Why don't animals have wheels?

by Richard Dawkins

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The wheel is the archetypal, proverbial, human invention. We don't just travel on wheels, it is wheels – forgive me – that make the world go round. Take apart any machine of more than rudimentary complexity and you'll find wheels. Ship and aeroplane propellors, spinning drills, lathes, potters' wheels – our technology runs on the wheel and would seize up without it.

The wheel may have been invented in Mesopotamia during the fourth millennium BC. We know it was elusive enough to need inventing, because the New World civilisations stilll lacked it by the time of the Spanish conquest. The alleged exception there – children's toys – seems so bizarre as to prompt suspicion. Could it be one of those false legends, like eskimos having 50 words for snow, which spreads purely because it is so memorable?

Whenever humans have a good idea, zoologists have grown accustomed to finding it anticipated in the animal kingdom.. Why not the wheel? Bats and dolphins perfected sophisticated echo-ranging systems millions of years before human engineers gave us sonar and radar. Snakes have infra-red heat detectors for sensing prey, long pre-dating the Sidewinder missile. Two groups of fish, one in the New World and one in the Old, have independently developed the electric battery, in some cases delivering currents strong enough to stun a man, in other cases using

electric fields to navigate through turbid water. Squids have jet propulsion, enabling them break the surface at 45 m.p.h. and shoot through the air. Mole crickets have the megaphone, digging a double horn in the ground to amplify their already astonishingly loud song. Beavers have the dam, flooding a private lake for their own safe-conduct over water.

Fungi developed the antibiotic (of course, that's where we get penicillin from). Millions of years before our agricultural revolution, ants planted, weeded and composted their own fungus gardens. Other ants tend and milk their own aphid cattle. Darwinian evolution has perfected the hypodermic needle, the valved pump, the fishing net, the harpoon, the fishing rod, the water pistol, the automatic focus lens, the lightmeter, the thermostat, the hinge, the clock and the calendar. Why not the wheel?

Now, it is possible that the wheel seems so marvellous to us only by contrast with our rather undistinguished legs. Before we had engines driven by fuels (fossilised solar energy), we were easily outpaced by animal legs. No wonder Richard III offered his kingdom for four-footed transportation out of his predicament. We show up poorly against two-legged runners, too, in the form of ostriches and kangaroos. Perhaps most animals wouldn't benefit from wheels because they can already run so fast on legs. After all, until very recently, all our wheeled vehicles have been pulled by leg power. We developed the wheel, not so as to go faster than a horse, but so as to enable a horse to transport us at its own pace – or a bit less. To a horse, a wheel is something that slows you down.

Here's another way in which we risk over-rating the wheel. It is dependent for maximum efficiency on a prior invention – the road (or other smooth, hard surface). A car's powerful engine enables it to beat a horse or a dog or a cheetah on a hard, flat road, or smooth, iron rails.

But run the race over wild country or ploughed fields, perhaps with hedges or ditches in the way, and it is a rout: the horse will leave the car wallowing. Size for size, a running spider is surely faster than any wheeled vehicle over any terrain.

Well then, perhaps we should change our question. Why haven't animals developed the road? There is no great technical difficulty. The road should be childsplay compared with the beaver dam or the bower-bird's ornamented arena. There are even some digger wasps that tamp soil hard, picking up a stone tool to do so. Presumably the same skills could be used by larger animals to flatten a road.

Now we come to an unexpected problem. Even if roadbuilding is technically feasible, it is a dangerously altruistic activity. If I as an individual build a good road from A to B, you may benefit from the road just as much as I do. Why should this matter? This raises one of the most tantalising and surprising aspects of all Darwinism, the aspect that inspired my first book, The Selfish Gene. Darwinism is a selfish game. Building a road that might help others will be penalised by natural selection. A rival individual benefits from my road just as much as I do, but he does not pay the cost of building.

Darwinian selection will favour road building only if the builder benefits from the road more than his rivals. Selfish parasites, who use your road and don't bother to build their own, will be free to concentrate their energy on outbreeding you, while you slave away on the road. Unless special measures are taken, genetic tendencies towards lazy, selfish exploitation will thrive at the expense of industrious roadbuilding. The upshot will be that no roads get built. With the benefit of foresight, we can see that everybody will be worse off. But natural selection, unlike we humans with our big, recently evolved brains, has no foresight.

What is so special about humans that we have managed to overcome our antisocial instincts and build roads that we all share. We have governments, policed taxation, public works to which we all subscribe whether we like it or not. The man who wrote, "Sir, You are very kind, but I think I'd prefer not to join your Income Tax Scheme", heard again, we may be sure, from the Inland Revenue. Unfortunately, no other species has invented the tax. They have, however, invented the (virtual) fence. An individual can secure his exclusive benefit from a resource if he actively defends it against rivals.

Many species of animals are territorial, not just birds and mammals, but fish and insects too. They defend an area against rivals of the same species, often so as to sequester a private feeding ground, or a private courtship bower or nesting area. An animal with a large territory might benefit by building a network of good, flat roads across the territory from which rivals were excluded. This is not impossible, but such animal roads would be too local for long distance, high speed travelling. Roads of any quality would be limited to the small area that an individual can defend against genetic rivals. Not an auspicious beginning for the evolution of wheel.

Now I must mention that there is one revealing exception to my premiss. Some very small creatures have evolved the wheel in the fullest sense of the word. One of the first locomotor devices ever evolved may have been the wheel, given that for most of its first two billion years, life consisted of nothing but bacteria (and, to this day, not only are most individual organisms bacteria, even in our own bodies bacterial cells greatly outnumber our 'own' cells).

Many bacteria swim using threadlike spiral propellors, each driven by its own continuously rotating propellor shaft. It used to be thought that these 'flagella' were wagged like tails, the appearance of spiral rotation resulting from a wave of motion passing along the length of the flagellum, as in a wriggling snake. The truth is much more remarkable. The bacterial flagellum is attached to a shaft which, driven by a tiny molecular engine, rotates freely and indefinitely in a hole that runs through the cell wall.

Picture (see suggestions faxed separately to Jeremy Bayston)

The fact that only very small creatures have evolved the wheel suggests what may be the most plausible reason why larger creatures have not. It's a rather mundane, practical reason, but it is nonetheless important. A large creature would need large wheels which, unlike manmade wheels, would have to grow in situ rather than being separately fashioned out of dead materials and then mounted. For a large, living organ, growth in situ demands blood or something equivalent. The problem of supplying a freely rotating organ with blood vessels (not to mention nerves) that don't tie themselves in knots is too vivid to need spelling out!

Human engineers might suggest running concentric ducts to carry blood through the middle of the axle into the middle of the wheel. But what would the evolutionary intermediates have looked like? Evolutionary improvement is like climbing a mountain ("Mount Improbable"). You can't jump from the bottom of a cliff to the top in a single leap. Sudden, precipitous change is an option for engineers, but in wild nature the summit of Mount Improbable can be reached only if a gradual ramp upwards from a given starting point can be found. The wheel may be one of those cases where the engineering solution can be seen in plain view, yet be unattainable in evolution because its lies the other side of a

deep valley, cutting unbridgeably across the massif of Mount Improbable.

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