

an assumption of special creation." What is of interest to us here is that creationists again gloss over this discriminatory evidence. Cracraft (1983:177) says: "To my knowledge they (scientific creationists) have never denied the existence of a hierarchy of similarity, nor have they provided a credible, scientific explanation as an alternative to descent with modification.

Returning to our illustration, there is a second tactic that could be used to create the impression that the straight line is better supported than the exponential curve.

b) The "straight liner" could claim that that the incompleteness of the data for H_2 constitutes evidence for H_1 . This claim makes at least three mistakes. Firstly, it assumes that H_2 and H_1 are the only two alternatives. In chapter 2 we saw that this is methodologically unsound. Yet creationists (e.g. Enoch 1968:105) often claim that evolution and special creation are the only alternatives. Secondly, the demands of the straight liner are unreasonable. He gives the impression of being very rigorous in requiring that the supporter of the exponential curve fill in the gaps. But it is easy to see his inconsistency. With regard to completeness of evidence H_1 is worse off. The principle that he has violated is that hypotheses should be compared over equivalent domains. For the given set of co-ordinates H_2 is superior to H_1 . Thirdly, the straight liner makes the issue the *amount* of evidence when it is the *kind* of evidence that is crucial. Very little discriminatory evidence may be needed to favour one hypothesis over a rival. If E_1 - E_4 is the only evidence we have, then E_3 and E_4 is all that is needed to tip the scales against H_1 .

Incidentally, we can see here why the straight liner's approach might have a certain appeal. It is well known (Kitcher 1982) that creationists take advantage of a popular misconception that real science is pure fact. Since evolution is just a theory it is not really science they say.

This illustration helps us to see that the straight liner's problem is not a purely empirical one. Let us imagine that additional evidence E5-E8 is found. Does this evidence compel acceptance of H2 over H1. Not to the hard-liner. He could point out that the lines drawn between E4 & E5, E5 & E6 etc. are interpolations and not facts. Therefore H2 is not really factual and therefore that H1 and H2 are both unscientific. The straight liner might say that it is quite permissible for him to believe H1. No amount of evidence will convince one such as this. Since the curve H2 is infinitely divisible, it can never consist of pure fact. The straight liner's error is that he holds to a discredited view of the nature of science. Popper (1972a:36) has shown that universal statements, (the bricks of scientific theories) can never be reduced to pure fact.

Creationists argue very much like the straight liner. They say that evolution predicts that there should be a finely graded series of transitional forms. Instead we find gaps in the fossil record. Therefore the facts speak against evolution and for special creation. This argument is not uncommon (e.g. Frair and Davis 1967:30, Chittick 1984:64-65, Gish 1985, Wright 1985). Below are a few quotes:

"It may therefore be asserted that the facts of paleontology, namely, the sudden appearance of all the invertebrates with their distinct specialization in the cambrian era, and the complete absence of undisputed fossils in the precambrian rocks, and the absence of intermediate forms linking the basic kinds of animals and plants, argue more for instantaneous creation than for evolution" (Enoch 1968:55).

"One example of the scientific evidence for creation is the sudden appearance of complex fossilized life in the fossil record, and the systematic gaps between fossilized kinds in that record. The most rational inference from this evidence is seemingly that life was created and did not evolve" (Gish *et al* 1981).

Evolutionists have tended to respond to such claims by pointing out that creationists are ignorant (this is the more charitable claim) of certain basic facts: Despite the imperfections in the fossil record (Raup 1983:158) there are precambrian fossils (Godfrey 1983:198); the emergence of life was only sudden on a geological time scale ; there are transitional forms (Godfrey 1983:198-202, Cuffey 1984:257, Miller 1984, Burke 1985, Berry 1985). I wish to emphasize, along with others such as Kitcher (1982) and Kehoe (1983), that there are additional philosophical problems with the creationist arguments. To treat the problem as purely empirical is to fall into a creationist trap. They create a superficial impression that theirs is the truly empirical approach, when no amount of evidence will actually satisfy them. Setting up an impossible standard, and putting the onus on the evolutionist to meet this standard, they put him on the defensive. Our response to the creationist should not be to just display the evidence for evolution, but also to expose their faulty philosophy of science.

The creationist's mistake is that he has conflated negative and discriminatory evidence. Negative evidence does not count against a theory because it is unreasonable to demand complete evidence. That a significant part of the creationist problem is a philosophical one can be seen from the way they treat transitional forms.

Archaeopteryx is a classic transitional form, showing both reptilian and avian features. It is of interest to note that the responses of creationists are quite divergent. One objection is that *Archaeopteryx* is not a true intermediate. The creationist Baker (1976:12) says that "if archaeopteryx has got a fully reptilian skeleton, then it has certainly got feathers that are fully bird-like. There is no suggestion of something at the half- way stage between a reptilian scale and a bird feather, which is what an intermediate creature would be expected to possess." This sort of objection was answered by Darwin (1859), of course, so we won't let it detain us here.

For our purposes a second objection is most interesting. Cousins (1971:89-99) claims that *Archaeopteryx* is not a true missing link; but rather an aberrant bird. We can dispute this interpretation, of course, but the tactic of interest to us here is that when a major gradation is found, the absence of finer gradations is taken to be evidence against evolution. If these were found the creationist could point to the absence of even finer gradations and so on. Any evidence can be discounted because negative evidence will always be available. The creationist's mistake is that he has given negative evidence the status of discriminatory evidence.

Complete evidence is not needed to decide between rival hypotheses- only discriminatory evidence and not much of it. There was enough in Darwin's day, in order to show that evolution is superior to the creationism of the type promulgated by Morris and Gish, one need only show that that as one goes further back in the fossil record, the fossil forms become progressively different from the forms existing today. That is all. One does not need to show a finely graded series with innumerable links. Special creation, in contrast, does not predict this order. All forms should be uniformly distributed throughout the fossil record. Figure 7-3 displays the superiority of evolutionary theory over scientific creationism by representing these positions as curves and the evidence as dots.

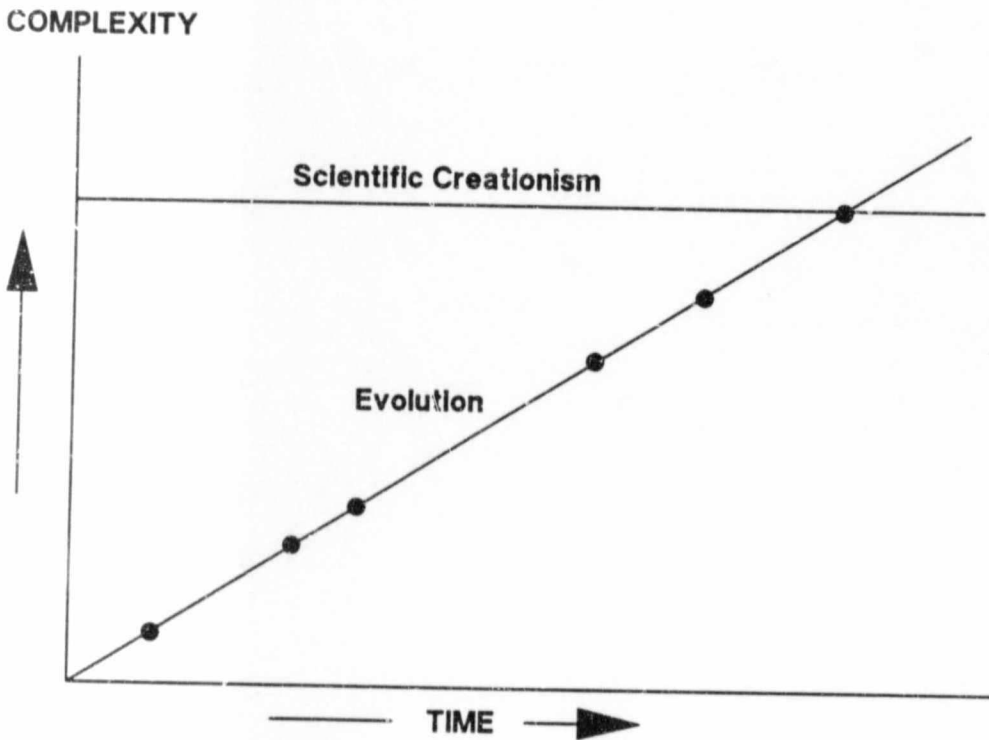


Figure 7-3. A graphic representation of the fossil evidence for evolutionary theory and scientific creationism.

Note that the superiority of evolutionary theory is evident in spite of underplaying the amount of evidence for it.

Darwin admitted that the fossil record was incomplete (1859:291-316). In spite of this it was sufficient to favour descent by modification over independent creation. He writes (1859:330): "Let us now look to the mutual affinities of extinct and living species. They fall into one grand natural system; and this fact is at once explained on the principle of descent. The more ancient any form is, the more, as a general rule, it differs from living forms. "

My object has been to show that creation scientists practice poor method; they fail to distinguish between common and discriminatory evidence and between negative and discriminatory evidence. Others (e.g. Kitcher 1982:30-54, Futuyma 1982:175-196) have come to similar conclusions. In the following statement it is evident that Futuyma comes to the same sort of conclusion as mine, although he does not give the types of evidence appropriate names. He writes (1982:176): "In actuality, almost all creationist literature simply consists of attacks on evolution, rather than positive evidence for creation. To the creationists any [negative] evidence against evolutionary theory apparently constituted [discriminatory] evidence in favour of creation."

Our examination of creation science provides perspective on the problems in evolutionary biology; it shows that the problems are relatively minor.

The common evidence appealed to by the creationist is, for example, mere similarity between organisms; when the evolutionist has done the same it is at a much finer level- using the sympatric occurrence of sibling species to support sympatric speciation. The discriminatory evidence ignored by the creationist is, for example, the obvious imperfections in living things. When the evolutionist has done the same it is again at a much finer level- his ignoring of

the fact that the special conditions required for sympatric speciation are hardly ever met in nature.

It is as if the debate is over the identity of some animal. While the evolutionists are discussing amongst themselves whether the dog is a dalmation or daschund, the creationists think the animal is a kangaroo. The common evidence appealed to by the creationist is merely presence of fur; for the evolutionist it is the presence of floppy ears. The discriminatory evidence ignored by the creationist is the presence of a well developed placenta and the absence of a pouch; when the evolutionist does the same he ignores the presence of black spots.

Method in evolutionary biology

In the next section the methods used by evolutionary biologists are discussed. The main contention is that many of the problems that exist in the field would be solved if common and discriminatory evidence were consistently distinguished. I identify ways of thinking that encourage confusing these types of evidence, and show how to avoid the pitfalls in this type of thinking.

The first problem we will consider is reliance on common evidence. It should be noted that, in many cases common evidence is not merely gathered, but an exaggerated importance attached to it.

We can recall a few instances: Mayr (1963:17) claimed that "this striking discontinuity between sympatric populations is the basis for the Biological (= Isolation) species concept..." Yet we have seen that the Recognition Concept accounts for this phenomenon as an incidental consequence of speciation in allopatry. Reproductive isolation is a fact but it must not be given undue emphasis and needs understanding.

Tauber and Tauber (1977a,b) gathered information showing the sort of genotypic changes that have or may have lead to the formation of a particular daughter species. The sympatric origin of host races in *Rhagoletis* is a fact. There is nothing wrong with reporting this. But then they tried to give it greater importance by claiming that it favoured one mode of speciation over another. There is some indication that this occurs more generally in biology. Loehle (1987) reports that in ecology researchers have sometimes sought to confirm rather than test hypotheses.

In seeking solutions to the problem, it will be profitable to find out what it is about common evidence that tempts one to exaggerate its value.

One reason is well known. The underlying argument, though fallacious, has superficial plausibility. The fallacy is called affirming the consequent and has the form

$$\begin{array}{l} \text{If } P \text{ then } Q \\ Q \\ \hline \text{Therefore } P \end{array}$$

The fallacy resembles the valid *modus ponens* argument

$$\begin{array}{l} \text{If } P \text{ then } Q \\ P \\ \hline \text{Therefore } Q \end{array}$$

The solution is to be aware of the various forms of argument and to know which are valid and which are not.

A second reason is that evidence as a whole often gets credit that should really only be given to discriminatory evidence. Consider the following argument cited by Shaw (1981:37).

"If Einstein's theory is true then light rays passing close to the sun are deflected.

Careful experiments reveal that light rays passing close to sun are deflected.

Therefore Einstein's theory is true."

Shaw gives the above as an example of an argument, which, though invalid, is apparently widely and successfully used in science. The argument has prestige then, and appears to give credence to the view that it is enough to simply find evidence in support of a theory, without any concern for the types of evidence. However, if we look closer we see that the evidence (the second statement in the argument) is really discriminatory. Shaw attributes the arguments success to it being advanced against a background of unstated, competing theories. In other words the argument is presented with the understanding that the evidence discriminates against Newtonian Mechanics- everyone knows that according to this theory light always travels in straight lines.

A third reason is that it is thought that the way to solve difficulties in evolutionary biology is to simply appeal to the facts. However, as logicians well know, facts can sometimes get in the way of sound reasoning. The invalid logic of an argument may appear irrelevant if the facts precisely fit the predictions of a hypothesis. Logicians achieve neutrality by using symbols and a special notation. Using analogies such as the one developed in chapter 6 can also help to solve this problem. We saw that the game makes it easy to see why common evidence may be appealing and yet cannot be relied on.

A fourth reason is that the evidence needed to adjudicate between alternatives is not always easily obtainable. Futuyma and Mayer (1980) report cases which *prima facie* look favourable to sympatric speciation, but where there

is insufficient evidence to exclude the possibility of allopatric speciation. The pressure to produce significant results may incline one to overvalue a line of evidence.

A fifth reason is that whereas common evidence is of less value methodologically it is often more concrete or directly observable than discriminatory evidence. Take reproductive isolation as an example. It is common to both the Isolation and Recognition concepts of species and Mayr (1963:17) says of it that "this *striking* discontinuity between sympatric populations is the basis for the the Biological (=Isolation) species concept..." (emphasis mine). This contrasts with the independence of the complexity of the fertilization system on the proximity of other species. Here the evidence is discriminatory but it is not as obvious. Williams (1973) has discerned that the sort of evidence that, for instance, supports allopatric over sympatric speciation as the prevailing mode is often not 'human-sized.' The predictions that discriminate between the two modes are not about individual cases that can be directly experienced, but about patterns in groups of phenomena. The solution is to use the right criterion when evaluating evidence; to be more impressed by evidence that discriminates than by that which is concrete.

A second problem area in evolutionary biology is that discriminatory evidence is often undervalued. It is not just that the significance of this evidence is not discerned, but that it is played down.

One case noted by Paterson (1981) is that of Dobzhansky attempting "to play down the logical inconsistencies which exist between the isolation concept of species and the admitted occurrence of speciation in allopatry." He quotes Dobzhansky as saying: "These two hypotheses (allopatric speciation and speciation by reinforcement) are not mutually exclusive." If speciation occurs in allopatry then it does not make sense to define species in relational terms

(Paterson and McNamara 1985). Populations do not evolve into species to prevent hybridization with other populations.

Another case is that of Littlejohn's (1965) work on the *Hyla ewingi* complex. We have already seen that Littlejohn tried to support the reinforcement model on common evidence. What is interesting is that evidence did exist that counted against the reinforcement model. Master (1960), whom Littlejohn quotes, pointed out that under the reinforcement model, one would predict that the call structure of the allopatric population, free from the selective pressure for specificity, would be more variable; while the sympatric populations, under conditions which require distinct call structure, would be less variable.

Under the second model one would predict that because the call structure is not influenced by the presence of a closely related species but by some other factor, the variances of call components in the allopatric and sympatric populations would be similar.

On comparing the call component variances between the allopatric and sympatric populations, Littlejohn found them to be similar (which supports the model that reinforcement is an effect). He found the result surprising, and thus apparently admitted to himself its discriminatory significance, but, and this is his error, he continued to opt for the reinforcement model.

Although the focus of this thesis has been on speciation and the species problem, the problem does occur elsewhere in biology. For instance, a number of ecologists have pointed out that the conditions required for competition to occur include a homogeneous and constant environment with limiting resources. Pro-competitionists admit that the environment may at times be variable, heterogeneous with abundant resources, but believe these circumstances to be rare. Yet there is mounting evidence, that these

circumstances are more frequent than admitted by pro- competitionists (Price 1984, Wiens 1977, Connell 1983).

There are several possible reasons for why the significance of discriminatory evidence is obscured and undervalued. Firstly, we have already seen that to discern its significance, one has to have performed the previous steps in the MCT approach. Alternatives have to be adequately delimited before multi-cornered predictions can be made from them. The deductions from these alternatives must be carefully followed.

A second reason has already been dealt with. Williams cites cases of (discriminatory) evidence which is not "human-sized." To assess the relative importance of allopatric and sympatric speciation, we need data on the patterns in the distributions of species pairs for instance. The fact that these data are not directly observable has obscured its methodological significance.

A third reason is that the wrong question is often asked. The question should not be, for example, whether a particular mode of speciation occurs, or is plausible, but how frequently it occurs and consequently how important it is in evolution.

A final problem area is confusion over where the burden of proof should lie in equivocal cases. Worthington (1954) says of a few case studies that "...they appear as *prima facie* cases of true sympatric speciation, until they can be explained on other premises." For others (Mayr 1963:480, Fryer and Iles 1972:572) the burden of proof rests on the supporters of sympatric speciation. Viewing the problem from the perspective of the common versus discriminatory evidence distinction helps to solve it. Since the equivocal cases could go either way, we should not base our acceptance of a model on these. Our adjudicating should be based on the unequivocal cases alone.

This thesis has focused on the problems in evolutionary biology and might create the impression that method in the field is more bad than good. Our examination of creation science puts these problems in perspective. As we have seen these are minor in comparison to the problems in creation science.

In focusing on the problems in evolutionary biology, I have sought to understand why they have occurred so that solutions can be found. I submit that one way forward is to distinguish consistently between common and discriminatory evidence; to ask not if there exists any evidence for or against a theory, but whether the theory is the best alternative in light of the right kind of evidence. Evolutionary biology is science; it is, on the whole, good science. Improving its methods will give the anti-evolutionists even less of the little case they have.

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