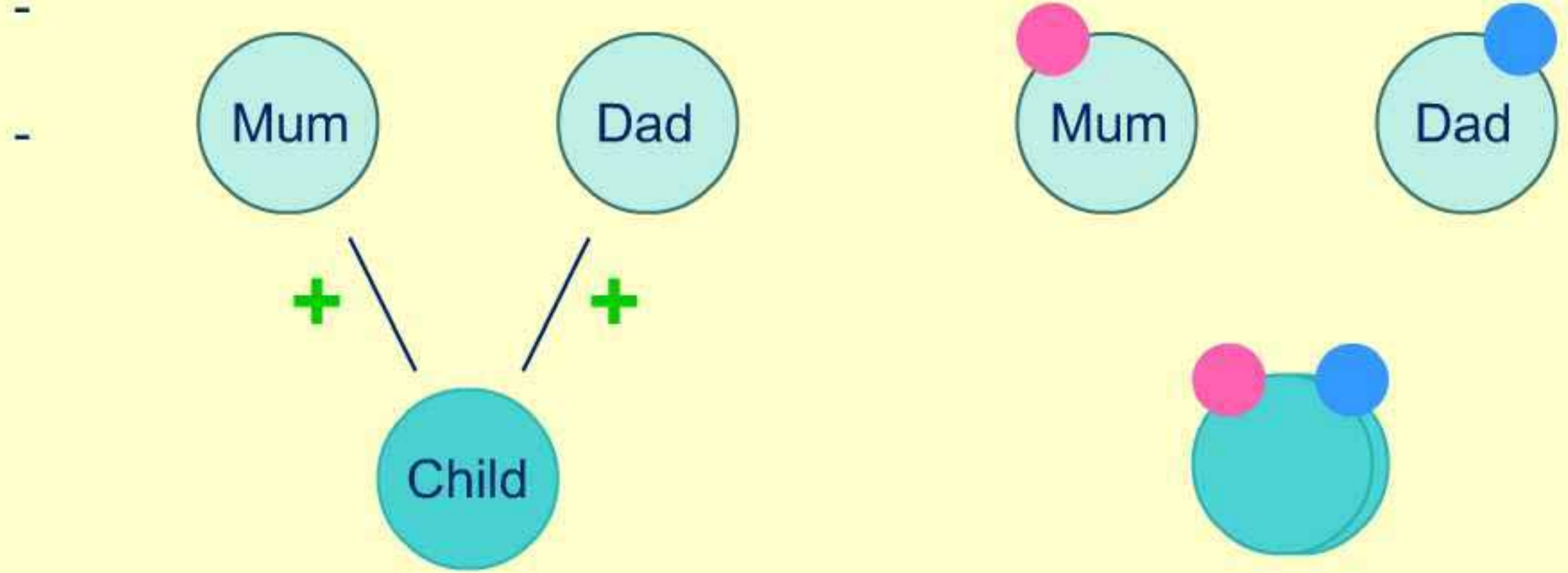

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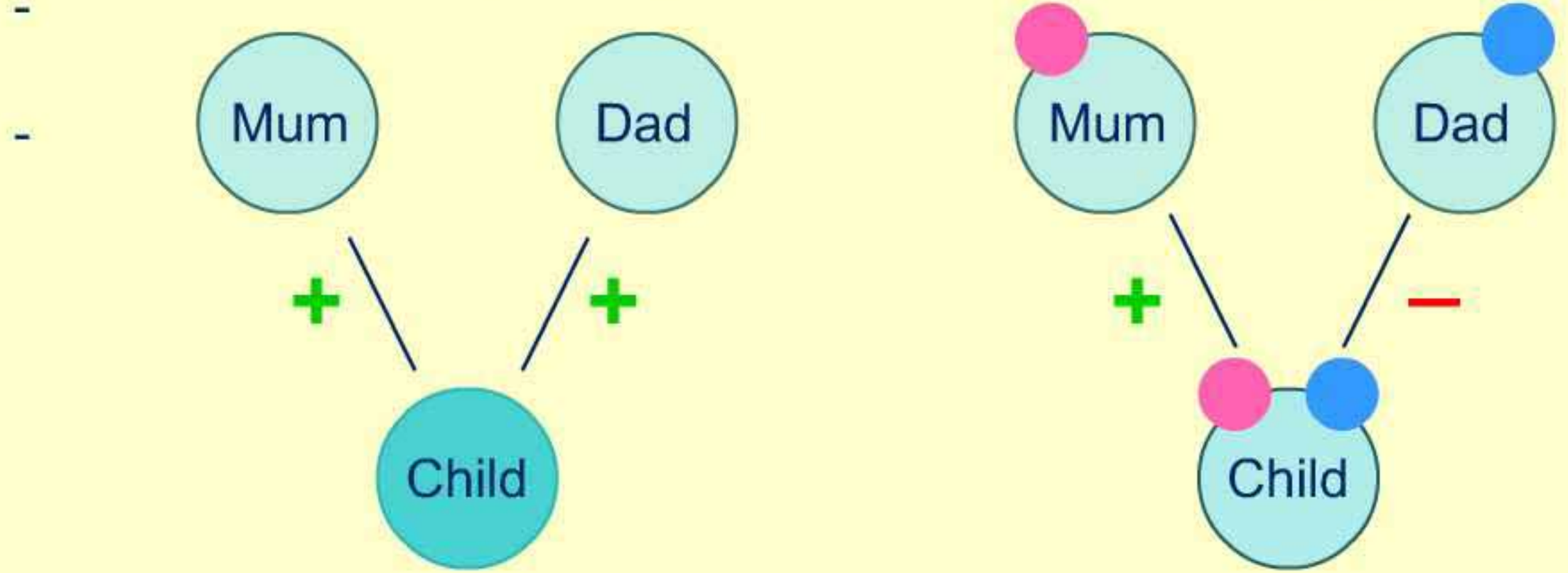


Battles fought between male and female genomes

- You need genes from both mother and father

- 'Imprinted' genes in mammals

- There may be only around 100 of these genes

- High risk of mutagenic interference:

- Prader-Willi, Angelman and Tourette syndromes, autism, Bipolar affective disorder, epilepsy and schizophrenia

Imprinted genes and sexual conflict

- Fathers want big babies

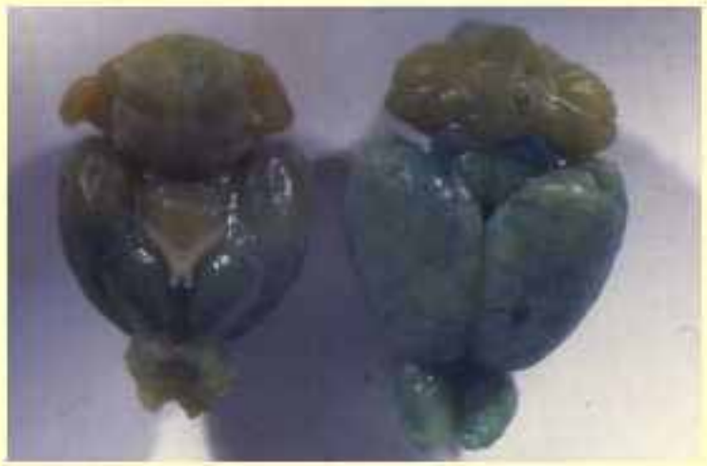
  - Foetal growth
    Igf II KO
    (Constancia *et al* 2002)

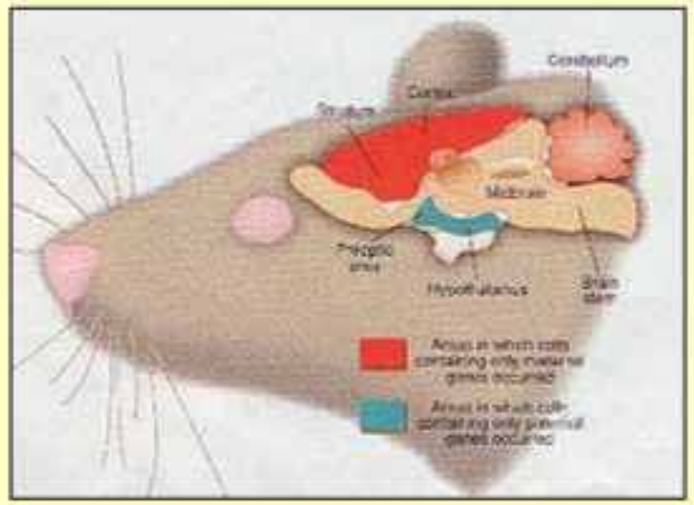
- Fathers want good mothers

  - Maternal and nurturing behaviours
    PEG3 KO
    (Li *et al* 1999)

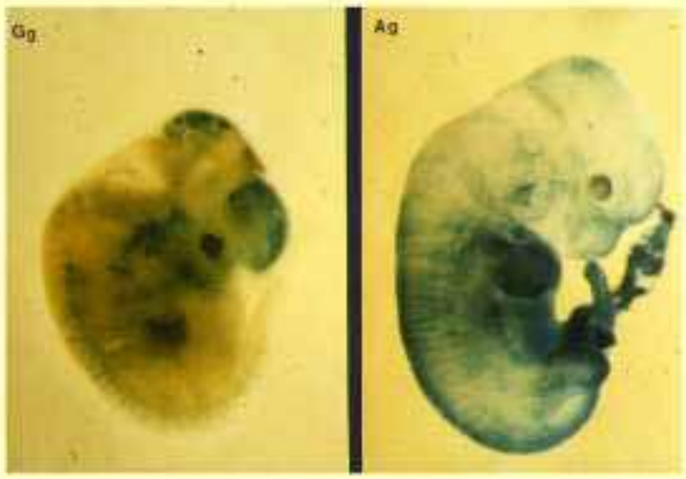
Imprinted genes and sexual conflict
(Allen *et al* 1995)

Maternal genes contribute to the cognitive and thinking parts of the brain





Paternal genes contribute to the 'baser instinct' and motivational parts of the brain



Imprinted genes on the X-chromosome

- Boys only inherit their X chromosome from their mother
- Turner's Syndrome 39,XO
-
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- Females may want to keep males socially inept, but with good resource provision skills

Summary:

- Males and females have equal numbers of imprinted genes
- As yet there is no evidence for changes due to monogamy
- At this level, both males and females always watch their backs !

Which species practice monogamy and does it promote female equality ?

- 10-25% of offspring produced within monogamous partnerships involve third parties

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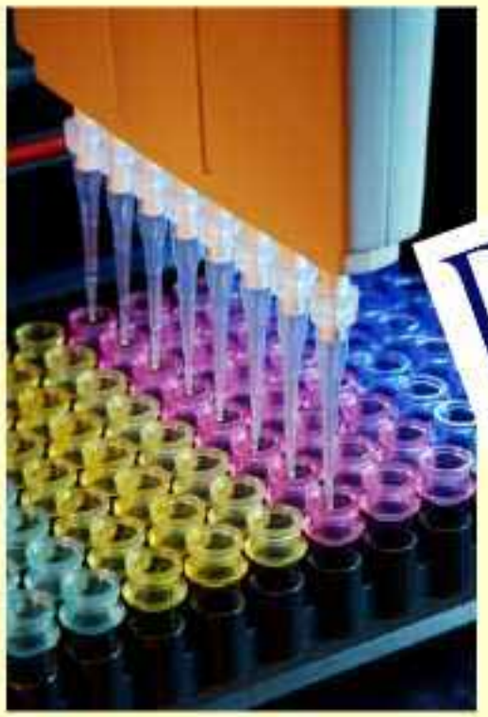

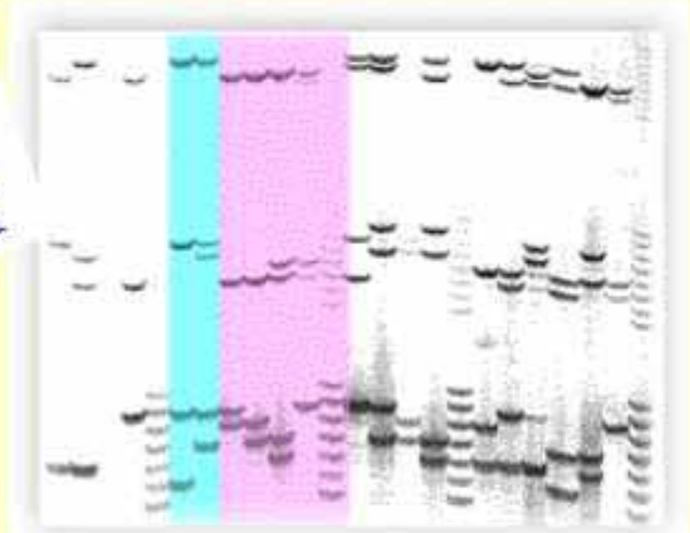

Typical results for cases of DNA Paternity testing

Which species practice monogamy and does it promote female equality ?

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- "If you wanted monogamy dear, you should have married.....a swan ! "

-

Which species practice monogamy and does it promote female equality ?

- 10-25% of offspring produced within monogamous partnerships involve third parties

- "If you wanted monogamy dear, you should have married.....a swan ! "

- Yours truly, madly, deeply, faithfully - until something better comes along !

What species practice monogamy and does it promote female equality ?

- Birds 90% - Primates 12% - Other mammals - 3%

- dik-dik, prairie and pine voles, the californian mouse, marmosets and tamarins

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- Of 238 human societies surveyed by LeBarre only 43 (18%) are monogamous

So what makes a species adopt monogamy ?

Both sexes need a good reason to adopt this reproductive compromise

So what makes a species adopt monogamy ?

For males:

- To avoid long-distance travel
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So what makes a species adopt monogamy ?

For males:

- To avoid long-distance travel
- To provide all males with equal shares and boost the population
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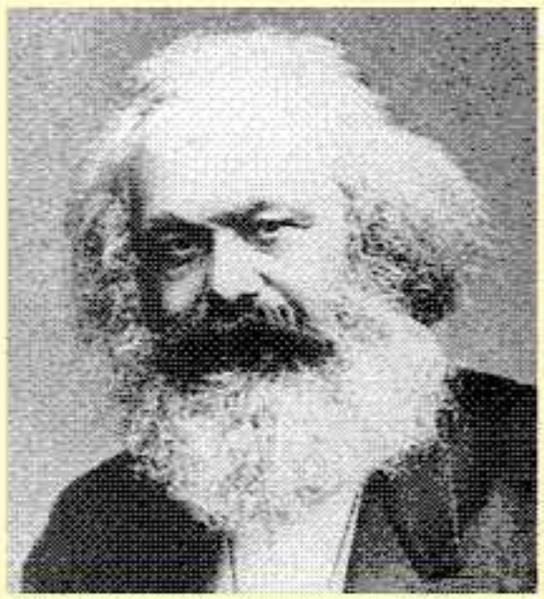

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- The political, economic, social and reproductive consequences of monogamy: Price (1999)

So what makes a species adopt monogamy ?

The political, economic, social and reproductive consequences of monogamy: Price (1999)

So what makes a species adopt monogamy ?

The political, economic, social and reproductive consequences of monogamy: Price (1999)

Parameter	Monogamous (84 states)	Polygynous (72 states)
- Mean population size	52.15 million	19.93 million
- Abolished death penalty	7 times more likely	
- Democracy	64 %	25 %
- Low levels of corruption	42 %	5 %
- per capita GDP	$10,000	$2000
- Military strength	High	Low

So what makes a species adopt monogamy ?

For females:

- To get help with looking after the kids
-
-
-
-

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- and.....

So what makes a species adopt monogamy ?

Greater freedom to play away ?

-

-

-

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So what makes a species adopt monogamy ?

Greater freedom to play away ?

- Extra-pair copulations (EPCs) by female birds and mammals occur when they are maximally fertile

- Females can have a fling with a bit of rough but keep a good resource provider/child-carer at home !

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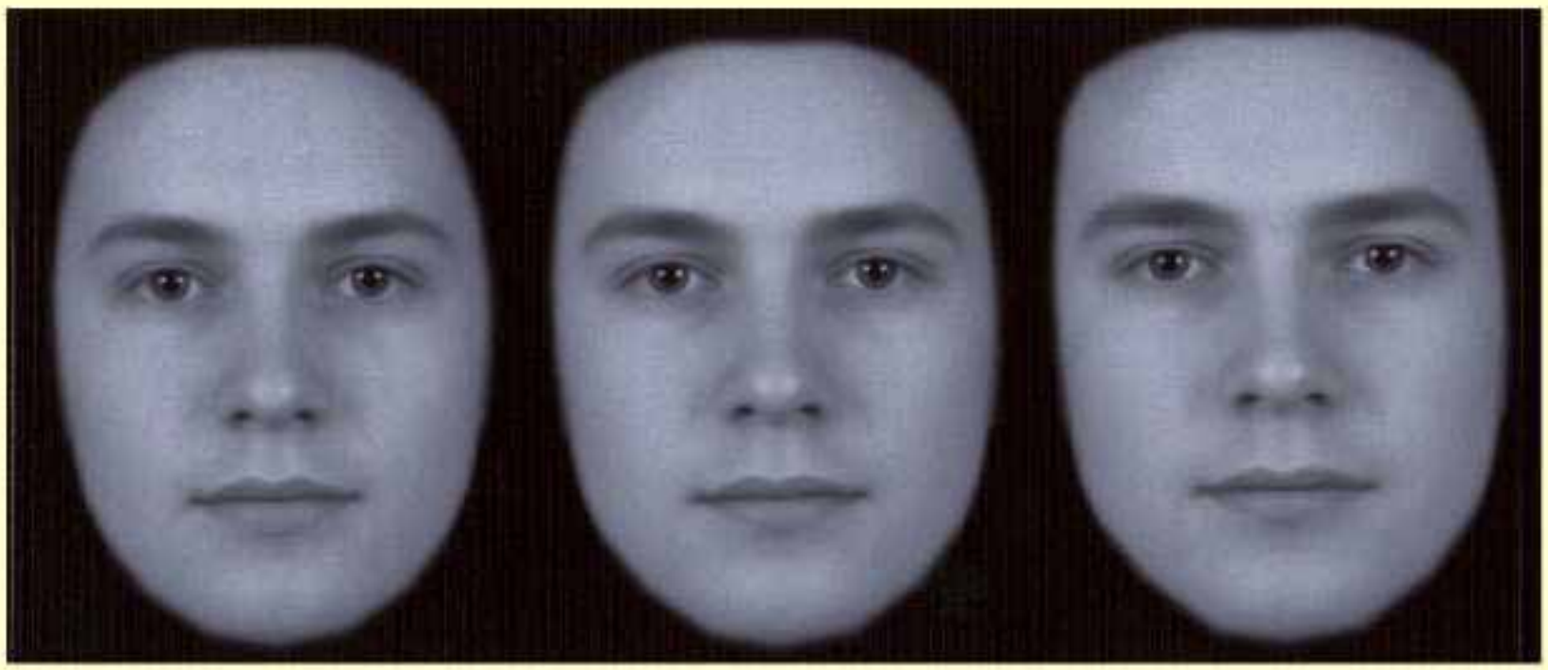

Feminised Normal Masculinised

Penton-Voak *et al* (1998)

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Greater freedom to play away ?

- Extra-pair copulations (EPCs) by female birds and mammals occur when they are maximally fertile

- Females can have a fling with a bit of rough but keep a good resource provider/child-carer at home !

- Allow sperm competition to pit partner vs novel 'bit on the side'

So what makes a species adopt monogamy ?

For both sexes monogamy reduces risk of sexually-transmitted diseases (protected sex !)

So do monogamous animals get divorced and why ?

- Impotence and infertility

-

Kittiwakes

So do monogamous animals get divorced and why ?

- Impotence and infertility
- EPCs - whether real or imagined

Mountain Bluebird

So do monogamous animals get divorced and why ?

- Open marriages do not seem to be on the agenda
- For all monogamous animals adultery is secret and done at high speed
- Males are far less discrete than females in this respect
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- Males are far less discrete than females in this respect
- Female unfaithfulness can be punished by reduced paternal care

So do monogamous animals get divorced and why ?

Divorce by DNA

By Jo Knowsley
SOCIAL AFFAIRS EDITOR

Landmark case as husband fights ex-wife's £300,000 claim after proving their children were fathered by another man

SHATTERED: Paul felt his 'life was a sham'

AN ACCOUNTANT is contesting his wife's claim for £300,000 in a divorce settlement – after DNA tests showed that his two children had really been fathered by another man.

The 43-year-old, known only as Paul so the children, aged 12 and nine, will not be identified, will argue that his wife's deception caused him incredible anger, pain and confusion and threatened to ruin his life. He is not seeking compensation for bringing up the children but wants her settlement reduced to reflect the fact that he has raised children who are not his own.

The case, which will be heard in the Family Division of the High Court in London next month, will create a legal precedent: it is the first time DNA evidence has been used to establish paternity and form part of a case in a divorce settlement.

For Paul, however, the court action is just another stage in a two-year nightmare which began when he discovered that his 12-year-old 'son' and nine-year-old 'daughter' were the children of his wife's lover.

Speaking exclusively to The Mail on Sunday from the flat in Kent where he now lives alone, Paul said: 'To discover after almost 16 years of marriage that not one but both my children had been fathered by my wife's lover made me feel violently sick.

'It meant that I had no children of my own, that I was not the family man I thought I was. My world collapsed like a pack of cards. To the outside world, it had seemed that we were a family with everything – I had a good job, we had a lovely house and two beautiful children. But really, I had nothing. Suddenly it felt as if my whole life was a sham.'

The saga began in 2000 when Paul decided to use a DNA test – available on the Internet – to test his then ten-year-old son. He used a swab to take saliva from the boy's mouth and his own and sent the samples to an American labor-

Mail on Sunday
3 November 2002

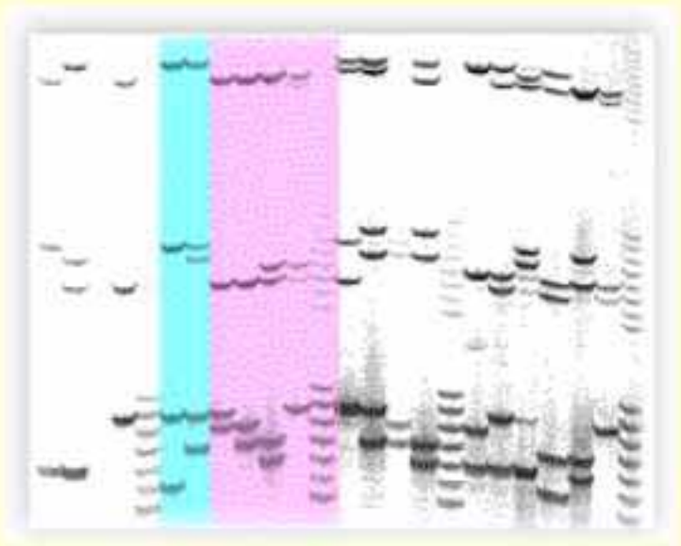
'She couldn't see she'd done anything wrong'

So what makes a species adopt monogamy ?

Monogamy at a species level must have some genetic control

- Monogamy genes ?

  - www.monogamy.com



Typical results for DNA monogamy testing ?

The search for monogamy genes

- Prairie and Pine voles are highly social, monogamous and males show parental care

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- Montane and Meadow voles are asocial, promiscuous and show no paternal care

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The search for monogamy genes

- Prairie and Pine voles are highly social, monogamous and males show parental care

- Montane and Meadow voles are asocial, promiscuous and show no paternal care

- The same pattern is seen in the Californian mouse compared with other mouse strains

-

The search for monogamy genes

- Prairie and Pine voles are highly social, monogamous and males show parental care

- Montane and Meadow voles are asocial, promiscuous and show no paternal care

- The same pattern is seen in the Californian mouse compared with other mouse strains

- A 1% difference is therefore enough !

The search for monogamy genes

- What does one look for ?

- A mechanism for developing exclusive social bonding between individuals

- A mechanism for maintaining such social bonds in the face of potential threats to them

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Arnolfini
van Eyck

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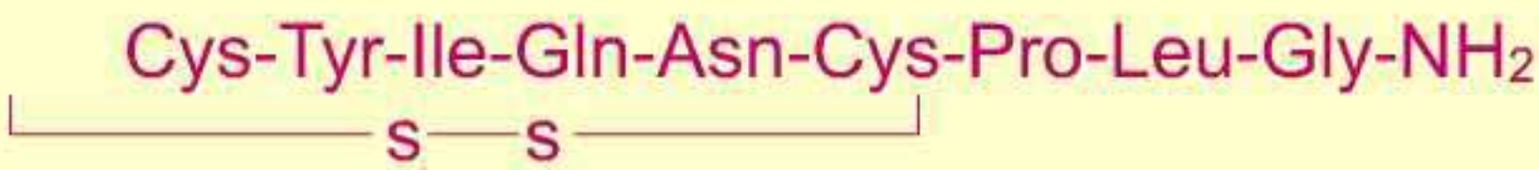

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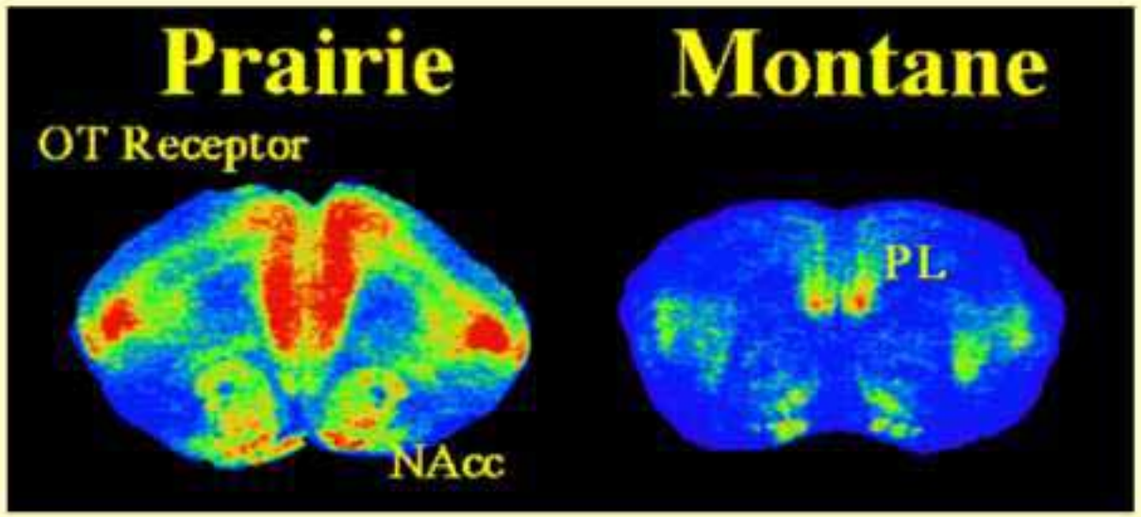

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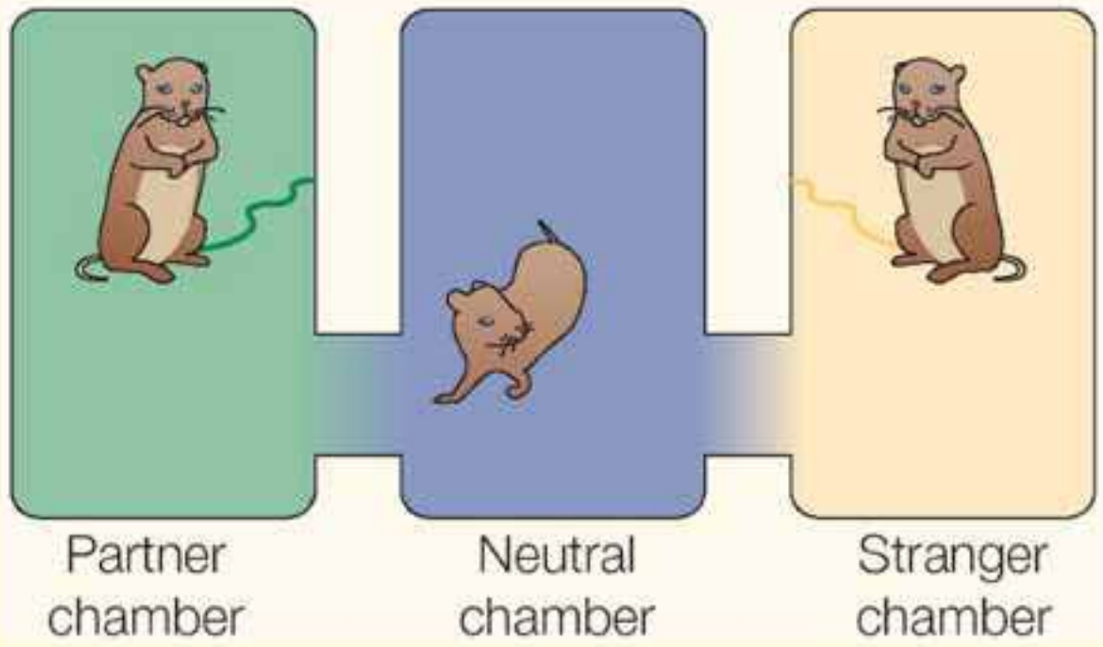
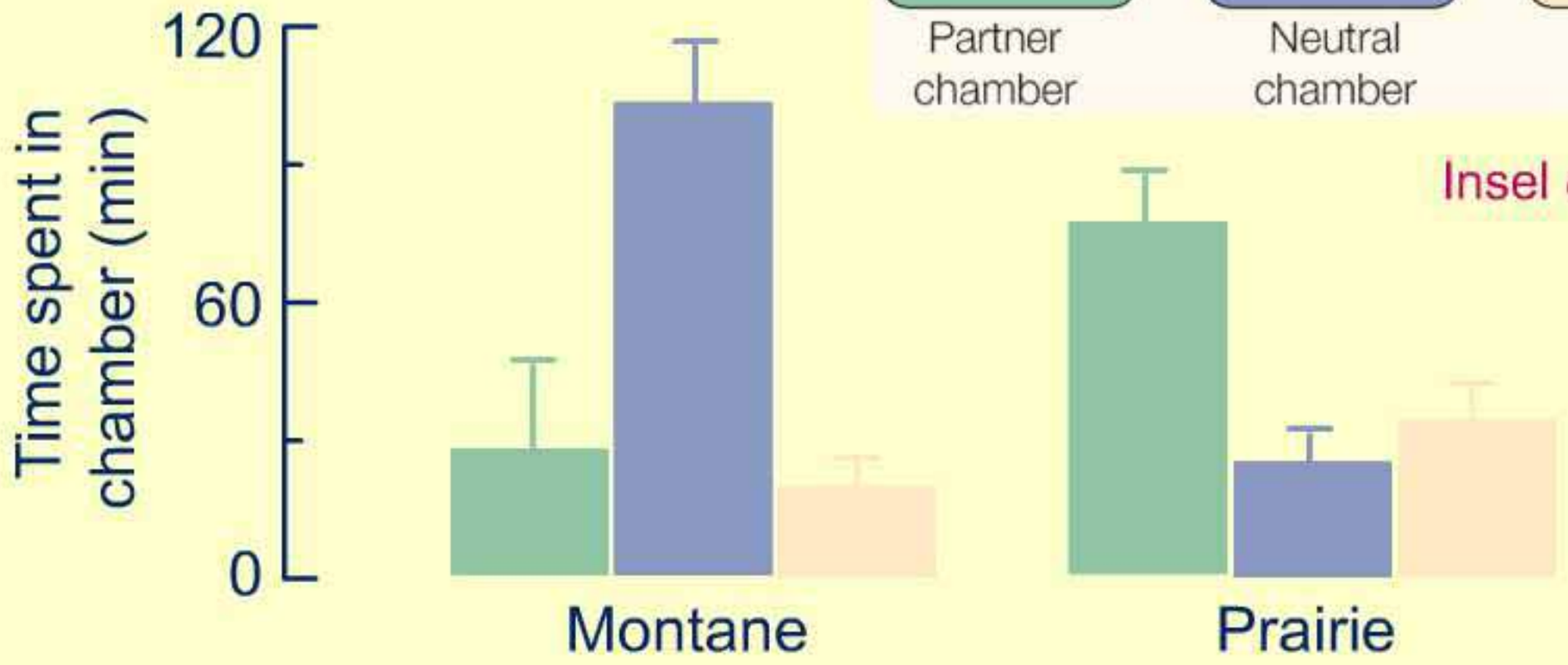


Insel *et al* 2001



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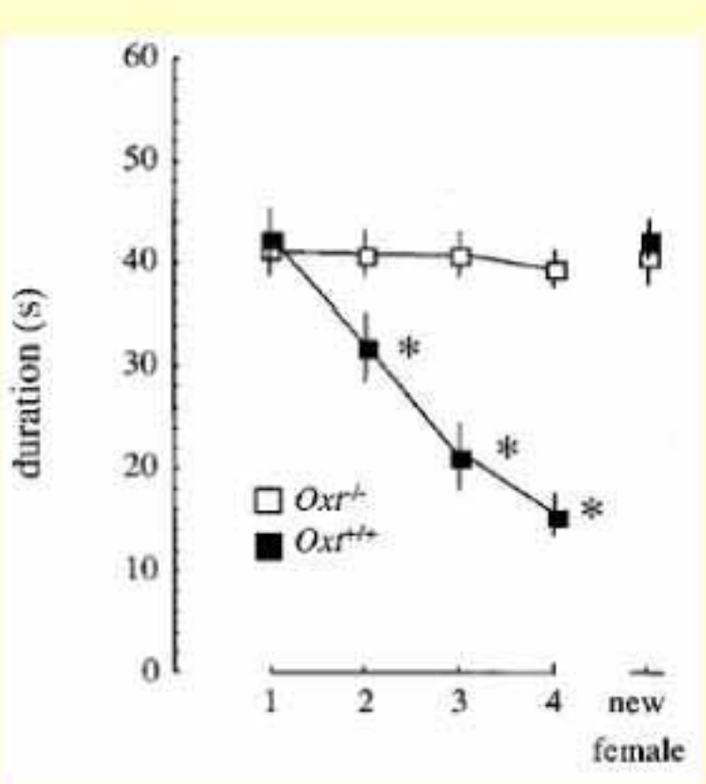

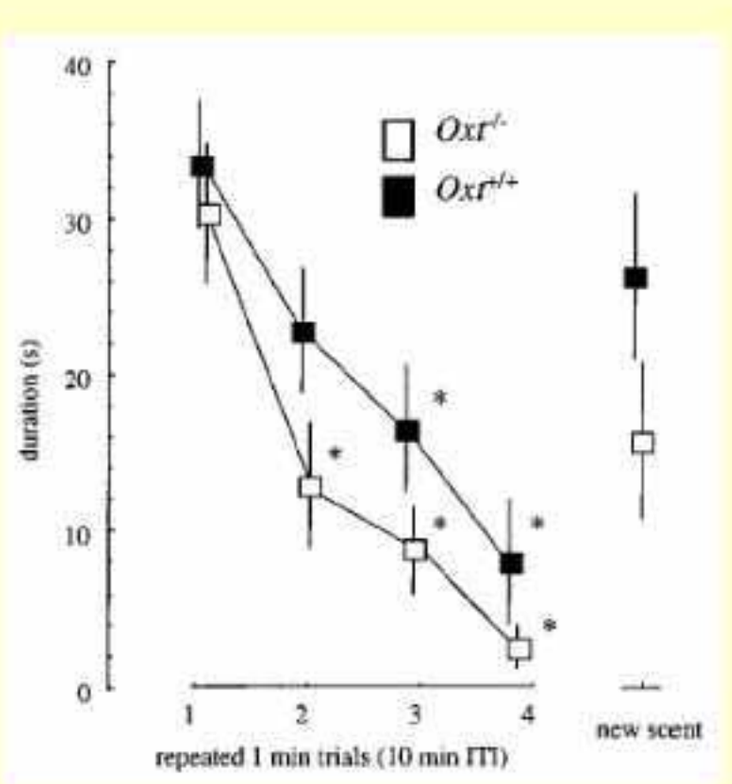

Ferguson *et al* 2000

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- Oxytocin is also important for allowing you to recognise your sexual partner

- When it is released it reduces anxiety

What controls the formation of exclusive bonds between partners ?

- It is the relatively asocial male mammals that have changed most to adopt monogamy

- Oxytocin may also help them remember their partner but not bond with them

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Cys-Tyr-Ile-Gln-Asn-Cys-Pro-Leu-Gly-NH_2 Oxytocin

s—s

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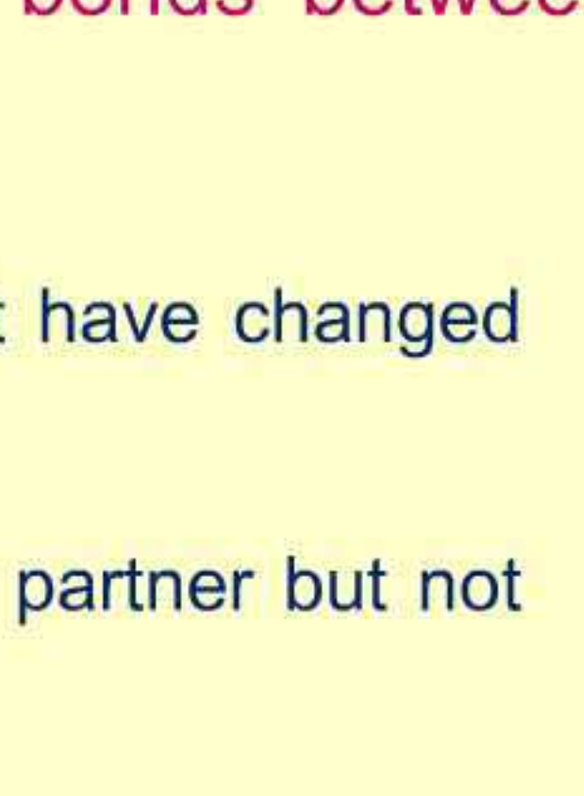

Young *et al* 2001

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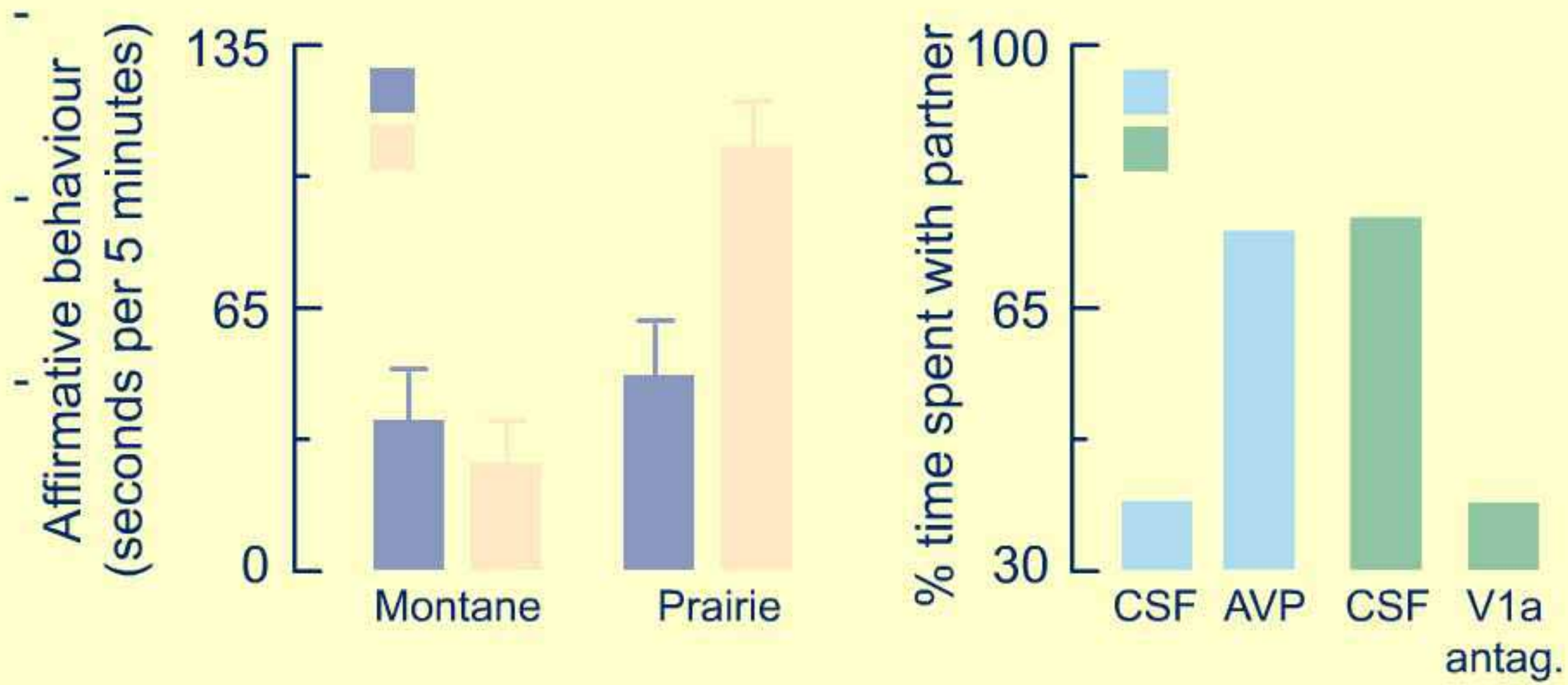

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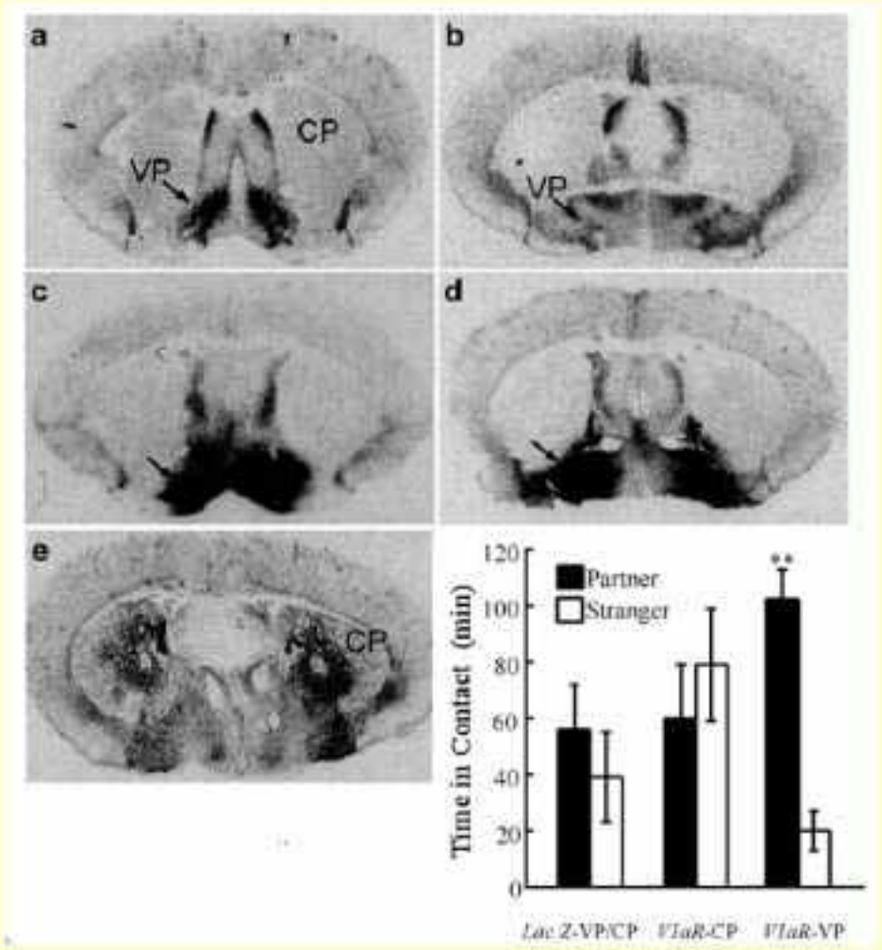

Pitkow *et al* 2001

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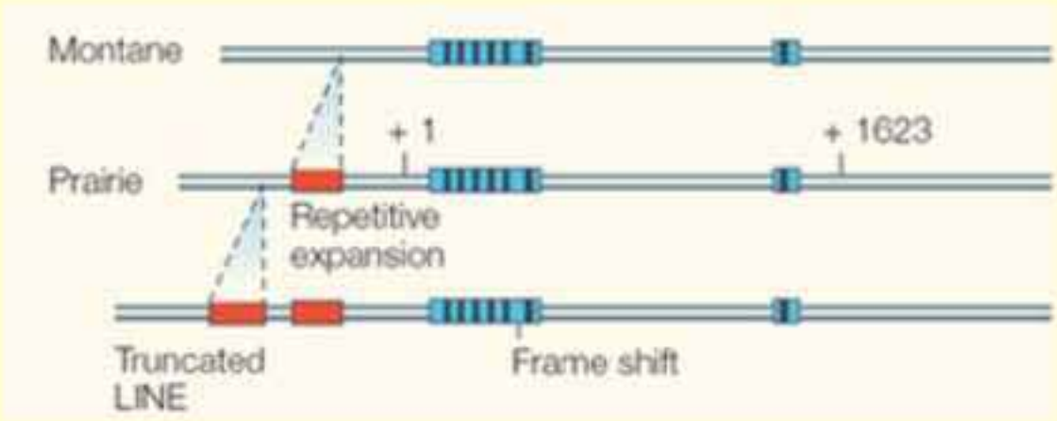

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- If this region from a vole is inserted into a mouse it becomes social in response to vasopressin

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Daily Mail, Thursday, August 19, 1999

Science finds a way to cure the love rats

All over: Jagger and Jerry

SCIENTISTS could be on the verge of finding a cure for love rats, it emerged yesterday.

Research on rodents has shown that a genetic tendency to infidelity can be reversed – and the effects on philanderers of the human kind may be just as drastic.

Sadly, it is a discovery that has come too late for the long-suffering Jerry Hall.

The latest success of genetic engineering might have allowed the former model, who never quite managed to get Mick Jagger to a legally-recognised altar, to have kept him by the fireside instead.

Scientists have managed for the first time to turn promiscuous, anti-social animals into friendly and faithful mates.

An American team achieved the transformation by inserting a gene from a monogamous species into a polygamous one.

The finding may also be important in treating such human disorders as autism, schizophrenia and Tourette's syndrome – a condition where sufferers spout obscenities in public.

The study, carried out at Emory University, in Atlanta, built on previous research involving voles.

Larry Young and his colleague Thomas Insel had already studied the monogamous prairie voles and their cousins the montane (hill-dwelling) voles, which have many mates.

'After mating, the male prairie vole forms a strong social bond. He prefers to be with that mate to the exclusion of all others,' said Dr Young.

'That pair nests together. When she has her babies he spends as much time with those babies as she does. He defends the nest. They stay together for the next litter and the next and the next.'

But montane voles behave in a vastly different manner – even though their genetic make-up is 99 per cent identical to that of their prairie vole cousins.

'When the montane vole mates, he immediately takes off and searches for another female,' said Dr Young.

The researchers managed to identify the DNA sequence that separated the two types of vole.

It is responsible for regulating how much of the peptide hormone vasopressin is released into the brains of animals, including humans. Vasopressin plays a role in male behaviours, including aggression, communication, sexual activity and social memory.

In the new study, scientists took a vasopressin receptor gene from a monogamous vole and inserted it into a polygamous mouse.

To their surprise, the resulting 'new mice' formed close relationships with females, says a report in the science journal Nature. Mice were used first because it is easier to change their genetic make-up.

The next step is to see whether genetic implants will also make the montane moles more faithful.

Dr Young said much more research would be needed to determine whether genetic manipulation could help treat antisocial disorders in humans.

He warned: 'In human cultures we may find that experience and values have a lot more to do with behaviour.'

In other words, the human love rats may not want to be cured.

'He takes off to search for another'

What controls the formation of exclusive bonds between partners ?

- Vasopressin brain infusions also facilitate social recognition

- Non-monogamous species have more receptors in areas associated with aggression

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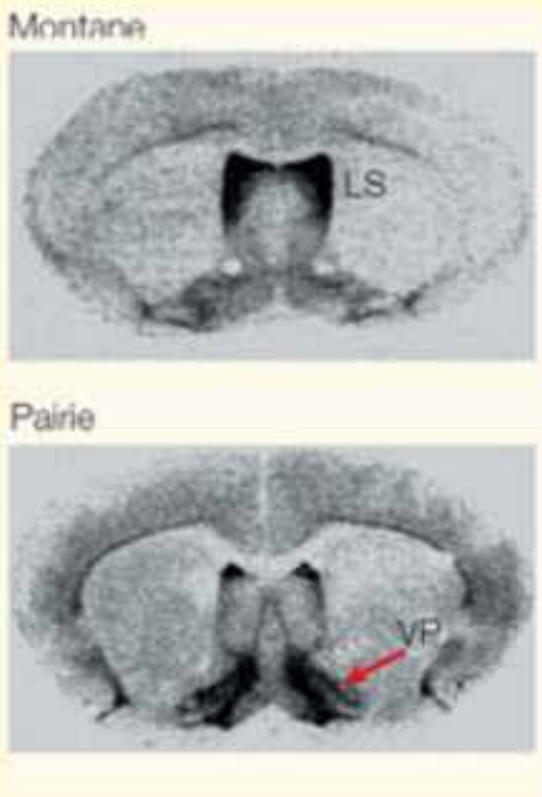

Young *et al* 2001

What controls the formation of exclusive bonds between partners ?

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- A fine balance between love and hate ?
- Oxytocin, vasopressin and human social disorders

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- Stress and social bonds
- Stress hormones facilitate pair-bonding
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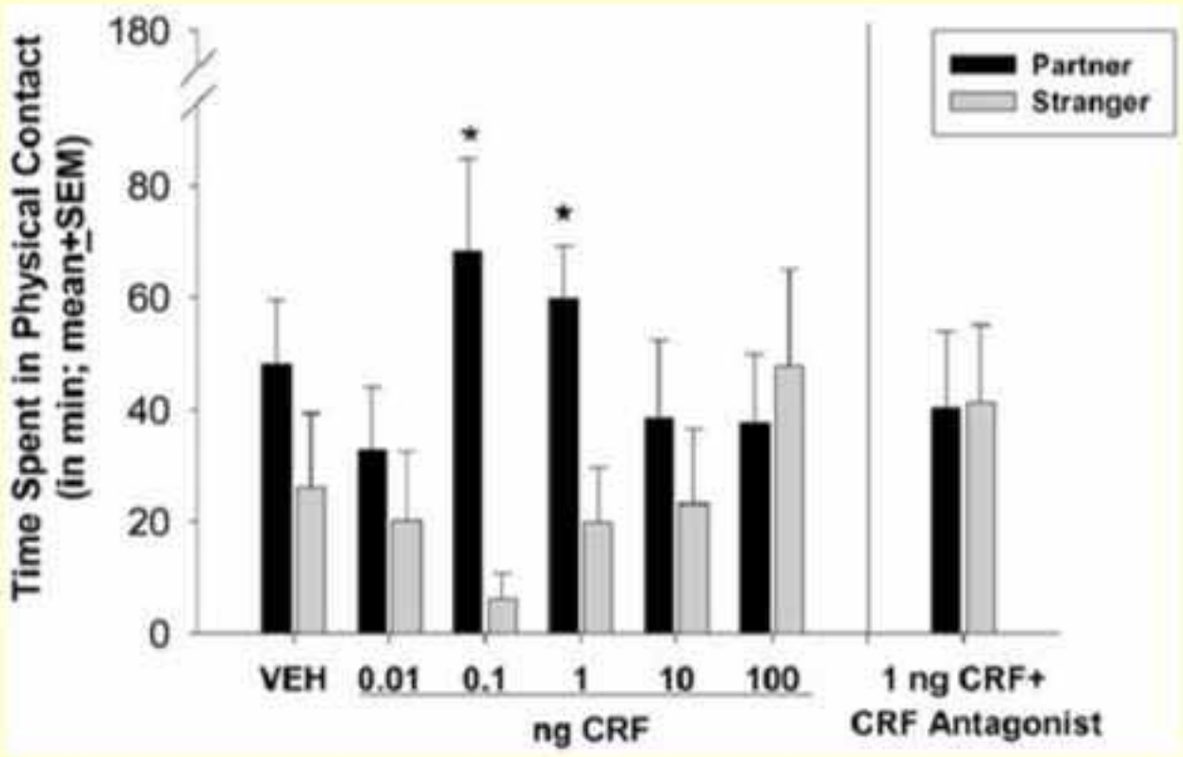

DeVries *et al* 2001

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- Stress and social bonds
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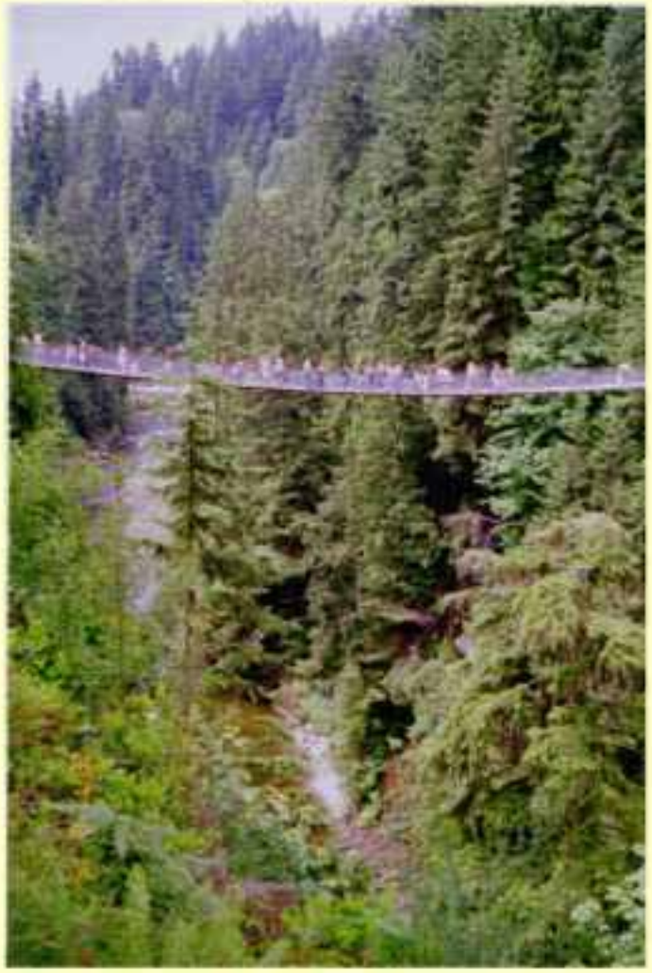
- Brain opiate systems promote social and bonding behaviour in sheep and monkeys
- Boys and girls on high level suspension bridges seem more attractive
- Shared experiences of stress during the course of a bond should strengthen it

Capilano suspension bridge
British Columbia,Canada



Dutton and Aron (1974)

Is there a monogamy gene ?

- Genome changes have increased the propensity with which both social and sexual interactions between individuals, and shared experiences of stress, promote pleasure

- They do not directly regulate sexual exclusivity

Sexual exclusivity

- Sexual exclusivity in this arrangement does not make compelling biological sense

- It is enforced legally or morally to maintain a strong, peaceful, well resourced, productive and democratic cultures

- Or by fear of losing all the other positive aspects of the social relationship

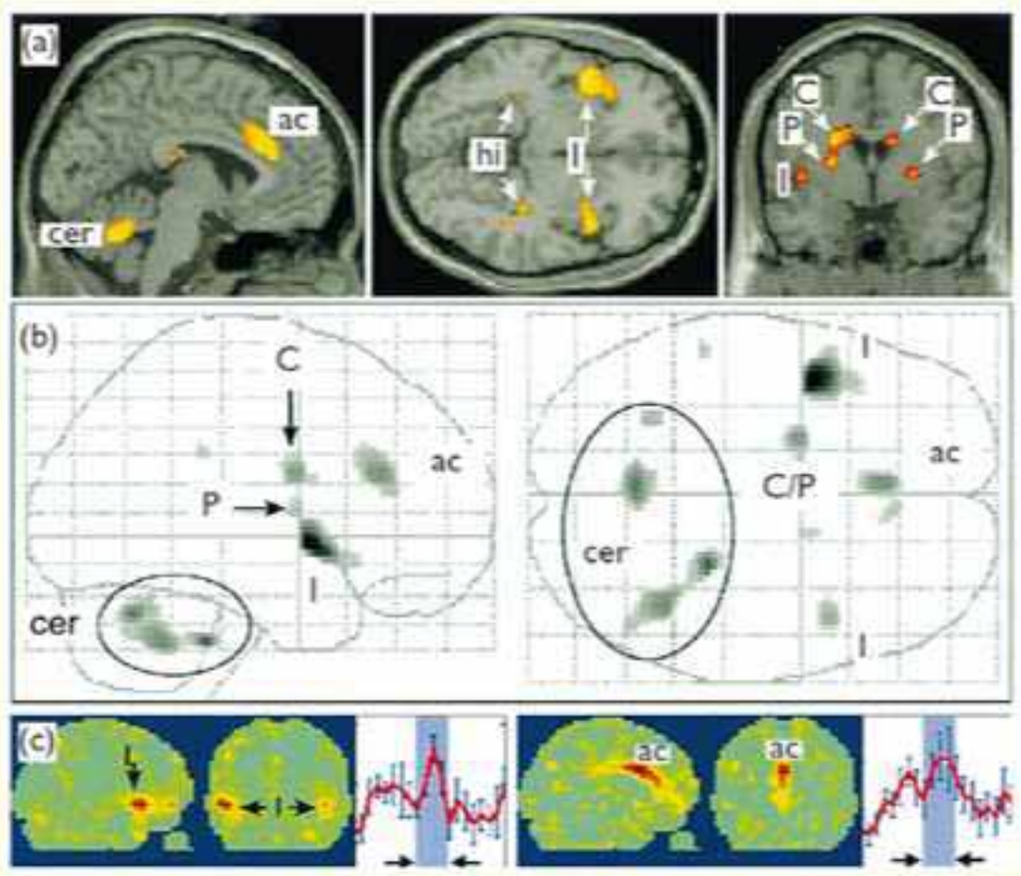
- Social exclusivity in pairs is much more stably maintained than sexual exclusivity

Some final thoughts on mongamy

- Monogamy has led to greater sexual equality and female choice
- The arsenals of the biological weapons used by males for sexual conflict have been reduced by monogamy
- Monogamy has not led to any signficant arms decommissioning in females !

Is there ever going to be a biological way to test whether you have met the ideal monogamous partner ?

Human brain scans have revealed four specific regions that light up only when you view images of your beloved partner



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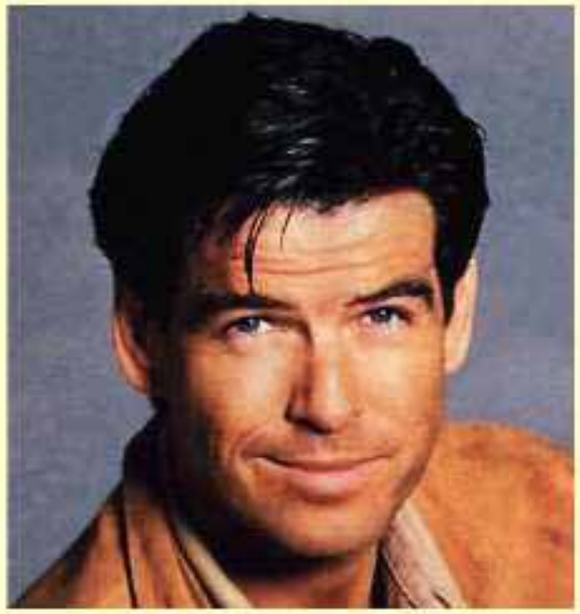
So, will this lead to the monogamy detector ?



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"Monogamy is impossible, but anything else is worse"

Francois Truffaut