

## SLE 132 – Form and Function

### Animal Behaviour



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## What is Animal Behaviour?

- An individual behaviour is an action carried out by muscles or glands under the control of the nervous system in response to a stimulus
- **Ethology** - the study of Animal behaviour



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# What is Animal Behaviour

- On the simplest level a behaviour is what an animal does.
- Why it does these behaviours is also important

## **Example – Male silky anole**

- Extending dewlap (brightly coloured skin flap beneath the throat)
  - Facilitates recognition by members of their own species
  - establish territories
  - attract mates



# Animal Behaviour

- **Proximate causation – “how”**
  - Focus on the environmental stimuli that trigger a behaviour as well as the genetic, physiological and anatomical mechanisms
    - Mechanistic basis of behaviour?
    - How does development influence behaviour?
- **Ultimate causation – “why”**
  - Focus on the evolutionary significance of a behaviour
    - Evolutionary history of behaviour?
    - Behaviour contribute to survival and reproduction?

# Nature versus Nurture

- There are genetic and environmental components of behaviour
  - both are important
- Debate over the relative degree to which both genes and the environment influence phenotypic traits
- Behaviour is phenotypic trait – like all phenotypic traits, there is variation in behaviours (a range of reactions)
  - e.g. between individuals, environments and times

# Innate behaviours

## Behavioural responses to well defined stimuli

Innate behavior is genetically programmed. Individuals inherit sets of behaviors just as they inherit physical traits. In general, innate behaviors will always be:

<b>Heritable</b>	encoded in DNA and passed from generation to generation
<b>Intrinsic</b>	present in animals raised in isolation from others
<b>Stereotypic</b>	performed in the same way each time by each individual
<b>Inflexible</b>	not modified by development or experience
<b>Consummate</b>	fully developed or expressed at first performance

## Behaviour Patterns (Fixed Action Patterns)

- A behaviour pattern is a sequence of coordinated movements that are performed together as a "unit" without interruption.
- Each is triggered by a unique stimulus (often called a **sign stimulus** or releaser)
- A praying mantis striking at prey is a typical example
  - The releaser for this behaviour pattern is any movement by a prey-sized object within striking distance.
  - Once initiated, the mantis cannot abort the strike if the prey escapes.
  - What would be the advantage of this type of behaviour?

## Behaviour Patterns (Fixed Action Patterns)

- Other common examples include courtship displays, hunting or food gathering, nest-building activities, and attack or escape movements.
- Unlike simple reflexes, it may involve a whole-body response and often require a threshold level of internal readiness (drive).



# Behaviour Patterns

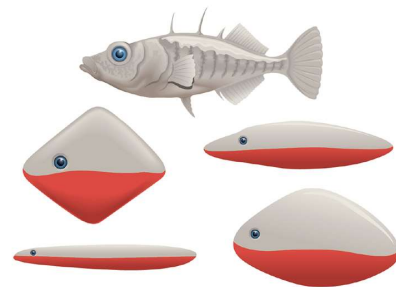
- Male three-spined stickleback fish.
- In mating season, males change colour, establish a nest within a territory, and aggressively defend it from other males while enticing females.
- Studies by Niko Tinbergen showed that the **red belly colouration** sets off an attack sequence in Male sticklebacks
- While a **swollen belly** set off a courtship sequence

# Behaviour Patterns

- A sequence of unlearned acts that once **initiated** is usually carried to completion.
- Triggered by an external cue known as a sign stimulus
- The presence of a coloured decoy set off a relatively invariable response
  - a head down attack



(a) A male stickleback fish attacks other male sticklebacks that invade its nesting territory. The red belly of the intruding male (left) acts as the sign stimulus that releases the aggressive behaviour.



(b) The realistic model at the top, without a red underside, produces no aggressive response in a male three-spined stickleback. The other models, with red undersides, produce strong responses.

▲ Figure 51.2 Sign stimuli in a classic fixed action pattern.

7 Suggest an explanation for why this behaviour evolved (its ultimate causation).

# Innate behaviours

**Reflex** – the simplest behaviour, sensory neuron, motor neuron response - type of behaviours

**Oriented Movement** – animal movement in response to external stimuli

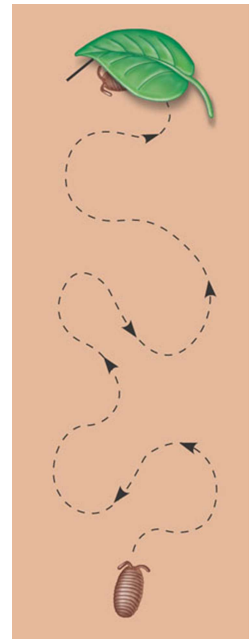
- Kinesis – a behaviour involving a (non directional) change in activity or turning rate (slaters, sow bugs)
- Taxis – an oriented movement toward or away from some stimulus (trout and other fishes)
- Migration – a regular long distance change in location (Birds, fishes and other animals)  
Orientation to the sun, stars, or earths magnetic fields as stimuli

**Behavioural Rhythms** – Those controlled or repeated to the daily, or circadian, cycles of light and dark in the environment or to the annual changes in that cycle over seasons

## Oriented Movement – Kinesis

A behaviour involving a (non directional) change in activity or turning rate.

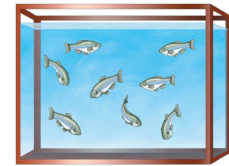
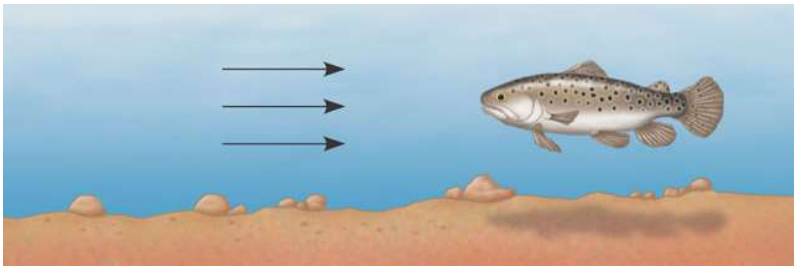
- Woodlice dry out easily
- When in dry conditions, they move more rapidly and change direction frequently (increasing the chance of moving into a new, more favourable area)
- When in a humid area they move slower and change direction less often.



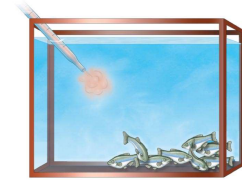
## Oriented Movement – Taxis

An oriented movement toward or away from a stimulus.

- Algae move towards light (positive phototaxis)
- Trout and many other aquatic organisms orient themselves to face into the oncoming current (positive rheotaxis)



(a) Minnows before alarm



(b) Minnows after alarm

## Oriented Movement - Migration

A regular long distance change in location  
(Birds, fishes and other animals)

Orientation used to navigate, usually on a seasonal basis

- Sun
- Stars
- earths magnetic fields

Most familiar – Bird and insect migrations



## Oriented Movement - Migration

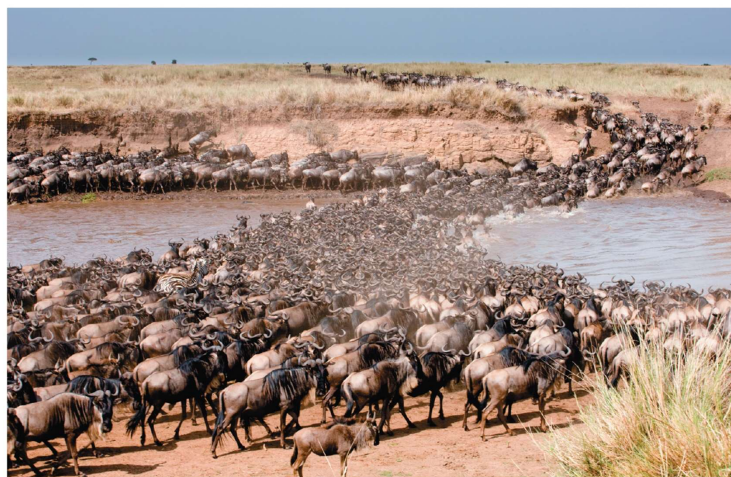


Christmas Island Red Crabs – Migrate to the sea every year to spawn, juveniles then migrate to jungles.

- Juveniles know paths to jungle and travel the same paths as parents back to the sea. What kind of behaviour is the knowledge of the route?

[https://www.youtube.com/watch?v=Yo7Rpr\\_xyOU](https://www.youtube.com/watch?v=Yo7Rpr_xyOU) – (3 mins)

▼ **Figure 51.3 Migration.** Wildebeest herds migrate long distances twice each year, changing their feeding grounds in coordination with the dry and rainy seasons.





# Innate behaviour

## Behavioural Rhythms

- Behaviour that is synchronized to the daily, or circadian, cycles of light and dark in the environment or to the annual changes in that cycle over seasons
- Can influence hibernation and migration
- E.g. Male fiddler crab (tidal rhythms)



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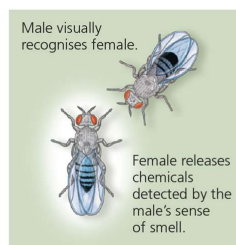


# Innate behaviour

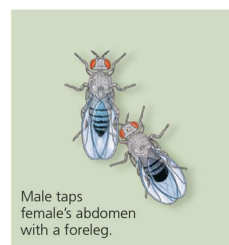
## Animal signals and Communication

- The transmission and reception of signals
- Visual, auditory, chemical and tactile signals
  - Pheromones are chemical substances that are sometimes used to transmit species specific information through the environment

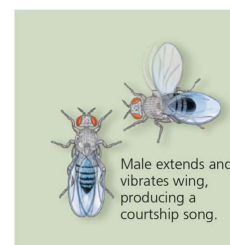
► **Figure 51.4** Courtship behaviour of the fruit fly. Fruit fly courtship involves a fixed set of behaviours that follow one another in a rigid order.



1 Orienting



2 Tapping



3 "Singing"

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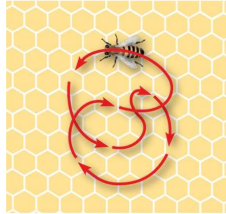


Bees dance in response to various stimuli to convey the message of that stimuli to other bees

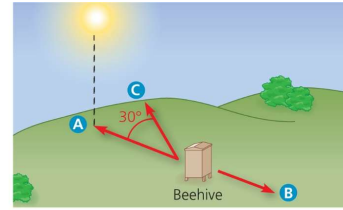
Waggle & Round dances  
<https://www.youtube.com/watch?v=PRGc7skekMQ>



(a) Worker bees cluster around a recently returned bee.



(b) The round dance indicates that food is near.



Location **A**: Food source is in same direction as sun.



Location **B**: Food source is in direction opposite sun.



Location **C**: Food source is 30° to right of sun.

(c) **The waggle dance is performed when food is distant.** The waggle dance resembles a figure eight. Distance is indicated by the number of abdominal waggles performed in the straight-run part of the dance. Direction is indicated by the angle (in relation to the vertical surface of the hive) of the straight run.

▲ **Figure 51.5 Honeybee dance language.** Honeybees returning to the hive communicate the location of food sources through the symbolic language of a dance.

## Quick Question

Innate behaviours are:

- A. encoded in DNA
- B. performed in the same way each time
- C. not modified by experiences
- D. All of the above are correct

## Learned Behaviours

- Innate behaviours result in nearly all of the individuals in a population exhibiting virtually the same behaviours
  - despite internal and external differences during development and throughout the life of the individual
- Learned behaviours, unlike innate behaviours, **can be variable depending on the experience** of the individual animal.

## Learned Behaviours

### Habituation

- Loss of responsiveness to a stimuli that conveys little or no new information (cry wolf effect)

### Spatial Learning

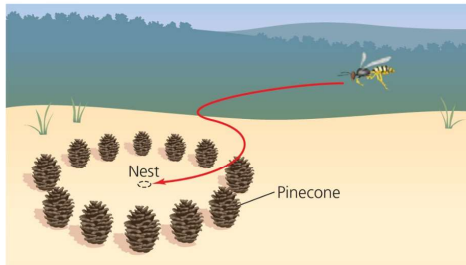
- Establishment of memory that reflects the environments spatial structure
- E.g. Digger wasps
- Cognitive maps – a representation in the nervous system of the spatial relationship between objects in an animals environment

▼ Figure 51.8

## Inquiry

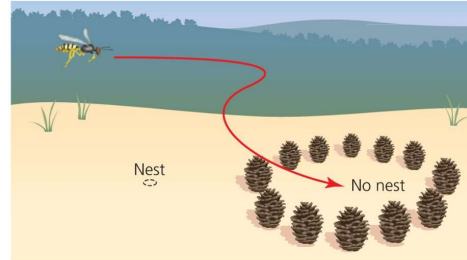
### Does a digger wasp use landmarks to find her nest?

**Experiment** A female digger wasp covers the entrance to her nest while foraging for food, but finds the correct wasp nest reliably upon her return 30 minutes or more later. Niko Tinbergen wanted to test the hypothesis that a wasp learns visual landmarks that mark her nest before she leaves on hunting trips. First, he marked one nest with a ring of pinecones while the wasp was in the burrow. After leaving the nest to forage, the wasp returned to the nest successfully.



Two days later, after the wasp had again left, Tinbergen shifted the ring of pinecones away from the nest. Then he waited to observe the wasp's behaviour.

**Results** When the wasp returned, she flew to the centre of the pinecone circle instead of to the nearby nest. Repeating the experiment with many wasps, Tinbergen obtained the same results.



**Conclusion** The experiment supported the hypothesis that digger wasps use visual landmarks to keep track of their nests.

Source: N. Tinbergen, *The Study of Instinct*, Clarendon Press, Oxford (1951).

**WHAT IF?** Suppose the digger wasp had returned to her original nest site, despite the pinecones having been moved. What alternative hypotheses might you propose regarding how the wasp finds her nest and why the pinecones didn't misdirect the wasp?

## Learned Behaviours

### Imprinting

- Involves both learned and innate components
- Is the formation at a specific life stage of a long lasting behavioural response to a particular individual or object
- Is distinguished from other learning by having a sensitive period – a limited developmental phase when certain behaviours can be learned



# Learned Behaviours

## Associative Learning

- The ability to associate one environmental feature (stimulus) with another
- Two types of associative learning
  - **Classical conditioning** – where an arbitrary stimulus becomes associated with a particular outcome (Pavlov)
  - **Operant conditioning** – trial and error learning, an animal learns to associate one of its own behaviours with a reward or punishment



▲ **Figure 51.9 Associative learning.** Having ingested and vomited a monarch butterfly, a blue jay has probably learned to avoid this species.

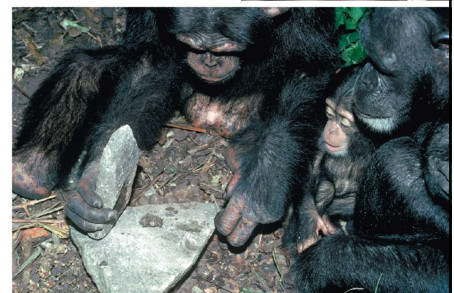
Which type of  
associative  
learning does  
this represent?



## Learned Behaviours

### Cognition and Problem Solving

- **Cognition** is one of the most complex forms of learning, it is the process of knowing represented awareness, reasoning, recollection and judgement
- **Problem solving** – the cognitive activity of devising a method to proceed from one state to another in the face of real or apparent obstacles



▲ **Figure 51.11** A young chimpanzee learning to crack oil palm nuts by observing an experienced elder.



## Quick Question

A Graylag goose is a ground nesting bird. If an egg rolls out of the nest the goose will roll the egg back into the nest with it's beak. It will even continue this action if the egg is removed, until it reaches the nest.

This is an example of:

- A. Migration
- B. Fixed action pattern
- C. Habituation
- D. Learned behaviour

## Quick Question

Which of the following is an example of a behaviour that can vary depending of the individual experience of an animal?

- A. Habituation
- B. Taxis
- C. Operant conditioning
- D. A and C

## Animal Social behaviour

- any interaction between two or more animals, usually from the same species
  - aggression
  - courtship
  - cooperation
  - even deception



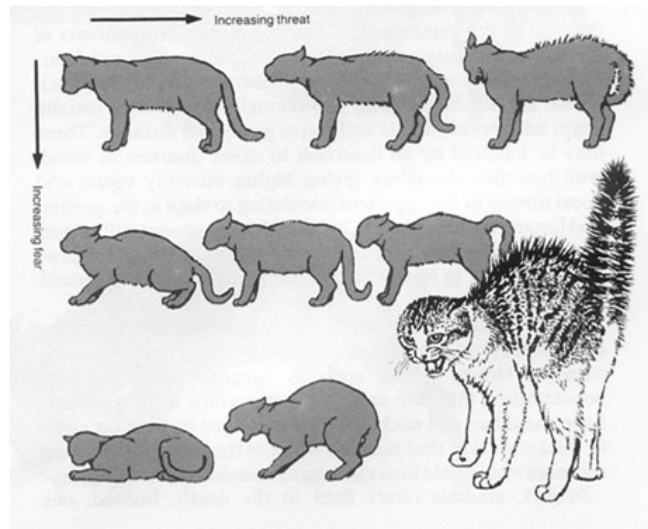
## Competitive Social Behaviour

### Agonistic behaviour

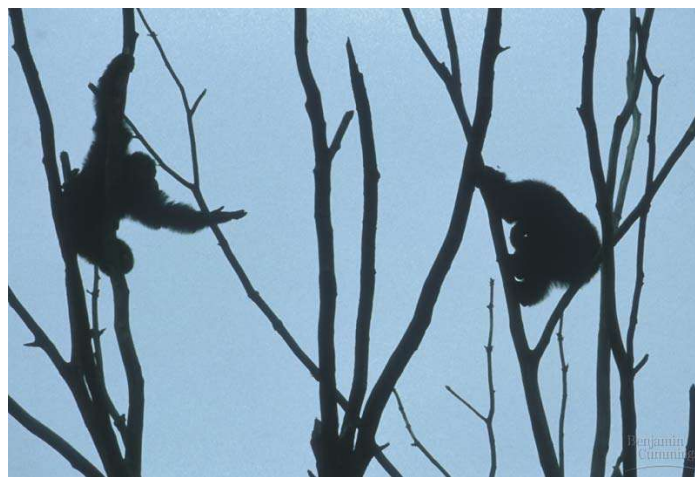
- a contest of threatening and submissive behaviour determining which competitor gains access to a resource e.g. a mate, food, territory
  - Much of this behaviour includes ritual – symbolic activity
  - Serious injury is rare
  - Natural selection favours ending a contest as soon as a winner is established
  - To avoid injury

## Agnostic behaviour

- Animals escalate an encounter by using threats of increasing intensity of aggression
- Or de-escalate using submissive signals of increasing fear



- Reconciliation behaviour often happens between conflicting individuals



# Dominance hierarchies

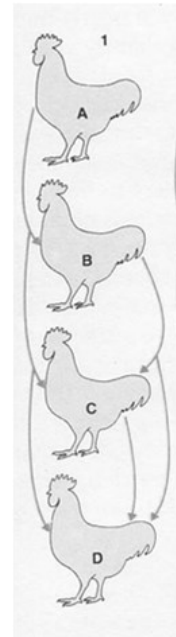
## “Pecking order”

the top ranked member controls the lower members of the group

- Alpha, beta rankings – where the alpha animal controls the behaviour of others
  - e.g. wolf packs have a dominant female who controls mating in the pack – based on food availability – meerkats have a dominant alpha pair
- Top ranked animals – guaranteed access to resources
- Lower ranked animals don’t waste energy or risk harm fighting

# Dominance hierarchies

- Pecking order in domestic hens
- In small groups there’s the “peck-right” hierarchy where a lower ranked bird never pecks a higher ranking one
- **Dominant individuals** have better access to resources such as food and roosting sites



# Territoriality

- **Territories** are defended areas used for feeding, mating or rearing young
- Territory size varies with the species, territory function, and resources available
- Some species defend territories only during the breeding season forming social groups at other times of the year e.g. magpies
- Drawbacks are that territoriality uses a great deal of an individual's energy



▲ **Figure 51.20 Agonistic interaction.** Male eastern grey kangaroos (*Macropus giganteus*) often "box" in contests that determine which male is most likely to mate with an available female. Typically, one male snorts loudly and strikes the other with his forelimbs. If the male under attack does not retreat, the fight may escalate into grappling or the two males balancing on their tails while attempting to kick each other with the sharp toenails of their hind feet.

# Territoriality

An individual might die or miss a reproductive opportunity as a result of defending a territory

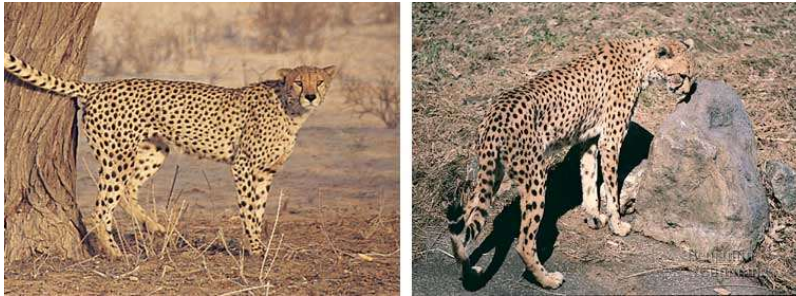


Frill Neck Lizards

<https://www.youtube.com/watch?v=utD66Z5Qb74> (2:22 min)

# Territoriality

- **Spraying behaviour** – an individual marks its territory with chemical markers
- Dominance hierarchies and territoriality tend to stabilize population densities by ensuring enough individuals reproduce to maintain a stable population



# Courtship & mating behaviours

- Natural selection favours mating behaviour that maximizes the quantity or quality of mating partners
- Mating behaviours and systems
  - the correlation between mating behaviour and reproductive fitness is vital
- **Courtship behaviour** – patterns that lead to mating
  - a series of displays and movements by the male or female



## Courtship – Three spined Sticklebacks

- behaviour that maximizes the quantity or quality of mating partners
- Male has a nest, that is well made and defended
- Proves that he is “fit” as he has the resources to build and strength to defend nest.

Satin Bower Bird

[http://www.youtube.com/watch?v=v\\_BurGW2rPU](http://www.youtube.com/watch?v=v_BurGW2rPU) (2:45 min)

Blue Footed Booby

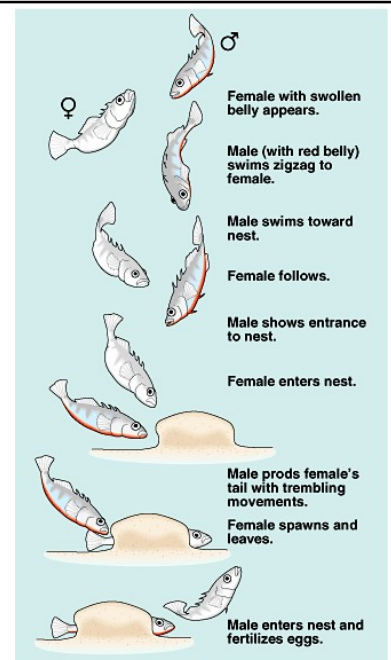
[https://www.youtube.com/watch?v=z922by9\\_6Fw](https://www.youtube.com/watch?v=z922by9_6Fw) (3 min)

Peacock spiders

<https://www.youtube.com/watch?v=5qkzwG2ILPc> (5 minutes)

3 spined stickleback fish

<https://www.youtube.com/watch?v=uiKXWWpjKU> (5 minutes)



## Parental Investment

- Time and resources expended for raising offspring
- Females usually invest more time into parenting because:
  - they make fewer, larger gametes
  - energetically more expensive
  - each gamete more valuable
- Females are usually more discriminating in their choice of mate – they look for fit males i.e. **better genes, the ultimate cause of the choice**
- Lower investment by males because they're capable of producing more, smaller gametes

## Mating systems

- **Promiscuous** – no strong pair bonds or lasting relationships
- **Monogamous** – mates remain together for a long period
- **Polygamous** – an individual of one sex mating with several of the other sex
  - **Polyandry** where one female mates with several males – common in birds
  - **Polygyny** – where a single male mates with many females
- Males generally are more showy
  - e.g. birds
    - Males little paternal care
    - Species fitter by mating with more females

▼ Figure 51.14 Relationship between mating system and male and female forms.

(a) Monogamy



In monogamous species, such as these eastern gulls (*Chroicocephalus novaehollandiae*), males and females are difficult to distinguish using external characteristics only.

(c) Polyandry



In polyandrous species, such as these red-necked phalaropes (*Phalaropus lobatus*), females (right) are generally more ornamented than males.

(b) Polygyny



Among polygynous species, such as satin bowerbirds (*Ptilonorhynchus violaceus*), the male is iridescent blue and is much more distinctive than the more camouflaged female.

## Social behaviours that help others

- **Altruism** = selflessness
  - a behaviour that reduces an individual's fitness
  - increases the fitness of other individuals in the population
  - e.g. pied butcher bird's alarm call
    - warns others but increases its risk of being killed

Rats will save drowning rats at risk to their own lives.

## Altruistic behaviour

Naked mole rats live in colonies

- Clear divisions of labour with a single breeding female (the queen), kings, worker and non-worker castes
- DNA analysis – all members of a colony are closely related
- Non-reproductive mole rats may sacrifice their own lives protecting the queen or kings
- Enhancing the chances of a queen or kings reproducing, a non-reproductive individual increases its chances of passing on genes identical to its own to the next generation