Bricks Without Straw: Darwinism in the Social Sciences

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ABSTRACT: The so-called evolutionary social sciences are based on the belief that Darwinism can explain the living world and that it therefore should be able to explain other complex systems such as minds and societies. In fact, Darwinism cannot explain biological evolution. It does make an important contribution, but this is towards understanding adaptation, which is a major problem in biology but not in the social sciences. Darwinism has much less to offer to the social sciences than to biology and the shortcomings it brings with it are much greater.

Keywords: Darwinism, social sciences, economics, sociobiology, adaptation.

The idea of applying Darwinism in the social sciences is hardly new –Herbert Spencer used the term 'natural selection' several years before the *Origin of Species* appeared– but it is only recently that it has become a major research strategy. What is more, its practitioners see it not merely as another technique at their disposal, but as revolutionising their subjects. No longer must the social sciences live in the shadow of theoretical physics. They too can be hard sciences, with almost everything of importance to be deduced from a few axioms. As the philosopher Daniel Dennett (1995) writes, "Darwin's dangerous idea is reductionism incarnate, promising to unite and explain just about everything in one magnificent vision." (He is not, it should be added, being ironic.)

This development has not, however, been universally welcomed. Ever since the publication of E.O. Wilson's (1975) *Sociobiology*, there has been a continuing controversy about Darwinism in the social sciences. Much of this has centred on sociobiology itself, partly because it was the first of the so-called evolutionary sciences and is still the most active area, and partly because it touches on many sensitive issues including race, gender differences, and public policy. The discussion in this article will use sociobiology as an example, though it generally applies to other extensions of Darwinism as well. (For parallels with economics, see Saunders, 1999).

While many critics have pointed out the shortcomings of sociobiology, they still generally leave you with the impression that there is nothing fundamentally wrong with the project; it's just that so far most of the applications are deficient in one way or another. This is largely because most of them share the sociobiologists' belief that Darwinism (more precisely, neo-Darwinism; see below) gives an adequate explanation of biological evolution. And if that were so, we might expect it to have a great deal to contribute to the study of behaviour as well, if only it were used properly. (Space does not permit even listing, still less describing, the critiques here; for examples see Rose & Rose, 2000).

But Darwinism has not explained evolution. It may explain why the peppered moth *Biston Betularia* has changed from a light form to a dark form and then back (and then again, it may not, because even this classical example of Darwinism is open to question) but it cannot explain how there came to be moths in the first place, which is the more interesting and important question. In the language of evolution theory, natural selection may account for microevolution but so far it has had very little to say about macroevolution. Yet macroevolution, the appearance of distinctly new forms, is what most people mean when they talk of evolution.

While Darwinism has not accomplished what its supporters claim, it has indeed made a major contribution to our understanding of biological evolution. This does not carry over to the social sciences, because it is to do with explaining adaptation, which is nowhere near as important a problem for social scientists as it is for biologists. Darwinism therefore has far less to tell the former than the latter.

What is Neo-Darwinism?

It would seem natural to begin any discussion about Darwinism by agreeing on what precisely the theory is. In fact, this is seldom done, and there is certainly no generally accepted or 'canonical' definition. The assumption seems to be that it is obvious what the theory is and therefore there is no need to define it. As we shall see, this is not the case. In biology, and all the more so in the social sciences, if we are going to rely on Darwinism we really ought to understand what we are committing ourselves to.

One of the very few neo-Darwinists to have given an explicit definition of the theory is Maynard Smith (1969). He writes that Darwinism explains evolution in terms of three properties: heredity, multiplication and variation. Offspring generally resemble their parents, but sometimes they do not. In general, organisms produce more offspring than are required to replace the parents. This leads to competition for resources, and if some of the variations increase the fitness, *i.e.* if they make organisms more likely to survive and leave offspring, then the proportion of individuals with those variations will increase from generation to generation. Eventually they will replace the original forms. In other words, natural selection can bring about evolution.

This is Darwinism; neo-Darwinism is obtained by adding the theory of Mendelian genetics, according to which the passage of characters from one generation to another occurs through the effects of discrete entities called genes, and the variations are caused by random mutations, *i.e.*, changes in the genes. Because it arose through the bringing together of two earlier theories, neo-Darwinism is also known as the synthetic theory of evolution.

As Maynard Smith acknowledges, however, the above is not a theory. It is a set of properties which neo-Darwinism assumes organisms possess, together with a conclusion that can be drawn from them. He continues: "The theory of neo-Darwinism states that these properties are necessary and sufficient to account for the evolution of life on this planet to date."

That is the crux of the matter. Neo-Darwinism is not just the theory that the natural selection of random genetic mutations can lead to adaptive evolution. Nor is it the theory that this process does occur in nature. Hardly anyone could disagree with either of those statements, but they are not neo-Darwinism. Neo-Darwinism is the theory that all of evolution can be explained by the natural selection of random genetic mutations. That's a very bold claim – which is presumably why most neo-Darwinists prefer not to make it explicitly. It is, however, the theory they actually use. If you read their work, you will that the explanations they offer are indeed in terms of genetics and selective advantages.

A century ago, Romanes wrote the following about A.R. Wallace, the co-discoverer with Darwin of the theory of evolution by natural selection:

> Mr Wallace does not expressly maintain the abstract impossibility of laws and causes other than those of utility and natural selection... Nevertheless, as he nowhere recognises any other law or cause ..., he practically concludes that, on inductive or empirical grounds, there is no such other law or cause to be entertained.

Things are no different today. Whatever neo-Darwinists may say when they are defending their theory, in practice it is as described by Maynard Smith, or, more recently, by Dennett (1995, p. 59)

> Here then, is Darwin's dangerous idea: the algorithmic level *is* the level that best accounts for the speed of the antelope, the wing of the eagle, the shape of the orchid, the diversity of species and all the other occasions for wonder in the world of nature. [emphasis in original]

Neo-Darwinism, Natural Selection and Evolution

Because there is no generally accepted explicit definition of the synthetic theory, neo-Darwinists tend to use the terms "neo-Darwinism", "evolution" and "natural selection" as though they were synonyms. In fact, they are not, and using them interchangeably leads to confusion.

In the first place, the "theory of evolution" can mean one of two things. On the one hand, it can be the theory that evolution has taken place, that the organisms we see today are the products of a process of descent with modification from earlier forms and, ultimately, from inorganic matter. Alternatively, it can mean one particular theory about how this process occurred, *viz.* neo-Darwinism.

Neo-Darwinists generally conflate the two meanings. This encourages them to ignore criticisms of their theory on the grounds that anyone who doubts their account of evolution must be some kind of creationist. At the same time, it gives the so-called creation scientists a much easier target because any weaknesses in the neo-Darwinist account of the evolutionary process can be used to cast doubt on the fact of evolution.

As for natural selection, while it is obviously important in evolution, it needs raw material in the form of variation. The study of evolution cannot therefore be only the study of selection; it must include the origin and nature of the variations from which the selections are made. All of science, not just one simple algorithm, must be brought to bear on the problem.

There is, to be sure, a way in which selection could conceivably be the whole of the story. Suppose the variations were random, not just in the sense that they do not occur preferentially in the directions in which they are needed, but in the much stronger sense that there is almost nothing at all we can say about them, except that they must be small. Then if we assumed that just about any small change was possible and, what is more, that it was not significantly more or less likely to occur than any other, it would follow that the origin of the variations had nothing to contribute to our understanding of the process, that selection was the only factor with a significant effect.

But even if they are brought about by random mutations in genes, the variations themselves will not be random. They occur in accordance with the laws of physics and chemistry, and in higher organisms they follow the patterns of developmental biology. Some variations are far more readily produced than others, and while small ones are more common, large, coordinated changes are by no means ruled out. It is not easy to determine which variations are most likely to occur, but it can be done: an example is given later in this article.

Darwinists sometimes use the metaphor of a large room in which monkeys are sitting at typewriters, hitting keys at random. A human is watching them, and when, purely through chance, a monkey produces *Hamlet* or the *Origin of Species*, he sends it off to be published. In that scenario the human can be said to be the real author of the work, and selection was the creative process.

A better metaphor would be a room full of humans. They produce real words, real sentences, real chapters. All the same, very little of their output is worth publishing. There still has to be an editor to select the relatively small proportion that can be used, and to suggest improvements and correct mistakes. The editor is still important, but he is not the creator of the work.

Genes for Behaviours

To see how Darwinism is used in the social sciences, we turn to the best known of the new evolutionary disciplines, sociobiology. This rests on the assumption that behaviour can be decomposed into distinct traits, or 'behaviours', each of which has evolved through natural selection. To explain why such and such a behaviour exists, we have to show that it gives an individual a selective advantage, that is, that it makes it more likely that he or she will survive and leave offspring. In the case of humans, since evolution by natural selection is a slow process, we have to suggest how it might have given a selective advantage to our Palaeolithic ancestors.

Sociobiology is still an active research area, but there has been a resistance to its application to humans, and there it has been largely superseded by 'evolutionary psychology'. This also assumes that there is a universal human nature which has evolved by natural selection. The difference is that this universality is supposed to exist "primarily at the level of evolved psychological mechanisms, not of cultural behaviors." As one supporter (Symons, 1992) puts it:

> Evolutionary psychology is the application of the adaptationist program to the study of the human brain/mind. Evolutionary psychologists assume that the brain/mind has many functions -- i.e. that it has been designed by selection to solve many different kinds of problems, each of which is likely to require its own distinctive kind of solution -- and therefore that the brain/mind comprises many domain-specific specialized mechanisms. For example, selectional thinking leads to the expectation that human perceptions of sexual attractiveness are underpinned by many specialized mechanisms (which operate according to their own distinctive rules and principles) rather than by some sort of generalized "learning" or "capacity-for-culture" mechanisms.

On the face of it, this sounds more scientific, but in fact it amounts to the same thing. For if each aspect of our perception of sexual attractiveness has its own mechanism, and if we don't know anything about what these mechanisms are or how they work, what difference does it make whether we speak of natural selection for the mechanism or natural selection for the particular behaviour? Instead of saying that men have evolved by natural selection to find women with narrow waists attractive, we say that natural selection has endowed men with a specific mechanism that causes them to find women with narrow waists attractive. This is merely playing with words.

And indeed, the evolutionary psychologists discuss precisely the same sorts of behavioural traits as the sociobiologists and in the same ways, and they rely on natural selection acting on genes for mechanisms for specific behaviours in the same way that sociobiologists rely on natural selection acting on genes for specific behaviours. In fact, both theories require that the links between the genes and the behaviours they determine must be direct, because if they are not, the population genetics arguments on which they rely do not work and the whole enterprise is in serious trouble

To see how precisely evolutionary psychologists believe genes can act, consider the following example, taken from one of the founding texts of the subject, Barkow, Cosmides & Tooby's (1992) *The Adapted Mind.* According to Buss (1992), empirical studies show that in all cultures, females consider status and resources more important in a potential mate than do males, while males consider youth and physical attractiveness more important than do females. The Darwinist explanation is – as always – that these preferences are the products of selection. Both increase fitness: women seek males who will be able to support them and their children, and men seek females who are fertile and whose babies are likely to thrive.

The account sounds simple and straightforward, but that's only because a great deal has been omitted. Above all, it relies on there being a gene with a very specific effect on behaviour. Yet there is no argument to support the claim that such a gene could exist. All the same, let us suppose, for the sake of argument, that it does. That still isn't enough, because, as Buss acknowledges, mate selection is often not a matter only for the couple concerned. In many societies, marriages are arranged, and there is even a common theme in folklore of parents trying, and usually failing, to prevent their daughter marrying a handsome but penniless young man. He proposes, therefore, that if parents turn out to be important, then "the evolutionary account would focus on mechanisms that have evolved in parents to socialize their children in predictable ways."

Note that mechanisms that cause parents merely to 'socialize' their children wouldn't be enough. They would actually have to specify the mating preferences that parents should inculcate into their children. Otherwise the preferences would be cultural, whereas the claim is that they are genetic. (Note that for this claim to be true it is not enough that genes are involved somewhere along the chain of causation. In many countries, men button their shirts with the left side over the right and women with the right side over the left. There is a sense, therefore, in which we can say that how a person buttons a shirt ultimately depends on whether they have a Y- or an X- chromosome, but that doesn't make it a genetically determined trait and no one would waste time trying to identify the shirt-buttoning gene.)

It is surely more plausible simply to suppose that because women bear and nurse children and so are likely to require support at some points in their lives, they will tend to behave so as to ensure they will have this support when they need it and societies will develop customs which promote this. There is no need to postulate a set of hypothetical genes to explain something we would expect to happen anyway, given ordinary human intelligence. The point here, however, is only that evolutionary psychology, like sociobiology, depends very strongly on the supposed power of genes to have very specific influences on behaviour.

It is easy to speak of such genes in the abstract, but it's a lot harder to imagine how they could work in the real world. Genes are not little imps that make us behave in specific ways, nor are they disembodied pieces of information. A gene is that part of the genome that is necessary to code for the production a single peptide (*i.e.* part of a protein) or RNA product. (Note, by the way, that the genome and the processes associated with it are so complicated that molecular biologists now define a gene in terms of what it does rather than by what it is. In particular, as a standard textbook reminds us, it is not to be thought of as a single contiguous stretch of DNA (Darnell, Lodish, Baltimore, 1986). This might lead you to wonder about genetic engineering: if a gene is not a contiguous stretch of DNA, what exactly is it that is being transferred?)

Everyone knows that to introduce a new chemical into the body or to change the concentration of one that is already there can affect behaviour in ways that are both significant and largely predictable. But these generally involve more than one behavioural trait (or mechanism, if you prefer). We are all familiar with the characteristic effects of alcohol or of some hormones, and in neither case are they restricted to one "behaviour".

Can we really speak of 'a gene for' the sorts of traits that sociobiologists insist their theory can explain? You can get an idea of how difficult it is to justify the concept from an attempt made by Dawkins (1982) (and quoted enthusiastically by Dennett, 1995). "Reading," Dawkins says, "is a learned skill of prodigious complexity, but this provides no reason in itself for scepticism about the possible existence of a gene for reading. All we would need in order to establish the existence of a gene for reading is to discover a gene for not reading, say a gene which induced a brain lesion causing specific dyslexia." He argues that such a gene is not implausible and that it is reasonable to call it a gene for not reading because that might well be its only noticeable effect.

He then continues, "... it follows from the ordinary conventions of genetic terminology that the wild-type gene at the same locus, the gene that the rest of the population has in double dose, would properly be called a gene 'for reading'. If you object to that, you must also object to our speaking of a gene for tallness in Mendel's peas, because the logic of the terminology is identical in the two cases."

The logic is indeed the same, but the point is not whether there is a way in which the internal logic of genetics permits us to ascribe a meaning to the expression 'a gene for reading'. It is whether the concept has anything to do with evolution, and, in particular, whether it can help us to understand how it has come about that we have the capacity to learn to read.

Clearly it does not. And indeed, in a similar discussion of eggshell removal by black-headed gulls, Dawkins acknowledges, "It most definitely does not follow that this particular locus 'for' eggshell removal was one of the ones on which natural selection worked during the evolution of the adaptation. On the contrary, it seems much more probable that a complex behavioural pattern like eggshell removal must have been built up by selection on a large number of loci, each having a small effect in interaction with the others." And a bit later on he adds, with commendable candour, "It is too bad if geneticists usually are forced to concentrate on loci that are convenient rather than evolutionarily important."

From time to time we read of the discovery of a gene for some behavioural trait or other, language for instance. It is worth bearing in mind that, as in these examples, the function was usually inferred from observations of individuals who lacked the gene in question. And that this makes it a gene "for" the trait only in a very limited way, though of course hardly anyone acknowledges that at the time.

If Your Only Tool is a Hammer

There is a saying that when the only tool you have is a hammer, everything looks like a nail. Neo-Darwinists deliberately restrict themselves to only one means of explanation, and, sure enough, to them everything takes on the form that their theory can cope with.

In the first place, by choosing to explain organisms in the way they do, they commit themselves to an uncompromising reductionism, as Dennett (1995) proudly acknowledges. But organisms are not mere assemblies of separate parts, and if we insist on seeing them that way, we miss a great deal. Besides, neo-Darwinist reductionism culminates with the gene, which is the entity taken as the unit of selection. Now that genes are defined by their function rather than as identifiable pieces of matter, the whole analysis is becoming circular.

Evolutionary social scientists are also hard-line reductionists, and with even less justification. It is significant that the term meme is due not to a psychologist or a sociologist but to a Darwinist (Dawkins, 1976. For a critique of the idea see Midgley, 2000). The domain-specific mechanisms that evolutionary psychologists assume exist owe more to the nature of Darwinist explanation and the influence of computer programming (which generally is indeed modular) than to the work of psychologists and neurobiologists (*cf.* the quotation from Symons (1992) in the previous section).

Sociobiology is given to the fallacy of misplaced concreteness, or 'reification'. We can, for example, certainly characterise some forms of behaviour as aggressive, but it does not follow that there is such a trait as 'aggression' that there could conceivably be a gene for. On the other hand, if there is no such trait, then it is much harder to use Darwinist arguments to explain aggressive behaviour.

Darwinists are also led to see everything in terms of competition and conflict. For instance, weaning is portrayed as a struggle between mother and offspring. The infants want to improve their chances of survival by continuing to feed from the mother as long as they can, while the mother wants to wean them quickly so she can start another litter. It's a nice example of Darwinism, and it seems consistent with what many of us have observed in pet cats.

When Gomendio *et al.* (1995) made careful observations of weaning in rats, however, they found a much more complicated interaction between mother and offspring. The change in diet from milk to solid food requires a number of major changes in the pup's digestive system, and when these have occurred, the pup can no longer digest milk properly and so has nothing to gain from demanding it.

This example also illustrates a danger that is common when Darwinism is applied in the social sciences. Scientists generally assume that if we can find a theoretical account that is consistent with the data that we have, then we have finished our work. If we cannot do this, then we know that there is more to be done, either by theoreticians or by experimenters or by both.

Because it is relatively easy to construct Just So Stories, it is possible to construct a Darwinist explanation of almost anything. Thus the fact that we can find such an explanation is not a strong confirmation of our hypothesis. If we were to look more closely at what is happening we might well discover that things are not as we had supposed, but there is little incentive to continue with a problem that is apparently solved.

At best this can be misleading; it can, for example, lead us to see behaviour as much less complicated than it really is because it is so much easier to imagine a gene for a single, stereotypical "behaviour" than to account for complex and often subtle interactions with signals and information passing in both directions.

At worst it can amount to using Darwinist arguments to give pseudo-scientific credibility to ideas that are little more than the prejudices of the researcher. It is natural to suppose that because we can explain *why* something is so, it must really be the case. That argument fails with an unfalsifiable theory like neo-Darwinism, because with a little ingenuity one can devise a story to explain almost anything. For example, if you believe women are inherently likely to be faithful, Darwinism explains that because they actually bear the young, they cannot increase the number of offspring by mating with many different partners, as males can. If, on the other hand, you believe they are inherently likely to be unfaithful, then Darwinism explains that they increase their fitness by becoming pregnant by powerful and promiscuous males and then finding caring males to look after them and their offspring.

There is a further danger, as well. Darwinist explanations inherently invoke selfishness and greed as the most important driving forces: hence the "selfish gene". It is possible to account for apparently altruistic behaviour through such devices as kin selection (Hamilton, 1964) and the iterated prisoner's dilemma (see Axelrod, 1984), but the explanation based on selfishness is the one that comes to mind first and, as in the case of weaning, the one that is likely to stand unless someone chooses to question an apparently solid story.

It follows that accounts with selfishness at the centre will tend to predominate. This is true both in the scientific literature and also in the popular press, and because of the very subject matter of the social sciences, what appears in the popular press is important. What is more, such accounts serve as a justification for selfish behaviour. For while philosophers insist – rightly – that we should not confuse "is" with "ought", the two are frequently conflated in people's minds. And it is harder to criticise someone for behaving selfishly if we believe that what he is doing is "only natural".

Throughout the ages, many Christians have been worried about the so-called Problem of Evil. If the universe was created by a God who is both omnipotent and good, how can there be evil in the world? The 18th century natural theologian William Paley, best known as the author of the famous parable about the watch and the watchmaker, proposed a solution (Paley, 1819). As a good Newtonian, he argued that the world must run according to laws. These generally work well, but it might sometimes happen that cases of "apparent evil" (Paley seems to have been reluctant to accuse his Creator of allowing genuine evil) would arise "out of the thwartings and crossings of laws whose effects are for the most part beneficient."

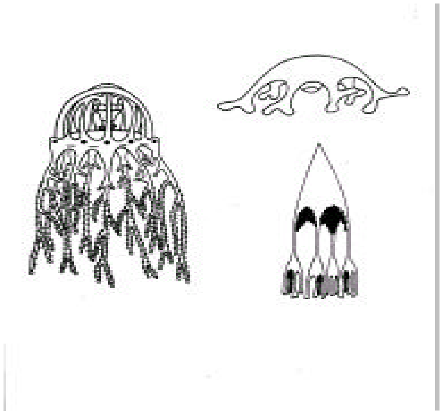
Sociobiologists, for their part, worry about the Problem of Good. Wilson (1975) calls altruism the central theoretical problem of the subject. If the living world was created by the action of a very powerful and inherently selfish force, natural selection, how can organisms be good? The answer appears to be that while selfishness and greed are the general rule, it can sometimes happen that cases of apparent good may arise out of the subtle workings of laws whose effects are for the most part selfish.

The Alternative

An argument that is often put forward in support of Darwinism is that there is no alternative. It has seen off its competitors, especially Lamarckism, and whatever shortcomings it may have, it is the only game in town. Unless and until something better comes along, we have little option but to stick with it.

There is, however, an alternative, though not in the sense of another theory which, like neo-Darwinism, claims to explain the whole of the living world in a sentence or two. On reflection, of course, one might ask why anyone should expect there could ever be such a theory in the first place. It is really more an approach than a theory. It amounts to nothing more than looking very carefully at the thing that has evolved, and using all of science to assist us in our task of trying to understand how it came to be the way it is. We will learn about the evolution of organisms by studying biology, about the evolution of behaviour by studying psychology and sociology, and so on.

To see how this can be done, we turn to an example from biology, the problem of explaining how the medusoid *Cordylopho,* shown on the left of the figure, has come to have such a very complicated shape. A Darwinian would begin with the *a priori* assumption that the medusoid had evolved from a simpler ancestor through a sequence of intermediates, each slightly more ramified and slightly fitter than the one before. The problem would then be to work out a hypothetical sequence, at which point the problem would be considered solved.



The shape on the lower right, however, is not a medusoid, in fact it is not an organism at all. It is a drop of fusel oil which has been allowed to fall into paraffin. Now a drop of fusel oil doesn't have ancestors, it doesn't have a genome, and it isn't subject to natural selection. It has that shape because the undirected physical forces between two fluids of appropriate densities, viscosities and surface tensions, and with the right relative velocity, can produce it. That can happen as a drop of one liquid falls into another, but it can also happen as a small, round, juvenile organism grows in the sea. So this particular form can appear relatively easily in nature, though you mightn't have thought so just from looking at it. And that is largely why we observe it.

It may well be that the medusoid's peculiar shape is useful to it, and no doubt if it were a severe handicap it would have been eliminated by natural selection. But this explains why the shape has *persisted*. It tells us neither how it arose in the first place nor why the medusoid doesn't have some other complicated form instead of this one. Selection was indeed involved, but it tells us very little about why medusoids look like they do. Unless, that is, you prefer to believe that natural selection has acted on a long sequence of random variations only to produce one of the relatively small number of forms that are also observed in inert drops of fluid.

It is, however, not just a matter of which account we prefer, because the explanation based on physics provides a solution to a problem which has dogged evolution theory right from the beginning: the gaps in the fossil record. One of the most strongly held tenets of Darwinism is that evolutionary change is gradual, and that, in particular, the major changes have occurred by the accumulation of small ones. Darwin himself wrote:

> On the theory of natural selection we can clearly understand the full meaning of that old canon in natural history, 'Natura non facit saltum.' This canon, if we look to the present inhabitants alone of the world, is not strictly correct; but if we include all those of past times, whether known or unknown, it must on this theory be strictly true.

And in the same vein, Dawkins (1985):

> Gradualness is of the essence. In the context of the fight against creationism, gradualism is more or less synonymous with evolution itself. If you throw out gradualness you throw out the very thing that makes evolution more plausible than creation.

Note that neither Darwin nor Dawkins bases his claim on empirical data. In fact, the fossil record is full of gaps and while there are isolated intermediates (such as Archaeopteryx) there are not long sequences of slowly varying forms. Darwinists believe that evolution is gradual because their theory requires them to. If the variations are truly random then they must be small, because it is hard to imagine how a large random variation could be anything but disastrous. And then evolution must be gradual.

In the past, Darwinists generally explained away the gaps by arguing that the fossil record is bound to be imperfect. Only a small proportion of organisms leave fossils and only a small proportion of fossils are ever found. As palaeontology progressed, however, this argument became less and less tenable. Eventually, Eldredge and Gould (1972) proposed that the gaps are real, not artefacts, and that evolution proceeds by periods of rapid change separated by long intervals in which relatively little happens.

Because neo-Darwinism is capable of providing an explanation for almost anything – which is either a strength or a weakness of the theory depending upon your point of view (Popper, 1934; on the falsifiability of neo-Darwinism see Saunders, 1988) – it can offer one for punctuated equilibria. The usual story is that significant changes generally occur in small groups that have become temporarily isolated from the main population. The long sequences of intermediates that the theory requires did in fact exist, but there were only relatively few individuals and they were in a different location from the others, which is why we so seldom find any.

By its very nature, this explanation lacks evidence that could support it. It relies on the not very convincing argument that throughout the ages, all the interesting evolution occurred just when no one was looking. Even neo-Darwinists do not seem to be satisfied with the account, and so punctuated equilibria remains controversial. It fits uncomfortably into their picture, and is sometimes even described as an alternative to neo-Darwinism.

Bringing physics into the picture changes everything. If we release a drop of fusel oil too close to the surface of the paraffin, we do not observe the ramified form shown in the figure. It appears only if the drop enters the paraffin at above a certain speed, and then it is in more or less its final form. There is no sequence of intermediate states, with first one 'tentacle', then two, and so on.

Much the same probably occurred in the evolution of the medusoids. Over a long period, we would expect changes in parameters such as the size of the organism or the elasticity of the membrane that surrounds it. These may or may not have been gradual, but even if they were, the change from no tentacles to many would have been abrupt, as it is with the drop of fusel oil. The reason we do not observe the intermediates in the fossil record is simply that there never were any.

A medusoid is a comparatively simple organism, and what happens in more complicated ones is harder to determine – but then real science tends to be hard. On the other hand, in more complicated organisms there is another factor to be taken into account and that is the nature of the developmental process. An organism is not assembled from prefabricated parts, like an automobile on an assembly line. Instead, an embryo develops as a whole, and this is much of the reason that it fits together so well. If an engineer decides to make a piston slightly longer and heavier, he has to adjust many other components to match it. If a mutation were to alter the shape of a bone, the developmental process can ensure that the other bones and tissues that are connected to it adjust automatically. There is no need to wait for separate appropriate mutations for each of them.

This adaptability makes large changes possible. For example, many babies whose mothers took thalidomide during pregnancy were born with severely deformed limbs. Yet the limbs were properly organised and the babies grew into adults who could lead normal lives. To be sure, these particular changes were disadvantageous to the individuals in which they occurred, but then most variations are. The point is that large, coordinated changes are possible. There is, incidentally, a genetic disorder which produces much the same symptoms as thalidomide, so it is not a question of a possible difference in effect between an externally supplied chemical and a natural gene product.

The practice of ignoring development carries over into the social sciences as well. Few sociobiologists consider the literature on child development when carrying out their own work. (See Karmiloff-Smith, 2000). Nor would we expect them to, for Darwinism focuses their attention on the selective advantage of a trait and on the gene that supposedly determines it. What lies between the genome and the trait is considered largely irrelevant.

The embryologist C.H. Waddington noticed that the developmental process has a number of distinctive features. For example, development is stable in the sense that perturbations along the way may have little effect on the end result. It typically proceeds to one of a restricted number of distinct alternative end states rather than to a broad spectrum of possibilities. He illustrated these in a diagram he called the "epigenetic landscape" (Waddington, 1940).

In fact, these features are what we would expect from a complex nonlinear system (Saunders, 1993). Such systems are typically resistant to small changes. Large changes are likely to occur rapidly rather than by the accumulation of small ones. Thus if we bring all of science into the study of evolution, instead of concentrating on natural selection, not only can we readily understand how punctuated equilibria can occur, it is precisely what we would expect.

Brains are also highly complex nonlinear systems and that too has implications for some of the properties of the mind and behaviour (e.g. Saunders & Skar, 2001).

Adaptation

If Darwinism can explain all of biology, it ought to be able to do the same for other similar fields. And even if it can't explain all of the living world in the way that is often claimed for it, as long as it is important in biology then we might expect it to be equally important in those other fields as well.

In fact this is not so. The chief contribution of natural selection is to a problem that is far more important in biology than in the social sciences, the problem of adaptation. Indeed that is the problem that Darwinism was specifically invented to solve. The idea of evolution had been seriously discussed for over a century before Darwin, but it was only after he explained how it was possible for organisms to arise by natural processes and yet look as though they were designed to function in a purposeful way, that most people felt able to accept the evidence that evolution had actually occurred. That's not the same as demonstrating that evolution had occurred by natural selection, but it was an invaluable contribution all the same.

Natural selection remains important today. No matter how we believe the variations occur, or how much of adaptation can be explained by the nature of the developmental process, the role of natural selection as editor – 'negative selection' – is essential to our understanding of evolution.

Things are quite different in the social sciences. It is not in the least difficult to explain why humans (and indeed many other animals as well) should behave in ways that are in their best interests, *i.e* that are adaptive. We only have to assume a little bit of learning and some common sense. It is possible, though highly improbable, that the evolutionary psychologists' explanation of why women are likely to want to marry men who will be able to support them and their children is correct. But – and this is the important difference with biology – it is not at all difficult to see an alternative. Indeed, most people would consider it so obvious as not to require much of an explanation at all.

Thus in biology, natural selection offers a solution to a problem that is otherwise very difficult to solve. The social sciences do not have the same problem, certainly not to anything like the same extent, and the potential role of Darwinism is correspondingly very much less.

Conclusion

Those who apply Darwinism to the study of such highly complex systems as organisms, minds, economies and societies believe they have discovered how to bypass the complexity. They can, so they claim, understand why these systems are the way they are and how they got to be that way simply by considering the selective forces that have acted on them. They study the systems themselves chiefly to discover what it is that has to be explained; the explanations are almost entirely in terms of external forces. Just as an astronomer can predict the orbit of a planet to a high degree of accuracy with very little knowledge of its internal structure, so the Darwinist claims to be able to be able to understand why organisms, minds and societies are as they are without devoting much time and effort to investigating their workings.

Like all universal panaceas, Darwinism cannot accomplish what is claimed for it. It cannot provide an adequate explanation of the living world, but there it does have an important role to play in explaining adaptation. Adaptation is a far less difficult problem in the social sciences, however, and natural selection has correspondingly less to contribute. At the same time, its characteristic shortcomings – in particular the tendency to reductionism, reification and the telling of Just So Stories – are more damaging.

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Figure Caption: *Cordylophora*, *Caldomena* and a drop of fusel oil in paraffin. After D'Arcy Thompson (1917).

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