

salmon are more similar than lungfish and cows. And in preferring cladogram *a*, cladists mean that they infer that lungfish and cows shared a more recent common ancestor than lungfish and salmon. This inference is drawn from the fact that lungfish and cows share derived characters (synapomorphies such as internal nostrils, an epiglottis, a two-chambered auricle and so on (Kesteven *Proc. Roy. Soc. Vict.* 59, 93; 1951)) not found in salmon.

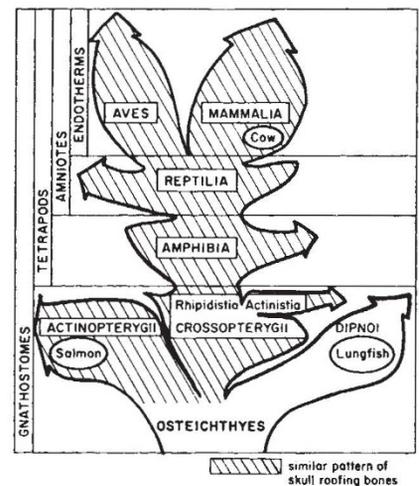
Given their reliance on overall similarity, it is not surprising that evolutionary systematists find that many of the groups they recognise are grades, nor that these grades 'happen to coincide with the major classes of the vertebrates' (Halstead *op. cit.*). Yet these vertebrate classes were recognised and named by pre-Darwinian systematists, who also used overall similarity as their guide, naturally enough. Overall similarity may be modernised or dignified by calling it 'genes in common' or 'shared genotype', yet when we do have access to comparative information on genes, as in globin sequences (Goodman *et al. Nature* 253, 603; 1975; Romero-Herrera *et al. Nature* 261, 162; 1976), the biochemists present their information in the form of cladograms, and use the same genealogical concept of relationship as Hennigians. Darwin (*Origin of Species*; see also Nelson *Syst. Zool.* 23, 452; 1974) wrote 'our classifications will come to be, as far as they can be so made, genealogies; and will then truly give what may be called the plan of creation'. He might be surprised that after 120 years, some palaeontologists would be occupied with the defence of pre-Darwinian concepts and classifications.

Halstead's report contains many misunderstandings and ambiguities, a few of which cannot be allowed to pass unchallenged. It is not, as Halstead says of cladistics, "axiomatic that . . . sister groups are given identical ranks"; it is however a logical consequence if a formal classification is required. Nor does cladistics insist on a classification which reflects all of the ideas embodied in the cladogram. Cladists do not assemble characters subjectively into a hierarchy: though we suspect that the hierarchy of which Halstead speaks is a reference to character weighting, not favoured by cladists. Halstead also accuses cladists of belittling the significance of parallelism. But this is outside the scope of cladism since the recognition of such an evolutionary event presupposes that we already know the phylogenetic relationships of the organisms concerned.

L. B. HALSTEAD AND COLLEAGUES  
REPLY: The mutual relations of salmon (an actinopterygian), lungfish (a dipnoan) and cow (a mammal, a class which can be traced back to rhipidistian crossopterygians by way of reptiles and amphibians) are certainly worthy of serious consideration. Gardiner *et al.* draw up "three cladograms showing three possible 'more closely related' pairs". Cladogram *a* is their preferred solution, but it is certainly not true to claim, as they do, that "*c* was the preferred solution of Parrington and Halstead". The cladists simply omit the possibility that none of the three pairings shared a more recent common ancestor, than any of the others, but rather were all derived from a pre-existing common stock, a view previously commended by Miles (*Palaeozoic Fishes*, 1971).

Assuming that cow, salmon and lungfish were derived from such a common ancestral stock, we would still insist that lungfish are closer to salmon on the grounds of neither having advanced significantly beyond the common heritage of all primary aquatic jawed vertebrates. In marked contrast, the cow is separated from both lungfish and salmon by several structural grades. The figure summarises these relationships.

At the meeting Gardiner presented a cladogram which purported to demonstrate that lungfish were more closely related to tetrapods than were either coelacanths or certain rhipidistian crossopterygians. The near structural identity of crossopterygians and early tetrapods makes it impossible for them to be separated by the uniquely specialised lungfish. Later in the meeting T. S. Westoll demolished this particular cladogram and pointed out that most of the features that Gardiner claimed were absent in coelacanths were in fact present in the material Westoll himself was studying.



Janvier's agnathan cladogram was a reflection of Stensiö's mistaken notion of the myxinoïd affinities of the heterostracans, which has been discussed and firmly rejected by workers in the field (see *Biol. J. Linn. Soc.* 5, 339-349, 1973; *Biol. Rev.* 48, 279-332, 1973, for a summary of this issue).

The current Hennigian orthodoxy brings to mind the situation at the beginning of the present century. Then Haeckel's Biogenetic Law and the attendant preoccupation with genealogies, had a stultifying influence on the whole of biology. 'When the results of a science are produced by methodological assumptions rather than by the evidence available, it is not science' as A. J. Cain remarked in his review of Hennig's book in *Nature*.

L. B. HALSTEAD  
E. I. WHITE

Department of Geology,  
University of Reading

G. T. MACINTYRE  
Department of Biology,  
Queens College, New York

Concerning Halstead's report of the meeting itself, we were surprised to read that papers delivered by two of us 'were demolished within hours'. Freedom of speech goes a little too far here, and we request that Halstead justify his assertion by saying who did the demolition work, and how it was

B. G. GARDINER

Department of Biology,  
Queen Elizabeth College,  
London W8

P. JANVIER

Laboratoire de Palaeontologie,  
Université de Paris,  
Paris V

done. Halstead charges us with 'religious fervour', but the charge might be reversed, for to us his statement that cladists 'are already entrenched in some of the major museums in the world' has an offensive taint of McCarthyism and the witch-hunt.

C. PATTERSON  
P. L. FOREY  
P. H. GREENWOOD  
R. S. MILES  
R. P. S. JEFFERIES

British Museum (Natural History),  
Cromwell Road,  
London SW7