matters arising

'Unmixing' of the deep-sea record and the deglacial meltwater spike

BERGER, Johnson and Killingley[1] have suggested that at about 12,000 yr b.p. a large part of the world ocean was covered by a layer of meltwater from the Laurentide ice sheets. Such a finding is of interest in that it helps to explain the relatively rapid melting of the Würm/Wisconsin glacial ice sheets. Mason[2] calculates that the total excess of insolation due to the Milankovitch mechanism[3] north of 45°N between 16,000 and 6,000 yr b.p., when about 90% of the ice melted, was 1.0×10^{25} cal, while about 3.2×10^{24} cal was required to supply the latent heat of fusion of the ice sheets. The initial melting of the ice sheets was probably rapid and this gives rise to problems of energy supply, since little solar insolation is absorbed directly by the high albedo surfaces of ice sheets. Saltzman[4] and Newell[5] have suggested that mean global ocean temperatures increased during the period of growth of ice coverage, reaching a maximum sometime after the time of maximum ice extent and a minimum sometime after the interglacial. The latent heat of fusion for melting the ice sheets could then be supplied by the deep oceans. This result is not confirmed by ocean-surface temperature estimates for 18,000 yr b.p. by CLIMAP project members[6], though changes in deep ocean temperatures are very uncertain. Adam[7] has pointed out the importance of a layer of meltwater on ocean-surface temperature. The stratification of salt in such a layer will produce a stable stratification. Further, solar insolation warms the top, adding a thermal density stratification to the already strong salinity density stratification. Both factors inhibit the downward mixing of absorbed solar heat, raising the surface temperature of the ocean in the presence of a surface meltwater layer above the value that would be found without one. This effect would be at a maximum during the summer when the Northern Hemisphere was receiving extra insolation due to the Milankovitch mechanism. Seawater has a low albedo (10% or less) so it would be a very effective absorber of the extra heat. Very rapid summer melting of the ice-sheets could therefore be possible using the extra heat supplied by the Milankovitch mechanism, which was absorbed by the meltwater on the ocean surface and then transferred to the ice sheets by atmospheric advection. Further later warming could be caused by the release of carbon dioxide to the atmosphere as suggested by Berger, Johnson and Killingley.

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Rare male mating advantage

A SEARCH for and establishment of any frequency dependent component of Darwinian fitness is often likely to meet frustratingly diverse alternatives of interpretation. O'Donald[1] has demonstrated frequency dependence with a model based on a constant female 'preference' parameter for some of our data[4–7] on rare male mating advantage. This 'pseudofrequency dependence' ensues in 'multiple choice' matings when the input ratio of type *a*: type *b* males is varied, because as either type becomes rare, its success occurs in greater proportion relative to that of the more common type. The principle that frequency dependency may arise with application of constant fitness components has been pointed out particularly by Prout[2] and was previously mentioned by Spiess and Langer[3]. Thus according to O'Donald, there is no need to invoke a change in a female's preference (we prefer to use the term bias) towards the types of courting males. In effect, the burden of proof for a behavioural interpretation of our data[4–7] cited by O'Donald falls on us. We respond here with some evidence in favour of our behavioural interpretation, both published and unpublished.

We have had no evidence in the experiments cited or in subsequent experiments that females show preference toward either type of male when tested at control frequencies (*A* males equal to *B* males). We cannot rule out the possibility that a small fraction of females displays some negligible amount of preference. Our mating data can be explained for controls, as well as most of the cases when female ratios were varied[5], merely on the basis of relative courtship and mating ability of the male types, not invoking assortative, or preferential parameters among females. Briefly, our hypothesis was as follows: a virgin female at the start of a mating test samples courtship cues from males and becomes habituated to the majority type of male so that she tends to accept a male with a different cue merely because it interrupts the habituation. While O'Donald's model does not include a differential preference among females, we assume that, if preferences were real, they would be likely to differ among types of females and some evidence for assortative mating would be expected. No general evidence for assortative mating was found[5,6] for AR: PP *Drosophila pseudoobscura* or for Hu: WW *D. persimilis*.

O'Donald's model assumes both types of female to have identical proportions of constant preferences. If so, then varying the ratio of AR:PP among females, for example, should not affect the amount of frequency dependent advantage for males. However, in AR:PP experiments, when ratios of females as well as males were varied simultaneously (Table 4 and Fig. 4 in ref. 5), frequency dependent advantage was much less than when ratios of males alone were varied. No minority advantage occurred for females when their ratios were varied. O'Donald would need to postulate that two female karyotypes have different