

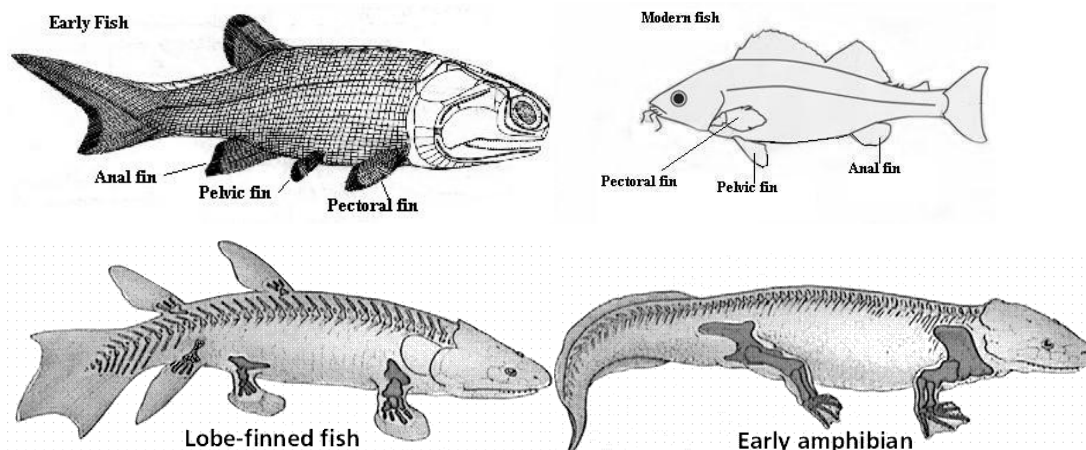
# Where have all the monsters gone?

by Owen K. Wilby

In past editions of Oracle I have written of my long-time fascination with monsters and their biological relevance, now I want to discuss their disappearance from the modern world.

Some, unfortunately, are still with us. The one-eyed Cyclops is a result of a catastrophic failure of the embryonic single eye-field to separate into two eyes, either as a result of a genetic mutation or an ingested plant toxin. It is not the offspring of a race of one-eyed giants living in the hills of ancient Greece. Similarly the babies with extra limbs, extra faces or extra bodies, as so recently seen in India and the USA, are incompletely separated identical twins. These are all variations of the “Siamese Twin” phenomena – biological accidents - and are not physical manifestations of the gods of the Hindu pantheon. Many of the gods and monsters in our mythology have been invoke to explain accidents of birth – someone else must be to blame! The most important part of my job is to try to ensure that we are not to blame – that the drugs, pesticides and other chemicals to which we are exposed are actually safe and do not harm our unborn children.

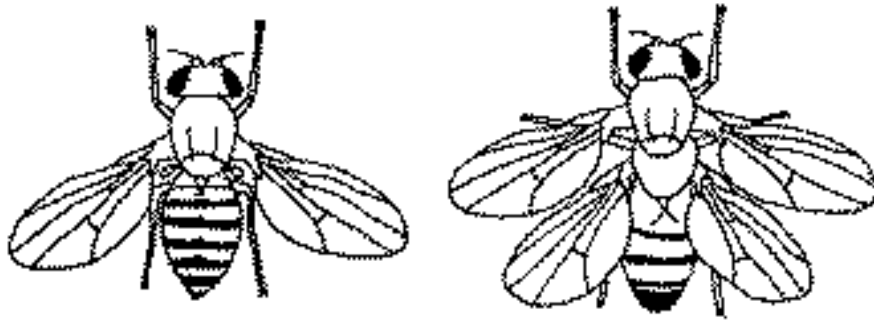
The monsters that fascinate me most are those with six legs, not insects (or fairies for that matter) but vertebrates like you and me with an extra set of limbs –arms, legs or wings – between the normal pair: angels, demons, dragons, centaurs and flying horses for example



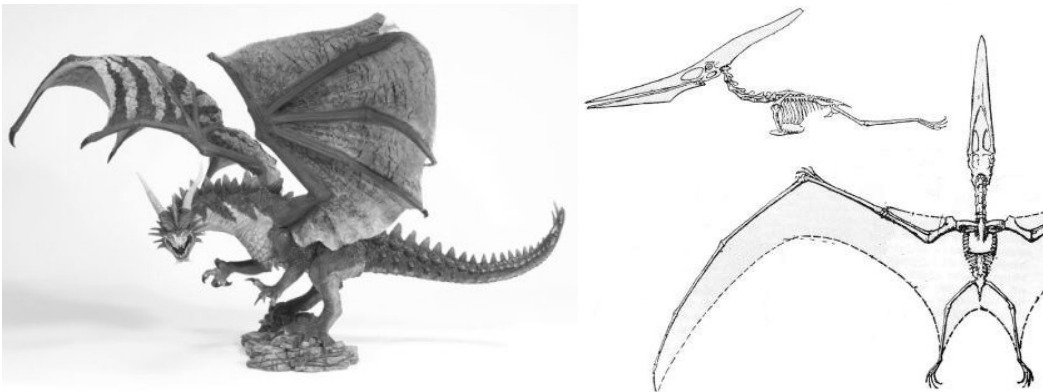
Let me first consider why we only have four limbs. 400 million years ago, in the Devonian period, the seas were full of life and amongst all this diversity were ancient fish with two sets of paired fins – the “pectoral” set just behind the head and the “pelvic” set further back, nearer the tail is the unpaired anal fin. Some fish today have a similar set-up, in others the pelvic fins have moved much closer to the head. Fins are important for propulsion and manoeuvrability and the fish that had the set that worked best in a given environment was the one that survived and bred – “survival of the fittest” in fact. What we can say from the well documented fossil record is that, in shallow muddy waters, a pair of stubby paddles at each end of the body proved to work best and so the “lobe-finned” fish evolved. This led to an early amphibian with four legs that climbed out of the water onto the land with all its richness of insect food and no vertebrate predators. Then in easy stages, more advanced amphibians, then reptiles, then birds and mammals appeared, including us, all with four limbs variously adapted to their particular habitat and life-style.

So how could we get six legs? Most people envisage upper-body duplication giving an extra set of front legs that could then become wings. Insect bodies consist of a series of segments with pairs of appendages – antennae, wings or legs for example. The bithorax mutation in the common fruit fly

(Drosophila) increases the number of body segments between one generation and the next, giving an extra thorax and set of wings.



Versions of these genes that control the insect limb and body patterns are also found in vertebrates, controlling similar patterns in their development. We can gain an extra rib, vertebra or finger in the womb as a result of a mutation or a developmental mistake in our patterning genes. However, it is not possible to simply “double up” the number of limbs and girdles, since the vertebrate body is not segmented like that of an insect. The story of evolution told by our genes is even more fascinating than that told by our bones – but that’s for another time and place. What is needed is an ancient fish with six paired fins. An additional set in the mid flank region, duplicated from the pectoral fins, is the most likely, but a laterally duplicated anal fin is quite possible. The ancient lobe-finned fish had skeletal structures in their anal fins very similar to that in their pelvic fins and modern fish have been found with duplicated anal fins. But, if there ever were fish with more than two sets of paired fins, they must have been at some sort of a disadvantage and died out. Maybe they were not able to compete effectively for food, or maybe they just got unlucky and were in the wrong place when the volcano erupted or the meteor struck! Either way, there seems to be no trace of them in our fossil record, but perhaps it happened differently on another warm wet world somewhere else.



Dragons are everybody’s favourite monster, populating myths and legends throughout the world. Every small boy knows that dinosaurs were real and most know that their relatives the pterosaurs were the first to evolve powered flight. The largest pterosaur had a wing span of about 40 feet (Quetzalcoatlus, wonderfully named after the Aztec winged serpent god) – what more could you ask for? Given a six-legged amphibian, a six-legged lizard should follow. There are plenty of large ferocious four legged examples still around, the 10 foot Indonesian Komodo Dragon and the 28 foot giant Australian salt-water crocodile to name but two. It would be quite reasonable to expect a six-legged version of the pterosaur to dominate the skies of an early Earth as the first flying vertebrate predator, but, in the absence of some Harry Potter type magic, simple physics prohibits something like a fat flying crocodile ever getting airborne! The fossil record contains beasts with two legs and two wings between the size of a sparrow and a light aircraft, but there is no sign of a

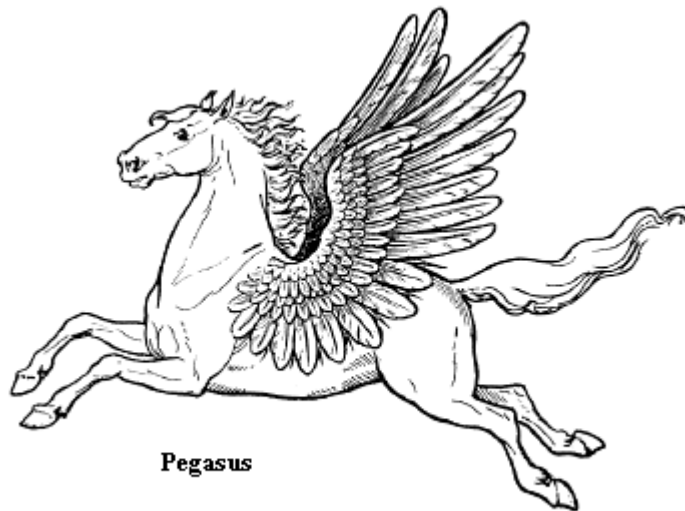
true Jurassic or Cretaceous dragon. As for that other classic feature of dragons - fire breathing, or rather, fire belching, presumably from hydrogen or methane generated by gut bacteria and ignited by pyrogenic tooth enamel - one hiccup and they would be their own ecological catastrophe, blown to smithereens!

So why are dragons so popular? Probably because they are a metaphor for unrestrained natural forces – storms and volcanoes for example – mixed with glamorised encounters with real animals and distorted tales of rampaging armies. “St George and the Dragon” is much more romantic than “George and the quite large crocodile” and “they pillaged and burned the countryside like a marauding dragon” could quite easily become “the marauding dragon pillaged and burned the countryside!”



Centaurs are my personal favourites because, on the face of it, they are the perfect example of what a six-legged mammal should look like. Their heart and lungs would be in the upright torso and the digestive and reproductive organs in the horizontal abdomen, slung between two strong sets of legs. This frees the upper limbs as arms and puts the head high up out of harms way to develop a human-like intelligence. There is nothing here that contravenes any principle of physics, biology or evolution as I understand it. Unfortunately they are just an early Greek traveller’s tale – or more likely a frightened Greek survivor’s tale – of an encounter with horse riding barbarian archers and swordsmen from the Steppes of Asia. In the telling and re-telling,

the horse’s head got lost and the man on a horse became a horse/man hybrid and a powerful symbol of lust, passion and brutality, to be incorporated into fables and moral tales. Like the characters in so many of these tales from ancient cultures, it is only our modern naivety and gullibility that makes us think they must be true, especially if there is a god involved.



**Pegasus**

As a zoologist, angels and flying horses give me much more of a problem. Both of these are conventionally depicted as hairy mammals with large bird-like wings covered in feathers. Unfortunately, one of the guiding principles of evolution theory is that you do not get such a mixture of derived features from two such widely separated lineages in one organism. Birds evolved from small theropod dinosaurs that evolved from an amphibian via a lizard; mammals evolved from the same amphibians but via a different set of lizards (the mammal-like reptiles) and

were around well before birds. Hair and feathers are both ultimately derived from reptilian scales but are mutually exclusive developmental pathways. The upshot of this is that I know of no way to naturally evolve either an angel or a flying horse, they must, therefore, be supernatural or truly imaginary.



This leaves me with demons and here we are back to biological possibilities. Bats have evolved very effective wings from shrew-like or squirrel-like front legs and there are more different types of bat than any other mammal, a sure sign of a successful genus. Given a six-legged tree shrew, a line of winged primates could have evolved looking some what like us and our ape and monkey cousins, but with bat wings, big pectoral muscles and a much lighter body and legs. This may not be everybody's idea of what a devil or demon should look like, but it could happen without supernatural intervention.

Which all goes to illustrate the wonderful complexity of life and its driving force - evolution. Many more things are possible than those we have seen, but the human imagination can also conceive of the biologically and physically impossible.

*Personal views of **Owen K. Wilby**, if you disagree please write!*