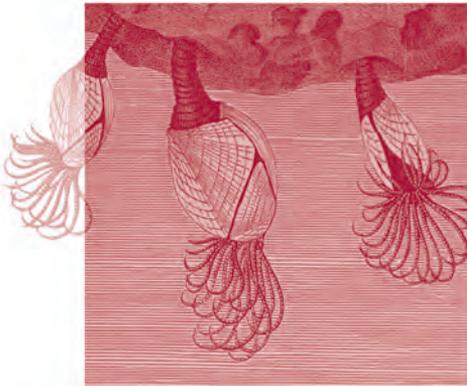




The Linnean



Carl Linnaeus
1707-1778

NEWSLETTER AND PROCEEDINGS OF THE LINNEAN SOCIETY OF LONDON

VOLUME 25 • NUMBER 2 • APRIL 2009

A forum for natural history

Darwin's "Abominable Mystery"

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If you turn up "Abominable mystery" on Google, linked to Darwin, you will find there are some 62,600 references cited. It is perhaps remarkable that this over-quoted remark came not from one of Darwin's many published works dealing with plant science, but from a letter that he wrote to J.D. Hooker, then Director of RBG Kew. On July 22nd, 1879, Darwin wrote: "The rapid development as far as we can judge of all the higher plants within recent geological time is an abominable mystery" (Darwin and Seward, 1903). Botanists have been mulling over the phrase ever since the letter was published, and in this anniversary year the *American Journal of Botany* has devoted the January number to a series of articles on that theme. It appears that any topic that Darwin found "mysterious" must surely warrant further investigation, especially two hundred years after the great man's birth!

The phrase has of course been of particular interest to palaeobotanists, because as Darwin's letter makes clear, he was concerned with the fossil record of the appearance and rapid diversification of the angiosperms. This aspect of the fossil plant record was already evident in Darwin's time, although the picture has become clearer over the intervening century. Most authors have assumed that what concerned him was the relative rapidity of the evolution of the group, its rapid spread and the early differentiation of the main lines within it, which seemed to be in conflict with the slow and gradual change, implicit in his concept of natural selection. In his very thorough exploration of what lay behind Darwin's much-quoted phrase, Friedman (2009) addresses several other aspects of early angiosperm evolution which have been seen by some as part of the mystery. These include not only the rapidity of change seen in the fossil record, but the phylogenetic relationship of the major clades within the angiosperms, the search for the ancestral (gymnospermous) group from which they evolved, and the record of the "first angiosperm". These and other related problem areas have indeed received much attention, most particularly over the last fifty years.

Friedman (2009), having given an excellent review of the historical background to the controversy, argues that Darwin was much more concerned with the general issue of "rapid evolution" than with the angiosperm story itself. He offers the challenging proposition that "Darwin's abominable mystery is not in the final analysis about angiosperms *per se*". None the less, as Friedman explains, Darwin was evidently attracted to two processes which he felt might explain the angiosperm mystery. The first of these was his idea that the early – slow – stages of their evolution might have taken place in some remote location where the fossil record, if it had ever existed, has either been destroyed or remains undiscovered. For in a later letter to Hooker, of August 11th 1881 he wrote: "I have been so astonished at the apparently sudden coming

in of the higher phanerogams, that I have sometimes fancied that development might have slowly gone on for an immense period in some isolated continent or large island, perhaps near the south pole” (Friedman 2009). Perhaps that line of thought may have been engendered by Darwin’s Galapagos experience of isolated islands as homes of evolutionary innovation and centres of high endemism.

On a very different tack, Darwin evidently saw some comfort in the role of the dependence of the success of angiosperm biotic pollination on the rise of appropriate insect groups to effect that process. Saporta (1873) had suggested that the rise of the angiosperms was closely linked to the diversification of insects through their role as pollination vectors. In his 1879 letter to Hooker, Darwin stated: “Saporta believes that there was an astonishingly rapid development of the higher plants as soon as flower-frequenting insects were developed and favoured intercrossing” (Friedman 2009). So perhaps the suddenness of angiosperm diversification was the product of biotic pollination – a subject dear to Darwin, and on which he was to publish his famous book in the context of orchid/insect interdependence (Darwin 1877).

The significance of biotic pollination to angiosperm origins and early evolution has been extensively explored, and it seems clear that the adaptations of a coloured perianth, scent and nectar secretion are fundamental features of a large part of angiosperm diversity. But Darwin seems to be aware of the vulnerability of invoking biotic pollination as the key process in achieving rapid evolutionary change. For as he wrote in 1876, “As a large quantity of pollen is wasted by anemophilous plants, it is surprising that so many vigorous species of this kind abounding with individuals should still exist in any part of the world, for if they had been rendered entomophilous, their pollen would have been transported by the aid of the senses and appetites of insects with incomparably greater safety than by the wind.... It seems at first sight a still more surprising fact that plants after having once been rendered entomophilous, should ever again have become anemophilous” (see Friedman and Barrett 2009). The enormous species-richness of the grasses, which appeared relatively late in the evolution of the angiosperms, demonstrates that the switch to anemophily proved to be no impediment to rapid evolutionary diversification.

Despite the research of the last half century, and the greatly expanded fossil record of early angiosperms (Endress & Doyle 2009, Friis *et al.* 2006, 2009, Stockey & Rothwell 2009, Doyle 2008) there still remain divergent views on the issue of “rapidity”. Friedman (2009) in his concluding remarks says that “the earliest manifestation of angiosperms, as now understood appears to be significantly less abrupt than that of the fossil record Heer and Saporta described in the 1870s and 1880s”. This is clearly true, but perhaps there is nevertheless more to this issue than just tighter definition of what “rapid” means in the context of early angiosperm evolution. Friis *et al.* (2006) state that “it is very clear that the major differentiation of angiosperms took place over a relatively short time during the early Cretaceous. This is clearly recognised in the record of fossil angiosperm pollen, but is also supported by patterns in the changing diversity and abundance of angiosperm reproductive structures through this interval”. A similar view is expressed by Stockey *et al.* in their introduction to the *American Journal of Botany* special issue dedicated to the Abominable Mystery. They write: “what looked like a very rapid evolution of modern taxa to Darwin and his colleagues,

we now know was in part a false impression created by uncritical taxonomic assignments. Nevertheless, by any measure, the initial diversification and rise to dominance of angiosperms was still remarkably rapid” (Stockey *et al.*, 2009).

So it seems that the mysteriousness of the rise of the flowering plants has not been entirely dissipated. If Fellows of this society are interested to catch up on current views on the matter, there is a two-day discussion meeting at the Royal Society on May 11th–12th on the theme of “Darwin and the Evolution of Flowers”. As with all Royal Society discussion meetings, they are free to attend, but pre-registration (on line) is essential. The online registration form, and programme information can be found at: www.royalsociety.org.

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