Smell and Male seasonal breeding (Role of Pheromones)

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Introduction

- It is easier, from an evolutionary perspective, to change the timing of the mating season than to change the duration of gestation or lactation.
- Seasonality in animals a function of interaction btwn extrinsic (env't) & intrinsic (genetically programmed) events (mainly endocrine)
- Extrinsic/Env:
- *Temperature, humidity, amount and distribution of rainfall, solar radiation and photoperiod, nutrition, productive system management, social interactions*
- *Main predictor = photoperiod. (*Ungerfeld et al ., 2011)

-Cont-

- Photoperiod affects circadian & circannual rythms in animals.
- Intrinsic:
- Life expectancy, gender (Simpson et al., 1982)
- social interactions among individuals within the same population, predator-prey interactions, parasite- and pathogen- host interactions

  (Taberlet et al., 2011, Burns et al., 2010)

Review

- Spermatogenesis
- Differentiation of Sertoli cells,
- Formation of sex cords containing pre-spermatogonia and Sertoli cells,
- Appearance of Leydig cells,
  - **Production of testosterone**
  - **Male germ cells enter mitotic arrest**
  - **resume development at puberty**

birth to puberty

- Normally formed male gonad (testis)
- Leydig cells remains fairly constant from late fetal period thro' out the postnatal period.
- However, juvenile and pubertal cells are different in ultra structural xeristics -SER, RER, Golgi & mitochondria. (Hardy et al., 1991)
- Sertoli cells - differentiation commences during puberty (de Kretser and Kerr 1988)

  number of the Sertoli cells in the testis remaining stable throughout adulthood (Wang et al., 1989).

Stimulation of activity at puberty

- Activation of the Hypothalamo – pituitary – Gonadal (HPG) axis
- GnRH → Pituitary hormones;
- Pituitary LH and FSH
- Testosterone, cortisol, prolactin – All play a role in sexual maturity & behaviour
  - (Borg *et al., 1992)*

Role of smell

- Pheromones
- Def.
- Pherein - to carry
- Hormon – excite
- Ref as **ecto-hormones**:
  - chemical messengers that are emitted into the environment from the body where they can then activate specific physiological or behavioural responses in conspecifics.

Classification: -

(1) signal/releaser & (2) primer -

- *Releaser*
  - A specific reaction, definite behaviour
  - Short term, immediate
- *Primer*
  - Developmental process (Tristram D. W., 2003)

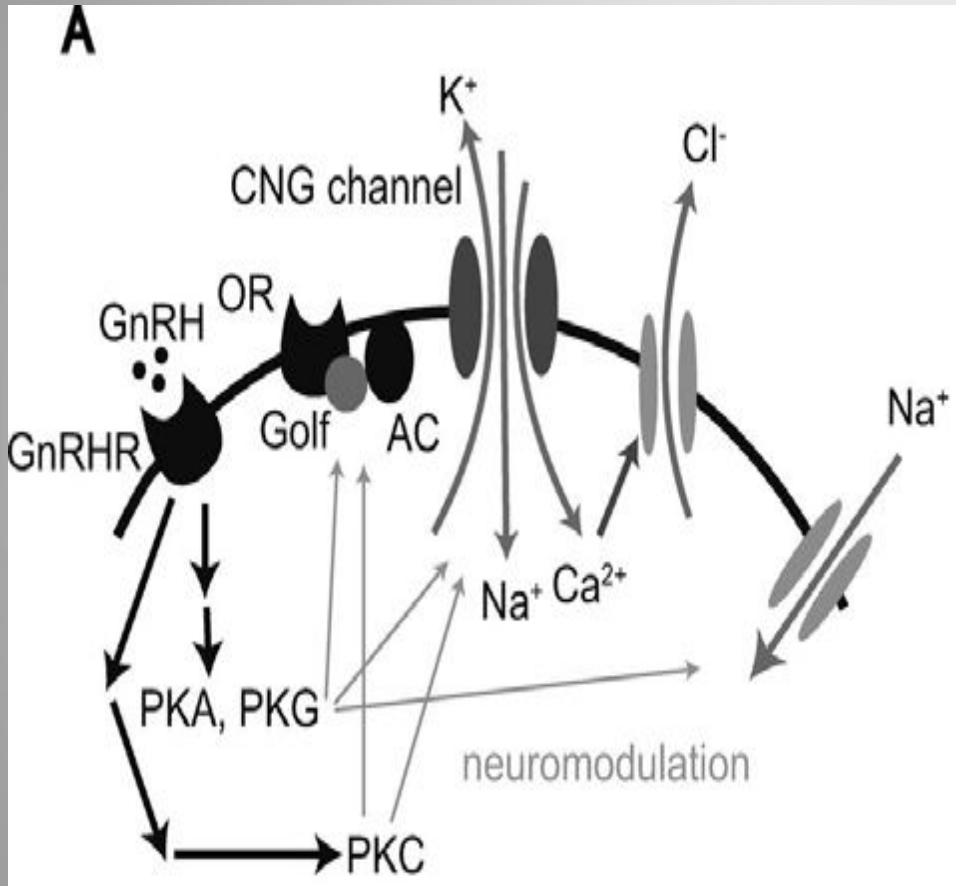
Pheromone - detection

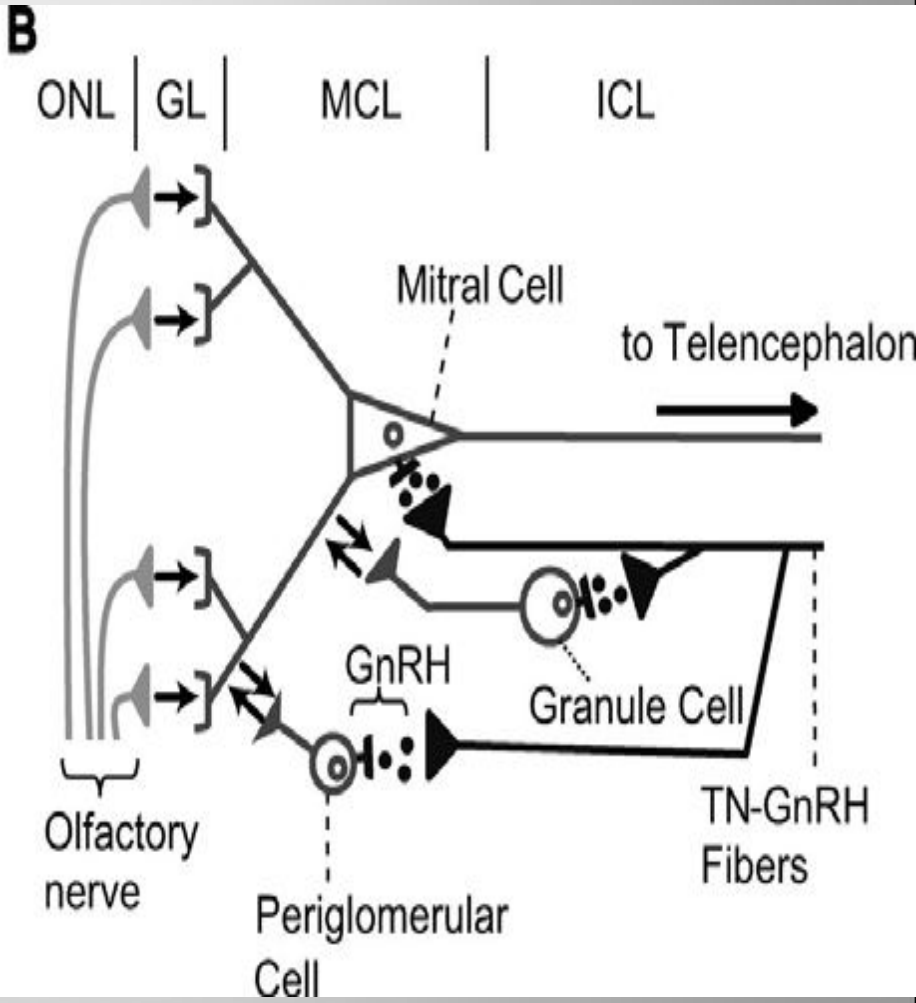
- VNO/ Jacobson's organ
- located above the hard palate on both sides of the nasal septum
- detection of volatile pheromones by the main olfactory epithelium (MOE)
- leads to the activation of a population of glomeruli and abutting mitral cells in the main olfactory bulb (MOB)
- mitral cells extend axons to the medial/vomeronasal amygdala

- cont-

- The amygdala sends impulses to the hypothalamus → GnRH → reproductive hormones release.
- VNO destruction dramatically reduced the capacity of female mice, when tested while in estrus, to display lordosis in response to the receipt of mounts from a male.
  - Martel and Baum, 2009a

VNO mechanism of action





cont

- The terminal nerve (TN) is a major source of GnRH in the olfactory epithelium (Amano et al., 2002)
- GnRH acts as a neurotransmitter and neuromodulator;- alters the membrane excitability of mitral cells, thereby modulating their firing activity (Hardy et al., 2005)
- GnRH conc. In the olfactory bulb is increased within 1 hr when ♀ Prairie Vole is exposed to male urine (Dluzen et al., 1981)

Effects in various *spp*

- Swine
- Androstenone in saliva:

  attracted estrous sows, and facilitated their receptive, “standing” behavior when pressure was applied to the back by a mounting male. (Dorries *et al*., 1995)
- occlusion of the VNO ducts in female pigs failed to disrupt their detection/motivation to approach this odor (Dorries *et al*., 1997)

Star fish

- Pre-ovulatory pheromones released into H_2O lead to LH surge in males

Response;

- Increased swimming & searching behaviour upto 12 hrs
- Increased milt volume within hrs
- Increased sperm release, motility & male competitive behaviour (Norm Stacy, 2003)

Equine

- Behavorial response:
- Foreplay - the male will smell, nibble , lick mare, exhibit flehmen.
- Following ejaculation - stallion may smell the mare’s genital area and the ground, flehmen and urinate.

Shoats

- females are anoestrous (before puberty, during gestation and lactation, during photoperiodic or nutritional anoestrus) – Shackelton & Shank, 1984
- temperate regions- Most sheep breeds show reproductive seasonality,
- Tropics - very weak or does not exist at all
- females are more seasonal than males, and ewes' breeding season is normally shorter than rams' one, from the same breed. *(*Ungerfeld et al ., 2011)

- cont-

"Ram effect"

- Ram wool/fleece contain pheromone – smell stimulate onset of estous and full ovulatory response
- **"Female effect"**
- exposure of males to oestrous females
- - ↑ LH secretion, plasma testosterone, FSH, cortisol & prolactin (Howland *et al. 1985)*
- FSH, Testo – associated with courtship behaviour
- Cortisol, prolactin – mounting and intrommision - Borg *et al., 1992*
- anosmic ewes exhibit a depressed ovulatory response to rams (Morgan *et al., 1972)*

- **Ram** - Behaviour
  - sniffing, extending neck and curling lip (flehmen) response
  - tongue goes in and out, may bite the female's wool raise and lower one front leg in a stiff-legged striking motion

bovine

- Male to female pheromones
- prepubertal heifers receiving oronasal treatments with bull urine reached puberty earlier than heifers receiving control treatment with water.
- The urine-treated heifers calved earlier and had a shorter calving season than the control heifers (Izard & Vandenbergh, 1982a)
- ovarian activity - exposure to bulls, or their excretory products shortened postpartum anoestrus; hastened resumption of luteal activity after calving (Landaeta-Hernández *et al., 2004;* Berardinelli & Joshi (2005b),

Captive Male emus

- Seasonal changes in testicular morphology and blood plasma concentrations of LH, testosterone, and prolactin;
  - Testicular mass – ↑ two fold during breeding season
  - Testicular T, plasma LH, prolactin tubular diameter - ↑ during breeding season (O'Malley, 1998)

Red sided garter Snake (*Thamnophis sertalis parietalis*)

- Conspecific trailing behaviour of males result from female (and she–male) derived sexual attractiveness pheromone. (Y- maze)
- No change when other male present in maze (Michael, P. 2001)

Wildebeest (Gnu)

- Calving in feb/march
- Rut – Intense in May/June (Northern migration)
- Males cued by early estrus females - become more territorial and start to separate small harems from the main herd
- Smell key to rutting behaviour (Mysterud, Coulson, and Stenseth, 2002)

Mice

- The exposure of male mice to female mice or to urine from female mice induces a luteinizing hormone (LH) surge (Maruniak and Bronson 1976)
- females without a pituitary gland, or urine from such females, fail to induce the LH surge in males

  (Johnston and Bronson, 1982).
- Male mice prefer the odors of estrous over nonestrous females (Kavaliers and Kinsella, 1995)

coyote

- ↑ in testosterone, testicular vol, ejaculate quality and quantity btwn Dec & April (breeding season) Minter el al 2008.
    - *Not directly linked to pheromone*

Man

- maximum attractiveness of female mosquitoes (*Aedes aegypti) to cycling women occurred on days 13, 18* and 23 after the onset of menses, - corresponds well to the peaks in estrogen secretion during menstrual cycle. Roessler (1963)
- Men rate women bodily odours more pleasant around ovulation cmprd to other menstrual phase. (Thornhill, Gangestad, 1999)
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Man –cont-

- male underarm volatiles, when applied to the lips of women subjects, accelerate the next LH pulse and improve mood ratings (Preti *et al*., 2003)
- Increased earnings of lap dancers during follicular phase as opposed to luteal phase has been attributed to smell! (Miller et al, 2007)

Discussion

- The extent to which male-female interaction succeeds in inducing fertile reproductive activity is constrained by a range of interacting factors, particularly by photoperiod and more particularly in females (Walkden-Brown et al., 1999)
- Between-sex pheromonal communication clearly occurs in animals.
- There are different GnRH systems in the brain that express specific forms of the GnRH peptide (Okubo and Nagahama, 2008).

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- Food availability and ambient temperature determine energy balance, and variation in energy balance is the ultimate cause of seasonal breeding in all mammals and the proximate cause in many.
- Photoperiodic cueing is common among long-lived mammals from the highest latitudes down to the mid-tropics. It is much less common in shorter lived mammals at all latitudes. Bronson, F. H. (2009)

-Cont-

- climate change:

  the small rodents of the world may adapt rather easily but the longer lived mammals whose reproduction is regulated by photoperiod may not do so well. - (Bronson, F. H. 2009)

- Seasonal breeding patterns has concentrated on photoperiod, in the temperate latitudes.
- A major gap in our knowledge concerns the tropics; that is where most species live and where we have the least understanding of how reproduction is regulated by environmental factors. (Bronson, F. H. 2009)

- Reviewed literature does not rule out the possibility of pheromonal communication in species such as humans which lack a functional VNO.

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thank you