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Todd Charles Wood
Kurt P. Wise
Roger Sanders
N. Doran

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A Refined Baramin Concept

Todd Charles Wood,[1] Kurt P. Wise,[1] Roger Sanders,[2] and N. Doran[3]

[1] *Center for Origins Research and Education, Bryan College, Dayton, TN, USA*
[2] *Weatherford, TX, USA*
[3] *Tallahassee, FL, USA*

Abstract. In this brief article, we will discuss problems with various concepts of the baramin proposed in the twentieth century. To address these shortcomings, we propose a refinement of the baramin concept based entirely on similarity. The refined baramin concept synthesizes the best of preceding theories and provides a basis for exploring the theoretical foundation of modern baraminology research. We encourage researchers to use the refined baramin concept to develop a broader creationist model of biology.

Creationist concepts of biology have largely centered around God's creation of plants and animals 'after his kind' (Gen. 1). Henry Morris writes,

> That God is the Creator of all things, including all plants and animals, is the unequivocal teaching of Scripture. That these were all established in distinctive groupings called 'kinds' (Hebrew *min*) and that there are permanent clear-cut gaps between these kinds (though much potential variation within kinds) is the equally clear teaching of Scripture (Morris 1984, p. 372).

Based on citations in *The Genesis Flood* (Whitcomb and Morris 1961, pp. 66-67), we may attribute Morris's interest in the 'kind' to the work of Frank Lewis Marsh, who wrote numerous books on the subject of God's created kinds, or in his terminology *baramin* (Marsh 1941; Marsh 1947; Marsh 1950; Marsh 1976).

Despite the centrality and importance of the baramin ('kind') to Frank Marsh's understanding of creation, Marsh never gave a formal definition of the term. Even more oddly, despite coining the term *baramin*, Marsh never even used it consistently. He used *baramin*, *kind*, *Genesis kind*, *created kind*, *basic kind*, *basic unit*, and *basic type* interchangeably. Throughout his writings, Marsh described his idea of the baramin, discussed mechanisms of variation within a baramin, and refined his hybridization criterion for recognizing baramins, but he left the formal baramin definition unstated. As a result, creationists still struggle with defining the baramin and justifying baraminology methodology, and evolutionists have found ample opportunity for criticism (Cracraft 1984; Monroe 1985).

The criticism of the baramin focuses primarily on the lack of an operational application of the nebulous baramin that would allow, for example, a complete enumeration of 'created kinds' (Cracraft 1984). Partly in response to these criticisms, several creationists in the 1990s have presented different modifications of Marsh's original system (ReMine 1990; Scherer 1993a; Wise 1990), but these new systems have their own shortcomings, which we will review here. The purpose of this article is to present a refinement of current thinking about the baramin. Beginning with Marsh's various descriptions of the baramin, we will review creationist's attempts at defining the baramin. We will evaluate each of the recent descriptions of the baramin, highlighting their strengths and weaknesses. To advance our understanding of God's creation, we will present a refined baramin concept that builds on the strengths of previous definitions, and, as we believe, provides a basis for application of baraminology to empirical research.

A REVIEW OF BARAMIN CONCEPTS

Frank Marsh's Baramin. In his first book *Fundamental Biology*, Marsh already referred to the "kind" as if the concept was well-established among his fellow Seventh-Day Adventist creationists (Marsh 1941, pp. 92-93). According to Numbers (1992), the modern "kind" concept originated from a debate over flood geology between creationists George McCready Price and Harold Clark. In his 1940 book *Genes and Genesis*, Clark advocated incorporating natural selection into creationism, allowing it to operate within genera or even families and orders. Price recoiled from this apparent concession to Darwin and maintained a position of species fixity. Upon reading Marsh's *Fundamental Biology* (1941) and *Evolution, Creation, and Science* (1944), Price eventually conceded, somewhat grudgingly, that Marsh's interpretation of biology was correct (Numbers 1992, pp. 126-130).

Marsh believed that the repetition of the phrase 'after his kind' in the creation account indicated the importance of reproduction "after its kind." Whereas Clark interpreted this repetition as a moral rule, Marsh inferred from it a biological law that the members of a "kind" were only capable of producing offspring that were members of the same kind (Marsh 1941, p. 49; Numbers 1992, p. 130). As a consequence of this law, members of two different kinds could never successfully reproduce, and interspecific hybridization was possible only within baramins.

In the first edition of *Evolution, Creation, and Science* (1944), Marsh gave his most definitive description of the baramin. He wrote that "organisms which now live have descended from beings of the same kind which were created" (p. 24). Thus the "kind" is a created unit that persists through reproduction. In the same edition, Marsh also used the biological law of reproduction to illustrate how members of a baramin could be identified. If interspecific hybridization occurs only within a baramin, then species that are capable of hybridizing must belong to the same baramin (Marsh 1944, pp. 148-149).

Three years later, Marsh added a new chapter on "The Genesis Kind" to the second edition of *Evolution, Creation, and Science* (1947), as an outgrowth of his correspondence with Theodosius Dobzhansky (Numbers 1992, pp. 131-133). In the new chapter, Marsh clarified his baraminic membership criterion to account for questions of ontogeny. He wrote, "Two organisms are members of a kind if their germ cells will join in true fertilization" (p. 169). Thus, to Marsh, hybrid embryos that do not come to term still constitute positive evidence that the parent species are members of the same baramin (p. 170). As a consequence, "true fertilization" is sufficient evidence for baraminic relationship.

In the same edition, Marsh discussed the possibility of additional membership criteria. In one passage, Marsh clearly stated his belief that baramins could not be distinguished by morphology alone. Because of the biological law of reproduction, common physiology was the only defining characteristic of the baramin. Because of the successful cross of the radish and cabbage, Marsh concluded that morphology could be vastly different even within a baramin (Marsh 1947, pp. 170-171). In another passage, Marsh seems to make an exception. When discussing reproductive isolation in *Drosophila*, Marsh stated that two species that were morphologically indistinguishable were probably members of the same baramin even though they could not cross (pp. 172-173). We might summarize Marsh's view as follows: Morphological similarity can imply baraminic relationship, but morphological difference does not necessarily indicate different baramins.

In his 1950 book *Studies in Creationism*, Marsh further modified his view of the baramin. He began by admitting (correctly) that the phrase "after his kind" was not directly linked to reproduction in Genesis 1 (p. 238). Instead of arguing for a biblical basis for baramins, Marsh constructed an argument based on morphology. He first claimed that nature reveals fundamental morphological discontinuities between kinds of organisms and that reproductive discontinuity goes 'hand in hand' with morphological discontinuity (p. 238-239). This position effectively reversed his baramin description from both editions of *Evolution, Creation, and Science*. In his earlier works, he began by inferring the biological law of reproduction from Genesis 1, and he minimized the significance of morphology. In his 1950 work, he began with morphological discontinuity and inferred reproductive isolation from it. By maintaining his belief in a reproductively-isolated baramin, Marsh could retain his hybridization criterion. Marsh's reversal of the baramin description illustrates the problems that arise from the lack of a formal definition of *baramin*.

In *Studies in Creationism*, Marsh also expanded an idea that he had originally presented in the second edition of *Evolution, Creation, and Science*. Marsh believed that God created most baramins (except humans) as populations with "racial" differences (Marsh 1950, pp. 248-251). According to Marsh, a monotypic baramin was created as a uniform population with no phenotypic variation. A polytypic baramin was created with initial variation. Marsh used the polytypic baramin to explain chromosome differences in extant horse species. Although capable of hybridizing, the horse, donkey, and zebra differ markedly in the number of chromosomes they possess. Instead of proposing that these differences arose through speciation within the baramin, Marsh relegated the differences to God's original creation.

As can be seen in the preceding overview, Marsh changed his description of the baramin over time. Though he retained hybridization as the primary method of recognizing baramins, the foundation of the baramin changed from strictly Scriptural to morphological. Inherent in Marsh's baramin is the belief that the baramin is the "unit of creation" of living things. Marsh merely altered his understanding of how those units manifested themselves to our perception. Unfortunately, his point becomes obscured because of his vaguely-conceived baramin. For example, Marsh implied that empirical evidence reveals that kinds do not cross; however, any successful hybrid proved to Marsh that the parental species belonged in the same baramin. Without additional baraminic membership criteria, the claim that baramins never cross is tautological.

Siegfried Scherer's Basic Type. In 1993, the German creationist group Word and Knowledge (Wort und Wissen) published a collection of papers titled *Typen des Lebens* that centered around Scherer's formal *basic type* (Scherer 1993a). In the first chapter of *Typen*, Scherer introduced his definition of a basic type in a review of species concepts. He defined *basic type* pragmatically using two membership criteria. Two organisms belong to a basic type if "they are able to hybridize" or if "they have hybridized with the same third organism" (p. 17). Like Marsh's "true fertilization," he qualified these criteria with a third claim that "two organisms belong to the same basic type if ... embryogenesis of a hybrid continues beyond the maternal phase, including subsequent coordinated expression of both maternal and paternal morphogenetic genes" (p. 18).

The chief advantage of this system should be readily apparent. Unlike other supraspecific classification ranks, the basic type is subject to experimental verification. Disputes over membership within a basic type can be resolved by any manner of hybridization experiments, including artificial insemination. This practical utility of basic type biology has produced a fruitful scientific research program (Hartwig-Scherer 1998; Scherer 1993b).

Despite the utility of the system, numerous problems remain, as Scherer recognizes (Scherer 1998). First, and most obviously, the hybridization criterion only applies to sexually reproducing organisms. Thousands of species cannot be classified into basic types. Second, even with sexual organisms, questions of 'hybridization success' render the interpretation of hybridization data ambiguous especially in cases of wide hybridization. Scherer's third basic type membership criterion addresses this difficulty, but further work will be needed to make the third membership criterion practical. Third, hybridization failure is also ambiguous. Whereas a viable interspecific hybrid offspring is clearly a 'successful hybrid,' failure to produce any offspring can be caused by any number of differences in the parental species. As a result, the converse of the membership criteria do not hold: Failure to produce a hybrid does not necessarily indicate separate basic types.

A more serious concern about basic type biology is Scherer's inconsistent philosophical applications. For example, Scherer (1998) claims that basic type biology predicts a polyphyletic origin of basic types and that major discontinuities at all levels of comparative biology divide basic types. It is unclear how the observation of interspecific hybridization would predict anything about the origin of species or discontinuity. While it could be argued that discontinuity could be a corollary that arises from study of identified basic types, it certainly would not be an *a priori* prediction of basic type biology. The origin of basic types could not be deduced simply from studying basic types and is definitely outside of the realm of basic type biology. These difficulties should not inhibit the practical use of basic type biology where it can be applied, but they do highlight the necessity for a larger system that is philosophically consistent and generally applicable to all organisms.

Walter ReMine's Discontinuity Systematics. ReMine introduced discontinuity systematics at the Second International Conference on Creationism (ReMine 1990) and later elaborated on the subject in his book *The Biotic Message* (ReMine 1993). The method is based on the concept of 'discontinuity,' a word which he leaves undefined. In *The Biotic Message*, he describes discontinuity as "large-scale morphological gaps and an absence of large-scale phylogeny" (p. 443). This notion is certainly not unique to ReMine. For example, Cuvier's idea of the four *embranchements* incorporates the notion of absolute separation with no intergradation. Even Marsh expressed his belief in ubiquitous discontinuity (Marsh 1947, p. 101).

Modern systematics does not recognize discontinuity at all. Indeed, Gould (Gould 1994) and others (Berry 1984; Lack 1961) refer to common ancestry of all species as a 'fact.' There can be no discontinuity in the evolutionary tree. Thus, evolutionary systematic methods begin with the assumption that all taxa are related, and seeks to determine *how* they are related. If discontinuity is truly ubiquitous, these methods cannot be used to detect or study it. Consequently, ReMine recognized that a new method that recognizes discontinuity was needed in order to study it. ReMine also made the important observation that Marsh's system (and subsequently Scherer's) lacked a method of detecting discontinuity between baramins. As noted above, the hybridization criterion allows two species to be assigned to the same baramin, but failure to hybridize does not constitute evidence of different baramins (recall Marsh's discussion of *Drosophila*). To correct this oversight, ReMine introduced four terms that permit detection and description of discontinuity (ReMine 1990).

ReMine defined the terminology of discontinuity systematics using the framework of phylogeny. A holobaramin is "a complete set of organisms related by common descent" or "a group containing all and only those organisms related by common descent." A monobaramin is "a group containing only organisms related by common descent, but not necessarily all of them." An apobaramin is "a group of organisms which contains all the ancestors and descendants of any of its members, but which may contain subgroupings that are unrelated to each other" or "a group of organisms not sharing an ancestor or descendant with any organism outside the group." A polybaramin is "a group of organisms which does not share a common ancestor" (ReMine 1990).

Instead of relying on a single criterion, ReMine advocated a method of successive refinement or approximation to identify holobaramins using a variety of criteria. Because holobaramins contain monobaramins, refinement and expansion of monobaramins to include more species will aid in the identification of the holobaramin. At the same time, apobaramins can be successively divided into smaller groups, the membership of which should begin to converge on the largest monobaramins. Since holobaramins are simultaneously monobaramins (share a common ancestor) *and* apobaramins (share no ancestor with other organisms), the holobaramin can be identified when the membership of an apobaramin and monobaramin coincides (ReMine 1990).

The proposal of successive approximation marks a significant departure from Marsh's and Scherer's systems that rely on a single membership criterion. To identify continuity and discontinuity, discontinuity systematics considers evidence from morphology, ecology, genetics, molecular biology, and paleontology. Hybridization aids the identification of monobaramins by revealing a common physiology and development, implying common ancestry. Consequently, Scherer's basic type biology could be considered a subset of ReMine's discontinuity systematics. Because basic type biology lacks a method of identifying discontinuity, basic types cannot be directly equated with holobaramins or apobaramins.

Discontinuity systematics is more broadly useful than Marsh's and Scherer's exclusive focus on hybridization, but problems exist with ReMine's terminology as well. Most importantly, the ancestry of modern individuals is ultimately unknowable. Even the ability to hybridize cannot always be taken as evidence of common ancestry. For example, the originally-created ancestors of modern organisms themselves shared no common ancestor yet successfully reproduced. Furthermore, ReMine's definition of holobaramin necessarily excludes the first (created) ancestors of modern organisms. Holobaramins consist of organisms 'related by common descent,' which the original ancestors are not. This problem is most apparent when we consider bacterial (or archaeal) holobaramins. By ReMine's definition, two identical bacteria created by God would produce separate holobaramins, even if the offspring of one was indistinguishable from the offspring of the other.

Kurt Wise's Baraminology. In order to render discontinuity systematics more suitable to the young-earth creation model, Wise adapted discontinuity systematics to produce baraminology (Wise 1990). Wise retained ReMine's terminology and his method of successive approximation, but he added several features that distinguish baraminology from both discontinuity systematics and basic type biology. In contrast to both ReMine and Scherer, Wise advocated using the Scripture as a source of biosystematic data. Wise also followed Marsh's original ideas with his retention of the generic term *baramin* and his proposal of the non-phylogenetic term *archaebaramin*.

In summarizing ReMine's discontinuity systematics, Wise presented slight modifications of the terminology definitions. He defined holobaramin as "a group of organisms which is surrounded by a phyletic discontinuity and yet is not completely divided by one." A monobaramin is "a group of organisms which is not completely divided by a phyletic discontinuity, but may or may not be separated from all other organisms by phyletic discontinuities." A polybaramin is "a group of organisms divided by at least one discontinuity." An apobaramin is "separated from all other organisms by phyletic discontinuity, but may or may not be divided by at least one phyletic discontinuity." Like ReMine, phylogenetic relationship formed an essential part of Wise's definitions (Wise 1990).

To fully integrate discontinuity systematics and young-earth creationism, Wise introduced one new term and reinforced the reality of the baramin as a distinct entity. Because ReMine stated that discontinuity systematics can only deal with creatures for which we have evidence of their existence, Wise coined *archaebaramin* to describe the theoretical first group of organisms from each baramin that was created by God, and he applied the term *baramin* to an archaebaramin and all of its descendants (thus resolving the problem of the holobaramin omitting its ancestors). Wise's discussion of the archaebaramin retained Marsh's assertion of absolute reproductive isolation between archaebaramins. Wise also followed Marsh by allowing variation to exist within the archaebaramin, even to the extent of making certain reproductive combinations impossible, although he claimed that no complete genetic discontinuity divided any archaebaramin. The possibility of reproductive isolation within the archaebaramin allowed for multiple holobaramins to arise from a single archaebaramin. Wise also allowed for adaptation to take place in the descendants of the archaebaramin. Finally, Wise claimed that the reproductive isolation of the archaebaramin marked off a distinctive morphology for that archaebaramin that no other archaebaramin could overlap.

Although Wise came closer than Scherer or ReMine to formalizing Marsh's original intuitive baramin concept, there are several problems with his version of baraminology. First, he builds on ReMine's phylogenetically-defined discontinuity systematics terms. As a result, the problems with ReMine's system would also apply to Wise's baraminology. The exception would be Wise's resolution of the question of holobaraminic ancestors. Most importantly, Wise only described the archaebaramin but did not formally define it, much like Scherer's definition of the basic type. Without a formal definition, both Scherer and Wise lack a philosophical justification for their methodologies.

REFINING THE BARAMIN CONCEPT

Though the baramin concept has been widely adopted by most young-earth creationists, no one has yet offered a philosophical definition of the baramin that would then justify the methodology of baraminology. The problems of Marsh's, ReMine's, Scherer's and Wise's baramin concepts highlight the need for a fresh approach to the baramin. At the same time, the productivity of baraminology and basic type biology research (Cavanaugh and Wood 2002; Cavanaugh et al. 2003; Robinson 1997; Robinson and Cavanaugh 1998a; Robinson and Cavanaugh 1998b; Scherer 1993b; Wise 1992; Wood 2002; Wood and Cavanaugh 2001) would suggest that a completely new system would be unnecessary. Instead, we recognize the need to retain aspects of previous baramin concepts that have led to fruitful research, while refining the philosophical basis of the baramin.

Here, we will present a formal baramin definition that builds on Wise's archaebaramin. We formulate this definition in the larger context of important considerations about creation biology in general. For the application of baraminology, we believe that ReMine's successive approximation and Marsh's and Scherer's emphasis on hybridization are valuable contributions to the practice of identifying baramins. Therefore, we retain the four terms of discontinuity systematics, but we will redefine them slightly. We introduce our formal baramin definition with the question of theory-neutrality.

Should creation biosystematics be theory-neutral? The biosystematics methods of Scherer and ReMine are purported to be "rather objective" (Scherer 1998) or theoretically "neutral" (ReMine 1990). In fact, ReMine explicitly avoids referencing creationists in *The Biotic Message* (p. 2). By contrast, Marsh and Wise embed their systematics into a larger model of young-earth creationism (Marsh 1947; Wise 2002). We believe that biosystematics should be integrated into a Biblically-consistent scientific model to maximize its theoretical support and explanatory effectiveness. We offer three reasons for this position.

We maintain that theory-neutrality is impossible. Scherer comes closer to theory-neutrality than ReMine. Discontinuity systematics is a creationist method because discontinuity is an inherently creationist concept. Scherer's 'predictions' (1998) of basic type biology reveal an unwritten concept of basic type that is more than a convenient taxonomic device. Even though their authors might disagree (e.g. ReMine, 1993, p. 508, note 2), we find that both basic type biology and discontinuity systematics are influenced and motivated by a creationist worldview.

More importantly, the pursuit of theory-neutrality actually hinders the development of creation biology. To make a creationist theory 'theory neutral' (i.e. palatable to non-creationists), much of what makes it distinctly creationist must be removed. This may be useful, for example, in order to get a controversial scientific study reviewed by competent evolutionary scholars in a secular journal, but the elimination of creationist content as a general practice generates more work for creationists. To integrate 'theory-neutral' research back into the creation model from which it came, all that was excised must be replaced. This elimination and replacement of creationist ideas from research results in two major steps (removal of creationism and replacing creationism). Simply proposing and using openly creationist ideas and methodology should advance creationism more efficiently.

Finally and most importantly, the integration of theories into a larger model strengthens both through consilience. Consilience describes the explanatory power of a theory that explains a wide diversity of data that otherwise appear unrelated. In the case of developing novel biosystematics for young-earth creationism, the weak, nascent theory of baraminology benefits from the explanatory power of the whole young-earth creation model. As baraminology is refined and strengthened through research, the entire creation model becomes more powerful, credible, and convincing. As baraminology is being developed, the strength of the larger creation model provides reasons for continuing its development. For example, if young-earth creationism is correct, baraminology (or something very similar) is the only viable systematics method even if it is currently poorly-conceived. Thus, it behooves us creationists to continue working in the area of baraminology as an openly-creationist area of research.

Foundational Concepts. In reformulating the baramin, we intend to formalize the intuitive concepts of Marsh and Wise, while retaining as much of the existing terminology as possible to provide continuity with existing baraminology literature. We do not believe that our refinement provides a satisfactory resolution to the charge of arbitrarily-defined baramins, but we do believe that the refinement advances our understanding of creationist biosystematics. We will also argue that our refinement offers specific advantages over previous baramin concepts.

Before we discuss the practical definitions that can be utilized by practicing baraminologists, it is necessary to develop a theoretical foundation from which operational definitions can be derived. To provide this theoretical foundation, we will describe large-scale patterns in biodiversity using new terminology that can be precisely defined. With this novel terminology, we will then re-define the terms of baraminology. This foundational terminology consists of four concepts: biological character space, potentiality region, continuity, and discontinuity.

Biological character space represents a theoretical, multi-dimensional space in which all possible biological characteristics comprise individual dimensions. Particular character states occupy unique positions along the dimension that corresponds to the appropriate character. An individual organism is then precisely described by a point in biological character space. Because organisms are not uniformly distributed throughout character space, we propose that not all organismal forms are possible. Consequently, we define a *potentiality region* as any discrete region of biological character space within which organismal form is possible. Any point that does not lie within a potentiality region describes an organism that cannot exist. Because the potentiality region describes possible organismal forms with respect to biological character space, the potentiality regions do not change. Because all potentiality regions are bounded by regions of character space that describe impossible organismal forms, gradualistic transmutations from one potentiality region to another are not possible.

We use the term *continuity* to describe significant, holistic similarity between two different organisms. By *significant*, we mean that the similarity between the two organisms should be statistically verifiable (or perhaps biologically meaningful). By *holistic*, we mean that the similarity between the organisms should embrace all types of biological characteristics. In our framework of biological character space, continuous organisms should be close together and will certainly be within the same potentiality region. Two organisms continuous with the same third organism would also be continuous, allowing organisms to form 'shapes' or 'clouds' of continuity in biological character space (Figure 1). *Discontinuity* is a significant, holistic difference between two organisms. Two organisms that are discontinuous with respect to each other are found in separate potentiality regions. Note that a lack of continuity *does not*, by default, constitute evidence of discontinuity. Significant, holistic difference must be demonstrated.

Distinguishing continuity from mere similarity (and discontinuity from difference) hinges on the meaning of *significant* and *holistic*. In practice, we recommend that holism be the primary criterion and that significance be evaluated in light of holism. Since no researcher is capable of evaluating a perfectly holistic dataset that includes all possible characters, datasets should be assembled from a balanced variety of morphological, ecological, and molecular data. Datasets that overemphasize a particular source of data (e.g. dental) should be avoided. For example, a dataset that consisted primarily of molecular characteristics obscures evidence of discontinuity (Wood 2002), although molecular data can be informative when used in context with other data (Robinson 1997; Wood and Cavanaugh 2001).

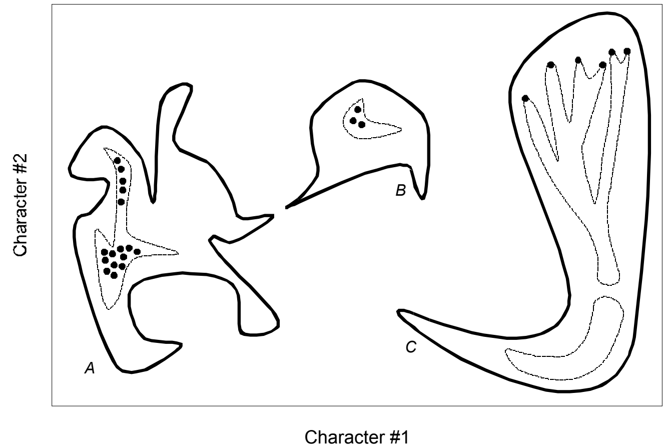

Figure 1. Illustrated here are three different hypothetical potentiality regions (heavy lines), baramins (dotted lines), and extant organisms (dots) as revealed in a two-dimensional slice through biological character space. In Region A, an irregular baramin has exploited a small fraction of the available potentiality region. The extant organisms in Region A occupy different regions of the baramin, implying that significant differences might be detectable. When compared with the taxa of Region B, however, the differences between the taxa of Region A seem insignificant. In Region C, the baramin has progressed through the biological character space of its potentiality region over time, resulting in a tree-like pattern through history. Extant organisms in Region C occupy only the tips of the 'branches' of the tree-like structure. Furthermore, an additional area of the potentiality region was explored by an extinct set of organisms that did not descend from the ancestors of the tree. Nevertheless, the apparent difference between the extant and extinct species do not constitute evidence of discontinuity because they occupy the same potentiality region and are actually discontinuous with Regions A and B. Note in Region C, although the baramin appears to be composed of two parts, it is properly described as a single baramin.

The question of significance could also be problematic, because significance is so heavily influenced by choice of data. Consequently, significance should be subordinated to the need for a holistic dataset. Once a holistic dataset has been assembled, statistical techniques should be used to reveal patterns of similarity that could indicate continuity or discontinuity. We recommend that hybridization be treated as a separate category of ‘biological’ significance. Because of the similarity required to produce an interspecific hybrid, we judge species capable of hybridization to share biologically signficant holistic similarity (continuity). Hybridization demonstrates holistic similarity by revealing basic similarities at the chromosomal, cellular, developmental, and anatomical levels of organization that otherwise could not be revealed without detailed biological research.

The Refined Baramin Concept. Utilizing these conceptual foundations, we define a *baramin* as the actualization of a potentiality region at any point or period in history (including but not limited to all of history). The baramin can include all organisms created within a potentiality region (Wise’s archaebaramin), all of their descendents, or all of the extant organisms from a potentiality region. Critical to the definition of the baramin is that it encompasses *all* of the members of a potentiality region alive at any given time. Since it is unlikely that all members of a potentiality region can actually be known, the baramin is a purely theoretical construct.

When viewed holistically within character space, we should observe continuity between the members of the baramin, although detecting the continuity may depend on the context of the comparisons (Figure 1). Because members of a baramin could occupy different parts of its potentiality region, the continuity need not be manifested in an unbroken morphological chain. That is, continuity as significant, holistic similarity could be detected in a baramin with discrete morphologies; however, when compared with all other organisms, the continuity within the baramin should be detectable. As part of a potentiality region, the baramin is by definition discontinuous with all other organisms. As a result, any significant differences detected within a baramin should be insignificant when compared to members of other baramins. If discontinuity between the baramin and other baramins exists primarily in only some biological characters, certain reductionist systematics methods (such as molecular phylogenetics) should fail to reveal the discontinuity. Only holistic methods can be guaranteed to reveal continuity among the members of a baramin.

We recommend retaining *holobaramin*, *monobaramin*, *polybaramin*, and *apobaramin* for their methodological utility. We define *holobaramin* as a group of known organisms that share continuity (i.e. each member is continuous with at least one other member) and are bounded by discontinuity. Whereas the baramin can be used in a purely theoretical sense to describe organisms that existed at some point in history, the holobaramin is reserved for organisms that are known to us by some kind of evidence. As members of a baramin, members of the same holobaramin share continuity with at least one other member of the holobaramin but discontinuity with organisms outside of that holobaramin. The holobaramin, then, is the complete set of known organisms that belong to a single baramin.

We define *monobaramin* as a group of known organisms that share continuity, without regard to discontinuity with other organisms. We define *polybaramin* as an artificial group of known organisms that share continuity *and* discontinuity with different members of the same group. Polybaramins consist of parts of different holobaramins and should be avoided in biosystematics. We define *apobaramin* as a group of known organisms bounded by discontinuity, without regard to internal continuity of its members. Importantly, apobaramins may describe actual structures of baramins in biological character space (e.g. mammals) or an apobaramin may be a single holobaramin. These definitions maintain the features of discontinuity systematics that are useful for successive approximation.

BIBLICAL AND THEOLOGICAL QUESTIONS AND BIOSYSTEMATICS

We believe that the refined baramin concept is superior to previous baramin concepts in two ways. First, rather than endorse any kind of inferred ancestry as part of our definitions, we utilize the similarity-based concepts of continuity and discontinuity. This effectively removes a layer of inference from identifying baramins. Instead of inferring baraminic membership from ancestry, which is inferred from similarity, we advocate inferring baraminic membership directly from similarity. Second, the emphasis on holism avoids problems associated with hybridization as the sole membership criterion. Holism allows us a means of incorporating hybridization into systematics (because it reveals holistic similarity), and holism also allows alternative methods to be developed that can apply to predominantly asexual organisms.

The refined baramin concept also has limitations, not the least of which is the accurate judging of 'significant, holistic' similarity or difference, as discussed briefly above. One might argue that the refined baramin concept is arbitrary because of this lack of clarity; however, because of the benefits of removing layers of inference and returning to holism, we believe that the limitations can be overcome with future research. Furthermore, we also believe that biblical and theological considerations do not support the rigid systems of Marsh or Scherer, and therefore warrant further theoretical work on the nature of the baramin. In the remainder of this article, we will discuss Biblical and theological issues in an effort to justify further refinement of baramin concept. While these considerations do not unequivocally support our refined baramin concept, they instead reveal the need for a new justification of biblical biosystematics.

Biblical Considerations. The refined baramin concept allows us to make sense of the diverse threads of biblical evidence that led to Marsh's original proposal of the baramin in 1941. Our review of this evidence should appropriately begin with the Hebrew term *mîn* (translated 'kind' in most English Bibles), as the source of the 'min' in *baramin*. Unfortunately, the word is poorly understood, and many scholars disagree on its meaning. For example, Woodmorappe wrote, 'the Hebrew term for creation kind [*sic*], *min*, is a real entity and not simply that "like begets like"' (Woodmorappe 1996, p. 6). In contrast, Held and Rüst emphasized "separation" as a possible meaning of *mîn* when they wrote that *mîn* " were neither created nor fixed, but originated through change and separation, becoming unable to merge again with their progenitor kinds" (Held and Rüst 1999). Schepens (1923) would likely agree with their interpretation. Westermann states that the meaning of *mîn* is "precisely the same as that of the word used today in the natural sciences, namely species or genus" (Westermann 1994, p. 126), but Seely claims that *mîn* could be any category from phylum to species (Seely 1997). Futato offers a fifth opinion that *mîn* is not a technical classification term at all (Futato 1997). Considering the disagreement over the meaning of this word, it is best to approach its interpretation with caution.

The confusion over the meaning of *mîn* stems in part from its sparse usage. The word occurs only 31 times in the Hebrew Bible, 30 of those in the Pentateuch and one in Ezekiel (Kaiser 1980; Schepens 1923). In all instances, the word refers to animals or plants and appears together with the prefix *l*[e] ("according to") and a pronoun suffix (*his*/*her*/*their*) (Payne 1958; Williams 1997). Some have noted that *mîn* is never associated with humans in Biblical references (although it is used for humans in Sirach; see Fabry 1997). While God creates animals and plants "according to their *mîn*," humans are made in God's own image (Strickling 1980). *Mîn* is also used occasionally in extra-Biblical literature, but these references occur much later than the writing of Genesis (Fabry 1997; Williams 1997).

The etymology of *mîn* is uncertain (Beauchamp 1969; Cazelles 1964; Fabry 1997; Futato 1997). Some scholars connect it to the Arabic *mana* ("separate" or "divide"), but the Arabic word is much later than *mîn* and probably has no relation to the Hebrew term (Cazelles 1964; Kaiser 1980; König 1911; Williams 1997). Considering the late usage of *mîn* to refer to 'division' in the Mishna and Dead Sea Scrolls and its Biblical usage as a word of classification, most scholars agree that *mîn* probably indicates division of some kind (Jones 1972; Payne 1958). Thus, God created animals and plants according to their divisions.

Whatever the exact meaning of the word, we can see from the text of Genesis that *mîn* are not directly linked with reproduction but with creation. Only at the creation of fruit trees (Genesis 1:11-12) does the phrase "after his kind" appear to modify a reproductive structure, "fruit." Even in this case, however, the structure of the verse would seem to imply that "after his kind" modifies the earlier term grass rather than fruit. Thus, verse 11 could be read in part: "And God said, Let the earth bring forth grass (the herb yielding seed and the fruit tree yielding fruit) after his kind." According to Wenham (1987, pp. 20-21), this reading agrees with ancient understanding of this verse as well as most modern commentators.

The remaining usages of *mîn* in Genesis 1 clearly modify organismal creation (Gen. 1:21, 24-25). Furthermore, when God commanded organisms to "Be fruitful and multiply" (Gen. 1:22, 28), He does not qualify that reproduction with "according to their kind." If *mîn* indicates reproductive limits, why should it be used only for creation and not for reproduction? Although Marsh admitted that *mîn* was not linked to reproduction in 1950 (Marsh 1950, p. 238), the equation of *mîn* with reproductive fidelity commonly appears in modern creationist writings (e.g. MacArthur 2001, p. 99; Sarfati 1999, p. 32).

If *mîn* does not mean a reproductively isolated group of organisms, what basis does the creationist have for assuming that the refined baramin concept is an accurate description of living things? A number of other Biblical considerations can help to clarify biological creations. The creation account itself can be used to argue for discontinuity among living things, but we must use it carefully. The creation of plants on Day Three, flying and swimming things on Day Five, and land animals on Day Six implies a fundamental discontinuity between these four (or three?) groups of creatures. At the very least, we may reject an evolutionary origin of these groups.

Terms used for the organisms created on each day (such as "herb" vs. "tree") could be simple descriptions of the individual organisms created or they could be fundamental divisions of life. Some creationists insist on the latter interpretation (Berndt 2000), but the former cannot be rejected. For example, baraminology research has shown that woody and herbaceous plants can occur in the same monobaramin (Wood and Cavanaugh 2001), but if "herb" and "tree" of Gen. 1:11-12 refer to a division of baramins, woody and herbaceous plants must be classified into separate baramins. If "herb" and "tree" refer to the individual organisms without necessarily reflecting their baramins, no problem would exist. While the text generally supports discontinuity of biodiversity, further linguistic and baraminological research will be necessary to clarify the detailed meanings of Genesis 1. Given the present state of our knowledge, we would expect that supraordinal taxa are generally separated by discontinuity.

Should we then infer that species are discontinuous, thereby reverting to the earlier views of Linnaeus that all species are specially-created? We believe that at least two passages of Scripture could be interpreted to support supraspecific taxa as real entities. Creationists have long used baramins as an apologetic for how Adam named the animals (Gen. 2:19-20) and how Noah fit everything on the Ark (Gen. 6:19-21). If we assume that only a few thousand bird and beast baramins exist (Jones 1973), Adam could easily name them in a day and Noah could easily fit them on the Ark. The Flood narrative contains specific references to *mîn* (Gen. 6:20, 7:14); therefore, the *mîn* of creation appear to be equated with the *mîn* saved during the Flood, whatever the *mîn* actually are. The connection of *mîn* with Adam's naming of the birds and beasts is non-existent, but the naming of larger groups, such as baramins, does have an instinctive appeal for explaining how Adam accomplished his task in a single day. Although alternative interpretations of these passages could be proposed, we infer that the beasts and birds named by Adam and the animals on the Ark were groups larger than species because this interpretation is sensible and maintains the inerrancy of Scripture.

From these Biblical considerations, we find that although *mîn* has been a mainstay of creation biology for many years, there is very little linguistic support for viewing it as a scientific term in the modern sense. For this reason, our refined baramin concept specifically avoids equating the baramin with any Biblical category. Nevertheless, we do find biblical support both for discontinuity between high-ranking taxonomic groups (here we suggest supraordinal taxa) and for continuity among species. The association of *mîn* with "division" suggests that we may divide plants, flying creatures, swimming creatures, and land creatures into separate *mîn*. The description of their creation on different days also supports discontinuity among these major groups of organisms. Likewise, some evidence for continuity can be inferred from the association of *mîn* with the Flood, suggesting that *mîn* are wider groups than modern species. These conclusions fall far short of defining a baramin as a fixed unit of creation among living things in the sense of Frank Marsh, but the refined baramin concept as a separate philosophical construction accommodates all of the Biblical data.

Theological Issues. Although Frank Marsh expressed dislike of scholasticism and the wedding of church doctrine with Aristotle (Marsh 1944 pp. 33-50), he only rejected species fixity, as defined by narrow, "modern" species concepts. Marsh unequivocally accepted the fixity of the baramin, a belief that he derived from his interpretation of the Genesis creation narrative. In *Variation and Fixity in Nature*, he wrote, "According to the Genesis account, a *fixity* was built into the world of living things by a creation of organisms *in all their kinds*"(Marsh 1976, p. 91). Marsh's baraminic fixity strongly resembles the essentialism-derived species fixity of Linnaeus.

Marsh believed that baramins were incapable of crossing with other baramins, that baramins could only originate by God's creative act, and that baramins could not evolve into other baramins.

On the question of fixity and essentialism of baramins, we remain purposely undecided. We recognize that Aristotelian and Platonic concepts have been adapted and used by Christians throughout the centuries, and that these concepts are still utilized by modern researchers (Reynolds 2003). We also note that the joining of theology and Aristotelianism has led in the past to poor models of biology (e.g. see Marsh's (1947) and Mayr's (1982) discussions). Although we recognize that these applications could merely be misinterpretations of Aristotle or Plato, we would like to defer comment on the relationship between baraminology and essentialism. We have specifically constructed the refined baramin concept to allow future research in this area without including essentialism as a foundational concept. Instead, we here offer a theological argument for supposing that organismal form would have some permanency.

Rather than fixity of species, we advocate the *persistence of baramins*. Rather than asserting that species must necessarily occupy a very narrow region of biological character space (i.e. are fixed), we argue that God would need to create organisms with great morphological flexibility and adaptability in order for baramins to survive (persist) to the present. The only need of fixity would be for the revelation of God to persist. We believe that a reasonable theological argument could be made for persistence rather than fixity of species, beginning with two Biblical premises:

1. God desires to be known (John 1:14, Rev. 21:3, Matt. 27:51, Gen. 3:8-9).
2. Creation is a manifestation of His desire to be known (Ps. 19:1-4, Rom. 1:19-20).

If biological creation is to be understood as a revelation of God, it stands to reason that, like His written revelation (Is. 40:8), the revelation in creation ought to persist. The persistence of God's revelation in creation has two important applications to biology.

First, fixity of species would be a poor design principle if God intended for the revelation to persist. God knew that sin would enter His creation, and He knew that the consequences of sin would bring drastic changes to the Creation. Thus, any organisms that were perfectly adapted to their environments and fixed in that adaptation could only die in the face of environmental changes brought on by sin. In order for God's revelation in creation to persist, organisms must be adaptable to the inevitable environmental changes. Fixity of species would lead to catastrophic extinction and thus the elimination of the revelation in creation (apart from God intervening by re-creation, for which we find no biblical support).

Second, persistence of the revelation of God implies that certain characteristics of the creation should have remained unchanged since the beginning. In order for God's attributes to be "clearly seen since creation" (Rom. 1:20), attributes of the creation itself must persist. Those attributes of creation may be expressed in a variety of ways, allowing for the adaptability of organisms, but the attributes themselves must be detectable at any point in history. Note that these attributes of creation need not be associated directly with baramins or potentiality regions. The important attributes could be manifested by examining many baramins or by examining individual organisms. Persistence of revelation only requires that some attributes of creation also persist.

Could God allow unlimited adaptability and still have creation manifest His attributes? We do not believe that unlimited change would be consistent with three pieces of biblical evidence. First, the details of God's written revelation are important. Jesus claimed that even the smallest details of the Law would be fulfilled (Matt. 5:18). James claimed that an offense in one point of the Law makes us 'guilty of all' (James 2:10). These verses, and others like them (e.g. Rev. 22:18-19), suggest that even the details of the written revelation are important. Second, God is also mindful of the details of His creation. Jesus uses God's provision for His creation as a model of His (much greater) provision for His children (Luke 12:24-28). Third, at the Flood, when God had the opportunity to restructure creation, many details remained the same. Rather than creating new organisms (and people), He provided salvation to humans and organisms in and out of the Ark (Gen. 6:13-14, 8:11), and He promised that after the Flood the diurnal and annual cycles would not be disrupted (Gen. 8:22). Since God values the details of the written revelation and creation, and since He did not change many details of creation when He had the opportunity at the Flood, unlimited variability of organisms seems inconsistent with the constancy and care God has provided for His creation.

Taken together, these lines of reasoning imply that God would indeed create discrete groups of organisms with the ability to change and adapt but not enough to eradicate God's original plan of creation. Thus, we define the potentiality region as a bounded region of biological character space. Within the divinely-established boundaries, variation can occur, but change beyond the boundaries might obscure the revelation. The biblical and theological evidence even provides a framework in which to search for these baramins: they should generally be equal to or lower in rank than an order but higher than a species.

CONCLUSION

It is our hope that the refined baramin concept will stimulate new research into the origin, nature, and meaning of God's biological design. Already, we can see a number of intriguing avenues of research. For example, our concept of the potentiality region raises the question of its origin. According to Plato, the material world around us reflects an ideal world of "forms." While the potentiality region appears very platonic, it would be premature at this stage to equate Plato's forms with the potentiality region. Further research should aid in understanding the nature of the potentiality region.

The refined baramin concept also could be used to explicitly justify recent advances in statistical baraminology, namely baraminic distance (Robinson and Cavanaugh 1998b) and Analysis of Patterns (Cavanaugh 2002). Each of these methods utilizes data from a variety of sources (holism) and analyzes them for signs of significant similarity or difference. Similarly, many of Wise's discontinuity criteria could be revised and justified under the refined baramin concept (Wise 1992). Considering the strong potential for wide applications of the ideas in this paper, we encourage researchers to explore baraminology using the refined baramin concept.

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