

They are basically concerned with differential rates of evolutionary change; and the precise role of selection has not, as yet been ascertained. We should not be too surprised if speciation turns out to have an accidental as well as an adaptive component. The imaginative and enquiring spirit of Darwin lives in all except the minds of those with other axes to grind.

I have a feeling that Darwin would be overjoyed at the general acceptability of his concept of fine-grained adaptation under natural selection, and would not be unreceptive to its possible dissociation as a process from that of speciation. Marx, on the other hand, could but grunt that a dissociation of the two processes no longer requires the inevitability of a change of state of one species into another. GABRIEL DOVER  
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## From the museum...

SIR — As music is the food of love so surely debate is the nourishment of science, but the crashing cymbals of your leading article of 26 February were a discordant accompaniment to a meagre meal<sup>1</sup>. Your subsequent article<sup>2</sup> sets the stage for a more reasoned discussion.

Controversy and debate over the hypotheses associated with the concept of organic evolution have recently received considerable attention. It can hardly be described as a rot permeating just the British Museum (Natural History) but rather the open questioning of evolutionary theory by serious biologists and philosophers — a fact apparently denied in your first leading article. Furthermore there are clear indications of unease amongst educationalists<sup>3,4</sup> at the way in which the concept of evolution is being taught, not as an hypothesis open to criticism but as a fact.

Many practising biologists and teachers echo Olson's remark "Evolutionary theory should be treated like any other scientific theory, as a matter for dispassionate and objective study of the evidence available"<sup>5</sup>. Yet this only reflects the more pungent and provocative comment made by Darwin's "bulldog" over a century ago "... the scientific spirit is of more value than its products, and irrationally held truths may be more harmful than reasoned errors. Now the essence of the scientific spirit is criticism"<sup>6</sup>.

The views of many scientists in this museum are encapsulated in a quotation from the museum's "recent brochure":

Biologists try to reconstruct the course of evolution from the characteristics of living animals and plants and from fossils, which give a time-scale to the story. If the theory of evolution is true, the features used to classify species in groups . . . were acquired by the common ancestor of the group and inherited by the living descendants . . . In this light, the groups-within-groups of classification are seen as the descendants of more or less remote common ancestors. And classifying animals and plants is a way of expressing ideas about the course of evolution. This is why classification is interesting and important to biologists, and why the work of classifying is never finished. For new discoveries lead to new ideas about the course of evolution.

Our understanding of the theory of evolution is that it is an amalgam of many subsidiary hypotheses, related not only to the patterns of

organic diversity but also to the mechanisms whereby they arise. Here we are faced with a core theory and its protective satellite belts. Clearly various aspects of these hypotheses have been criticized and improved upon, and there is no reason to believe that this evolution has stopped, nor should we pretend that it has stopped. As practising systematists we recognize and we do not underestimate the enormous heuristic value of the theory as a stimulus to research.

The theory of evolution must surely be considered an "open question" and we therefore agree that "in the public presentation of science, it is proper whenever appropriate to say that disputed matters are in doubt"<sup>7</sup>. We cannot see, however, how the views expressed in the museum's brochure indicate any divergence from such an objective. Rather, they make a positive statement about the utility of the theory as an explanation for the diversity of life.

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SIR — Dr Colin Patterson<sup>1</sup> says that cladistics is "not about evolution". Cladistics may therefore be considered essentially a method of classification. Based on morphological characters it arranges taxa into a hierarchy and the hierarchy itself has no necessary phylogenetic implications<sup>2</sup>. Since cladistic classifications are based on "derived" similarity, it seems to have been accepted<sup>3</sup> that they may resolve the classification hierarchy more fully than traditional classifications, which are based on "clustering" similarity<sup>4</sup>.

If this is all there is to cladistics then at least its taxonomic substance seems uncontroversial. However, any such hierarchical classification, whilst practically useful, is essentially non-scientific<sup>5</sup>, as the aim of science is to explain simple taxonomic relations, then to test the explanation (scientific theories) to see if they make sense<sup>6</sup>. Evolutionary theory is one such scientific theory<sup>7</sup>.

Cladistic method can be incorporated into evolutionary theory by simply accepting that the cladistic hierarchy represents an assumed time axis, a view taken by Hennigian cladists. A historical sequence is "predicted" from the morphology of organisms and in context of Popperian concepts of science, cladists have gone on to compare the congruence of such predicted sequences with other such sequences based on different, semi-independent lines of evidence, such as historical geography<sup>8</sup>.

However, stratigraphy can also be used constructively in such comparisons to call into question the sequence of taxa presented by cladograms and thus to test the usefulness of the hypothesis outlined above<sup>9</sup>.

Cladists to date have applied the concept of testing mainly from an internal perspective of character analysis<sup>10</sup>, and historical time-space coordinates of taxa have in general been ignored. The cladogram has thus been regarded as absolute, whilst evidence from stratigraphy, because it is incomplete, has been recognized as relative — and apparently therefore as worthless<sup>11</sup>. Little attempt has

been made to hold the cladistic system itself up to test. It seems to have been overlooked that cladistic classification may make morphological evidence seem convincingly complete, even though it is not actually complete. I do not understand how a system that is relative (cladogram) can be assumed to be absolute and thus used universally to ignore or "refute" historical evidence that is actually true<sup>13</sup>. The view promulgated here regards both sets of evidence as relative, and thus as commensurable. Cladograms present a relative sequence and stratigraphy presents a relative sequence, and both have their own semi-independent corroborators and falsifiers. In actual practice the testing role of stratigraphy would therefore be difficult, a sign of a mature science<sup>9,12</sup>; in some cases the stratigraphy may be trusted more than the cladogram, in others the cladogram may be relatively well corroborated<sup>13</sup>.

It is, on the other hand, naively easy to question the cladistic system as a basis for delimiting species. Since cladistic hierarchies reflect characters of organisms, and since such characters are expressed as a hierarchy of proper sub-classes (monothetic sets)<sup>4</sup>, a logical consequence is that classes cannot be discriminated from individuals within the context of character analysis. Men and women form cladistically distinct taxa, and pregnant women a taxon nested within women as a whole. Straightforward genealogical observation refutes this, since a pregnant lady can deliver a son and return to her generalized condition. This argument may seem facile but for the fact that one cladist has recently described several new species out of what many evolutionists might take to be sub-specific populations<sup>14</sup>. At any rate there is a potential danger of over-splitting taxa.

My view differs from some of my colleagues in that I maintain cladistics is about evolution and that any sensibly testable system will recognize that evolution is a complex, mature theory, requiring complex modes of testing beyond "naive falsificationism". Basically I consider evolution and the fossil record as very much the proper context for cladistics and not the converse. It is surely commonsense to use historical evidence to examine history and not to view it askance through a haze of global aristotelian philosophy of character analysis, as transformed cladists appear now to be doing. Transformed cladists may justly have rediscovered Aristotle, but if they decide to wipe out Galileo they reject not only Darwin but all of modern science<sup>12</sup>. CHRISTOPHER HILL

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