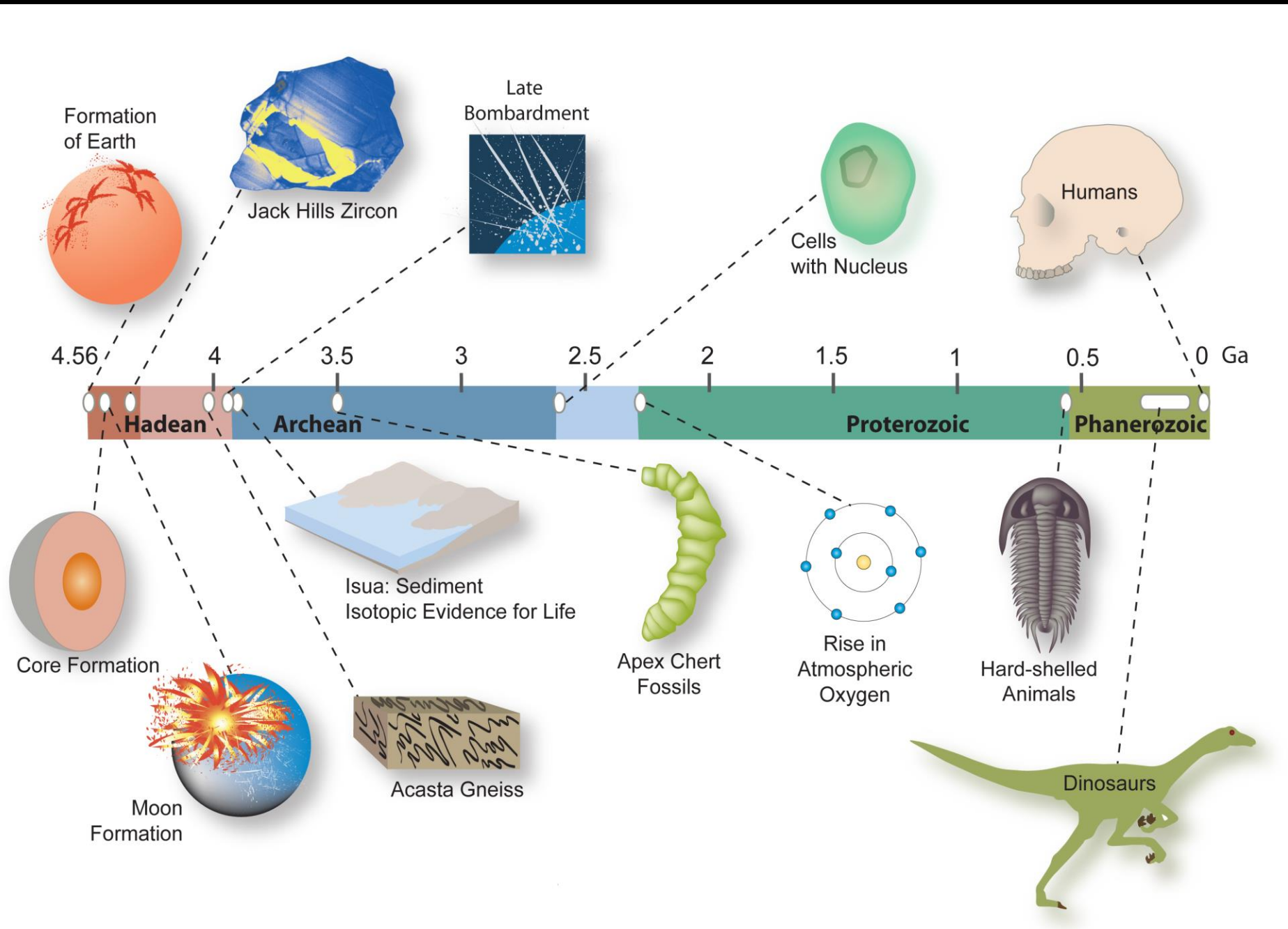
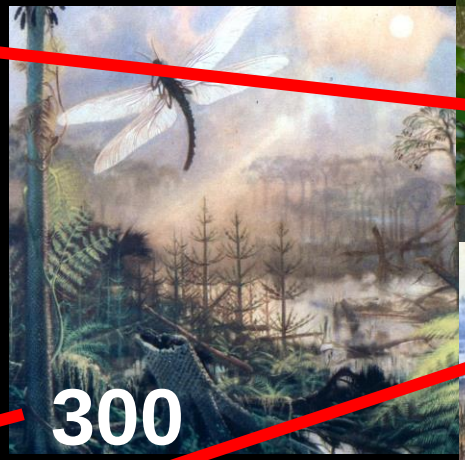
BUGWORLD

sex, violence and a cast of billions


Formation of Earth
Jack Hills Zircon
Late Bombardment
Cells with Nucleus
Humans
4.56
4
3.5
3
2.5
2
1.5
1
0.5
0 Ga
Hadean
Archean
Proterozoic
Phanerozoic
Core Formation
Moon Formation
Isua: Sediment Isotopic Evidence for Life
Acasta Gneiss
Apex Chert Fossils
Rise in Atmospheric Oxygen
Hard-shelled Animals
Dinosaurs

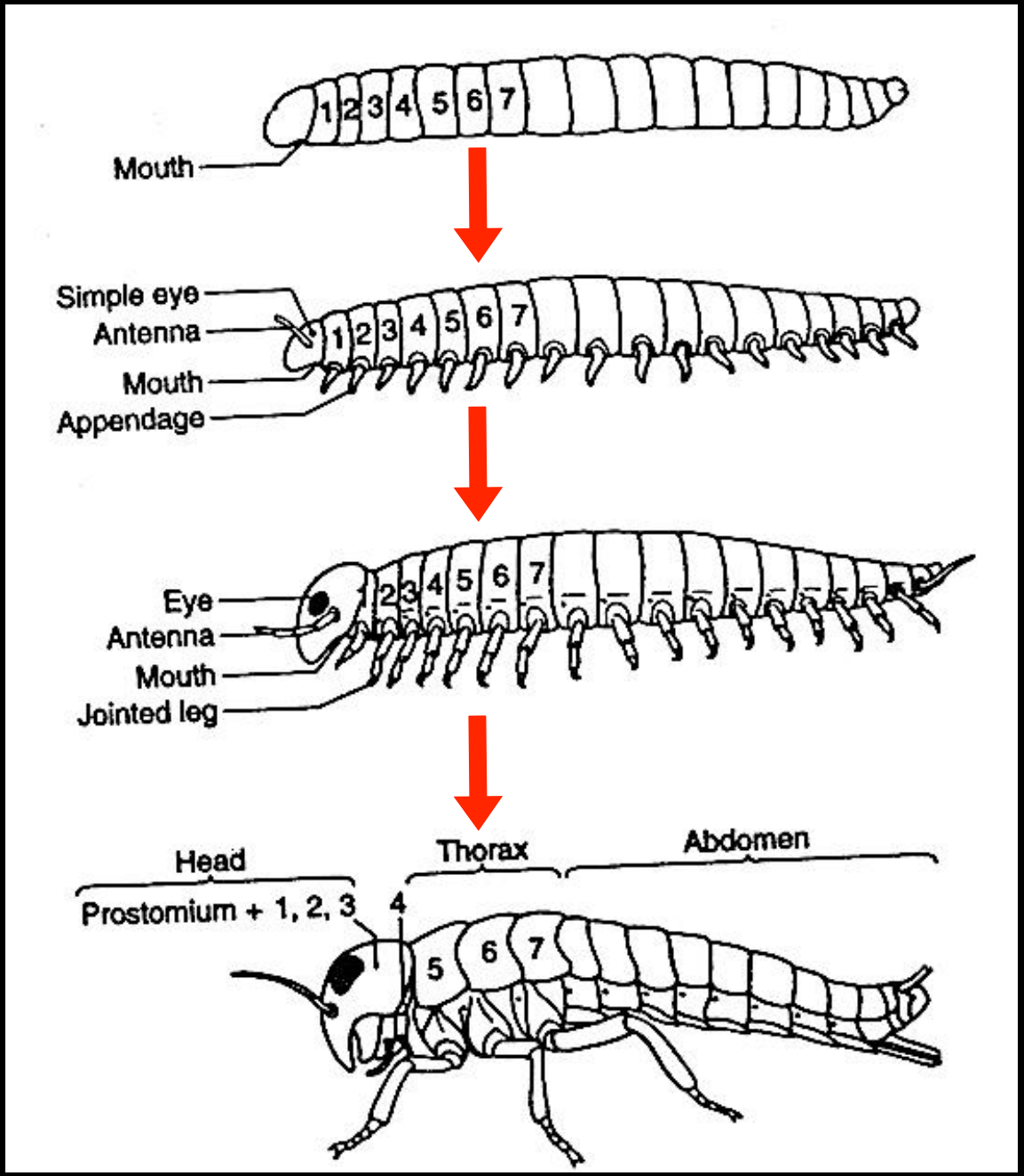
Era	Period / Epoch	Age
CAENOZOIC	Pleistocene	1.8
	Pliocene	5
	Miocene	25
	Oligocene	38
	Eocene	55
	Palaeocene	65
MESOZOIC	Cretaceous	144
	Jurassic	213
	Triassic	248
PALAEOZOIC	Permian	286
	Carboniferous (Pennsylvanian)	
	Carboniferous (Mississippian)	354
	Devonian	412
	Silurian	435
	Ordovician	492
	Cambrian	570
	Precambrian	Millions of years

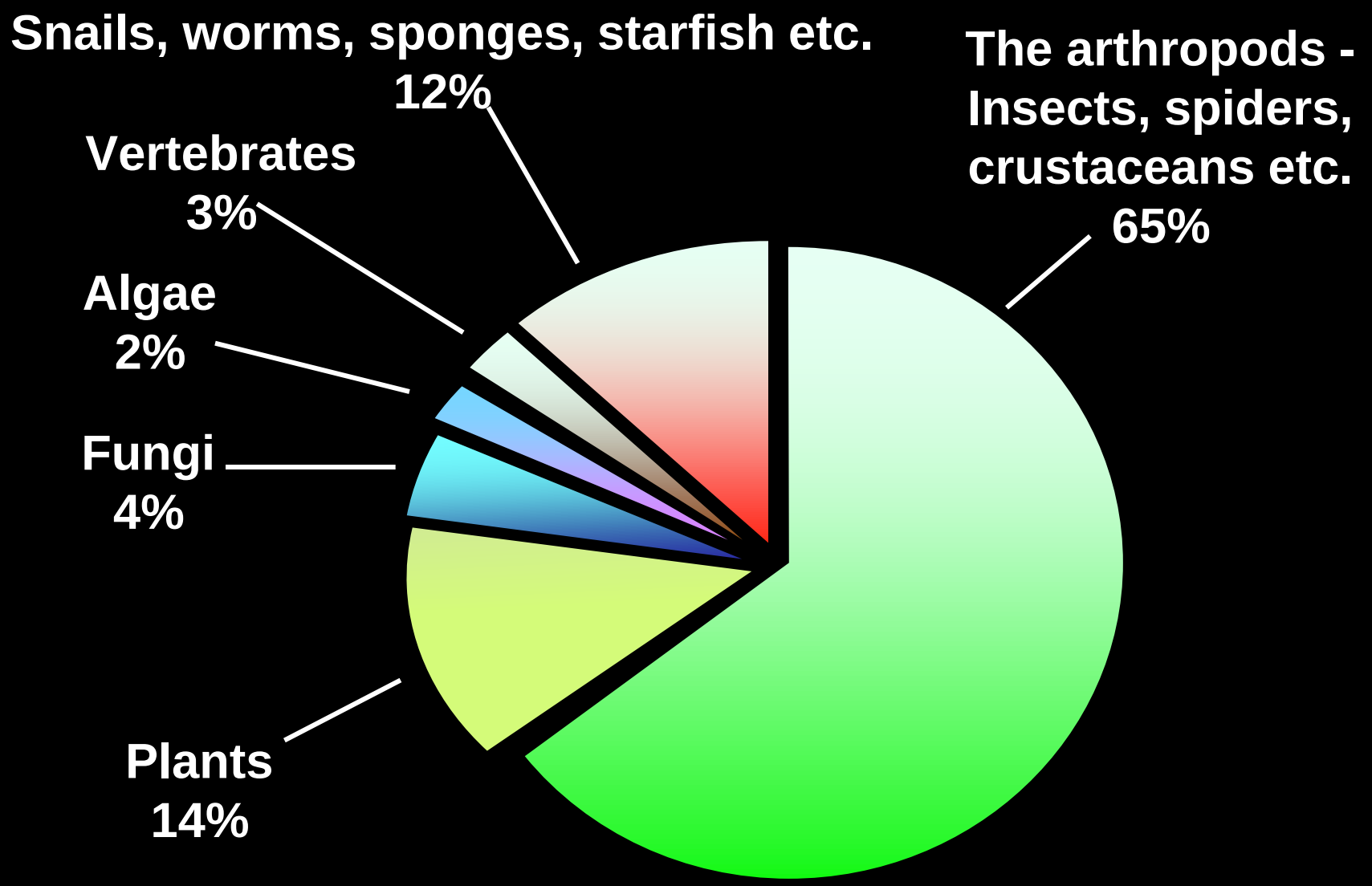


Worm-like ancestor

True segmentation

Segments become grouped together into functional units





Of all the world's species…….

Insects are the most successful and abundant multi-cellular organisms on the planet.




There are 18 quintillion insects on Earth at any time (18,000,000,000,000,000,000) -




that’s about 2 billion for every human being alive.

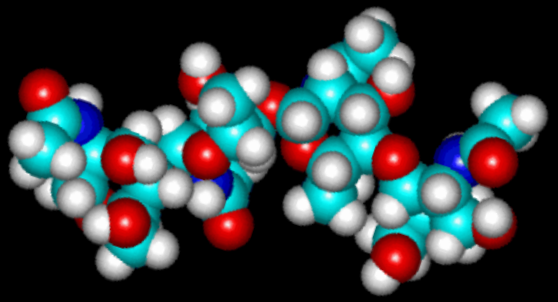
Why are insects so successful?

5 factors in a winning formula

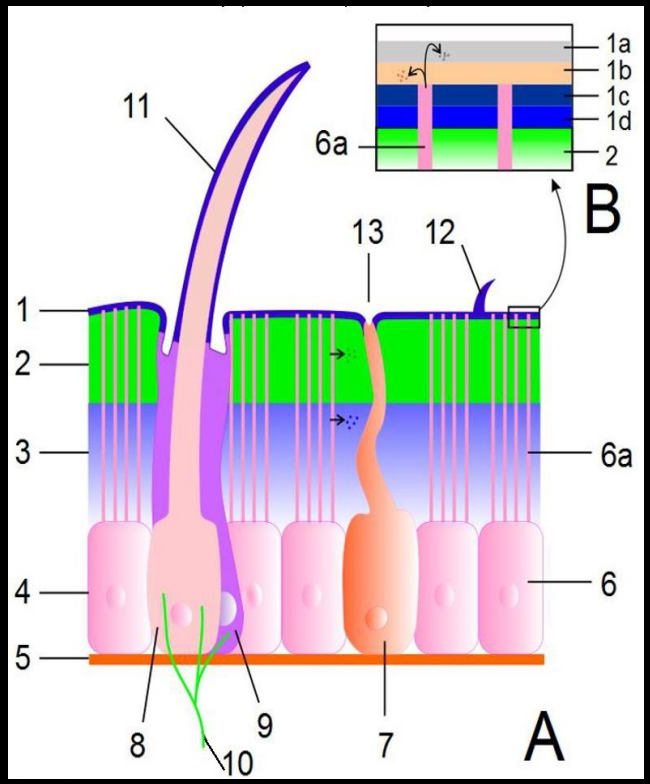
- they have a protective exoskeleton
- they have an efficient nervous system
- they are small-sized
- they evolved the power of flight
- they have high reproductive rates

Cuticle

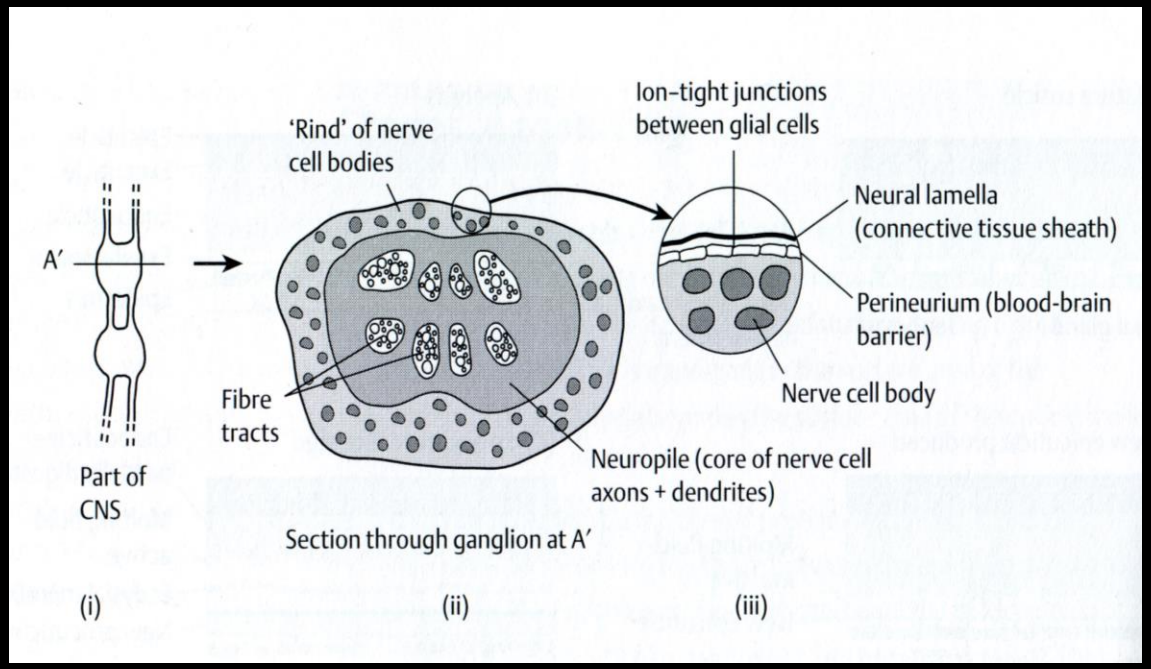
waterproof
protective
versatile
self-repairing

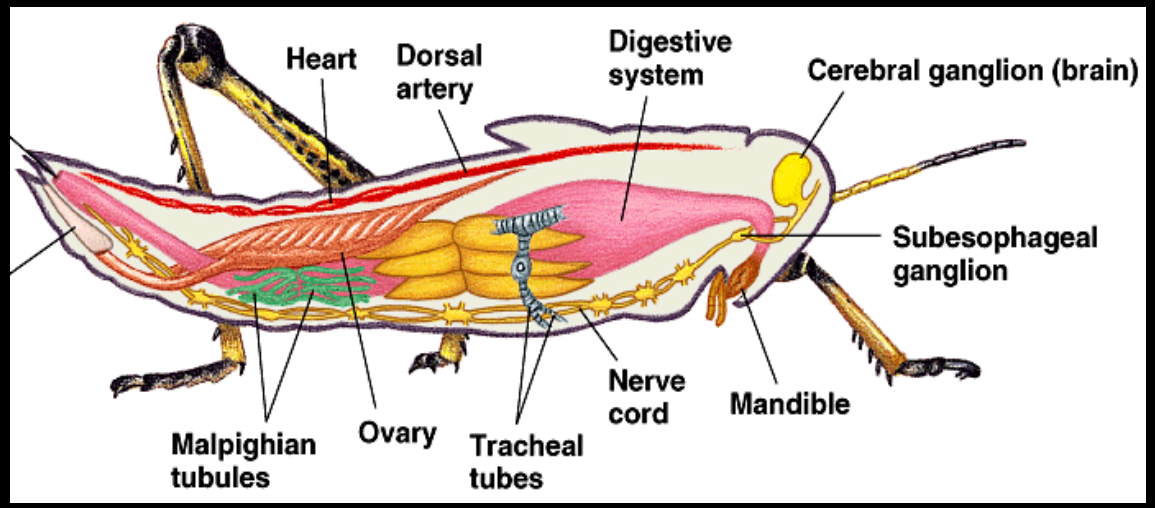


Chitin is a polymer of a N-acetylglucosamine, a derivative of glucose.



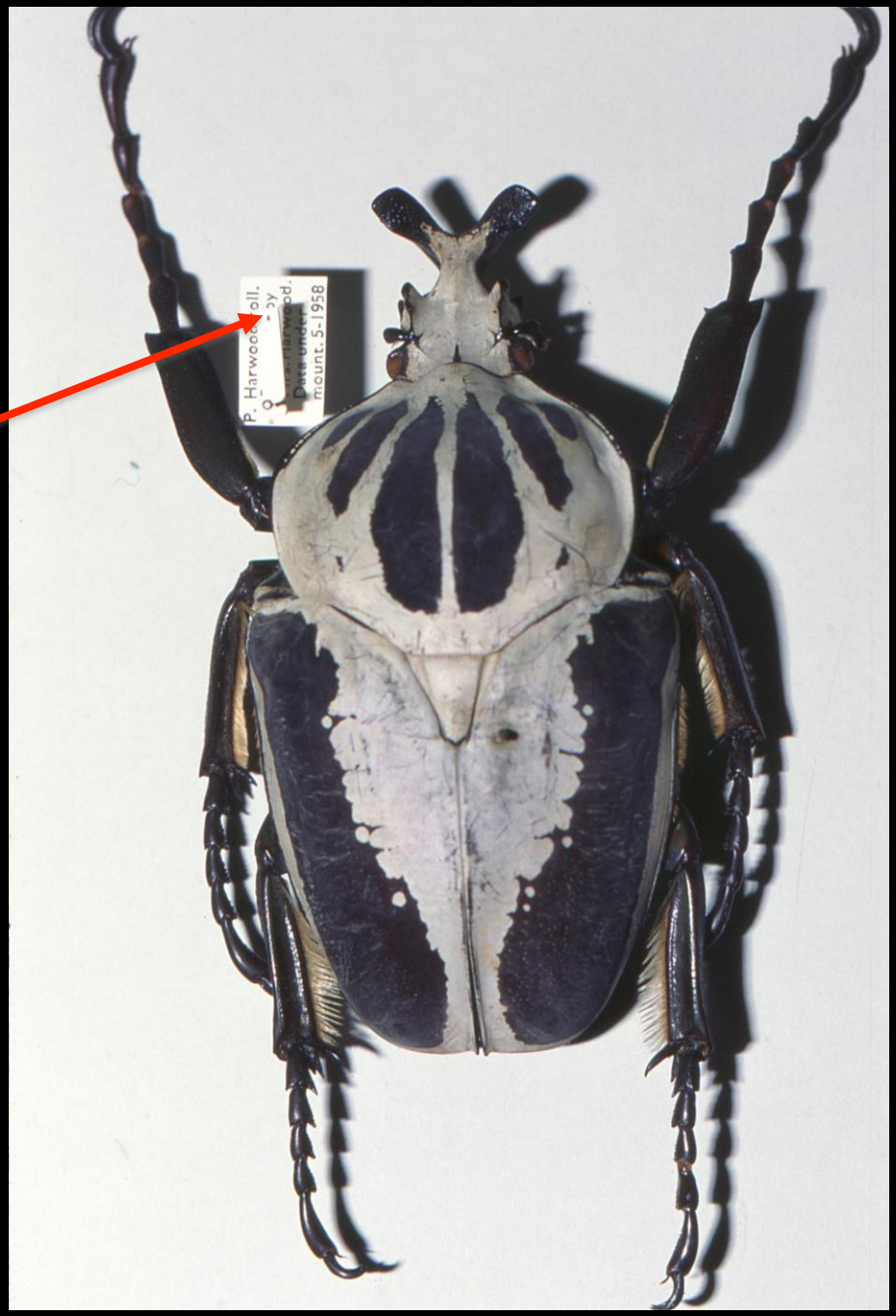
A highly efficient nervous system





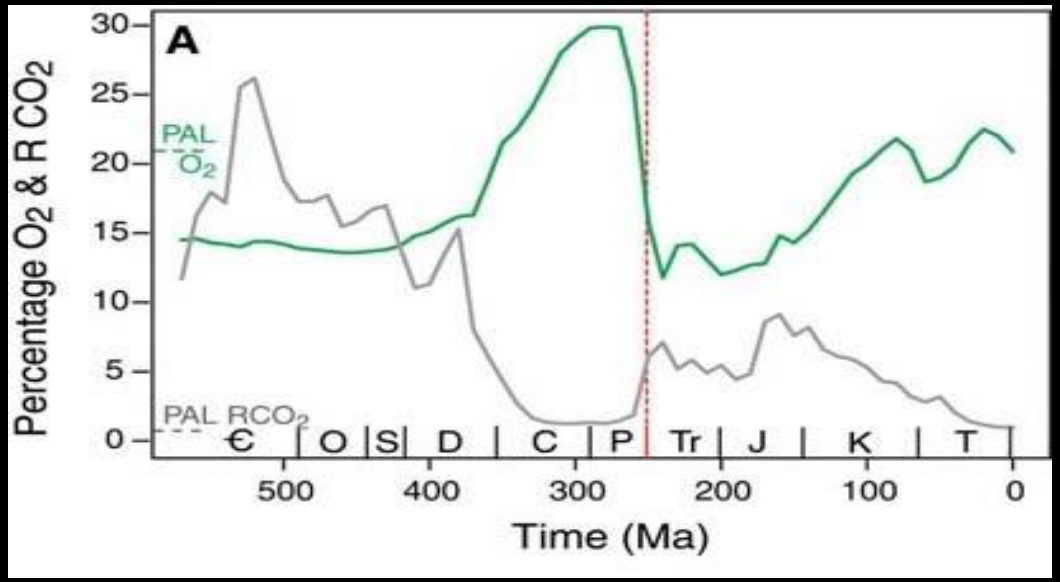
Size

Smallest beetle



Insects are typically 3-5 millimetres long.

250-300 million years ago many insects were large - some with a wingspan of nearly one metre



Why could insects today never become this big?

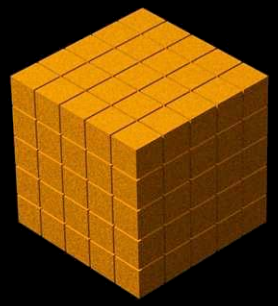
J.B.S Haldane (1892-1964)

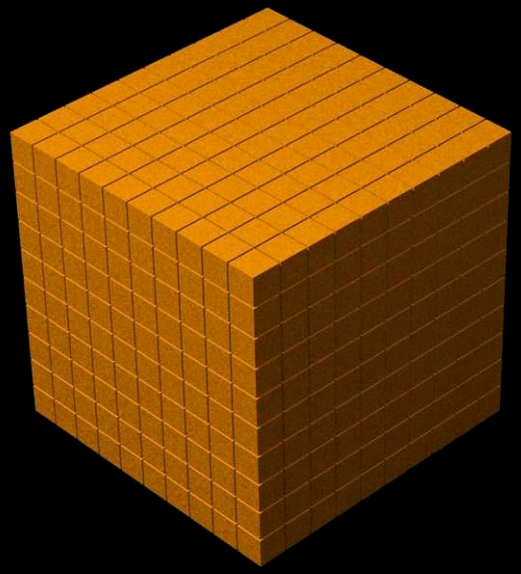
In 1928 Haldane wrote an essay entitled –

On Being the Right Size

You can drop a mouse down a thousand foot mine shaft and, on arriving at the bottom, it gets a slight shock and walks way. A rat is killed, a man is broken and a horse splashes.

Animals cannot change physical laws such as the accelaration due to gravity, the properities of water and the laws of thermodynamics





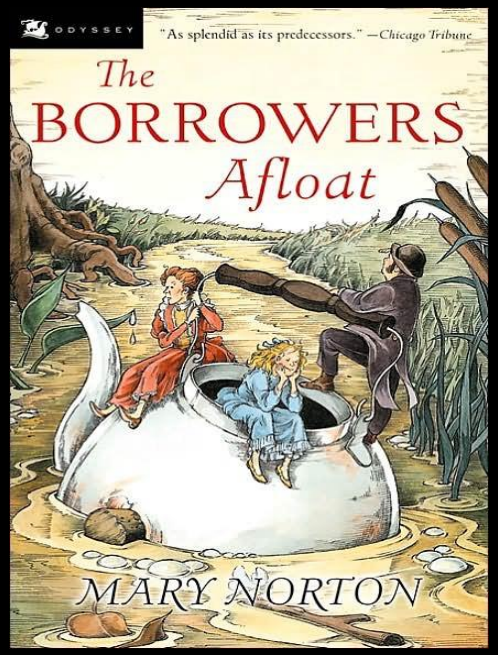
L=1	L=5	L=10
SA=1	SA=25	SA=100
Vol =1	Vol=125	Vol=1000

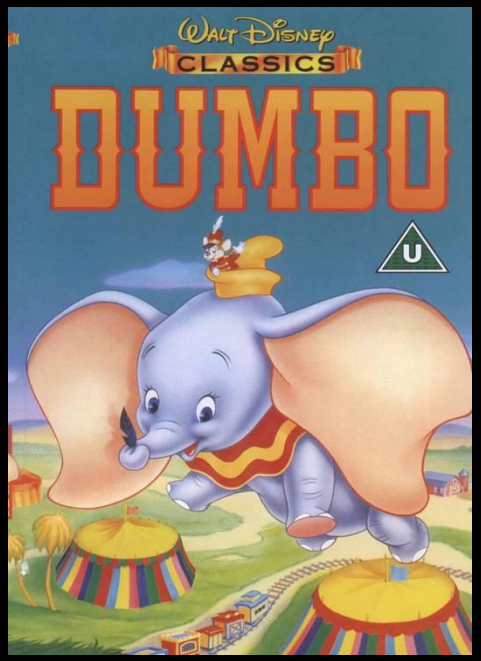
Small animals have lots of outside for not much inside

Large animals have lots of inside for not much outside


A HORROR HORDE OF CRAWL-AND-CRUSH GIANTS CLAWING OUT OF THE EARTH'S STEAMING DEPTHS!
NO MENACE LIKE IT KNOWN TO MAN OR BEAST BEFORE!
"This city is under martial law until we annihilate THEM!"
THEM!
"THEM!"
WARNER BROS.

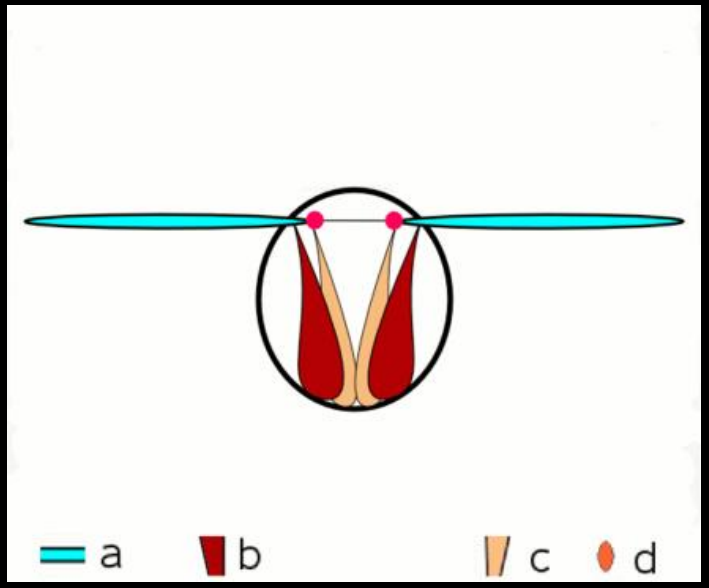

27
THE GIANT FLIES


ODYSSEY
"As splendid as its predecessors." —Chicago Tribune
The BORROWERS Afloat
MARY NORTON

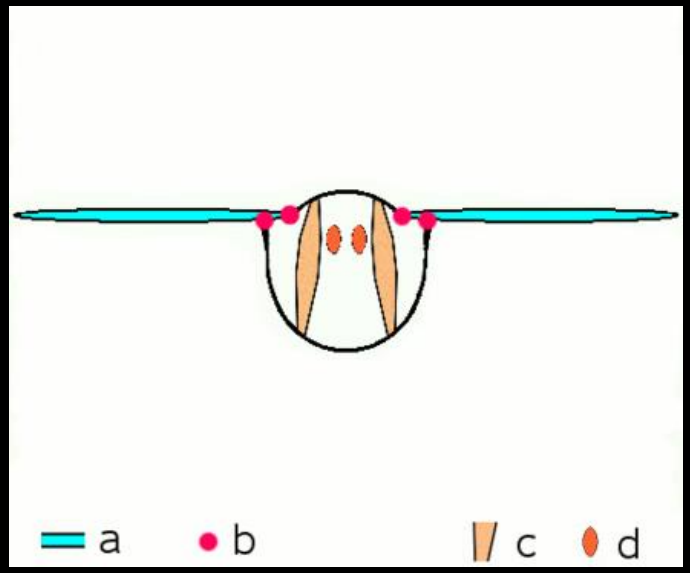

Walt Disney
CLASSICS
DUMBO
U

Flight

Insects evolved wings millions of years before birds or bats.

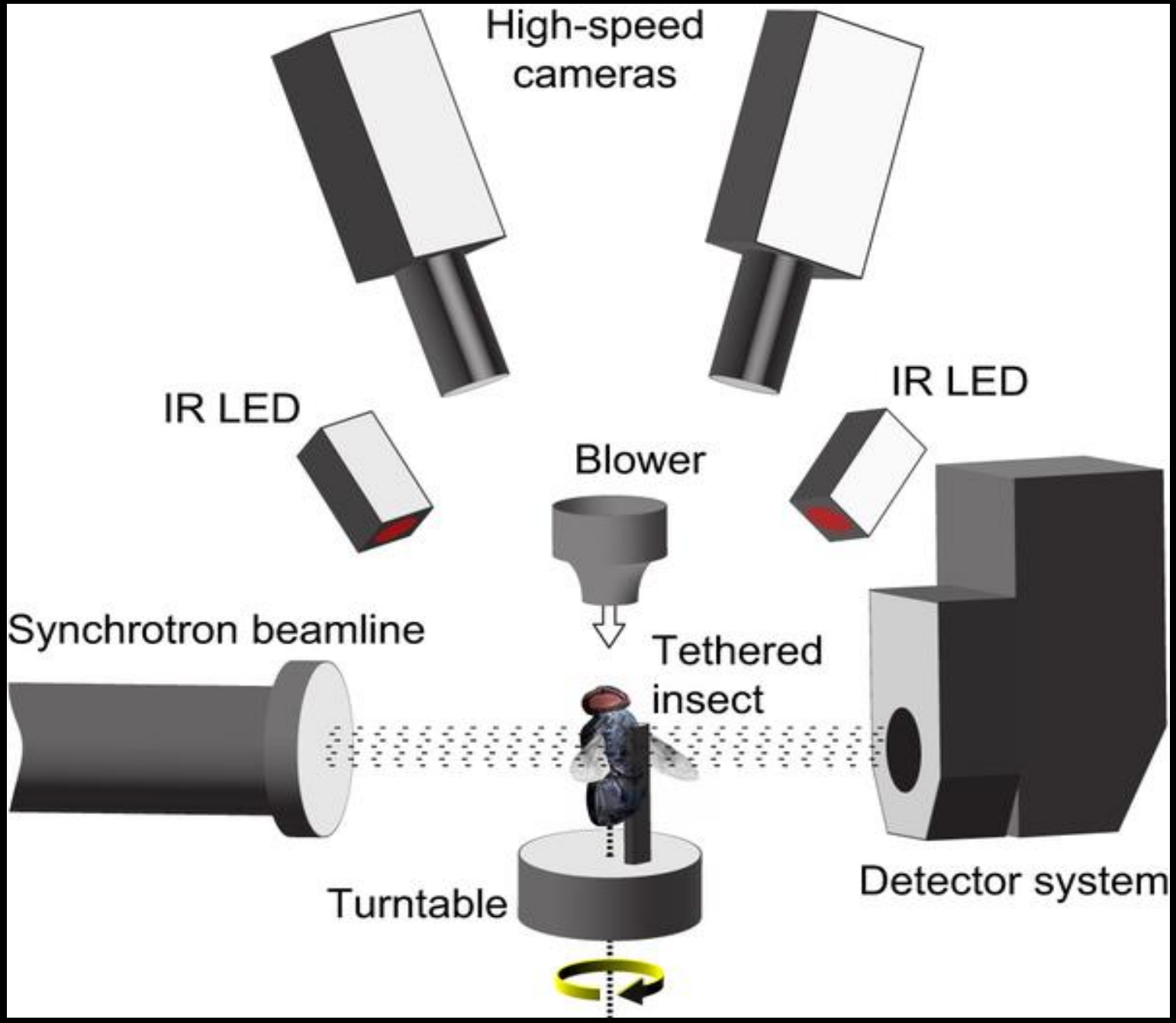


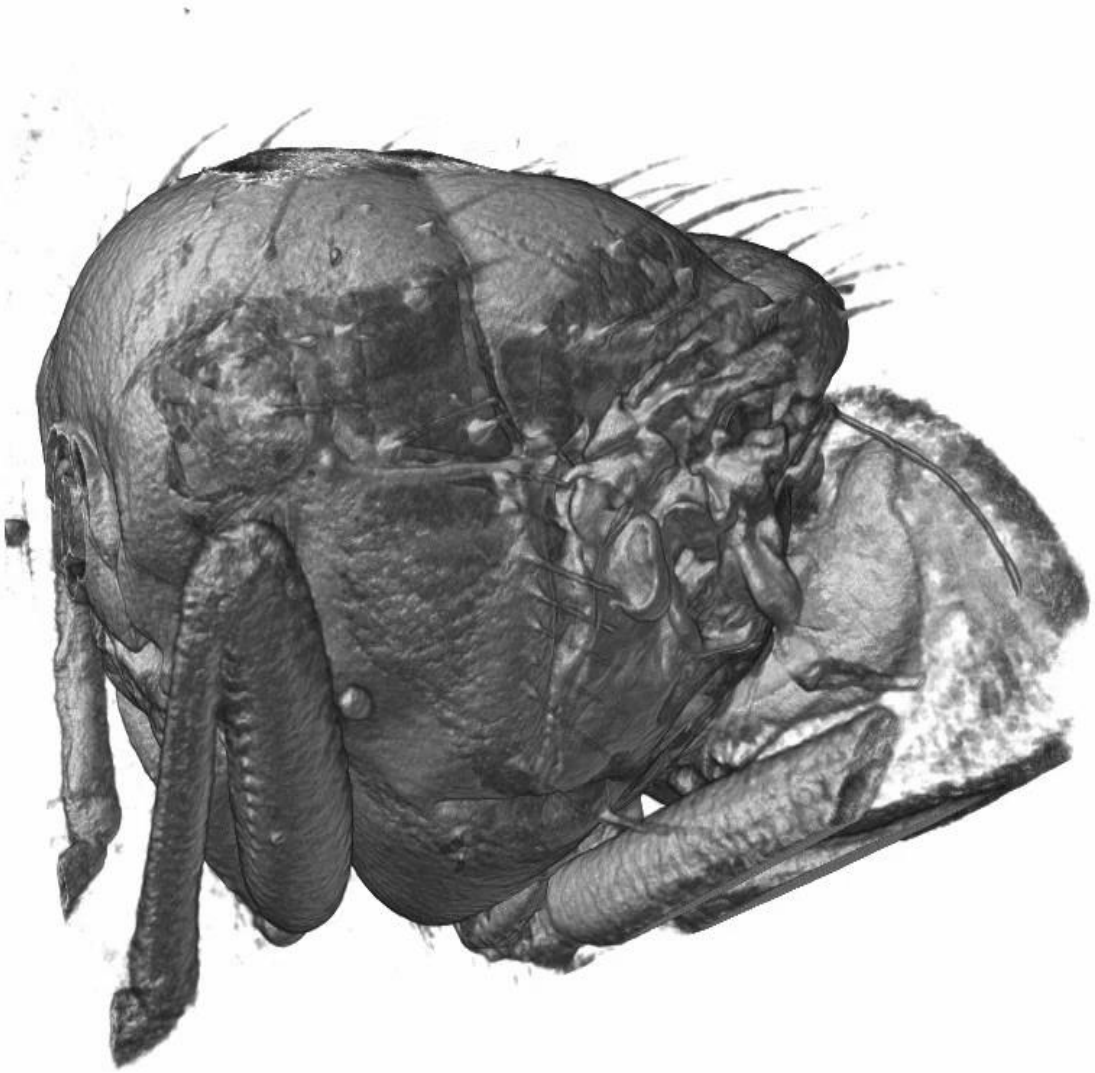
Direct flight motor



Siga, Wikimedia Commons.

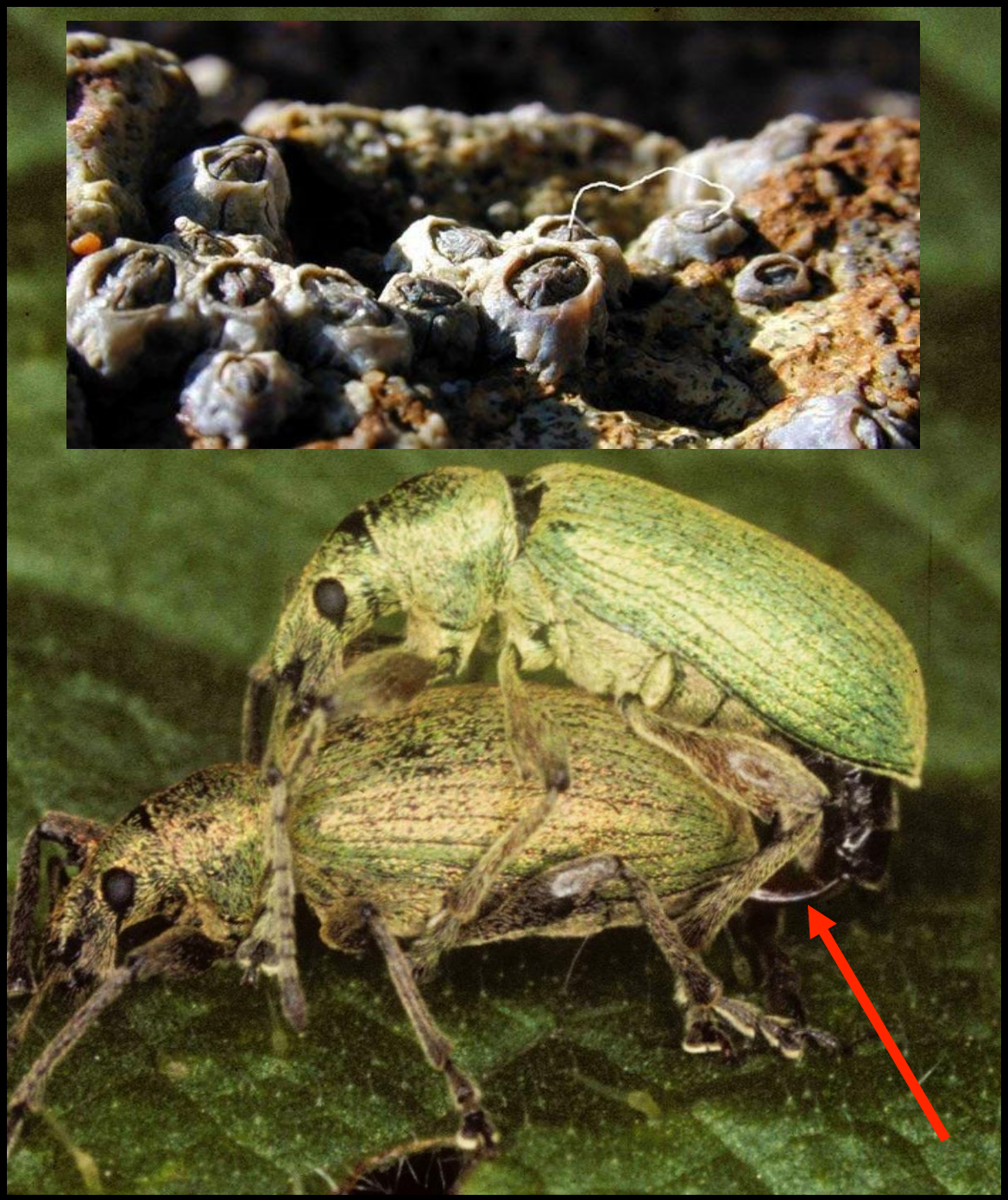
Indirect flight motor


High-speed cameras
IR LED
IR LED
Blower
Synchrotron beamline
Tethered insect
Turntable
Detector system



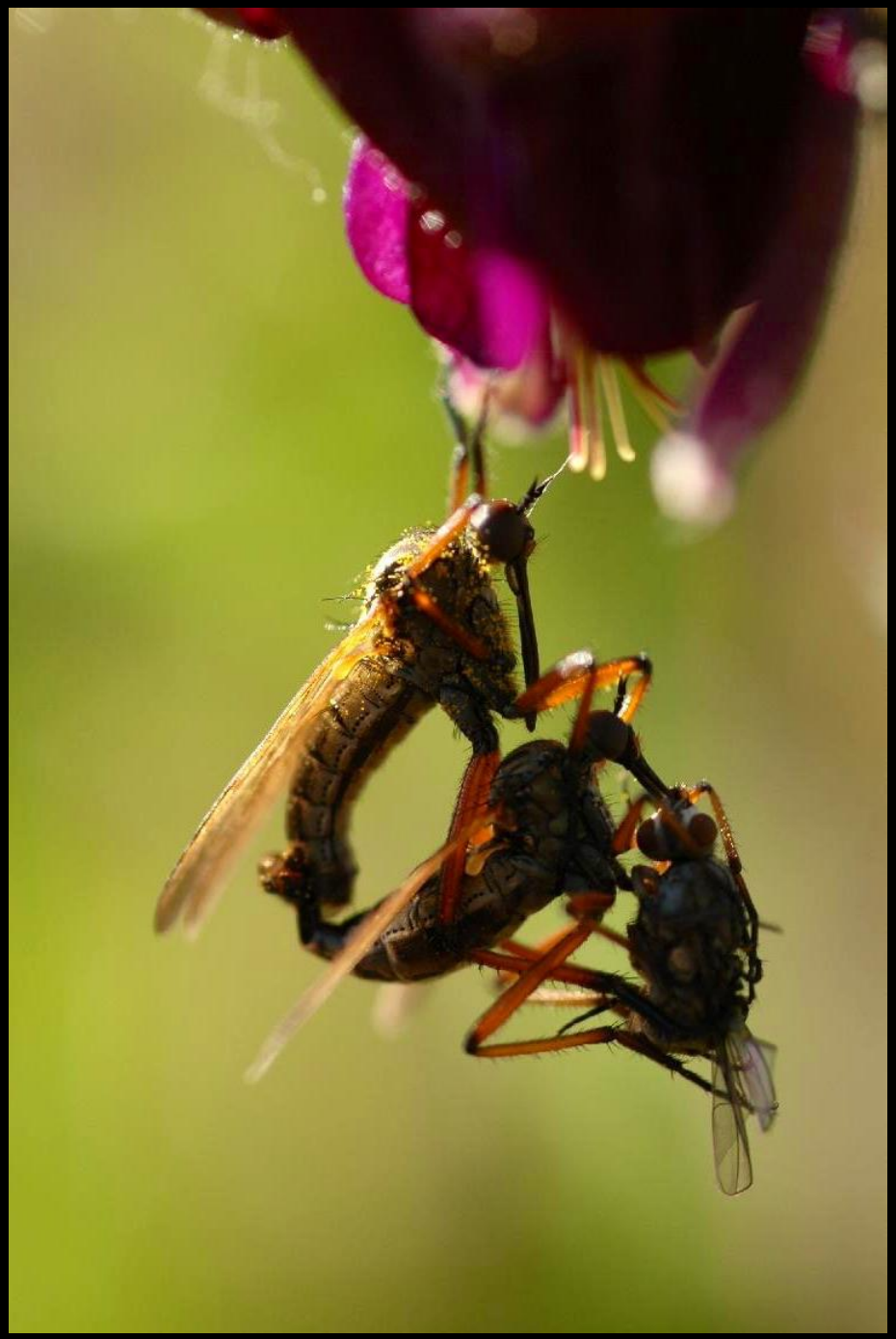
In Vivo Time-Resolved Microtomography Reveals the Mechanics of the Blowfly Flight Motor
Simon M. Walker, Daniel A. Schwyn, Rajmund Mokso, Martina Wicklein, Tonya Muller, Michael Doube, Marco Stampanoni, Holger G. Krapp, Graham K. Taylor https://flight.zoo.ox.ac.uk

Reproduction



Nuptial gifts

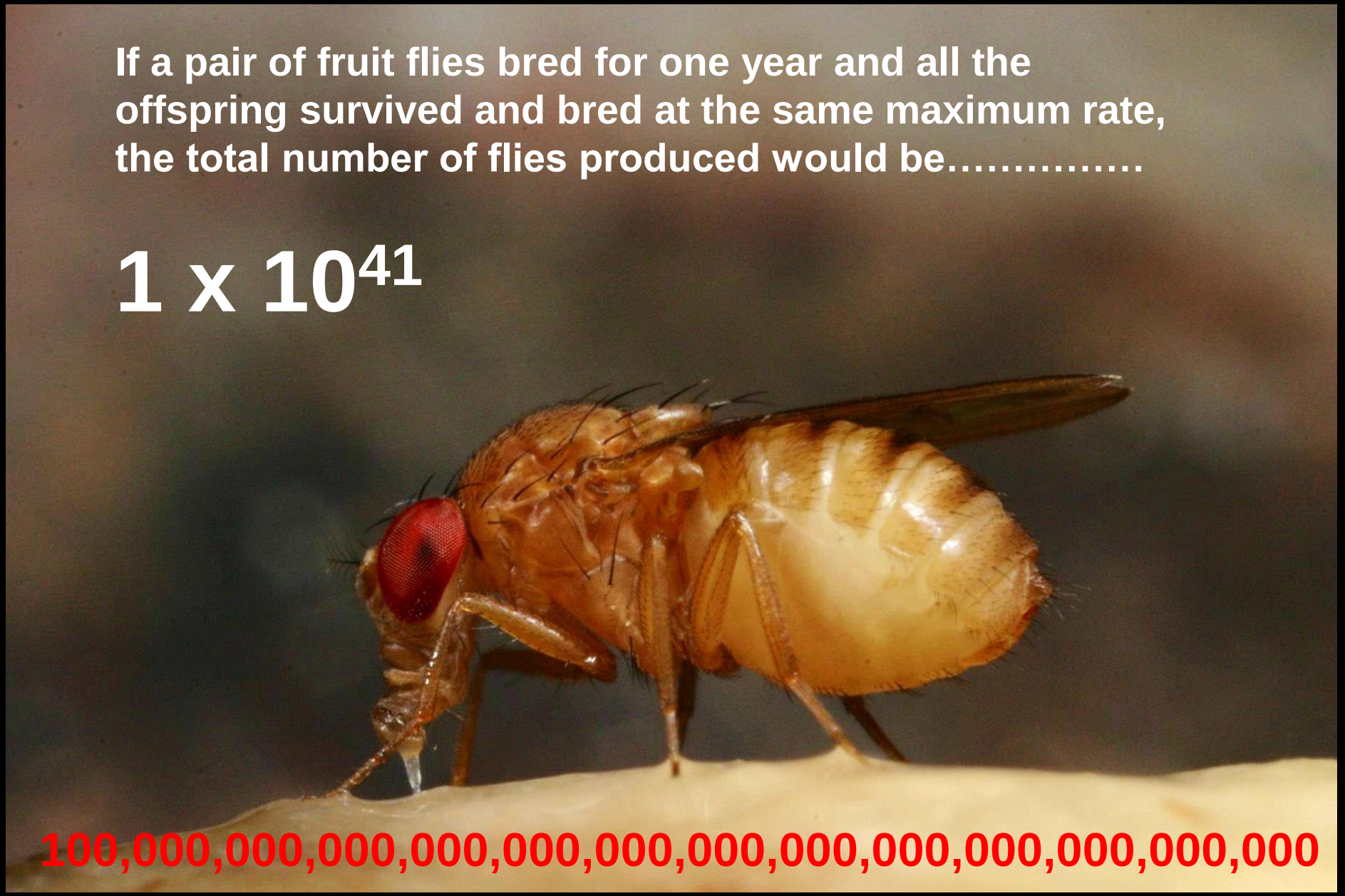
Dance flies (Diptera:Empididae)



Female *Photuris* fireflies lure their own males for sex but lure the males of *Photinus* as food. But there's more to it.

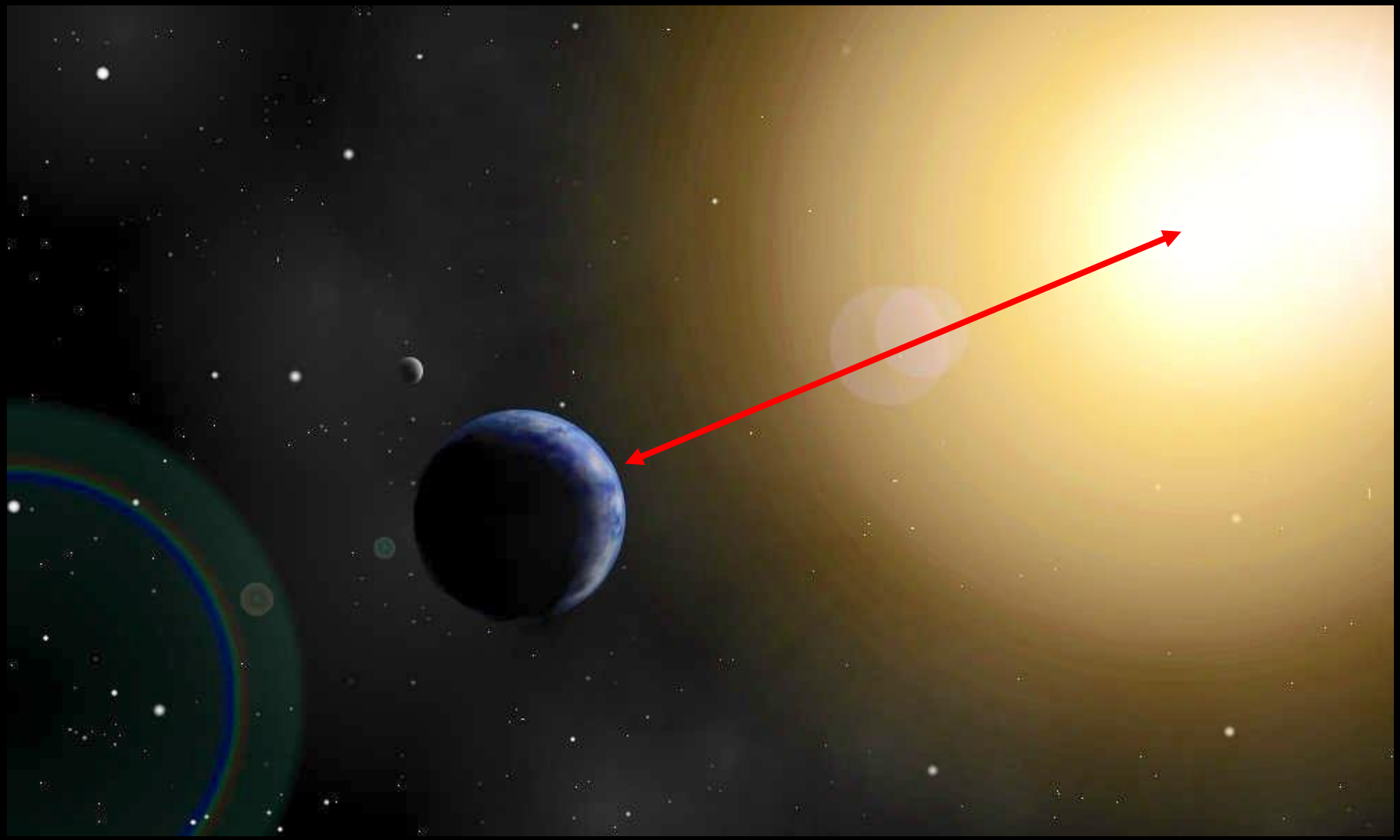
If a pair of fruit flies bred for one year and all the offspring survived and bred at the same maximum rate, the total number of flies produced would be……

1×10^{41}



100,000,000,000,000,000,000,000,000,000,000,000,000,000

The reproductive potential of insects is truly enormous



If packed together at about 60 per cubic centimetre, 1×10^{41} fruit flies would make a ball that would just fit between the Earth and the Sun.

1	2	4	8	16	32	64	128

340 billion tonnes

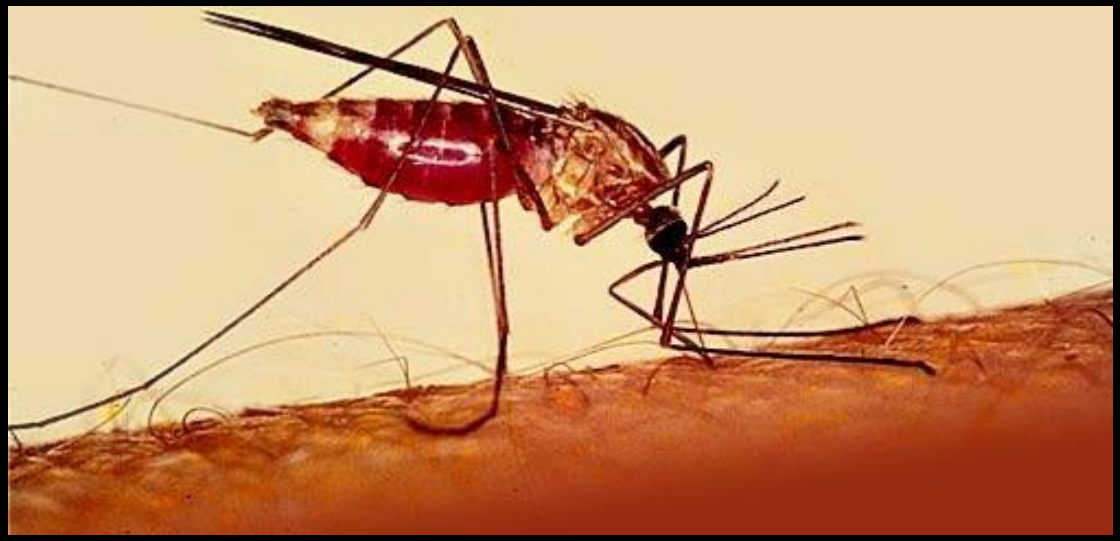
9,223,372,036,854,775,808

Why are insects important?

Ecosystem services:
Pollinators
Predators
Recyclers
Food for most species

Research:
As models for -
physiology, ecology
genetics, behaviour

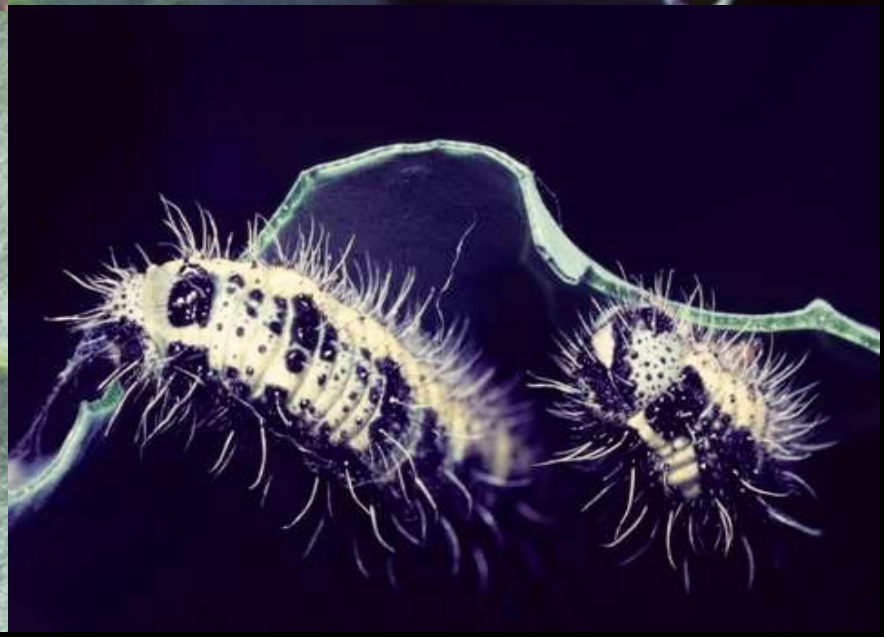
The dark side:
Pests
Disease vectors



Insects consume many times more animal flesh than all vertebrate carnivores put together

Ants are the major carnivores in terrestrial habitats, making up 25% of the total animal biomass.

Many insects lay their eggs inside the bodies of others.

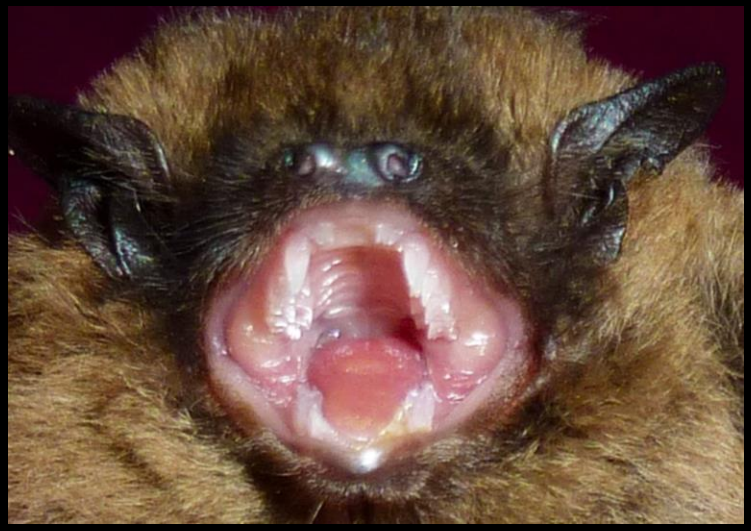


A bug's life……

eat upwards of 200,000
insects before it fledges

caterpillars while they are in
the nest

Insects are the food of the world



The Jurassic landscape was clothed by conifers, ferns, clubmosses and horsetails, but this world of browns and greens ...

...would be replaced by a world of colour. The Cretaceous period saw the rise to dominance of the flowering plants and the insects that pollinated them.

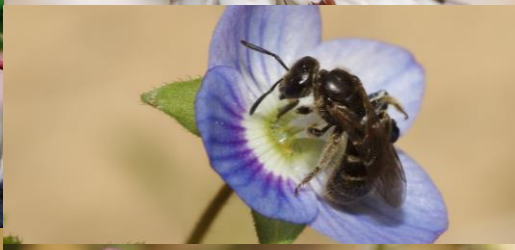










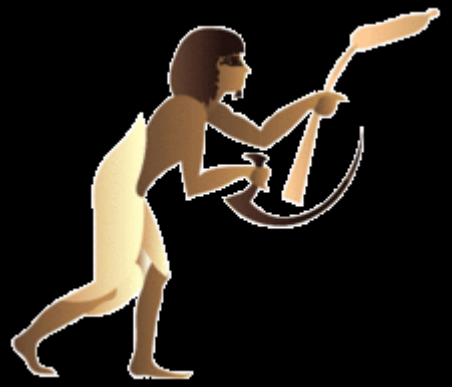


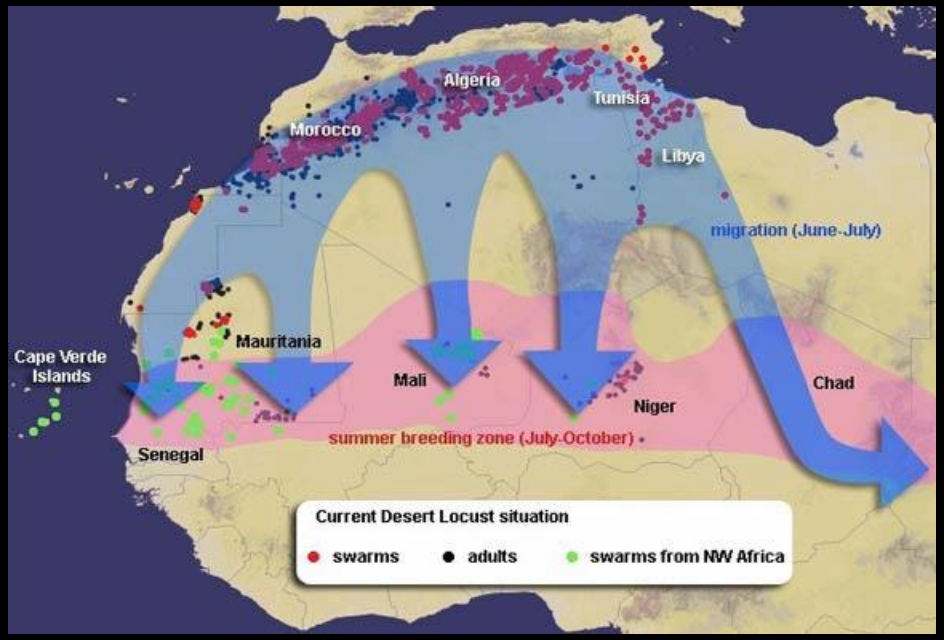


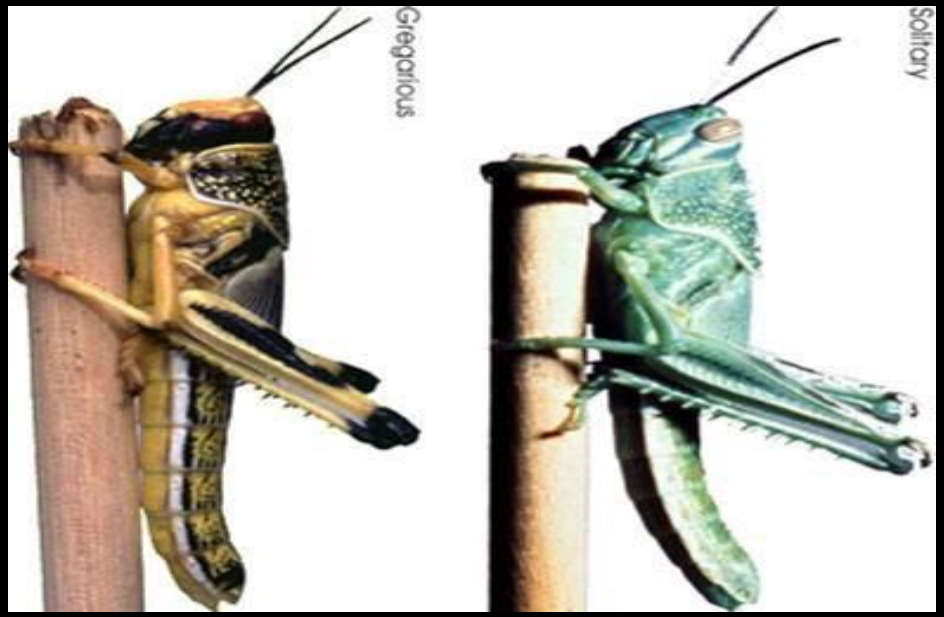

HASS AVOCADOS
75p
PREMIUM MELONS
1·50
PREMIUM MANGOS
90p
SWEET SEEDLESS SPANISH SATSUMAS
1·60
FRESH BELGIAN STRAWBERRIES
2·99
PUNNETT CLASS I
FRESH SPANISH RASPBERRIES
2·80
PUNNETT CLASS I


1·30
EGYPTIAN BOBBY BEANS
4·50
KG

One sixth of all crops are lost to pests







The Desert Locust - *Schistocerca gregaria*

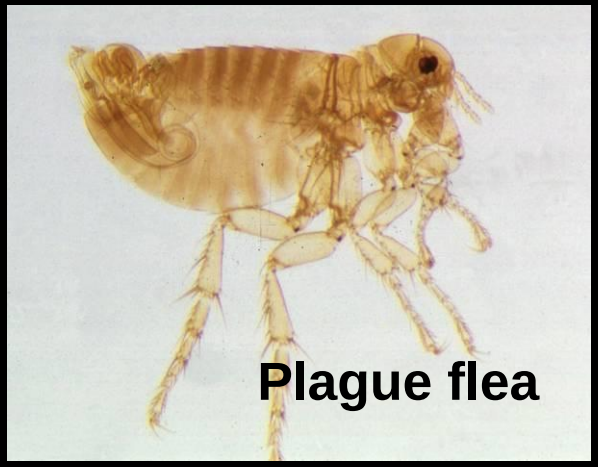
1 person in 6 is affected by a disease carried by flies

Malaria alone kills up to 3 million people a year - most are young children in sub-Saharan Africa - that's about one child every 30 seconds

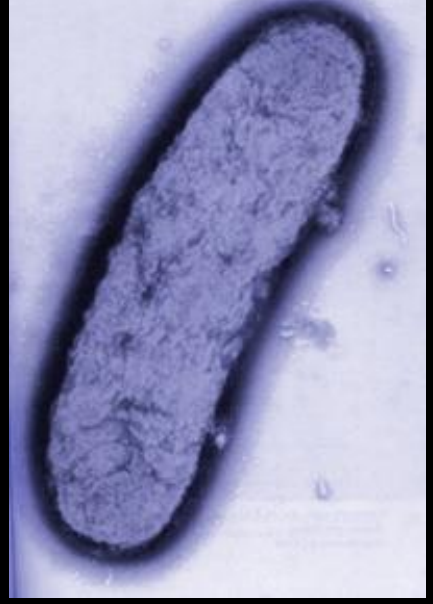
Some insect-borne human diseases

Malaria	**Mosquitoes** ***Anopheles*** **spp.**	**Protozoan** ***Plasmodium*** **spp.**	**3 million deaths p/a** **40% at risk**
River Blindness	**Black flies** ***Simulium*** **spp.**	**Nematode** ***Onchocerca volvulus***	**1 million blind +** **18 million affected**
Sleeping Sickness	**Tsetse flies** ***Glossina*** **spp.**	**Protozoan** ***Trypanosoma brucei***	**~0.5 million cases** **~50,000 deaths p/a** **25 million at risk**
Yellow Fever	**Mosquitoes** ***Aedes aegypti*** **& others.**	**Virus (Togaviridae).**	**~0.25 million cases** **~30,000 deaths p/a** **550 million at risk**
Plague	**Fleas** ***Xenopsylla*** **spp. & others**	**Bacterium** ***Yersinia pestis***	**1,000 - 3,000 cases p/a**
Typhus	**Body Lice** ***Pediculus humanus***	**Rickettsia** ***Rickettsia prowazeki***	**Prevalent worldwide**

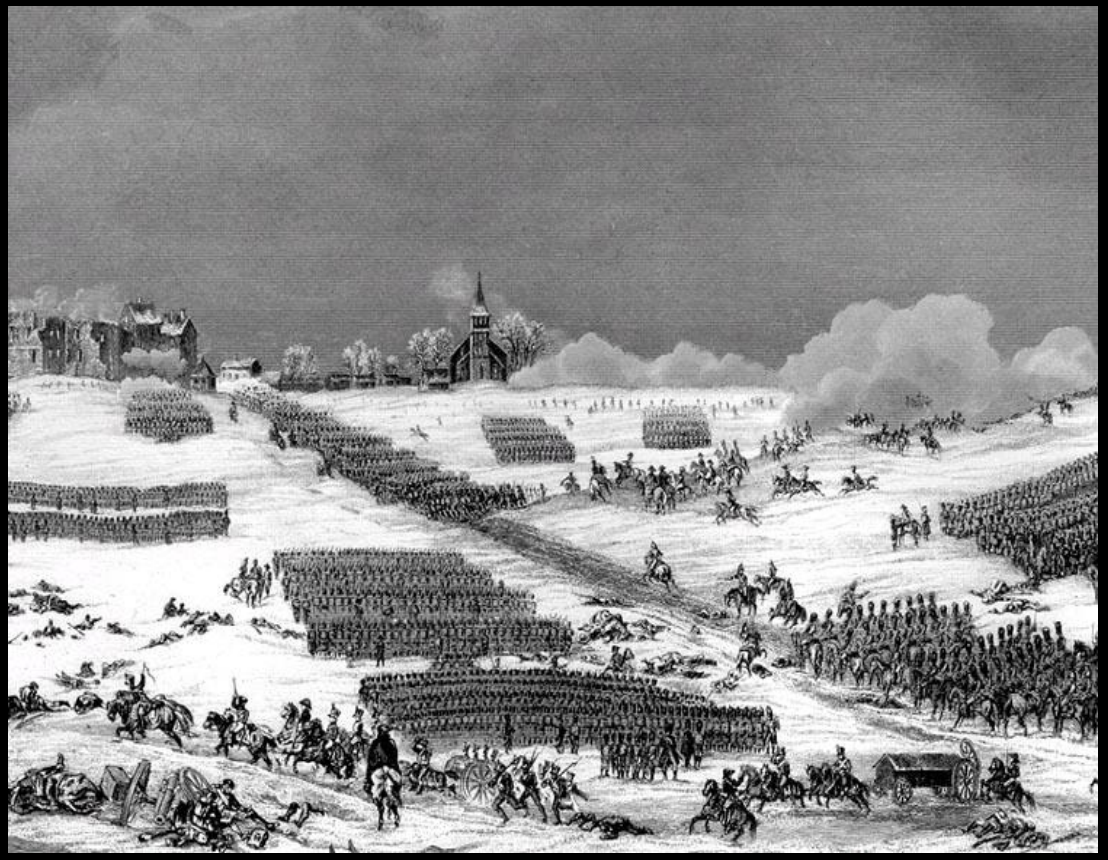
In 1347 a great plague swept over Europe bringing hysteria and death. One third of the population died and the course of history was changed

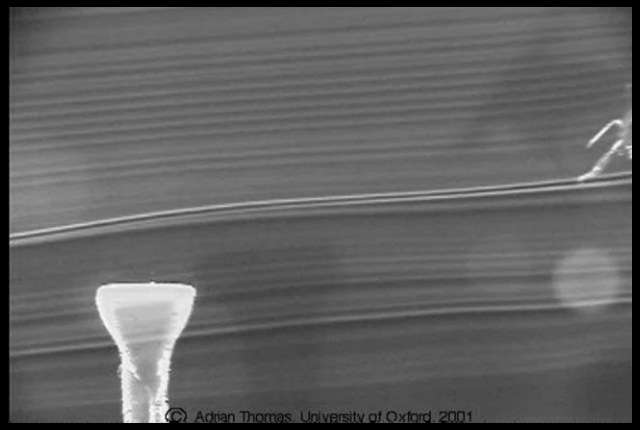


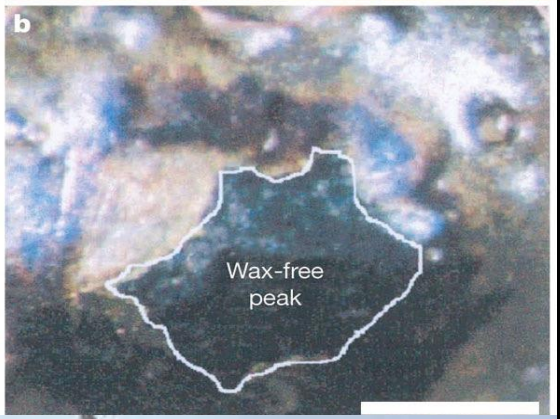
Yersinia pestis

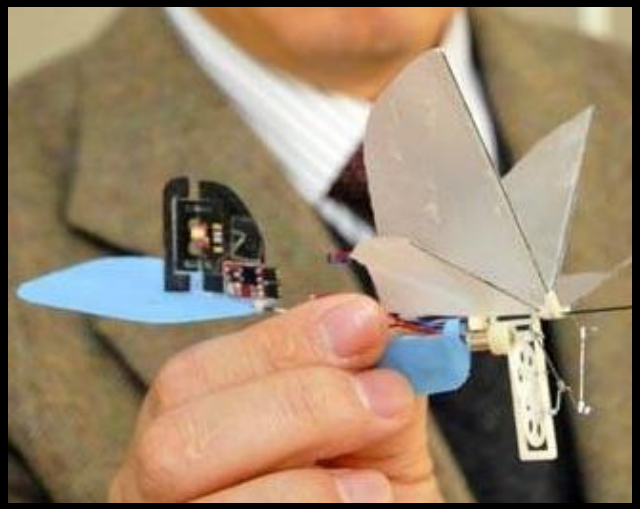


Epidemic typhus carried by body lice killed more soldiers than ever died in combat









Miniature flight systems

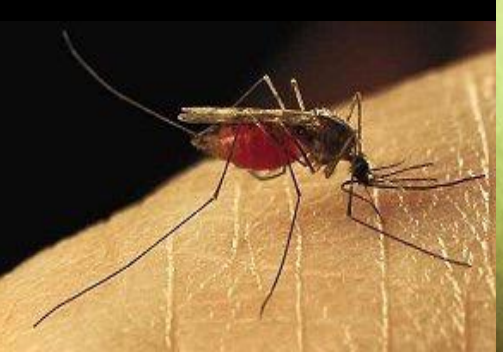
Catching fog

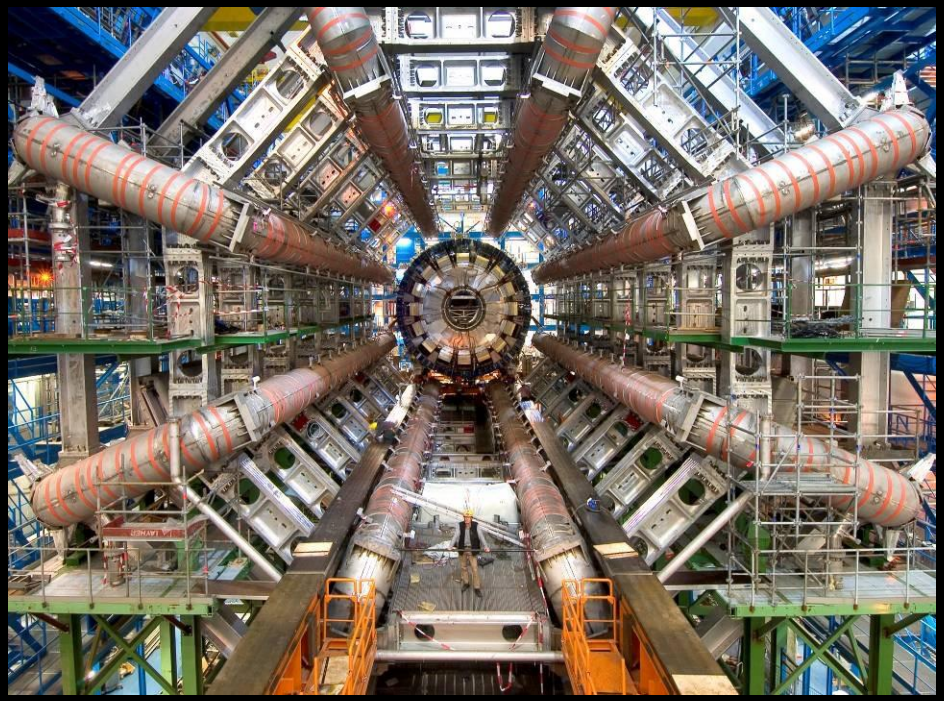
Vibratome

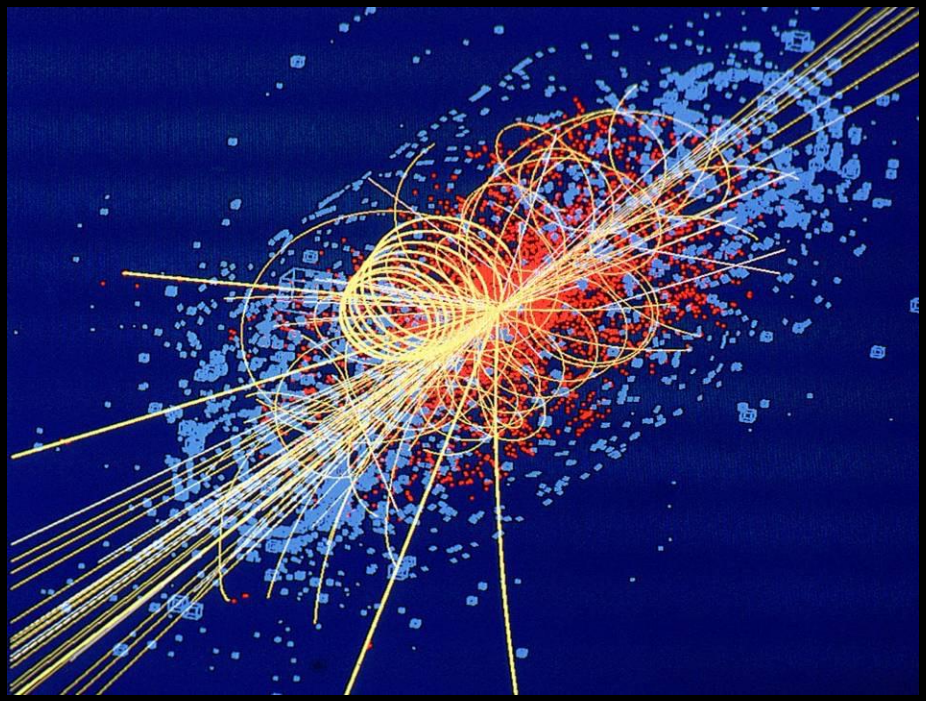


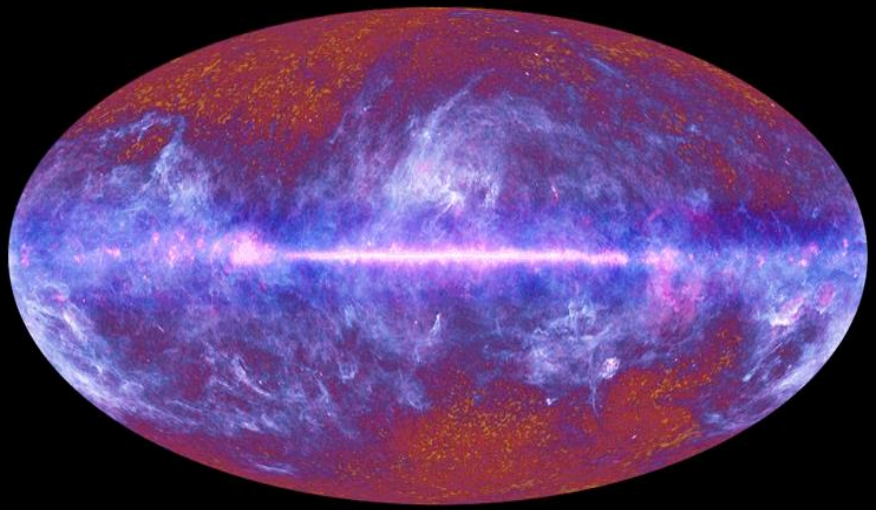


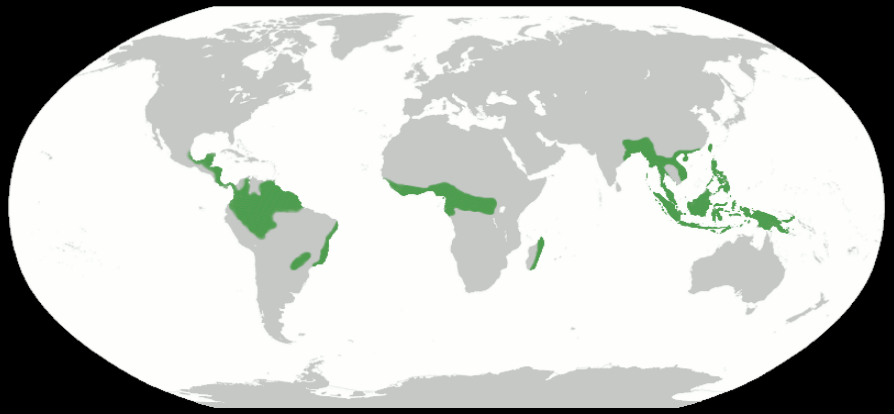




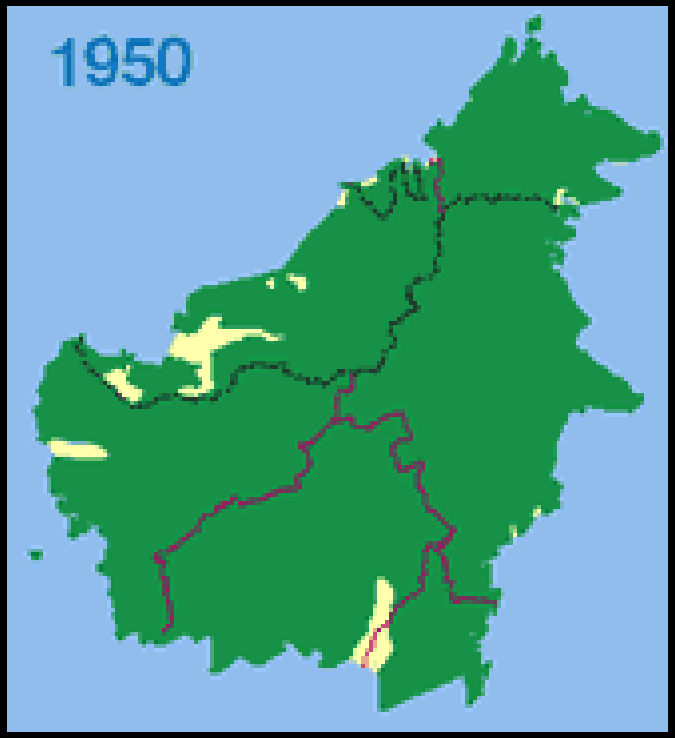




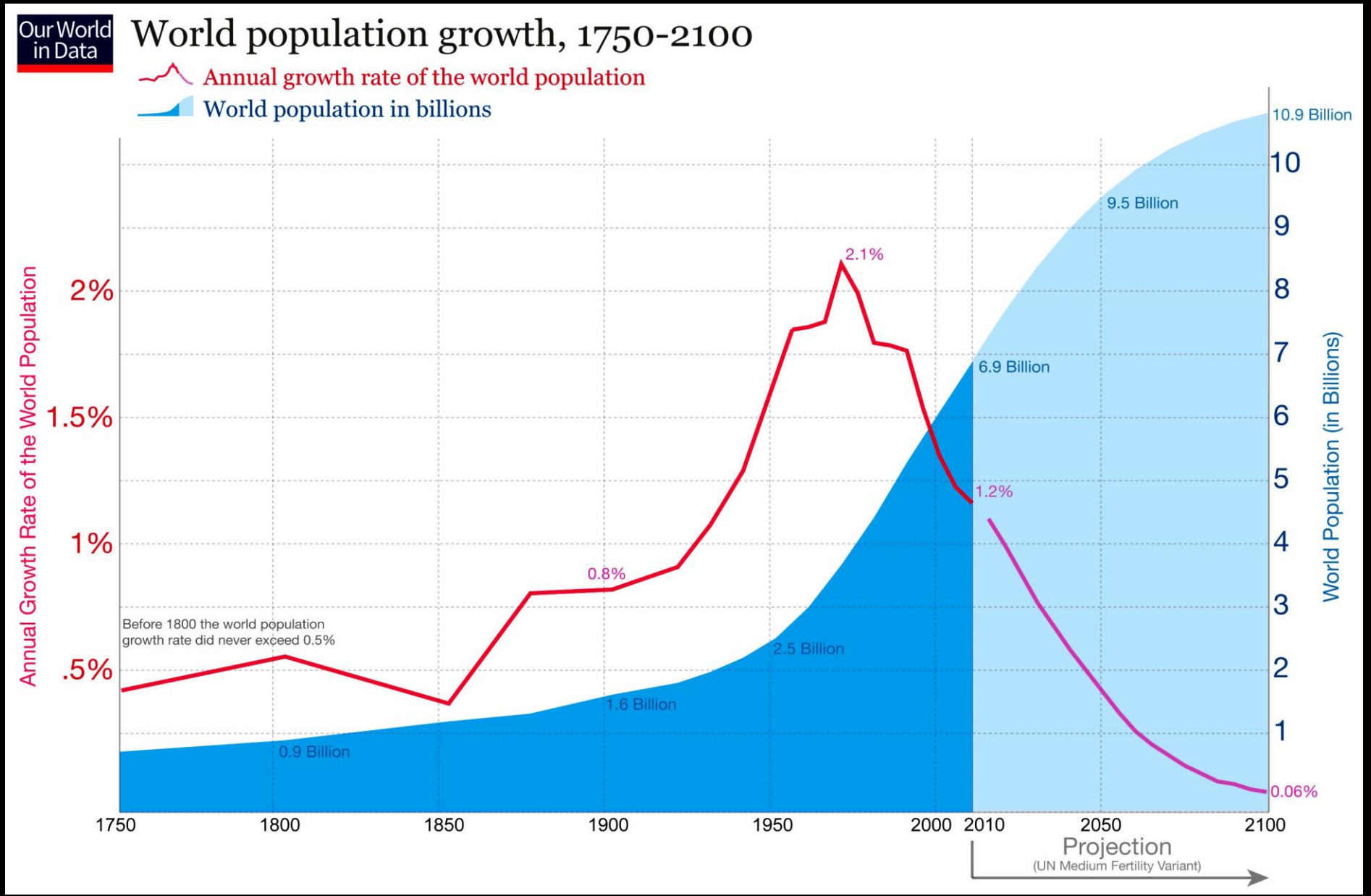

ESA, HFI AND LFI CONSORTIA



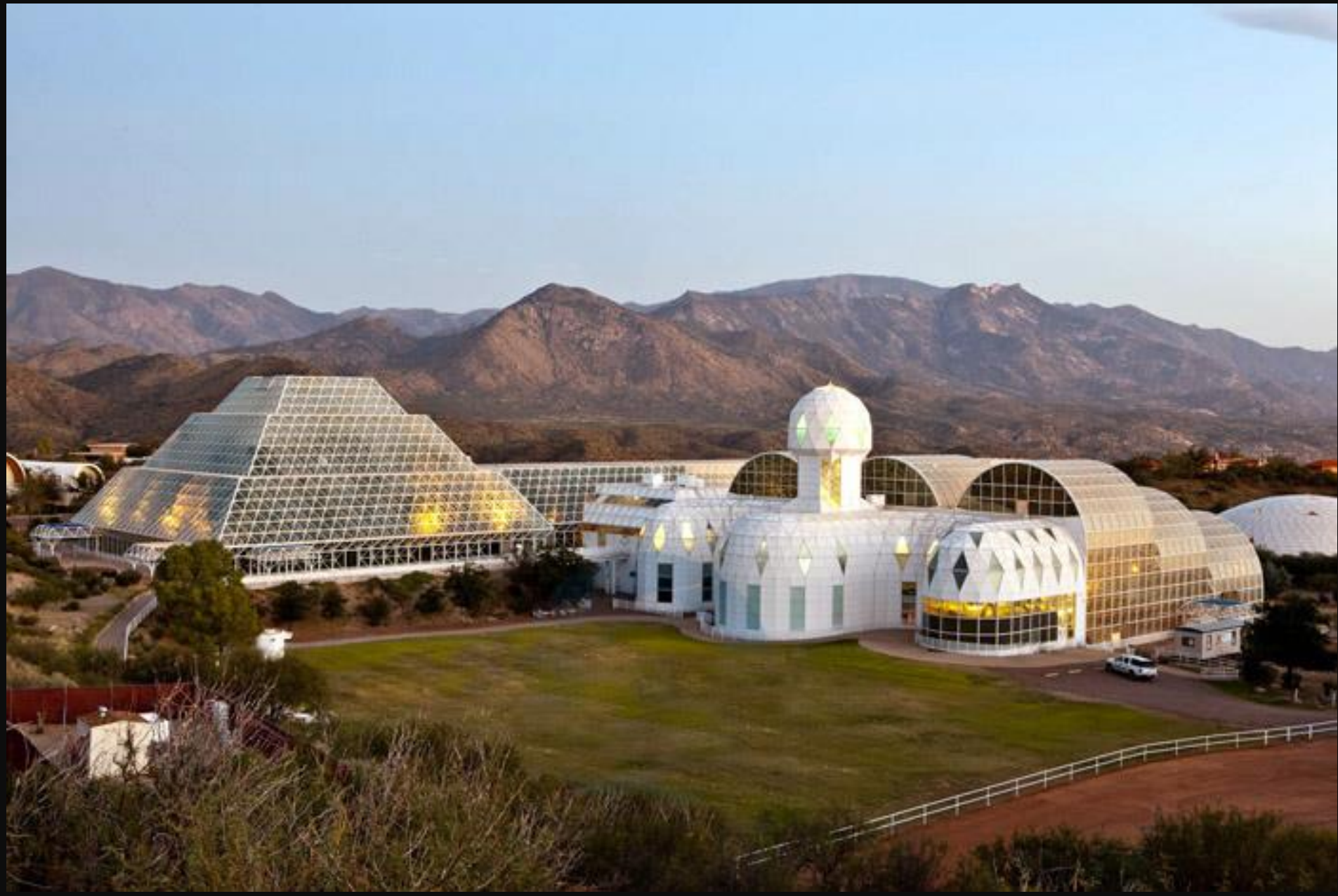
Rainforests contain 60-80% of all species. They cover just under 6% of the land surface area.



Deforestation in Borneo 1950-2020



Esteban Ortiz-Ospina and Max Roser (2016) – 'World Population Growth'. Published online at OurWorldInData.org.
Retrieved from: https://ourworldindata.org/world-population-growth/ [Online Resource]



Biosphere 2


PLAN A:
We must preserve as much natural habitat as possible - a task that requires immediate international action.
PLAN B: There is no PLAN B

Closest exoplanet to our Solar System.
Within host star's habitable zone - possibly Earth-like.

With thanks to: Rupert Soskin, Paul Brock, Graham Taylor, Simon Walker, Nico Vereecken, Maria Justamond, Mariana Ruiz Villarreal, Henry Bennet-Clark & Craig Packer