

Speciation and our own species

SIR—It is dangerous to build a methodological artefact into dogma. Students of the modern biota are constrained to study those phenomena which are amenable to their methods. Allopatric speciation and other processes of phyletic branching can be studied using modern organisms. Speciation without branching (phyletic speciation) perhaps cannot, so it is sometimes denied.

There is some positive evidence that the transformation of *Homo erectus* into *Homo sapiens* was both more or less gradual² and occurred in different parts of the world^{3,5}. The latter conclusion has been, and remains, especially common to students of East Asian and Australasian fossils. This evidence cannot simply be ignored with impunity. The phenomenon has been proposed for some other mammals also (refs 6–8 and M. Freudenthal, personal communication).

As discussed in more detail elsewhere^{4,9}, geographically extended phyletic speciation is a single process, not a matter of independent origin in different places in the manner of some polyploid species. The frequency of occurrence of such phyletic speciation remains controversial, but the mechanism itself consists entirely of a combination of generally accepted processes. These are, first, temporal continuity of regionally adaptive features; second, persisting gene flow from region to region; third, a single potential origin for each generally adaptive feature; and fourth, the spread of generally adaptive features by dispersal and natural selection within pre-existing regional populations elsewhere. The possibility of more than one place of partial or even complete origin is plausible for polygenic characters but it is unnecessary because of development or genetic interactions. 'Hitchhiking' and the like can partly homogenize neutral alleles and other DNA geographically. There is no more reproductive isolation at any one time than within normal species today. The above process is called speciation because it creates an entity which is adaptively (and in other respects) as distinct from its ancestor as are the species we see around us from their close contemporaneous relatives. Such differences are how paleontologists recognize allochronic species. If a later population could travel in time back to an earlier one, it might find itself reproductively isolated, but since this is both untestable and without causal effect, it is irrelevant to the pheromone. There is no implication as to how rapidly phyletic speciation may occur.

But one should not ignore the molecular evidence either, which points to differences of frequencies of variants among populations and even some qualitative

differences. These are used to construct distance matrices and phylogenetic trees, not all of which agree¹⁰ even apart from the usual and (at this scale) unjustified^{11–13} assumption of equality of rates of change. However, in the absence of locally temporal calibration (with associated error of estimate), we really have no idea when the branchings occurred. Perhaps they really are different for different genetic elements; under selection, genomes need not disperse even approximately together. They may have occurred before the origin of *H. sapiens*¹⁴, in part during it, afterwards, or all three.

The suggestion^{1,15} of a bottleneck in population size will be more convincing if enough genetic elements unrelated both functionally and chromosomally can be found to provide positive evidence. A bottleneck is now merely a plausible alternative; processes like meiotic drive and individual selection can mimic its results in particular cases, and different genetic elements now suggest different scenarios.

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The origins of chloroplasts in eukaryotes

SIR—While I agree with most of A.E. Walsby's *News and Views* comment¹ on the significance of the discovery by Burger-Wiersma *et al.*² of a filamentous prochlorophyte, I must take issue with his statement that the pairing or stacking of thylakoids (chlorophyll-bearing membranes) "... may be a quasi-mechanical consequence of the presence of chlorophyll *b* and the absence of phycobilisome structures ..." and "may not therefore be of any phylogenetic significance". This neglects a fundamental difference in the organization of photosynthesis between cyanobacteria (and eukaryotic red algae) on one hand and prochlorophytes and green eukaryotes on the other.

In cyanobacteria the thylakoid membranes are laterally homogenous; both photosystem II (which seems to be specifically associated with the phycobilisomes) and photosystem I are distributed across the whole membrane. In green eukaryotes there is a segregation of function; photosystem II is largely or entirely concentrated in appressed membrane regions, while photosystem I is predominantly located in single membranes. Freeze-fracture electron microscopy shows that *Prochloron* thylakoids are laterally heterogeneous, with a very similar pattern of intramembrane protein particles to that seen in green algae and higher plants^{3,4}. There is no *a priori* reason why either the presence of chlorophyll *b* or the absence of phycobilisomes would lead to this segregation and membrane specialization; the phylogenetic significance lies in the fact that *Prochloron* both has the same chlorophylls as higher plants and organizes its photosynthesis in the same way. It is conceivable that chlorophyll *b* could have arisen more than once, but hard to imagine that each time it would have been accompanied by the same major restructuring of the photosystem organization in the membrane.

Prochloron resembles the green chloroplast in another feature, the dispersed arrangement of its DNA⁵; cyanobacteria almost always have their DNA in a central nucleoid⁶. Burger-Wiersma *et al.*² report that their organism has a central nucleoid like that of cyanobacteria and unlike other prochlorophytes. They do not mention whether or not the thylakoids are stacked, and their published micrographs do not establish this clearly. Further electron microscopy to settle this point and freeze-fracture studies to establish whether or not the membranes are laterally heterogeneous are the next steps towards understanding the position occupied by *Prochloron* in the evolution of photosynthesis.

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