

EVOLUTION OF FLIGHT



~350 MYA

INSECTS WERE THE FIRST TO EVOLVE WINGS AND TAKE TO THE SKIES...LONG BEFORE THOSE PESKY DINOSAURS TOOK OVER THE PLANET.

The ability to fly has evolved four times during the history of the earth.

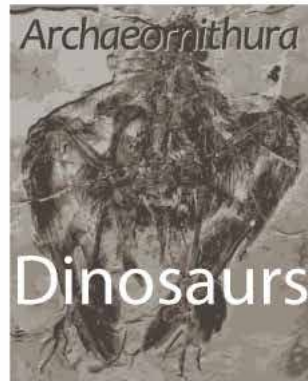
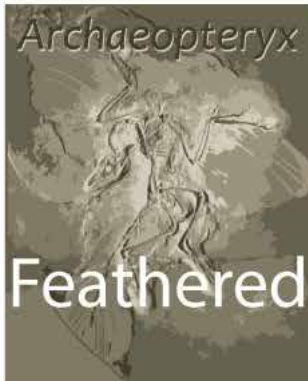
Pterosaurs filled the skies, ranging in size from a crow to the largest animals ever to fly. One species, *Quetzalcoatlus northropi*, had wings that spanned more than 10 meters.

~200 MYA

one elongated finger

Winged reptiles darkened the skies more than 200 millions years ago (MYA). They went extinct with their dinosaur cousins 65 MYA.

EX Extinct



Feathered Dinosaurs

~130 MYA

Feathered theropod dinosaurs evolved into modern birds, foregoing their complete extinction.



RECENT FOSSIL DISCOVERIES INDICATE THAT THE FAMOUS *ARCHAEOPTERYX* WAS NOT MY DIRECT ANCESTOR, BUT A COUSIN. MY GREAT GREAT GREAT... GREAT GRANDMOTHER MAY BE *ARCHAEORNITHURA!*

LAST BUT NOT LEAST BATS

~60 MYA

Bats may be the youngest organisms to fly, but they were flying for more than 50 million years before primates started walking upright.



FOLLOWING THE GREAT DINOSAUR EXTINCTION, MANY SMALL MAMMALS FOUND NEW OPPORTUNITIES TO EXPAND THEIR RANGE. ONE MAMMAL'S LIMBS WERE GREATLY ALTERED AND IT GAINED THE ABILITY TO FLY.

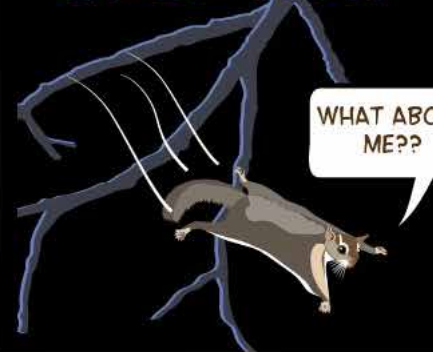
Like us, many bat species have opposable thumbs...

...but four very long fingers

THE FOSSIL RECORD IS VERY POOR FOR MY ANCESTORS, SO WE HAVE LIMITED INFORMATION ABOUT THE PROCESS.

GLIDING

Although powered flight evolved only four times, the ability to glide has occurred many more times in a wide range of organisms.



WHAT ABOUT ME??

PRIMATE: LEMUR

REPTILE: LIZARDS, GECKOS, SNAKES

MOLLUSC: SQUID

INSECT: WINGLESS ANTS

AMPHIBIAN: VARIOUS FROGS

FLYING FISH

RODENT: SQUIRRELS, MICE...



Bats took flight millions of years after birds. From large meat-eating harpy eagles to tiny nectar-loving hummingbirds, almost 10,000 bird species fill the niches of forests, fields, lakes, mountains, valleys, and cities. Besides the owls, however, most of them are active during the day.

I WONDER WHAT HAPPENED TO THOSE FLYING MAMMALS? THEY WERE A TASTY SNACK.

Fortunately, the winged mammals had another trick. They had the capacity to “see” with sound in the darkness of night.

I CAN HEAR THE FROGS CALLING. IT SOUNDS LIKE A CHOIR WITHOUT A DIRECTOR.

IF THE BATS ARE MAKING SOUND TO “SEE”, WHY CAN’T I HEAR THEM?



I PRODUCE ULTRASOUNDS TO MANEUVER THROUGH COMPLEX ENVIRONMENTS AND DETECT, LOCALIZE, AND CLASSIFY MY PREY. THE HIGH FREQUENCY RANGE IS BEYOND THE CAPACITY OF YOUR HUMAN EARS TO DETECT.

ECHOLOCATION

Distance is determined by signal return time.

I can increase the frequency when necessary. The shorter distance between each sound wave is critical for bouncing off small objects.

Micronycteris microtis is the only bat known that can detect silent motionless prey hiding in vegetation, like a katydid.

The returning frequency (white) increases if the prey is coming towards me.

DOPPLER EFFECT

I HEARD SOMEONE SAY HE WAS "BLIND AS A BAT". ARE BATS BLIND?

NO! LIKE OTHER MAMMALS, SOME BATS HAVE A KEEN SENSE OF SIGHT AND SMELL.

SCIENTISTS SAY THAT OUR BAT VISION AND SMELL MAY NOT BE AS SHARP AS THEY USED TO BE DUE TO EVOLUTIONARY TRADEOFFS TO USE OUR NOSE AND BRAIN FOR ECHOLOCATION.

Such modifications are clear in the leaf-nosed bats (Phyllostomids). They have enlarged ears to capture the returning sounds of echolocation and funnel it to the inner ear. Their brain is specialized for tiny frequency changes.

These bats also have elaborate noses that act like megaphones to emit and direct their outgoing sound.

In complete darkness, bats can navigate with only their echolocation. The moon provides enough light, however, so bats can use vision when they are close to an insect or fruit. They also use smell ... not only for food, but to identify their companions in a roost.

I THINK YOU ARE LOOKING FOR A DIFFERENT ROOST. YOU DON'T SMELL LIKE OUR GROUP.

Not all bats can echolocate. There is a group of bats in the Old World tropical and subtropical regions. These fruit bats or flying foxes have both keen vision and smell to find their dinner.

I'M A VEGETARIAN... OR SOMETHING LIKE THAT.

Like the diurnal birds, bats have evolved to focus on different types of food in different habitats. With more than 1300 species living worldwide (excluding polar regions), bats are very diverse and comprise about 20 percent of the mammal species.

THE LARGEST NUMBER OF SPECIES EATS INSECTS.



MANY BAT SPECIES ARE OMNIVORES LIKE HUMANS. FRUITS OR NECTAR MAY BE PREFERRED, BUT THEY EAT INSECTS AS WELL.



SOME SPECIES CAN FISH

DRACULA AND VAMPIRES SPREAD FEAR ABOUT BATS. ONLY THREE BAT SPECIES DRINK BLOOD AND THEY ALL LIVE IN LATIN AMERICA.



3

Bats are creatures of the night, but they are not flying to spread fear. They fly in search of food.

With their voracious mammal appetites, the winged mammals control insect populations. Blood-sucking mosquitoes are not just annoying, they also transmit serious human diseases such as dengue, malaria, and Zika.

Bats also devour moths whose caterpillars munch food crops and tree farms.

WHILE YOU SLEEP

Over 70 bat species have been observed in a Central American rain forest. Some species pollinate crops like bananas and cacao (chocolate). Others disperse seeds from fig trees, critical to a wide range of forest animals.

Because bats pass digested fruits with seeds in flight, they are called the *tropical tree farmers*.

About **half** of all bat species worldwide are threatened or endangered. This is due primarily to habitat destruction, pollution, and human persecution.

INSECTS ARE GREAT, BUT MY FAVORITE FOOD IS A TASTY MUD-PUDDLE FROG WHO SINGS ALL NIGHT.

I HEAR HIM CALLING NOW.
DINNER TIME.

DENGUE
MALARIA
ZIKA

SHHHH. I JUST FELT SOME RIPPLES IN THE WATER AND A BEAUTIFUL CALL FROM THAT MALE OVER THERE. HIS VOCAL SAC IS LARGER THAN THE OTHERS AND I THINK HE MIGHT BE THE ONE.

I THINK I WILL SWIM OVER AND SAY HELLO... HOLD ON! WHY DID HE STOP???

Male Tungara frogs are calling to find mates. The females in the water can see his vocal sac inflating in order to make the call. It is unclear, but she may even approach based on the water ripples.

The multiple modes of signals help the female to choose which male will be her mate.

THAT MAKES SENSE... LIKE A LIONESS CHOOSING THE LARGEST LION WHO ALSO HAS THE LOUDEST ROAR. BUT WHY DID HE STOP CALLING?

MY BROTHER SAW THE SHADOW OF A BAT AND STOPPED CALLING. I'M DUMBFUNDED. THAT BAT STILL ATE HIM. I CAN'T FIGURE OUT HOW IT FOUND HIM.

Turns out that the bats are eavesdropping on the mating calls. Like the frogs, the bats use multiple signals. First they hear the calling, then they detect the frog with echolocation.

THE CALLING BROUGHT ME TO THE SITE, BUT AS I APPROACHED, I USED MY ECHOLOCATION TO "SEE" THE MOVING VOCAL SAC. THEN I DID SOMETHING THAT IS VERY IMPRESSIVE.

I ECHOLOCATED THE RIPPLES THAT CONTINUED AFTER HE STOPPED CALLING AND FOUND HIM IN THE CENTER OF THE RIPPLES. IT IS ALMOST LIKE TIME TRAVELING.

You may have been wondering...
Why doesn't every male túngara
frog chuck all night long??

The energy required for a whine
or a chuck is not different.

HOWEVER, It turns out that not
only frogs are listening.



Trachops cirrhosus (frog-eating bat)

DINNER CALL

OR

Physalaemus pustulosus (túngara frog)

MATING CALL

