Coal fires and Darwinian theory

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Some evolutionary biologists have long claimed that the Darwinian evolutionary model of variation and selection can explain the evolution of human society as well as that of animals and plants. The debate has typically been at a fairly abstract level, whereas the deficiencies, indeed the basic unreality, of the Darwinian model is most convincingly illustrated by practical examples from history. The sort of down-to-earth case I have in mind is the shift in England from wood to coal fires and its antecedents and consequences. This was begun by the evolution of London from being a wood-burning to a coal-burning city between roughly 1570 and 1600, the first such city in the world, and which is a good opportunity for Darwinism to show what it can do to explain a real historical process. This transition from wood to coal fires has been comprehensively studied by Ruth Goodman in her excellent *The Domestic Revolution. How the introduction of coal into our homes changed everything* (2020) and I shall draw heavily from it in this paper.

The impetus for the transition from wood fires to coal fires came originally from London before it eventually spread to the whole of Britain. In the period 1570 to 1600 the population of London roughly quadrupled from 50,000 to 200,000, which made its continued dependence on wood as a source of fuel impossibly costly, when coal was a cheaper option. There had for centuries been a steady supply of coal to London by ship from Newcastle, where there was ample coal from the seams in Tyne and Wear. This ‘sea-coal’ was primarily used by the city’s blacksmiths and lime burners for whose purposes coal was the ideal fuel, but the new demand for coal was essentially domestic. Coal was the ideal cargo for ships, and water transport was about twenty-five times cheaper than by road. The exponential growth of the Newcastle coal trade led to a major increase in ships, which became an important source of seamen for the Royal Navy, of whom Captain Cook was the most celebrated example.

But to understand the more fundamental effects of the shift from wood to coal we need to examine the basic differences between wood and coal fires. Traditionally the wood fire had been placed on a hearth in the centre of the hall which at night functioned as a common sleeping-place. It was a very efficient source of heat which radiated from the central position, which also meant that it did not draw a cold draught, while the smoke went upwards

and escaped through the roof. The smoke was mostly above people's heads, and was not noxious or greasy, and the ash left by the wood fire was an essential cleansing agent, especially for clothes. Coal fires, however, were very different propositions. Coal burns hotter and longer than wood, and it needs an iron grate to lift it up and allow sufficient draught. (Wood fires, on the other hand, can be given sufficient draught by the suitable arrangement of the logs.) But coal smoke is also very different from wood smoke, notably in its sulphur content which stings the eyes, and it carries black and greasy smuts, while its ash is of no practical use. So not only does a coal fire need an iron grate but also a chimney to remove the very offensive smoke. Chimneys had been a feature of grand houses since the Norman Conquest, but were expensive because they had to be built of stone or brick, not lath and plaster. They also had to be built at the side of a room as part of the wall, which meant that they were less efficient in warming the room, and about 70 per cent of the heat went up the chimney, as well as bringing in a cold draught through the door and across the floor. But despite their drawbacks chimneys had a revolutionary architectural impact on domestic accommodation. The smoke from a wood fire had to be allowed to rise into the roof, which required a single storey building, but the chimney made it possible to have multiple storeys with a number of small rooms on the upper floors, since each room could now have access to the outside air through its own chimney.

There were many other effects of the shift from wood to coal, in particular from the fact that that coal fires also burn hotter and longer than wood fires:

'Coal cookery involved much higher heat and rather more sulphurous fumes. Iron pots were slower to heat than brass pots, being less thermally conductive, but they held the heat longer than a brass pot could. Most importantly, iron pots lasted much, much longer when employed over coal than brass ones did' (Goodman, 130).

The shape of the cooking pot when used over coal also changed.

'. . . flames from a wood fire tend to merge together in a single pyramid at the centre of the blaze, but the flames of coal rarely take this shape, instead being a series of smaller, lower, hotter and bluer flames, spaced above the upper surface of the red embers. Pots need to be much closer to coal fuel if you want to maximise their take-up of this heat', . . and 'Flames from a wood fire curl out and around a rounded vessel, heating its contents, but the many little points of flame produced by coal work most efficiently when presented with a broader, flatter profile' (ibid, 142-3).

These particular features of iron pots eventually led Abraham Darby at the beginning of the eighteenth century to develop the use of coke for smelting iron which could be used for casting cooking pots. Until the use of coke, the smelting of iron with charcoal had produced a

very brittle cast iron, ‘white cast-iron’, whereas using coke for smelting iron produced ‘grey cast-iron’, which was much more robust, and ideal for casting iron cooking pots, and a vast range of other products, notable various components for the steam engines produced around this time by Newcomen.

It should be noted that coke did not have to specially invented because it had been known about for a century or so before it was used in iron smelting. It had originally been developed by the brewing industry for drying malt, where the use of coal had imparted a disgusting taste to the malt. Coke was originally produced in a similar way to charcoal, where coal was piled up in a ‘clamp’, like that used by charcoal burners, and fired internally to leave coke as a residue[1].

Traditional wood-fired ovens has been heated by burning wood inside them, and when sufficient temperature had been reached the ashes and burning embers were swept out and bread or other items could be sealed inside and baked. It was possible to bake more than one batch after each heating, but obviously the oven became progressively cooler, and had to be heated up again. But the high, steady heat provided by a coal fire also made it possible to construct metal ovens that could be used for baking, and the development of cast iron allowed the production of coal fires next to ovens for this purposes in what became our familiar kitchen ranges. This ‘continuous oven’ for baking was obviously a revolutionary contribution to English cookery.

Whereas firewood in rural areas was available for all with minimum transport, coal deposits were highly localised, which meant that the use of coal outside London was vitally dependent on transport. Initially it was conveyed to the rest of Britain by the use of river traffic, but with the growth of manufacturing centres, particularly where steam power was used, rivers were not enough, and in 1760 James Brindley constructed the first canal to carry coal from the Duke of Bridgwater’s colliery directly to Manchester, and following this around 2500 miles of canals were constructed all over Britain, only being superseded as transport links by the railways in the nineteenth century.

The shift from wood to coal also deprived Londoners of wood ash as a cleansing agent, which produced much greater reliance on soap to remove grease from dishes and clothes. The use of soap also spread to the rest of the house as necessary to remove the grease and smuts from walls and floors produced by coal fires, and was another fundamental change in domestic economy.

What can the Darwinian model make of all this? In the first place the Darwinian model sees societies and their cultures as essentially populations of traits, as for example coal

fires or wood fires, soap or ash as cleansing agents, charcoal or coke for smelting iron, and so on. These compete with one another and evolutionary change then becomes a change in the relative frequency of these traits as some spread more widely than others.

While it is undeniable that in the transition from wood to coal the relative frequencies of many things changed significantly, this is only trivially true and simply describes one of the *effects* of the evolutionary process without in any way explaining it. It should be obvious, however, that the various elements of the wood to coal transition were not isolated phenomena in a population of traits but systemically linked together by the properties of wood and coal. Heating, smoke removal, iron smelting, cooking practices, modes of transport, steam power and so on were all interlinked in a complex causal web of interactions.

One striking feature of the Darwinian model is that it is not the least interested in origins because it treats all new biological forms as the result of blind genetic mutation, but this model of innovation is quite irrelevant in the transition from wood to coal. All the changes from wood to coal are explicable as the result of conscious human purposes, and the only blindness here was the obvious fact that no one could have foreseen all the manifold consequences that would follow from the initial change of fuel.

The Darwinian model of random mutation also assumes that change must be the result of *novelty*, but this, too, is wholly inadequate in the case of cultural change. Sea-coal, soap, coke, and chimneys were all known before the period we are considering, but became increasingly important as coal use became more widespread. So it is far more enlightening to think of every society and its culture not as a population of traits but as a repertoire of beliefs, institutions, practices, and technological devices that are *potentially* available to be called upon but which may not be of any significant importance at any one time. Rather than counting the increases in the number of iron grates or the number of chimneys, it is far more revealing to discover what a new practice such using coal as fuel *led to*, and made it possible for people to do things which they could not have done before. So the broad evolutionary significance of coal use was therefore that when combined with iron it was the basis of the Industrial Revolution, not simply to be measured in how many iron grates or chimneys it produced.

Again, the Darwinian model is not only atomistic, thinking in terms of a population of traits, but also *competitive*, thinking of all traits as 'trying' to maximise their own proportion in the population of traits. But one of the most obvious features of the shift from wood to coal is the *combinatorial* relation of the various traits, the essentially cumulative nature of the evolutionary process. This sort of complementarity between traits, between

shipping and coal, chimneys and multi-storey buildings, coke and iron pots, soap and wall-paper is the very essence of that complex causal web of interactions referred to earlier.

Success in the competition of traits is supposed by Darwinians to be the result of the superior adaptation of a trait to its environment, but the concept of adaptation has actually been very troublesome for evolutionary biologists. This is because every organism is a bundle of traits, and it is often not clear if a particular trait has been directly selected for, or is only *associated* with some other trait which is the one actually being selected for. But the concept of adaptation is not problematic at all in the case of human selection because this is inherently adaptive. By this I mean that it must necessarily take account of, and accommodate to, the properties of what it selects: of wood and coal, of iron as opposed to brass, of chimneys and how they remove the smoke, the properties of different kinds of smoke, and so on. Human selection therefore has to adapt to these properties, but it is very significant that in some cases it will also discover unsuspected properties of things which can be put to new uses, as long ago it was discovered that wood ash also has cleansing properties.

To sum up, social evolutionary changes such as that from wood to coal fires are not changes in a population of traits, but systemic processes involving a number of interrelated factors. The result as we have seen is a chain of reactions, partly based on human selection to satisfy human needs such as for warmth or cooked food, and also purposeful responses to changing circumstances, but also to the properties of the natural and cultural worlds. These properties and causal networks have their own consequences and generate a process of self-organization that is often outside human control or even understanding. But one thing we do know is that the Darwinian evolutionary model can tell us nothing about it.

Note

1. J.U.Nef "Coal mining and utilization", *A History of Technology* Vol.3 eds.Singer et al. 1979, p.80.