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MEDIATED DESIGN

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When I was an undergraduate, my plant physiology professor required students to write a term paper for his class. Since I found the subject terribly uninteresting, I asked my professor if he could recommend a topic that had something to do with evolution or origins, a topic in which I was very interested. My professor immediately recommended that I write about the origin of C_4 photosynthesis. I knew at the time that there are several types of photosynthesis. Flowering plants have at least three main categories, called C_3, C_4 and CAM. In C_3 photosynthesis, the plant takes carbon dioxide (CO_2) from the atmosphere and turns it directly into sugar. C_4 and CAM plants turn CO_2 into organic acids and temporarily store them. In C_4 plants, the acids are transported to a special region of the leaf called the bundle sheath cells (BSCs) where they are converted into sugar. In CAM plants, the acids are turned into sugar during the night when the temperature is lower. C_4 and CAM plants photosynthesize more efficiently than C_3 plants in hot, dry environments.[1]

Based on this preliminary knowledge, I assumed that C_4 photosynthesis was so complicated that it must have resulted from a creation event separate from C_3 photosynthesis. In technical terms, I expected that C_4 plants were *discontinuous* with C_3 plants because I assumed that God created the photosynthesis types in separate created kinds. As I began to research the topic, my expectations were shown to be incorrect. First, there is no clear taxonomic distinction between C_3 and C_4 plants. C_4 photosynthesis occurs in 16 different flowering plant families, but no family is entirely C_4. In fact, a clear distinction between C_3 and C_4 photosynthesis cannot be made in some plants. At least 23 species are known to be intermediate between C_3 and C_4.[2]

The most extraordinary example of C_3-C_4 intermediate photosynthesis is found in Flaveriinae, a subtribe of the largest flowering plant family Asteraceae. Strictly defined, the Flaveriinae consist of three genera (*Flaveria*, *Sartwellia*, and *Haploësthes*) and 28 species.[3] The largest genus *Flaveria* (21

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species) contains plants that photosynthesize by C_3, C_4, and a variety of intermediate types.[4] Most extraordinary of all, plants with these various photosynthesis types are capable of hybridization.[5]

In 1941, Frank Marsh proposed that species that could mate and produce offspring belonged to the same created kind, or in his terminology a *baramin*.[6] Subsequently, hybridization has become a common method of identifying baramins in modern creation thinking. Since the species of *Flaveria* could hybridize together, they must belong to the same baramin and therefore share an ancestor that might have survived the Flood as part of a vegetation mat.[7] The common ancestry of *Flaveria* would also mean that C_4 photosynthesis must be a historical development (since most of the plants in the baramin are strictly C_3). This led me to wonder how the post-Creation origin of C_4 photosynthesis could have happened, since C_4 is so complicated. Though some creationists are fond of using allelic variation (two or more variants of a gene), to explain the diversity of baramins, a change in photosynthesis type goes far beyond blue and brown eyes or smooth and wrinkled peas.

A possible answer to this conundrum would occur to me long after I turned in my plant physiology term paper. Molecular biology studies during the 1990s demonstrated that genes required for the C_4 photosynthesis pathway are present in C_3 species of *Flaveria*.[8] In C_3 plants, these genes are largely inactive, but in C_4 plants, the same genes are producing C_4 enzymes. Somehow, the C_4 genes in the C_3 plants were essentially shut down, while in the C_4 species they had been turned on. C_3-C_4 intermediate species represent plants in which only *some* of the C_4 genes had been switched on. This discovery led me to formulate a new idea about God's biological design.

When we think about design, it is helpful to make a distinction between God's plan and the way God implements His plan. In the Bible, we see many examples of God commanding others to carry out His will. A few examples include saving humans and animals on an Ark built by Noah, working through Abraham to create a new nation, destroying the Canaanites by the invading Israelites, and sending the Messiah through the Virgin Mary. In each case, God accomplishes His will (plan), not by *de novo* creation of something entirely new, but by working through existing parts of the creation. When applied to biology, I call this idea *mediated design*.

More specifically, I have come to believe that God created baramins with the ability to adapt to future change in specific, pre-designed ways. In contrast, many pre-Darwinian biologists, such as French anatomist Georges Cuvier, believed that each immutable species was perfectly adapted to the environment in which it lives.[9] The problem with this perspective is that if the environment changed, the species would most likely go extinct since it had no ability to adapt. Since we now know that the climate of the earth changed drastically during the history of the earth,[10] God must have created baramins to survive not just in their original environment, but in whatever future climates might arise. Thus, God must have created "hidden" adaptations in the original baramins waiting to be accessed at some point in the future, much in the same way that a Swiss army knife contains hidden tools that can be accessed as needed.

Mediated design explains the variation of photosynthesis types in *Flaveria* more simply than evolution. According to my understanding, God created C_4 genes in the genome of the *Flaveria* ancestor, but they were only activated later in history (probably after the Flood) by a presently unknown mechanism. In contrast, the evolutionist must propose that the C_4 genes evolved without any change in the plant's method of photosynthesis, and therefore *before* the genes could be changed by natural selection. Then at some later point, the C_4 genes began to be expressed and to be selected for the "complete" C_4 photosynthesis type. Not only did this happen in *Flaveria*, but it also happened in at least 15 other plant families. In contrast, the mediated design explanation is much simpler. It explains both the complexity of C_4 photosynthesis (it was designed), its presence in 16 unrelated families (a common designer), and why it appears to have "originated" randomly in different species (the design was mediated through the *Flaveria* genome).

Since writing up my original ideas with my colleague, David Cavanaugh,[11] I uncovered several other examples of what I suspect to be mediated design. CAM photosynthesis, the third type of photosynthesis discussed above, appears in numerous families and in isolated genera, much like C_4 photosynthesis.[12] Another example occurs in the legume family. Some legumes are able to form complex relationships with soil bacteria called rhizobia. In these mutualistic relationships, the plant creates a novel organ called a *root nodule* in which the bacteria live. The bacteria in return give the plant nitrogen they acquire directly from the atmosphere. Once again, this ability occurs seemingly randomly throughout the family. Some species can form nodules, while others that are very closely related cannot.[13,14] As a final example, consider the fish genus *Poeciliopsis* that not only bear live young but also develop a placenta. Just like C_4 and CAM photosynthesis and root nodule formation, the ability to form a placenta appears to be randomly distributed throughout the genus. Some species can form a placenta, but other closely-related species do not.[15]

Each of these examples fit the description of mediated design in which God creates a genetic potential for a complicated trait that is only accessed at some point in history after Creation. Some species in the baramin access the trait, while others do not. In the same way, some people use the corkscrew in their Swiss army knives, while others do not. What makes mediated design so exciting to me is that it facilitates further research. So often, I encounter the common misconception that creationism is defeatist; saying that "God did it" stifles further inquiry. Nothing could be further from the truth in the case of mediated design. With this idea, we can begin by investigating other C_4 plants, CAM plants, legumes, and *Poeciliopsis* to determine which species actually share an ancestor. Then we can examine their genomes to find the genes that are necessary to express their amazing traits. Ultimately, examining these genes should reveal to us the actual mechanism by which these traits become expressed. That's an entire research program developed by assuming a simple model of divine design.

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