

Why can't kangaroos fly?

How the first moments of an animal's life can limit millions of years of evolution.



One-hundred and twenty-five million years ago, two types of mammals evolved with two very different ways of producing young. One, the placental mammals, have long pregnancies, owing their name to the special organ that nourishes and protects their growing embryo until they are ready for the outside world. The others, the marsupials, have incredibly fast pregnancies, giving birth to young with bodies and brains that are hardly developed at all. They have no placentas, and instead, raise and nourish their young in an external pouch post-birth.

Placental mammals now dominate our planet with over 4000 species. They include everything from mice to minke whales, from bats to bears, and of course, ourselves. Marsupials, the group that includes kangaroos and koalas, however, only represent 300 species and are nowhere near as diverse, despite having just as much time to proliferate (Kelly & Sears 2011b).

Although marsupials appear in a fairly wide array of forms, especially considering extinct species like marsupial lions and marsupial rhinos, compared to the placental mammals, most stick to fairly standard body plans and modes of living. For instance, there are no marsupials that have evolved fins, like whales or seals for swimming. None have evolved brains with the capacity of the

placental primates, and certainly, none evolved wings to fly like bats.

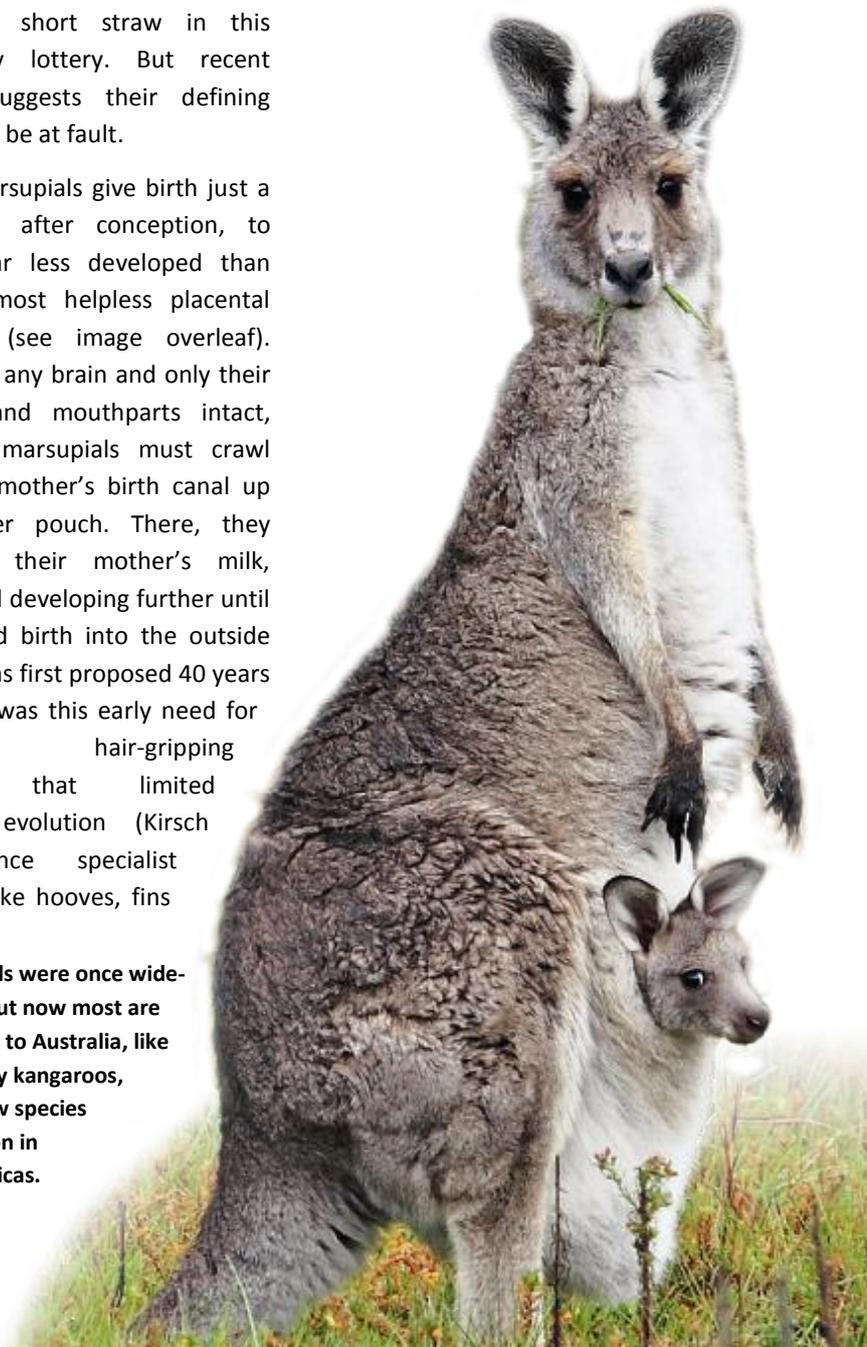
Due to their lack of diversity and apparently small brains, historically, marsupials have been mocked as our lesser (Kirsch 1977). The scientific name for the group- Metatheria - literally translates as "half-beast". For decades, scientists have questioned why marsupials appear to have drawn the short straw in this evolutionary lottery. But recent evidence suggests their defining feature may be at fault.

Marsupials give birth just a few weeks after conception, to offspring far less developed than even the most helpless placental new-borns (see image overleaf). With barely any brain and only their forelimbs and mouthparts intact, new born marsupials must crawl from their mother's birth canal up towards her pouch. There, they suckle on their mother's milk, growing and developing further until their second birth into the outside world. It was first proposed 40 years ago that it was this early need for developed hair-gripping forelimbs that limited marsupial evolution (Kirsch 1977), since specialist forelimbs, like hooves, fins

Marsupials were once widespread, but now most are restricted to Australia, like these grey kangaroos, with a few species hanging on in the Americas.

and wings would just not be up to the challenge of making the death defying crawl to the pouch.

Only 35 years later was any evidence found for this intriguing idea. By comparing limb morphologies of 94 living and extinct mammals, Florida scientists found that marsupial forelimbs are indeed more restricted in form than their placental counterparts' (Cooper &



Steppan 2010). Marsupials still have forehands similar to those of the earliest mammals that scuttled under the feet of dinosaurs (Kelly & Sears 2011a).

Adding more weight to the idea, marsupial hindlimbs, however, vary in form much more than their forelimbs, only lagging a little behind placental hindlimbs in terms of diversity. This is because the hindlimbs are not used to crawl to the pouch, remaining under-developed at birth and free to evolve to extremes (See image right). That's why kangaroos have been able to reduce their hindlimbs to a couple of toes for fast efficient movement over open space just like placental antelopes (Cooper & Steppan 2010). It also explains why the most aquatic marsupial, the water opossum, only has webbed feet on its hindlimbs (Cooper & Steppan 2010).

Bandicoots also provide an exception that proves the rule. Bandicoot mothers contort while giving birth and drop their young straight into their pouch. Liberated of the need to crawl at birth, bandicoots have been able to evolve the most specialised forelimbs of any marsupial (see image below) (Cooper & Steppan 2010).

Akin to that early need to crawl, it's thought that the requirement of a mouth to suckle could have limited marsupial brain



Marsupials (left, an opossum) are born with far less developed bodies than even the least developed placental mammal new borns (right, a mouse) (Kelly & Sears 2011b).

size. Indeed, the front part of the skull does appear to be constrained in marsupials, curiously however, the part of the skull holding the brain is not (Bennet & Goswami 2013). It turns out that, under closer scrutiny, when the abnormally big-brained primates are removed from the equation, marsupial brain size is no different to the placentals. In fact, comparing only small mammals, marsupials have even bigger brains (Weisbecker & Goswami 2010)!

The "half-beasts" are not only more intelligent than once thought, but the fact they are still here shows that they are evolutionary winners, despite the limits placed on their forelimbs. In fact, their unusual start in life could be their ultimate strength. Marsupials are thought to have travelled to Australia

Free to evolve, some bandicoot species only have two fingers on their forelimbs (Cooper & Steppan 2010).



via Antarctica when the land masses were still connected 55 million years ago. Why placental mammals didn't also make this journey seems puzzling, but it could be that they just weren't tough enough.

Marsupials invest very little in their young before birth and in times of stress can easily abort offspring from their pouch, whereas placental mammals are stuck with investing huge amounts of energy into their young once pregnant. Some scientists think that this easy get-out clause makes marsupials more suited to harsh environments, and could be why only they managed the difficult journey to Australia (Kirsch 1977).

While scientists have not found a way to test this idea yet, it shows that marsupials are not to be scoffed at. While there may not be many of them and they may never be able to take to the air or ocean quite like the placental mammals have, marsupials are highly evolved, specialist survivors.

Brief: 1000 word 'New Scientist' style article, based on a research seminar and our own further research.

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