Introduction to the Biology of Organisms

Top 10 new species of 2017-2018

Mariana Snailfish (pseudoliparis swirel)

New heterotrophic flower: sciaphila sugimotoi

Tapanuli orangutan (pongo tapanuliensis)

New Shrimp: Epimeria quasimodo

Science and Skepticism

- Often seen as a weak point in politics due to its uncertainty
- Always trying to refine findings (by asking questions), never reach the “final answer”
- There is no such thing as “truth”, everything is open to tests and falsification which is the nature of science

Scientists ALWAYS asks questions…

In 2015, a group of people published what they thought was the first species of genus Homo (nearly 2,400,000 years old). Small people were recruited to fit into the crevices of the tavern and they found 1680+ bones belonging to 18 individuals in two deeps caves of South America. Thought to have had funeral rites because how can all these bones found in the same area? Scientists were doubtful because the only real evidence of funeral rites dated back 600 000 years. In 2017, they analyzed the bones to discover that they were 300 000 years old, so much more recent homo species. There were probably 3-4 homo species living in the same time: Homo naledi, Neanderthals, Homo sapiens.

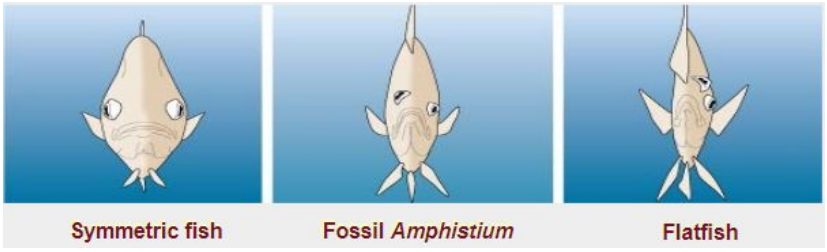
Last year, scientists discovered female human (hybrid) that was the result of crossing a neanderthal (mom) and denisovan (dad), which are two ancient human species. So, there were probably many species of humans one time, not linear. Now, there is only one.

Flatfish

- Larvae of flatfishes are phylogenetic fish with one eye on each side of the head and while they grow, metamorphosis occurs during development
- Migration of eye from one side of the head onto the other side
- Migration lasts hours, weeks
- Blind on one side
- Eyes pop up of their body, 360 degree vision
- Chameleons of the sea; can change its colouration to mimic the environment

What is the advantage of having asymmetrical eyes?

Unsure, but Darwin stated that the key to understanding evolution is determining the intermediates.



An Example of Evolution: Locomotion in Cheetahs

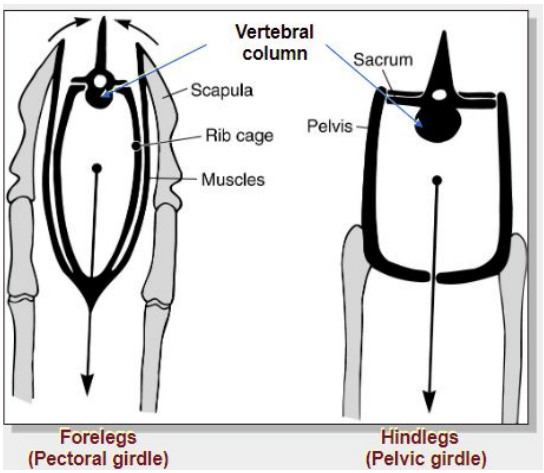
Darwin's theory: all animals come from a common ancestor

Cheetahs

- Efficient at hunting (fast, 110 km/h)
- They're prey are also fast (ex gazelles)
    - Evolutionary speaking: they have been coevolving, prey gets faster and faster to avoid, predator gets faster and faster to catch
- Very good at accelerating (advantage of surprise, from 0 - 70 km/h in 2 seconds)
    - Cheetahs slowly get close to prey, and then burst into speed so prey can't react
    - If the cheetah starts too far from the prey, success rate decreases
- Less endurance

Features of the Cheetah

- Pelvic girdle (hindlegs, pelvis) fused to the vertebral column
    - Femur attached to the pelvis (or hips)
    - Motor; aids with propulsion, important to generate speed.
    - Humans have the same and most mammals



- Pectoral girdle (forelegs, scapula) not directly attached to the vertebral column
    - Limbs slides on the ribcage
    - Scapula sticks out on the side of thoracic cage (like many quadrupeds, ex. dog)
        - In humans, scapula is towards the back of the ribcage and allows to make big arm movements. Common with ancestors that have lived in trees.
    - Ribcage sits on sling of muscle that acts as a shock absorber system, keeping ribcage and head stable
        - If all fused together, head would bobble

Conclusion: propulsion, orientation, stride length

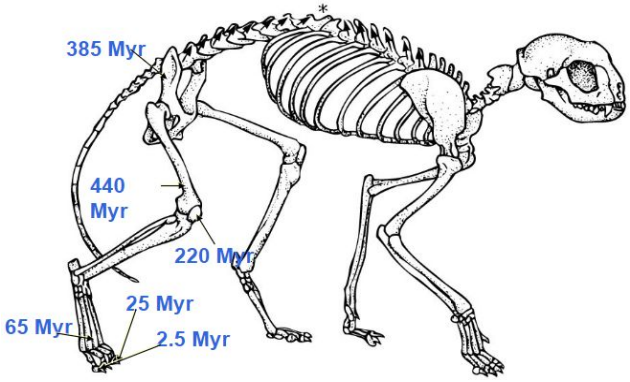
EVOLUTIONARY COMPROMISE: Cheetahs don't defend their prey unless predator is small because they're not good at running away. If they get hurt, they lose their advantage of speed. They become exhausted after accelerating 400-500 m. Over the years, the cheetahs that didn't defend their prey probably had better reproduction success.

EVOLUTIONARY COMPROMISE (ex. in humans): only mammal species that choke on food.

Hindleg Evolution

Appearance of limbs: 440 Myr

- Fish have spectral fin and pectoral fin that allows the fish equilibrium and orientation in water. When animals became terrestrial, it evolved into limbs seen in all tetrapods.



Pelvic girdle fused to the vertebral column: 385 Myr

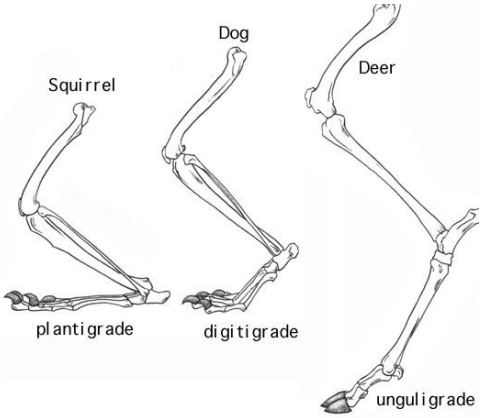
- Limbs attached to the hips when vertebrates started to invade land
- Provided support to the body in a less dense environment (from water -> air)
- Fish closely related to terapod (primitive amphibians)

Rotation of the knee and the elbow under the body: erect posture, 220 Myr

- Reptiles (i.e. crocodile, salamander, lizard) move in sprawl posture where the humerus is parallel to the ground. Movement consists of push up and torsion of body.
    - Costly in terms of energy
- Mammals: rotation of elbow and knee to become like columns. Movement of limbs like pendulum and is now more efficient.
- Lifted size constraint, mammals in general became large
- Dinosaurs: large, had rotation of the knee but not elbow (bipedal)
    - Birds are modified dinosaurs

Most carnivores walk on their fingers (digitigrade): 65 Myr

- Carnivores: need claws to tackle and catch prey. When they walk, the sole of their feet is above the ground making the limbs longer. Thus, they have longer strides and cover more distance faster. Adaptation for speed.
    - Exception: bears walk of soles, but they are more like omnivores (eat fruit)
- Humans walk on the sole of their feet
- Usually, distal part of the limb is thin which makes it lighter (gazelle, deer) and therefore faster



All cats (lions, tigers, cats...) have retractable claws: 25 Myr

- Claws are sharp and can suffer from wear and tear if used too often

Cheetahs have semi-retractable claws: 2.5 Myr

- Unique evolved feature
- There's a part sticking out when they retract their paws
- Gives traction (swift movements) to the cheetah which make it better at hunting

Adaptations

- Aids to classify vertebrates
- Adaptation of Vertebrates in cheetahs
    - Locomotion organs (fins or limbs)
- Adaptation of terrestrial tetrapods in cheetahs
    - Pectoral girdle (fin, scapula) detached from the skull leads to evolution of neck
    - Pelvic girdle (pelvis) fused to the vertebral column
- Adaptations of mammals in cheetahs
    - Rotation of the knees and elbows under the body (support and/or speed)
- Adaptations of the order carnivores in cheetahs
    - Walk on fingertips (digitigrade)
- Adaptations of the cheetah compared to other felines
    - Fur pigmentation (yellow with dots provides camouflage in environment)
    - Long and thin limbs especially in the distal end (stride length)
    - Lightweight, slender and muscular body (speed)
    - Flexibility of the spine (speed, stride, strength)
        - Can jump up to 6-7 metres
        - Extension of spine is responsible for 30% of the stride
    - Wide nostrils, heart and lungs with high functional capacity

Thus, What is a Cheetah?

- A cheetah is a mammal characterized by few derived traits (evolutionary innovations) that distinguishes it from other feline species
    - The species is the result of 3500 Myr of evolution (age of first living being)
    - More than 99% of its characteristics have evolved in species that are now extinct
    - Less than 1% of its features are unique
- So the cheetah is more the result of the history of its ancestors than of its own history
- This applies to all living species, including humans
    - DNA is unique feature that is found in all species, transmits hereditary from generation to generation
    - Humans (unique features, very few)
        - Complexity of the brain?
        - Articulation of speech?

Importance of Genetic Variability

- Royal cheetah is the result of a mutation in the genes associated with pigmentation that can occur once in a while (not a new species)
- No genetic variability in cheetahs (about 99.8%)
    - Skin graft would work because they're so similar
    - A simple disease could kill all cheetahs when in other species only 1-2% would be affected. There is no genetic resilience in cheetahs
- Hypothesis: they went through population bottleneck effect
    - Changes in the environment (climate, glaciers, disease) cause the cheetah population to be reduced to an isolated few. Those repopulated other areas, but no genetic variability was added.
- Darwin was one of the first scientists to consider the importance of genetic variability. Before that, it was seen as imperfections.
- Most species that have lived on the planet are extinct (99%, only have 1%)
    - Absence of cheetahs in North America
    - Fastest predator, puma, only reaches 60 km/h but our prey can reach 95 km/h (North American pronghorn). High speed animals are usually the result of coevolution between predator and prey. Scientist deducted that there must’ve been the presence of a predator that could obtain these speeds. This predator is the myracynonix “american cheetah” from 20 000 years ago (in fossil record).
        - Extinct now.
- <u>Convergent evolution:</u> independently, cats evolved fast speed on both continents