Further Studies of Behaviour

Stephen Taylor
Bandung International School

Further Studies of Behaviour

Natural Selection

The behaviours studied here are innate in nature.
They are automatic responses to stimuli which are controlled by genes and are therefore subject to natural selection.

Populations tend to produce more offspring than the environment can support, leading to a struggle for survival. Variations within populations can be selected for (if they improve the individual's reproductive fitness), or selected against (if they hinder an individual's survival or reproductive fitness).

Therefore innate behaviours, as well as physical traits, become optimised over time, through evolution.

Consider this when you see reports of behavioural patterns changing, bee colonies collapsing and reproductive seasons failing - *are we changing the environment faster than animal species can adapt to the selection pressures?*

In the hypothetical example to the right, what would happen to the animal population if the peak of food availability shifted?

Hypothetical breeding season example.
Selection pressure: food availability.
Innate response: breeding at set temperature

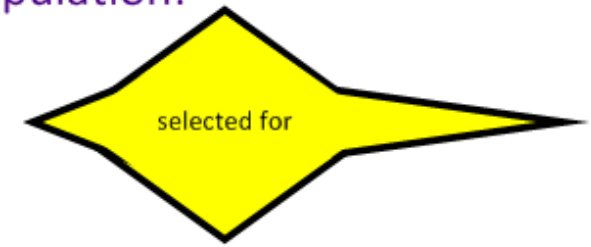
Food availability:

Breeding season

early med late

Individuals which breed just before or at maximum food availability promote their reproductive fitness, and pass on the gene for their breeding time.

Population:



Optimal behaviour has evolved.

The secret life of honey bees

Honeybees (*Apis mellifera*) are eusocial animals and live in colonies. Individuals interact closely and have set functions and responsibilities (castes).

http://www.youtube.com/watch?v=lE-8QuBDkkw

Queen
- function: to produce eggs
- flies only to mate and swarm
- controls colony activity through scent
- mates with many males at one time and stores sperm to be used through her life
- lays thousands of eggs
- cuts down on egg production if food supplies are scarce

Workers
- all females, non-reproductive
- go through series of roles in order: young bee, nurse, builder, guard, honeymaker
- live for around 30 days
- feed queen and drones

Drones
- haploid males
- only function is to mate
- mate in the air and die soon after

http://tinyurl.com/yebwlqa

Naked mole rats: colony living

Heterocephalus glaber is blind and eusocial.

http://tinyurl.com/yb3o2rp

Underground colonies consist of one queen (reproductive female), and a small number of reproductive males. All other individuals do not mate.

Intraspecific competition between females is fierce and bloody when the queen dies and the other females compete to take her place.

Social status depends on reproductive ability.

Non-reproductive individuals act altruistically to promote the survival and reproductive fitness of the queen and her offspring, which are all closely genetically related.

As a blind animal, what stimuli does the naked mole rat use to find food and mates?

http://www.youtube.com/watch?v=kIWp9WXKunM

Natural Selection can act at the colony level

A colony of individuals with set roles (castes) displays emergent properties.

The whole of the colony is more than the sum of its parts.
All individuals in a colony are closely genetically related.
Traits in an individual caste which are advantageous will promote the reproductive fitness of the queen, and thus ensure the propagation of the genes.
Deleterious traits will be selected against - the genes for those traits will not be passed on.

Natural selection may still act on the individual level, such as in female competition in naked mole rats colonies.

Examples:

- honeybees that are better at finding food sources will promote the reproduction of the queen and survival of the young bees. This food-finding trait is preserved.
- ants which are better able to defend the colony will ensure its survival, thus the genes will be passed on.

Meerkats: the survival and reproductive fitness of the colony depends on all members fulfilling their roles.
http://tinyurl.com/yd87jr8

Altruistic Behaviour

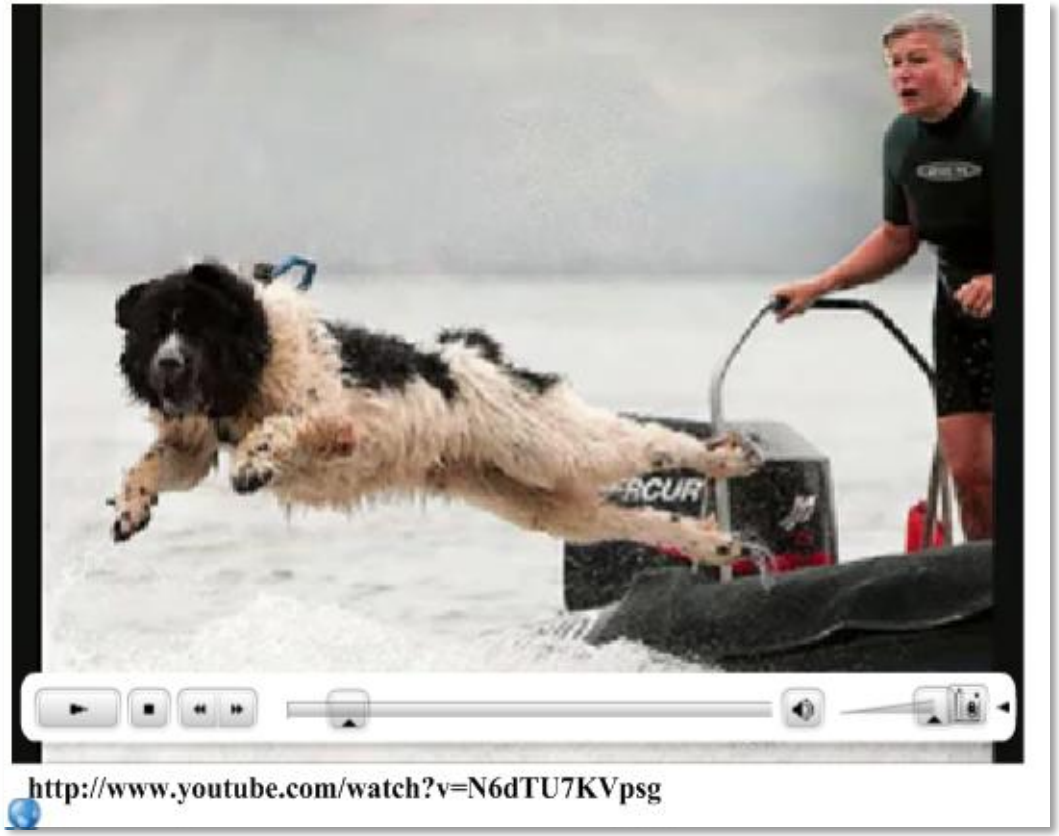
promotes the reproductive fitness of another individual at considerable cost to oneself.

Otherwise known as 'selfless' behaviour, this is where an individual's actions serve to promote the welfare or reproductive fitness of another individual at cost to the individual performing the act.

http://tinyurl.com/yffkrt8

Honeybee guards sacrifice their own life for the colony's survival

Introduction to altruism:



http://www.youtube.com/watch?v=N6dTU7KVpsg

Altruistic behaviour in animals species serves to promote reproductive success, either through kin selection, reciprocal altruism or a combination of the two.

Altruistic Behaviour is the product of natural selection

Innate behaviours are genetic in nature.
Genetic traits are subject to natural selection:
- advantageous traits are selected for
- deleterious variations are selected against

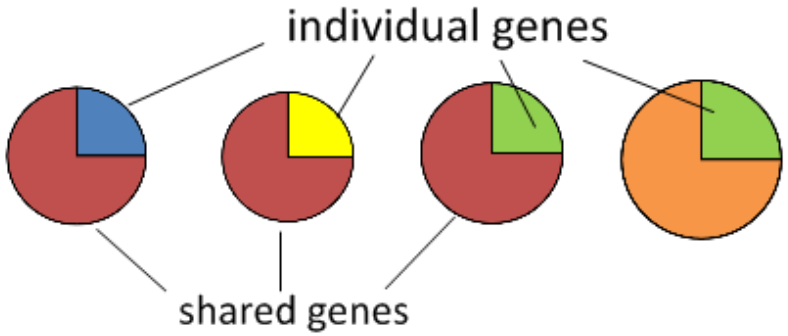
Altruistic behaviour can benefit the gene:

1. Kin selection
   Closely related individuals are promoted, thus ensuring the survival of shared genes

2. Reciprocal altruism
   Helping another may be returned in the future, ensuring the survival of oneself and thus aiding reproductive success.

If acting altruistically promotes the fitness of ones own genes, it will selected for.

In related individuals, a lot of genetic information is shared:



Positive traits in the shared genes are selected for, and ensure their own survival.

If an individual sacrifices its own reproductive fitness for the benefit of others, it serves to promote the success of the shared genes.

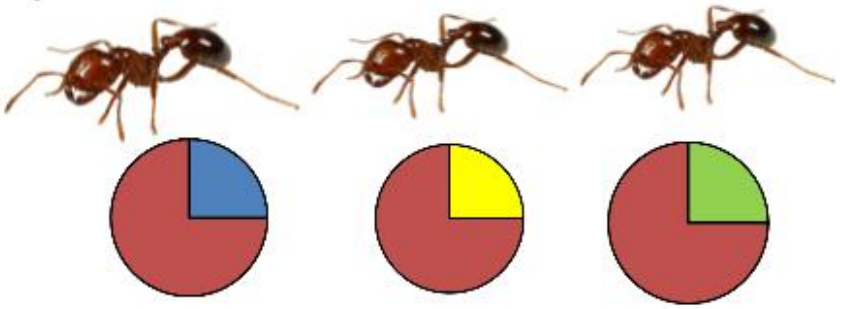
If these shared genes include those which programmed the altruistic acts, they too will be propagated - and so will the behaviour!

Altruistic Behaviour: Kin Selection

Ant colonies demonstrate kin selection in the same way as bees:

Males are haploid, females are diploid.

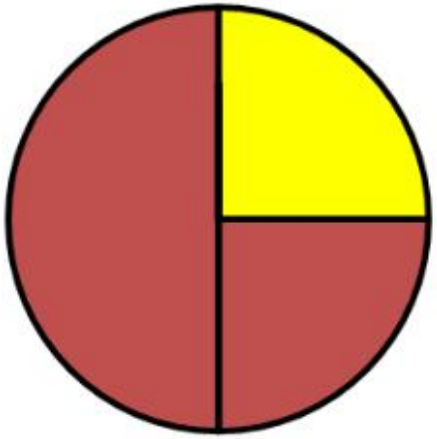
Therefore all diploid females are 75% similar genetically (the chromosomes passed on from males are not subject to independent assortment in meiosis and therefore are all identical; 50% of genes passed on from the queen will be shared)



By acting altruistically to defend the colony, raise the young or feed the queen, individual workers promote their own genes.

Drone's genes
no independent assortment
all identical

Queen's genes
independent assortment
50% similarity



Overall: 75% shared genes

EO Wilson: Ant whisperer

http://www.youtube.com/watch?v=5HKl8Luuotw

Altruistic Behaviour: Reciprocal Altruism

"*You scratch my back, I'll scratch yours*" (or: "*You share my blood, I'll share yours*")

Vampire bats (*Desmondus rotundus*), are hematophages.
to survive, they need to feed on 50% of their body weight every 24-36 hours. If they go 40 hours without feeding, they lose body weight quickly and can die.

They have developed blood-sharing as an altruistic act.

Through reciprocal altruism and a well-disciplined buddy system, unrelated bats can share blood with each other. Typically this is between females, or with the offspring of other females. This ensures the survival of one's own offspring if they need it.

Individuals which do not reciprocate can be expelled from the sharing group, and therefore will likely not survive should they need blood later - thus their non-sharing behaviour is selected against.

Reciprocation may be stronger between related bats.

http://www.youtube.com/watch?v=9Va9ull44yw

Altruistic Behaviour: Selfish Genes

TOK

Is anyone really that good?

(genes are selfish - not genes for selfishness)

Truly selfless?

Genes are the units of inheritance, conveyed by the organism.

If a trait helps the reproductive fitness of the organism, it therefore promotes the gene, and is selected for. Altruism is a product of genetics, and ultimately benefits the reproductive success of both the gene and the individual.

Therefore, we do not act out of true goodness, but as a product of our genes and the need to propagate them.

To what extent do you agree or disagree?

Watch the video and listen carefully to the explanation. Are there any truly selfless acts, or are they just a 'veneer' to promote our own reproductive fitness (however unconsscіously this may be)?

Richard Dawkins: The Genius of Darwin

http://www.youtube.com/watch?v=8y7ZZB6Mt1o

Foraging

the act of searching for, chasing, capturing, killing and consuming food

Benefit > Cost

Foraging results in food: a benefit in terms of energy

Foraging takes energy: there is a cost in terms of time and energy.

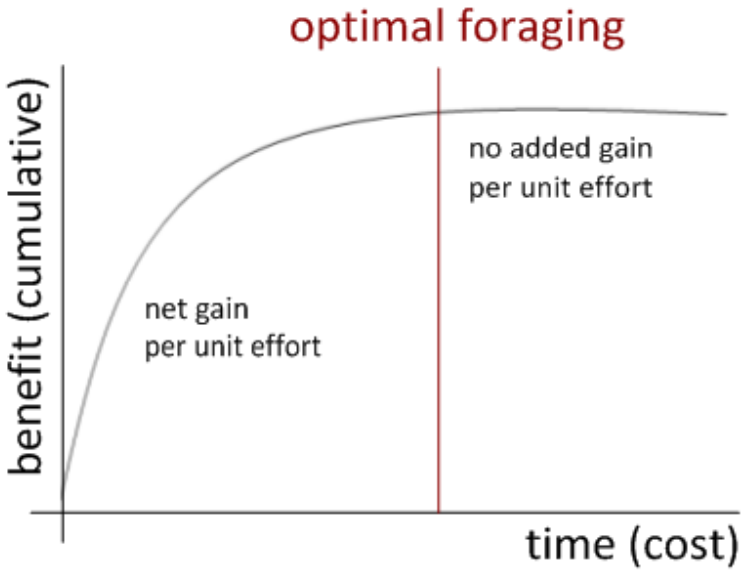
As long as the benefit of energy outweighs the energetic and time cost expended, the foraging strategy has a positive impact on the individual's reproductive fitness.

If a foraging strategy has an overall cost, it will harm the individual's reproductive fitness - and therefore have a deleterious effect. It will likely be lost through natural selection.

Foraging species eventually evolve what it known as

optimal foraging strategies

Their foraging behaviour represents the maximum benefit: cost ratio. (energy gain per unit effort)

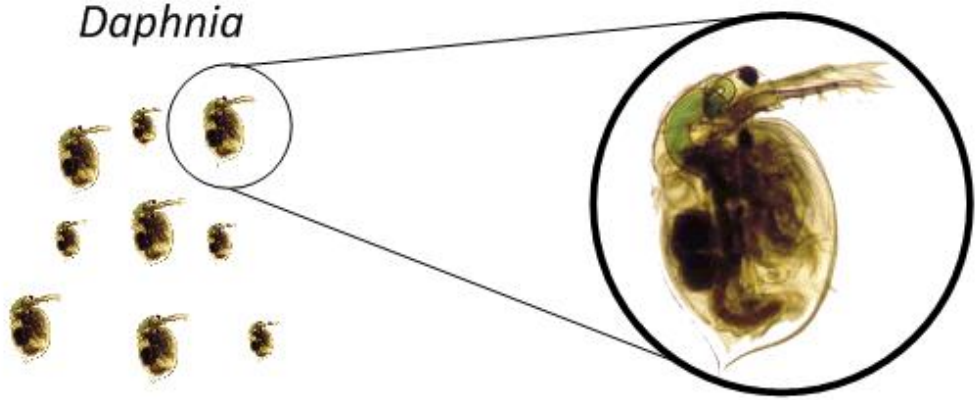


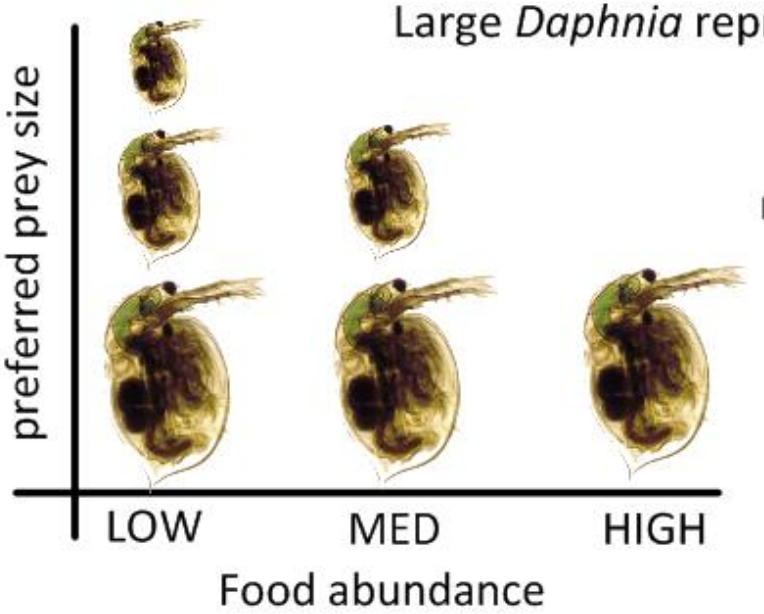
Optimal foraging

Benefit > Cost

Bluegill sunfish (*Lepomis macrochirus*)

Daphnia





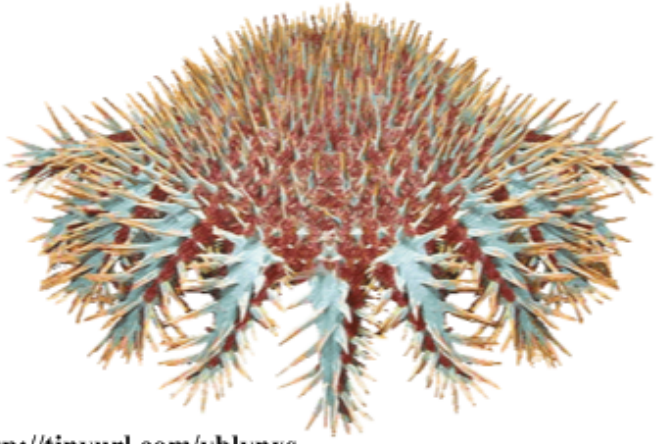
Large *Daphnia* represent a better benefit:cost ratio in terms of foraging. In times of abundance, bluegills will be selective of their prey, choosing only larger *Daphnia* and thus reducing energy spent on foraging (optimal foraging). When food is scarce, they will be less selective of food source, as the most important factor is to consume enough energy overall.

http://southshorefishing.net/fish/bluegill.htm

Optimal foraging

Benefit > Cost

Crown of thorns starfish (*Acanthaster planci*)

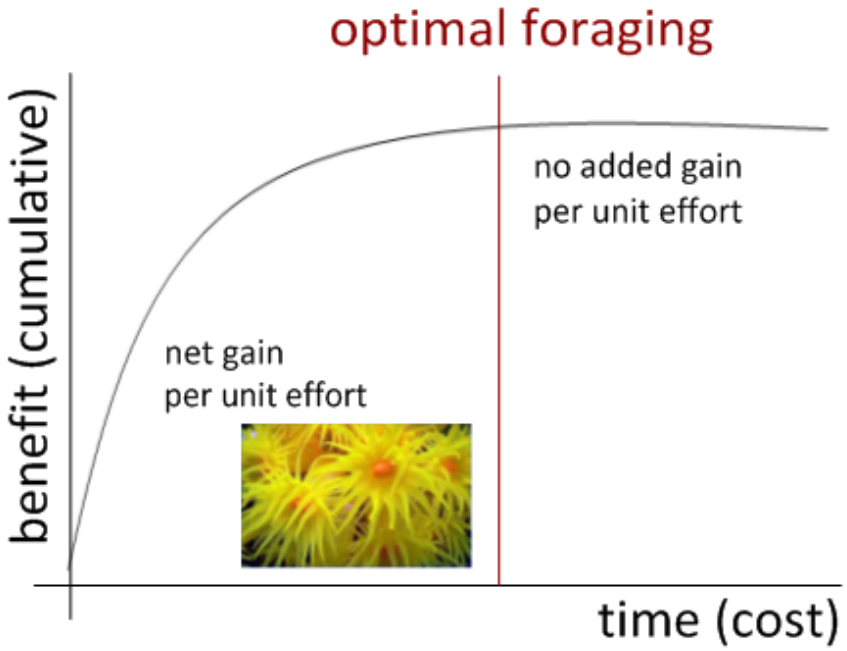


http://tinyurl.com/yblvnxs

A. planci grazes on coral polyps, the organisms that build coral reefs. They display optimal foraging through maximising patch residence time: they will remain in an area for as long as it is beneficial to forage there.
If the benefit: cost ratio is reduced, they move on.

A. planci causes widespread damage to coral reef ecosystems (especially the Great Barrier Reef in Australia), clearing up to $6m^2$ per individual per year!

The problem is worsening as we are overfishing their natural predators and therefore encouraging their populations to grow - and continue foraging.



Read more here: http://www.int-res.com/articles/meps/125/m125p185.pdf

Mate Selection

is another element of natural selection in action.

Peacock tails: deliver a reproductive advantage at a survival cost

Also known as sexual selection, females of some species will select their male mates based on an exaggerated trait. These exaggerated traits are more advertisements of reproductive fitness than they are adaptations for survival. Being physical or behavioural, and genetic in nature, they are subject to natural selection - leading to ever greater exaggerations!

Lyre bird: super-exaggerated birdsong:

http://www.youtube.com/watch?v=VjE0Kdfos4Y

Competition between males for mates can be fierce. The development of exaggerated traits represents availability of time and energy - and is desirable to the females as a trait for their own offspring.

Through descent with modification, these traits become ever more elaborate and attractive.

Mate selection is one force which can drive speciation between separated populations.

Mate Selection

Do humans demonstrate exaggerated traits to influence mate selection?

Mate Selection

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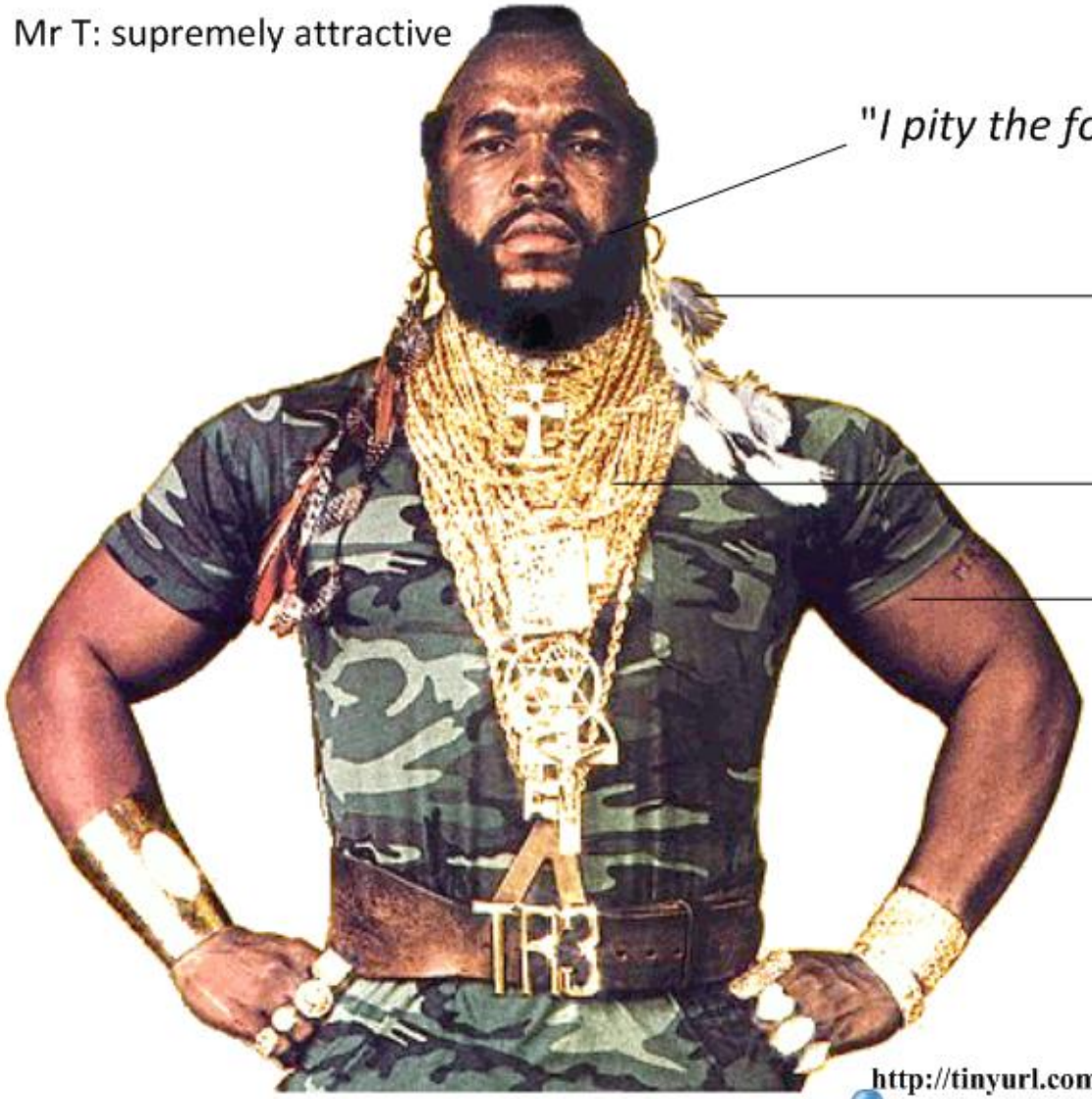
Mr T: supremely attractive



"*I pity the fool (who don't get mate selection)*"

Trophies of prey capture: display ability to provide for young

Bling: shows off wealth

Buff: shows macho-aggressiveness and an ability to defend the nest

Awesome van:

http://tinyurl.com/ybxno4c

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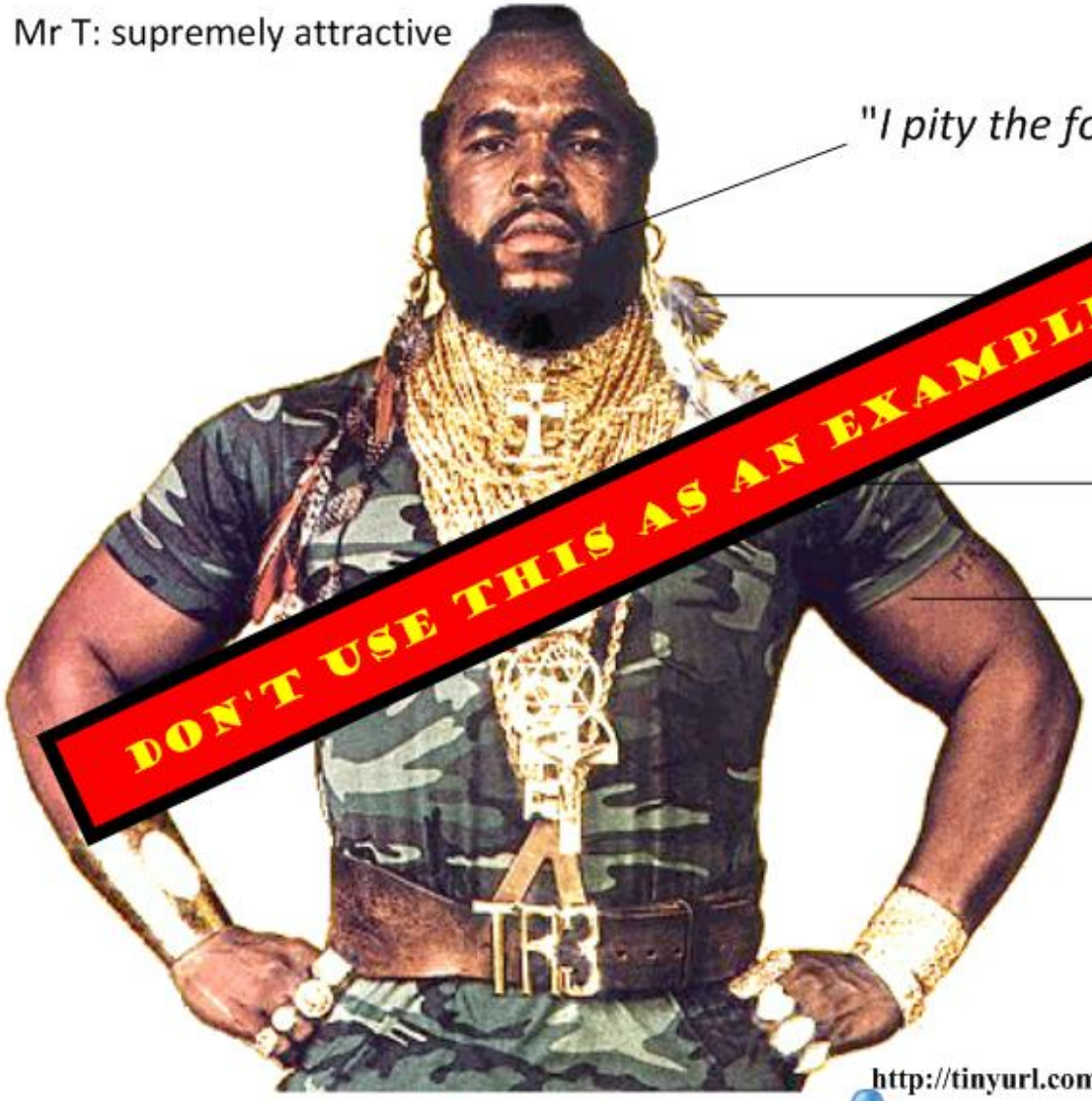

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DON'T USE THIS AS AN EXAMPLE IN YOUR EXAMS!

Rhythmical Behaviour

Behaviours and activities change rhythmically (over regular time periods).

If you walk around with your eyes and ears open, you'll notice that animal behaviour changes depending on a number of rhythmic stimuli:

- Seasonal changes
- Daily (circadian) changes
- Monthly (lunar) changes

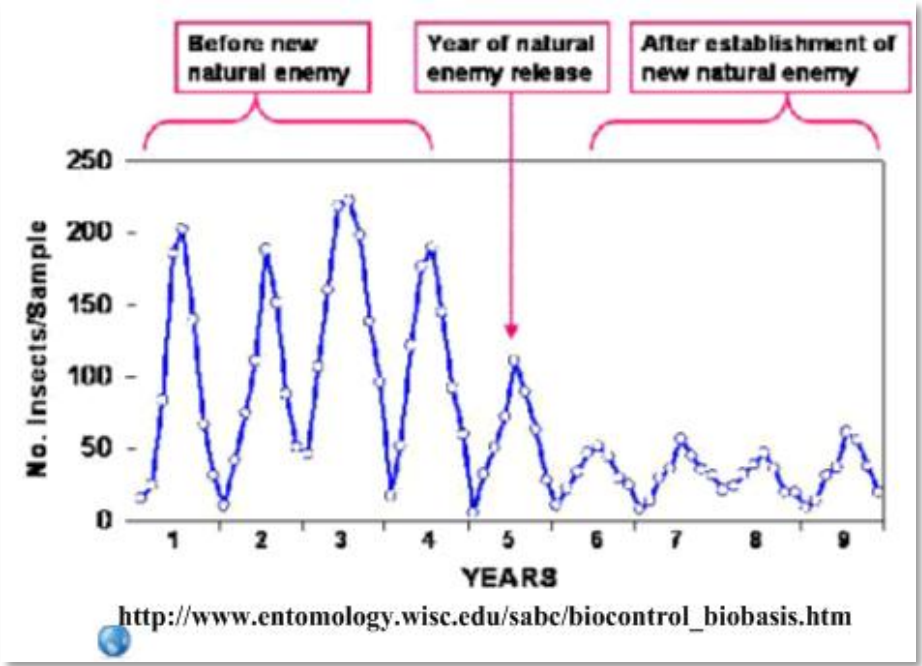
These behaviours, being innate, are also subject to natural selection and therefore have been (or are in the process of being) optimised by evolution.

- migration patterns of sharks and whales take advantage of seasonal phytoplankton blooms and the subsequent boom in food supply

- turtle nesting depends heavily on lunar cycles, as the moon illuminates suitable beaches

- bee populations boom during spring and summer, when more nectar is available

Tracking rhythmic patterns of behaviour could help control pest species:



In the hypothetical example above, populations of the herbivorous pest (e.g. aphids) boom in summer, when primary productivity is highest. Following the release of a biological control agent, pest populations decline, though still show the same seasonal variations.

Rhythmical Behaviour

Lunar cycles

The moon has a great influence over life on Earth. Daily (diurnal) cycles control tides and the behaviour of intertidal animal species. Monthly and annual cycles have a great impact on spawning, nesting and migration in many different species.

BBC Blue Planet: Ridley's Turtles

http://www.youtube.com/watch?v=T8tTak7foqU

Synchronised nesting of leatherback turtles (*Dermochelys coriacea*) leads to increased chance of survival of the hatchlings (too many for predators to cope with).

Lunar cycles control their migration of one Pacific population from the US to Indonesia and SE Asia, and mass egg-laying events take place at high tide on a night when the moon is between its last and first quarters. At this point in the cycle, the tide is weakest, so eggs are not as exposed to predators on the beach when the tide moves out.

Separate populations nest in Costa Rica, Sri Lanka and West Africa.

Rhythmical Behaviour

Seasonal Rhythms

Remember how photoperiodism controls flowering in the angiospermophytes? Well now think up through the food web. Population booms of primary producers result in opportunities for consumers - all the way up the food chain.

Seasonal behaviours include waking from hibernations (such as bats, hedgehogs and other insectivores), reproductive seasons (such as in many bird species) and migration and spawning seasons (such as in salmon and coral polyps).

"Thank goodness breeding season is over"
http://tinyurl.com/ydjghsd

Climate change impacts seasonal cycles:

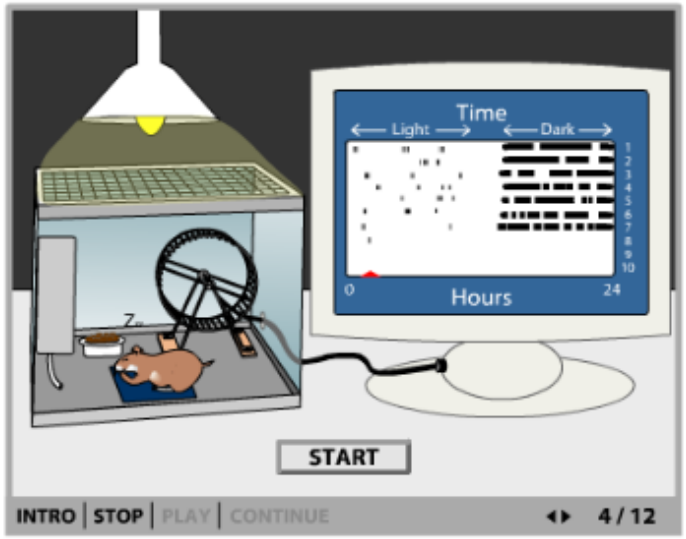
http://www.youtube.com/watch?v=drINEQFXbPY

These patterns of behaviour are innate in nature and thus subject to natural selection. Cycles have been optimised through evolution, with some small variation within populations.

The stimulus for these behaviours is generally physical in nature (day length, temperature), and coincides with food or resource availability. Climate change is having a negative effect on these cycles, for example stimulating early waking from hibernation where food availability may be limited.

Rhythmical Behaviour

Circadian Rhythms



Circadian rythms tutorial

http://bcs.whfreeman.com/thelifewire/content/chp52/5202002.html

Daily rhythmical behaviours (circadian rhythms) are controlled by a series of internal 'body clocks'. These are genetic in nature, and are generally optimised for 24 hour dark-light cycles.

They are influenced by light-dark cycles and are essential for healthy function of metabolism, including hormone production and sleeping/ feeding patterns.

Hamsters will self-select optimal lighting cycles in order to maximise their metabolic processes.

Research paper:

http://www.springerlink.com/content/wxl881134g284p18/

Rhythm and snooze:
the genetic basis for sleep patterns

http://www.youtube.com/watch?v=17L5S7Kk7Cc

For more IB Biology resources:

http://sciencevideos.wordpress.com