

**RAFTING:
A POST-FLOOD BIOGEOGRAPHIC DISPERSAL MECHANISM**

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ABSTRACT

Although biogeography has contributed important data to the debate on biological origins for centuries, global biogeographic models have had poor success at explaining biogeographic data. Heretofore, the best models (evolutionary biogeography models) have neither successfully explained the multi-taxon concurrence of trans-oceanic range disjunctions nor why areas of endemism exist where they do. Here a creationist dispersal mechanism is suggested. It is proposed that plants and animals rafted across oceans on and among masses of logs, plant debris, and vegetation mats in the immediate post-Flood world. United with post-Flood models of geology, climatology, and biology, a uniquely young-age creationist model of biogeography is generated which seems to explain not only the data explained by the best evolutionary models, but also data which such models fail to explain. Also introduced are eighteen biogeographic tests of the model.

HISTORY OF BIOGEOGRAPHY

Biogeography has contributed important data to the debate on biological origins for at least five centuries. A brief history of those debates is included here to familiarize the reader with the relevant discussions and data. The categories of biogeographic data and their relationship to historically important biogeographic theories are summarized in Table 1.

Fixity/Dispersal Model

Before the discovery of the New World, most western thinkers believed that biological organisms were unchanging and generated by a non-physical intelligence (usually either the Greek *logos* and/or the Christian God). With the Renaissance, the Western world returned (for a time) to accepting the Bible literally. As this happened, a global flood came to be taken seriously [6 pp. 2-3, 12]. Many believed that the land organisms got to their present positions by dispersing from the mountains of Ararat where the ark landed. By rejecting a global Flood, Carl Linnaeus (1707-1778) advocated a variation on this model [6 pp 18-20]. He maintained God created all the organisms on a single mountain in a global ocean, and as sea level dropped the organisms migrated to their present locations. Unchanging species dispersing from a single point of origin can be called a 'fixity/dispersal model' of biogeography. One of the earliest biogeographic observations – environmental specificity of species (Row 1 in Table 1) – is explained in this model by species dispersing to the environments for which they are best designed. Given the continuity of the known land masses and the limited number of known species, the fixity/dispersal model was not challenged by pre-Columbian biogeographic knowledge.

Although the fixity/dispersal model was held by many into the 18th Century (e.g., Linnaeus), 16th and 17th Century explorations of the New World produced substantial challenges to this model. Since only one set of organisms dispersed from only one location, a simple fixity/dispersal model would predict that similar environments in different locations should be inhabited by the same creatures. As early as 1500, however, Amerigo Vespucci noted differences in primates between the Old and the New Worlds [13]. Further explorations – especially in tropical regions of Africa and South America – revealed similar environments on opposite sides of the Atlantic were populated by very different creatures (Row 2 in Table 1) [13]. As more and more species were discovered, there was attendant concern that all the species could not fit onto the ark [6 pp 8-9, 16-18]. As more and more distant lands and islands were discovered, there was further concern that many of the organisms could not traverse the great distances to their present locations [6 p 23] (without, for example, passing through environments in which they couldn't survive) (Row 3 in Table 1). In 1589, for example, José da Acosta struggled with these issues as he considered South American species [13]. He wondered how the animals could fit on the ark. He discussed but rejected humans transporting the species, organisms swimming the separating oceans, and the post-Flood creation of species. In the end he

left the issue unresolved [33], as did many others after him [13].

Fixity/Creation Model

One potential solution to these biogeographic challenges would be to postulate that species were created in their present locations. This could explain the environmental specificity of species, take away the need for long-distance (e.g., trans-oceanic) distribution, and potentially explain why different animals were created in similar environments in different locations. Furthermore, for those who believed in a Flood, species created *after* the Flood would not strain the carrying capacity of the ark. A combination of this idea with species fixity creates what might be called a ‘fixity/creation model’ of biogeography. This biogeographic model was adopted by various thinkers in the late 18th and early 19th Century [6 pp 25-27] – most notably Georges Cuvier (1769-1832) and even Louis Agassiz (1807-1873) [6 pp 140-142]. By 1830, Candolle’s areas of endemism were commonly referred to as ‘centres of creation’ because of this idea’s popularity [6 p 11]. Darwin [10 p115] considered this model to be ‘commonly’ understood in his day and spent considerable effort countering it.

The simple form of the fixity/creation model would expect modern species to be perfectly matched with their environment – *i.e.* that no species would survive better at a particular location than the one found there, and no species would survive anywhere else better than where it currently resides. Acosta doubted the validity of this claim as early as 1589 because it *seemed*, at least, that some species *should* survive as well in places where they are not now found (e.g., Acosta thought elephants and giraffes ought to have survived quite well in South America) [13]. Darwin [10 p 115] pointed out that the repeated success of introduced exotics argues that species are at best locally – not globally – fit for their respective environments. Non-global fitness (Row 4 in Table 1) argues strongly against both fixity models of biogeography. In an *ad hoc* fashion, the fixity/creation model allows for the very same species to be created in two different regions, thus providing (*ad hoc*) explanation for disjunct species [6 pp 112-113]. On the other hand, Darwin [10, Chapters 11-12] argued that there are no examples of identical species in very different locations which couldn’t somehow migrate between the two regions. The variation of this view which was best able to explain these difficulties was introduced by Karl Willdenow (1765-1812) [6 pp 38-40]. Like Linnaeus before him, Willdenow rejected a global flood but affirmed the creation account and species fixity. He suggested that different organisms were created on different peaks in the primordial ocean. Then, as sea level dropped the organisms spread from each peak to their current locations. Another expectation of the fixity/creation model (even Willdenow’s variation) would be that different morphologies should be distributed more or less randomly across the earth. One would not necessarily expect, for example, that species most similar to each other would be in close geographic proximity (e.g., all the world’s kangaroos are only found in Australia). Similar taxa in geographic proximity argue against simple fixity models of biogeography (Row 5 in Table 1). Yet, Darwin [10, Chapters 11-12] pointed out there are many cases of similar species living in close geographic proximity (e.g., similarities between South America and the Galapagos Islands) – as if they were derived from the same ancestral stock.

Fixity/Vicariance Model

Attempting to explain the disjunct distributions of alpine flora on different European mountains without appealing to multiple creations, Edward Forbes (1815-1854) (and independently Charles Darwin [6 p 123]) suggested yet another biogeographic model [6 pp 117-123]. He suggested the species were widespread in lowland areas across Europe during a past, cold (glacial) climate. Subsequent warming isolated populations at cooler latitudes of disjunct mountains. A combination of the idea of vicariance, or separation of populations with species fixity creates what might be called a ‘fixity/vicariance model’ of biogeography. Variations on this kind of biogeographic model have been used to explain such disjunct populations as land snails on different Bahamian islands due to sea level rise and squirrels on either side of the Grand Canyon due to canyon erosion. Potentially, plate tectonics could be combined with this model to explain identical terrestrial taxa on either side of an ocean with a mid-ocean ridge running down its center.

Although the fixity/vicariance model can explain disjunct ranges of identical species, it fails to explain disjunct ranges in higher taxa, which differ at the species level (Row 8 in Table 1). As in the case of other fixity models, it also fails to explain why similar species tend to be in geographic proximity (Row 5 in Table 1).

Change/Dispersal Model

Beginning in the late 18th Century (e.g., Comte de Buffon between 1749 and 1804 [13; 6 pp 24-25]), the fixity of species concept was gradually replaced with various theories of biological change. The idea that species are continually arising, changing to new forms, and moving to new locations might be called the ‘change/dispersal model’ of biogeography. In particular, the evolutionary models of Darwin [10] and Wallace

posited that species adapt to their local environment. This model elegantly explains the environmental specificity of species, the differences in species found in similar environments at different localities, the local, non-global, environmental fitness of species, as well as the geographic proximity of similar species (Rows 1-5 in Table 1). This model predominated from the time of Darwin to the mid-20th Century.

Challenges to the change/dispersal model began to be enumerated even before Darwin entered the H.M.S. Beagle in 1831. In 1820, Augustin de Candolle [8] noted 20 locations on the earth where a large percentage of plant species were endemic. Such observations might lead creationists to suggest there were 20 gardens of Eden (or 20 landing sites for floating plant debris in the Flood) from which plant species dispersed to populate the surrounding regions (in part leading Candolle to accept a Willdenow-like model of historical biogeography [6 pp 53-56]). The endemism concept was reinforced when Candolle's areas of plant endemism were found to correspond geographically to areas of animal endemism. Both fixity/dispersal and fixity/creation models might expect at most one area of high endemism (the area from which dispersal occurred and/or the 'Garden of Eden'), but do not explain how there could be multiple areas of endemism (Row 6 in Table 1). Simple versions of change/dispersal models predict origination events would be more or less randomly arranged in time and space in large geographic regions (ocean basins for marine organisms; continents for terrestrial organisms). Intuitively, then, one would not expect high terrestrial endemism to be focused in small subregions of large continents such as Candolle documented (1-20 in Figure 1). Change/dispersal models would predict high endemism in geographically isolated areas (e.g., oceanic islands for terrestrial organisms; land-locked lakes for aquatic organisms), but would predict similar levels of endemism for all such isolated areas. It cannot, then, explain why such a small percentage of oceanic islands show high terrestrial endemism. Another expectation of a simple form of a change/dispersal model is geographical continuity. One would expect that a terrestrial taxon should be continuously distributed across terrestrial regions and not, for example, found in two limited regions separated by a large ocean (Row 8 in Table 1). Now called disjunct, Candolle called such distributions 'sporadic' [6 pp 112-113]. Even though Darwin devoted considerable discussion explaining such disjunctions away, they are not intuitive predictions of his theory. Given the difficulty in explaining dispersal across disjunctions, fixity/dispersal models cannot explain such disjunctions either (Row 6 in Table 1). In the 19th Century and the first half of the 20th Century, an increasing number of transoceanic disjunct populations were logged for terrestrial and freshwater organisms.

Change/Vicariance Model

Wegener [32] used a number of the trans-North Atlantic and southern continent disjunct distributions as evidence for continental drift. Wegener's drift hypothesis suggested yet another biogeographic model. The split and separation of a continental land mass might also split and separate any taxon which was on that continent. Independent changes in the vicariant populations would introduce differences – creating, for example, new lower taxa. Yet, because they have a common origin, the vicariant populations will be similar at a higher taxonomic level. What might be called a 'change/vicariance model' of biogeography would predict disjunctions in higher taxonomic groups of terrestrial and freshwater organisms across oceans created by continental drift. The change/vicariance model became the predominant biogeographic model after the general acceptance of plate tectonics theory in the 1960's.

Although the change/vicariance model provides an explanation for *some* of the disjunct distributions, it does not explain all of them [13]. Eastern Asian / eastern North American (e.g., [11, 25]) and trans-Pacific distributions (e.g., [36 pp197-9; 30]), for example, are not explained by tectonic-generated vicariance. Furthermore, there are floral and faunal similarities among areas of endemism (Croizat's [9] 'tracks' of dispersal) which do not correspond to the separation of continents postulated in plate tectonics (Row 7 in Table 1). As in the case of change/dispersal models, change/vicariance models expect a uniform distribution of endemism in large continental areas and high endemism on islands. Thus, both the localized areas of continental endemism pointed out by Candolle and the low frequency of islands showing high endemism are unexplained by change/vicariance models (Row 6 in Table 1). Further challenges to the change/vicariance model came as late 20th Century researchers found more and more examples of taxa which seem to have originated and diversified *after* the continents separated (e.g., [16]). So inadequate is vicariance theory to explain biogeography, that modern defenses of plate tectonics theory rarely include biogeographic evidence from living organisms. So compelling is the evidence for transoceanic biogeographical disjunction, however, that researchers continue to consider and propose the kind of transoceanic transport and land bridge theories which were popular in the 19th Century. Charles Lyell [20, pp.97-9], for example, listed several examples of vegetation mats floating far out to sea with animals on them. Although successful oceanic crossings on such mats would be extremely rare events (George Gaylord Simpson [29] called them 'sweepstakes routes'), Lyell argued that given enough time, many of them would be expected.

Ultimately, we are left with a string of theories of biogeography which do not comport well with the biogeographic evidence. Although the best of the theories (change/dispersal and change/vicariance models) explain quite a bit of evidence, they still fail to adequately explain why many areas of endemism exist, why many of those areas of endemism show similarities to one another when they were never adjacent to one another in the geologic past, and why substantial disjunctions are found in the distributions of many taxa. This paper suggests a creationist model of biogeography which we believe explains all the data currently explained by the best modern biogeographic models as well as much of the biogeographic data unexplained in these models.

Biogeographic Observation	Biogeographic Model					
	fixity/ dispersal*	fixity/ vicariance	fixity/ creation	change/ dispersal	change/ vicariance	diversification/ rafting*
environmental specificity	yes	yes	yes	yes	yes	yes
differences in similar environments	no	no	yes	yes	yes	yes
distance from Ararat	no	no	yes	yes	yes	yes
non-global optimization	no	no	no	yes	yes	yes
similar species in geographic proximity	no	no	no	yes	yes	yes
areas of endemism	no	no	no	no	no	yes
similarities among areas of endemism	no	no	no	no	no	yes
range disjunctions	no	some	no	no	no	yes

Table 1: Explanatory Power of Global Biogeographic Models of History. A ‘yes’ indicates that the category of biogeographic model (columns) is capable of explaining the category of biogeographic evidence (rows) without much special pleading. See text for explanation. An asterisk on a biogeographic model indicates that model can be true to the Biblical account (one-time creation, a global flood, etc.).

THE DIVERSIFICATION/RAFTING MODEL

Rafting Dispersal Mechanism

Soon after the initial eruption of Mt. Saint Helens, approximately one million logs were floating atop Spirit Lake, north of the mountain. Twenty-three years later, after many logs have become waterlogged and sunk into the lake, hundreds of thousands of logs are still floating. Virtually the only remaining species is Douglas Fir (*Pseudotsuga menziesii*) [3]. Steven A. Austin (personal communication) models the log mat size by an exponential decay curve and estimates Douglas Fir to have a flotation half-life of 75 years.

Noah’s Flood destroyed all the pre-Flood forests of the world. Pre-Tertiary fossils indicate that in the course of the Flood many of the pre-Flood plants were buried by sediment – some directly, many after becoming waterlogged and sinking to the bottom. Some floated for a short time; some floated longer. Based upon flotation times of modern plants, we might expect that many of the plants in the pre-Flood world had flotation half-lives long enough for them to float through the Flood – especially considering the higher density of brines. In fact, species with flotation half-lives equaling Douglas Fir in fresh water may have floated for several centuries after the Flood (perhaps some species floated even longer, given our limited knowledge of pre-Flood biology). Given the global destruction of forests, each system of ocean currents (e.g., North

Atlantic vs. Indian Ocean vs. circum-Antarctic) may have been carrying billions of logs by the end of the Flood. Whereas today's occasional log or stick provides a 'sweepstakes'-like probability of successful transoceanic transport, log mats immediately after the Flood may have been nearly as efficient for dispersal of some terrestrial organisms as was the land itself. Since the size of the Spirit Lake log raft has decreased exponentially with time, rafting efficiency in post-Flood times might be expected to decrease in the same manner.

Creationists are not in agreement about the salinity of the pre-Flood oceans. Even if one assumes a non-saline pre-Flood ocean, by the end of the Flood much of the world's ocean would have been saline. The challenge of transporting freshwater organisms across bodies of salt water has historically been understood as a challenge to Flood models. However, given the difficulty of mixing different brines, lakes of fresh water probably floated atop salt water during the Flood and after the Flood for some time. Log mats in such floating freshwater lakes may have provided a means of rafting freshwater organisms.

Post-Flood Biogeography

Combining the rafting mechanism for dispersal with other young-age creationist theories of earth history generates a young-age creation model of biogeography. First of all, there would have been organisms involved in the rafting which were not represented on the ark. The only organisms explicitly listed on the ark were terrestrial animals and their food. God apparently preserved non-terrestrial organisms and many plants (e.g., the olive tree: Gen. 8:11) through the Flood outside the ark. Most of the rafted debris itself was probably plant material which was intended to survive the Flood outside the ark. These plants and other organisms would have experienced trans-global dispersal even before land began rising out of the Flood waters and long before organisms on the ark were able to join them on the rafts.

The organisms which did disembark from the ark were not a random sample of pre-Flood organisms. Scripture (Gen. 7:8-9) infers that God chose the organisms to be placed upon the ark. Given His foreknowledge, it is reasonable to assume that He chose morphologies in each baramin which would be best equipped to repopulate the earth after the flood. Divine considerations in this selection process might well have included survival likelihood and maintenance requirements on the ark as well as survival likelihood, fecundity, and dispersal likelihood in the warm, wet, convulsing post-Flood world. In many cases, perhaps, God chose morphologies which would best utilize the log mats He knew would float atop post-Flood oceans. This suggests that many organisms were pre-designed for the post-Flood dispersal event. Divine intelligence, plus a designed predisposition to both rafting and rapid diversification, should have resulted in an extremely efficient and rapid dispersal and settlement of the post-Flood world. Many terrestrial organisms may have rapidly migrated from the ark to the rafting 'launch' points, crossed the oceans on the rafts, and established themselves at huge distances from the ark without leaving evidence of the dispersal process in the fossil record.

Geologically, it is thought that catastrophism in the post-Flood world was active for a considerable time after the Flood [4]. Residual catastrophism and dispersal by rafting would have been occurring simultaneously. Assuming the general validity of both catastrophic plate tectonics and the K/T as the Flood/post-Flood boundary [4], most of the continents were in their present positions, with a few notable exceptions. First, North and South America were still separated by a bit of ocean. The Panama isthmus would not rise to form a land corridor for faunal interchange until late post-Flood times. Second, India was still located in the middle of the Indian Ocean, moving north to slam into Asia in early post-Flood times. Third, partly as a result of India's position, an open seaway (known as the Tethys) extended from Southeast Asia across Asia and Europe in earliest post-Flood times. With the few exceptions noted above, modern continental configurations are fairly close approximations to continent/ocean relationships during times of post-Flood dispersal.

Climatologically, the post-Flood world is thought to have been cooling and drying [4]. Sea level was probably very slow to approach modern levels as well. Sea level and climatic changes would have altered the position and intensity of post-Flood ocean currents. All these changes – in current, climate, and sea level – would have been occurring concurrently with rafting. Until proper modeling can be done of coastlines and currents, the positions and magnitudes of modern currents must be understood to be only first-order approximations of those features for currents in early post-Flood times.

Geological and climatological conditions in the post-Flood world probably contributed even more vegetation to the log mats which survived the Flood. High rainfall rates and warm temperatures in immediate post-Flood times [4] probably resulted in very rapid plant growth. There were probably mechanisms of biological recovery activated during this time to make post-Flood vegetation even more extensive than would be

extrapolated from modern analogues. The high rainfall rates of post-Flood times combined with high-intensity residual catastrophism [4] is likely to have led to much mass-wasting – including the dislodging and floating of vegetation mats such as those Lyell [20] described in modern oceans.

There were also enormous biological changes occurring in the post-Flood world. Rapid, post-Flood intrabaraminic diversification seems to be a necessary component of a creation biology model [4]. This diversification would be occurring simultaneously with the rafting mechanism proposed here. In fact, as the diversification rate decreased (*a la* [35]), the rafting efficiency would also be decreasing.

THE MODEL'S EXPLANATIONS

Evolutionary models of biogeography purport to explain a fair amount of biogeographic information. Because intrabaraminic diversification generates species while organisms are dispersing, the diversification/rafting model explains all the same biogeographic data evolution claims to explain – namely environmental specificity, differences of organisms in similar environments, non-global optimization, and similarity in geographic proximity (Rows 1-5 in Table 1). At the same time, the diversification/rafting model does not abandon consistency with the Biblical text (namely, dispersal from Noah's ark), which is set aside in both change and fixity/creation models of biogeography. In addition, a rafting model decreases the total distance of dispersal necessary for many organisms to get from dispersal centers (*e.g.*, Noah's ark) to where they currently live. This loosens the dispersal distance challenge biogeography has placed on previous creationist biogeography theories.

THE MODEL'S PREDICTIONS

Besides the data explained by conventional biogeographic models, the diversification/rafting model seems to explain a large amount of biogeographic data which is *not* explained by these models. Biogeographic expectations which arise from the diversification/rafting model are listed below:

Raft landing sites should correspond to biogeographic 'gates' and areas of high endemism. One would expect rafting organisms to be beached approximately where currents are deflected by continents. Some of the organisms may disperse from there and diversify intrabaraminically. These landing sites should then correspond to 'gates' of dispersal and diversification (*a la* Croizat [9]). A certain percentage of the organisms will remain in the landing region. If some of their number also survives at the launch site and the two populations remain identical, they would create a transoceanic disjunct population. If the organisms remain at the launch site but change intrabaraminically, then one produces a large number of endemics. Our model would predict that areas of endemism should correspond to raft landing sites. Preliminary verification of this prediction is suggested by the general correspondence between modern currents' intersections with land and both Croizat's biogeographic 'gates' and Candolle's [9] areas of plant endemism (Figure 1).

Frequency of transoceanic disjunction should be directly related to raftability. All other things being equal, rafting should be more effective for more raftable organisms (*e.g.*, those which are smaller; those which are more aquatic; those which in lab experiments prove more adept at over-water dispersal). Preliminary verification of this prediction is suggested by a survey of the freshwater organisms of [5], where more organisms which spend their entire lives in water (*e.g.*, freshwater fish) have disjunct distributions than those organisms which spend only a portion of their lives in water (*e.g.*, terrestrial insects with aquatic larval forms). A survey of [5] also suggests that whereas a number of smaller taxa (*e.g.*, insects) have disjunct distributions very few larger taxa do (*e.g.*, vertebrates).

Taxonomic level of transoceanic disjunction should be inversely related to raftability. Since rafting will be more effective for more raftable organisms, the average time since a successful rafting event should be less. With less time for divergence, more raftable organisms should show biogeographic range disjunctions at lower baraminic taxonomic subdivisions.

Distributions of wind-dispersed organisms should mirror distributions of rafted organisms. Because winds drive currents, one would expect that organisms which are known to be dispersed by wind should have similar transoceanic distributions as is found for rafted organisms. In arguing that some identically-distributed trans-Atlantic species could have been dispersed by wind (winged lepidopterans) while others could have dispersed by currents (beetles which lived near beaches), [20] implicitly confirmed this expectation for high-latitude insect species.

Distributions of marine current-dispersed organisms should mirror distributions of rafted organisms. Since ocean currents drive the rafts, marine organisms which are known to be distributed by currents should have the same continental shelf distributions as is found in disjunct transoceanic distributions of rafted organisms.

Preliminary verification of this prediction comes from an examination of distribution patterns in [5]. The same disjunct distributions are found in many primarily freshwater organisms as well as secondarily freshwater organisms and even marine organisms which occasionally invade freshwater environments. *Geographic range disjunctions should be bridged by currents.* The rafting mechanism should produce transoceanic similarities between shorelines connected by currents. Range disjunctions should be found where the disjunction is bridged by the paleocurrent. In confirmation of this expectation, modern currents, as a rough approximation of paleocurrents, connect all seven of Wulff's transoceanic 'chief types of discontinuous areas' for plants [36 pp 82-91]. All Thorne's [31] seed plant transoceanic 'disjuncts' are so connected with the exception of about 170 genera in 'Pacific-Indian-Atlantic', amphitropical, and bipolar disjuncts (<6% of the genera Thorne counts as having disjunct distributions). The correspondence between modern ocean currents and Croizat's [9 Fig 259] 'generalized tracks' for both plant and animal taxa seems to be further confirmation of this expectation.

Direction of transoceanic dispersal should correspond with the direction of currents. The rafting mechanism should raft organisms in the direction surface currents travel. So, if the direction of dispersal can be deduced, it should correspond to the direction the currents traveled to produce that dispersal. Current directions can be inferred from a combination of: analogy with present currents; numerical climatic simulations; and (when applicable) sedimentary paleocurrent data. The direction of dispersal can be inferred from a combination of phylogenetic data, raftable versus non-raftable morphotypes, and fossil data.

The South Equatorial Current, for example, travels from Africa to South America. This is consistent with an Africa-to-South America dispersal indicated by older African fossils for pipid frogs [7], lepidosirenid lungfish [5 pp 56-7], and ceboid primates [33], a cladogram of pipid frog genera [12] as well as (less raftable) dioecious siparunacean laurels being found only in the New World [27]. This direction of dispersal seems contradicted by the molecular cladogram of rapateacean genera [15]. A cladogram of chalinid sponges [17 Fig 3.5] suggests dispersal from Europe and North Africa to the Antilles, which corresponds to the direction of the Atlantic Ocean's North Equatorial Current. A cladogram of megalyrid wasps [28] suggests dispersal from Chile to South Africa, which corresponds with the direction of the Circumantarctic Current. Cladograms for ecnomid caddisflies [5 Fig 7/18], parastacid decapods [5 Fig 3/3], diamasine flies [22 Fig 8.9], and pericichthyid fish [5 pp 155-7] suggest dispersal from Australia and/or New Zealand to Chile, which also corresponds to the direction of the Circumantarctic Current. Dispersal in the opposite direction seems to be indicated by a cladogram of embothriine waratahs [17 Fig 4.12]. Parastacid decapods [5 Fig 3/3] suggest an Australia-to-Madagascar direction of dispersal, which corresponds to the direction of the Indian Ocean's South Equatorial Current. A cladogram of Indian Ocean chameleons [26] suggests a dispersal from Madagascar at various times to Africa and the Seychelles, which corresponds to the direction of the South Equatorial Current, and from Africa to India, the direction of the North Equatorial Current. A spectacular example comes from [19 Table 7], where the number of identical beetle species suggests two dispersal directions – one from England and Scandinavia to the Faroes Islands and then to Iceland and West Siberia and the other from Greenland to Baffin and Ellesmere Islands and then on to the Hudson Bay and East Siberia. The first dispersal route corresponds to the North Atlantic Current which passes beside England and Scandinavia on its way to Iceland and West Siberia. The second dispersal route corresponds to the Greenland Current which curls about Greenland on its way to Baffin and Ellesmere Islands where dispersal can go to the south to Hudson Bay or to the north, entering the (now sub-ice) currents of the polar ocean to travel west to East Siberia.

Disjunct populations of plants and non-terrestrial organisms should show more divergence than disjunct populations of terrestrial organisms. Ark-born organisms would have taken advantage of the rafting mechanism at a later date than the organisms which might have survived outside the ark. Since the rate of intrabaraminic diversification seems to have decreased with time [35], after normalization against relative diversification rates, ark-born organisms might be expected to show less post-rafting divergence.

Early rafting routes should have been used only by plants and non-terrestrial organisms and should show more divergence. If Tethys and/or other transcontinental seaways were blocked by the time organisms exited the ark, the only organisms which should have been able to use these kinds of routes would have been those which survived outside the ark. Since such routes were blocked earlier than other routes, one might also expect greater divergence in these disjunct populations than is found in disjunctions created by later rafting events. As an example, the similarities between eastern Asia and eastern North America might be explained by Tethyan transcontinental rafting before the raising of the mountains upon which the ark landed. Whereas the great number of floristic similarities between the two areas (e.g., see [18]) might be explained by such a mechanism, recent research is questioning the similarities [e.g., 25], and the hypothesis seems strained both by the low taxonomic level of many of the floristic similarities (intra-genus disjunctions) and by the fact that cryptobranchid salamanders [24 Fig 3-4], and, even more significantly, procyonid

mammals [2 Fig 85] seem to have the same type of range disjunction.

Madagascar, Africa, and Western Australia should show greater faunal and floral similarities among themselves than any of them shows to India. For a time after the Flood, as India moved north through the Indian Ocean, it would have been in the southern trans-Indian Ocean circulation. Rafting should be expected between these areas until India moved across the equator and collided with Asia. Subsequent trans-Indian Ocean rafting should have continued to link Madagascar, Africa, and Western Australia, but not have involved India. This suggests that the India similarities would be older than those which do not involve India. There should therefore be more divergence in disjunct distributions involving India than those that do not. This might explain why the South African and Australian genera of mesamphisopid crustaceans are more similar to one another than they are to the Indian genus of the same family [5 Fig 3/21].

West Africa / West Indies / East Indies faunal and floral similarities might be expected up until late post-Flood times. A land bridge did not form between North and South America until late post-Flood times. Since the exact position of continents are critical, the resultant ocean circulation patterns need to be carefully modeled. It is possible that at various times, an ocean current may have left West Africa bound for the East Indies, skimming what are now the West Indies on its way. This may explain the rare, disjunct distributions which link the West Indies and Indian Ocean (e.g., the marine plant families Potamogetonaceae and Hydrocharitaceae [23]).

Rafting success should decrease exponentially through the Tertiary. The disappearance rate of logs in Spirit Lake may be described by an exponential equation (Steven A. Austin, personal communication). This suggests that transoceanic rafting success may be expected to decrease exponentially after the Flood. The fact that transoceanic rafting routes in the present were labeled 'sweepstakes routes' by Simpson may be a consequence of this trend. Testing this hypothesis will be possible as we improve our understanding of the post-Flood timescale and intrabaraminic diversification mechanisms.

Percentage of transoceanic range disjunctions should decrease from families to genera to species. As intrabaraminic diversification occurs, membership will tend to be larger in higher intrabaraminic taxa. All other things being equal, this means that higher taxa will be more likely to be sampled by rafting events and thus produce transoceanic disjunctions in their distributions. The greater generality of higher taxa also makes it more likely that a raftable morphology will be found in that taxon. The effect of this is that a greater percentage of higher taxa will have disjunctions than in lower taxa. This expectation is strongly confirmed by Thorne's [31] conclusion that 78.4% of seed plant families have markedly disjunct distributions whereas this is true of only 24% of the genera and less than 1% of the species.

Within terrestrial baramins, the Lower Tertiary morphologies will tend to be more raftable than Upper Tertiary morphologies. Given that God would choose from a baramin the morphology best equipped to repopulate the earth after the Flood, many baramins were probably represented on the ark by more raftable morphologies. In many baramins, then, terrestrial fossils soon after the Flood may be expected to possess more raftable morphologies than the same baramins later in the fossil record. Although small body size may have been chosen for the warm post-Flood earth [4] and perhaps even for space and maintenance considerations on the ark, raftability may have been a factor as well. If, among baraminic possibilities, small morphologies were chosen to be on the ark, then the mean body size of that baramin would be expected to increase with time. Thus, Cope's Law may in part be due to this expectation of rafting biogeography.

Less raftable organs, behaviors, etc. will tend to be found on one side of a transoceanic disjunct higher taxon. Since intrabaraminic diversification probably revealed many structures not exhibited in preceding organisms (e.g., C-4 photosynthesis in plants [34]), it is likely that structures were realized after the Flood which were not helpful in rafting. If such a morphology arose on the near side of an oceanic barrier, the organism would be prevented from rafting the barrier. Alternatively, the morphology may have arisen *after* rafting the ocean barrier. Either way, the less raftable morphology will be on one of the two sides of the ocean. Only in the less likely situation of independent realization of the same morphology on either side of an ocean would it be found in populations on each side of the ocean barrier. As an example, the survival of dioecious species on the far side of a geographic barrier requires both male and female individuals to successfully navigate the barrier. This means that the trait of monoeciousness is more raftable than the trait of dioeciousness. Thus, among siparunacean laurels which are distributed in tropical Africa and the New World, the dioecious forms are found only on the New World side of the Atlantic [27]. This seems to be a confirmation of this expectation

Paleobiogeography should correspond with neobiogeography in Tertiary and Quaternary, but not in Primary and Secondary. Due to large changes in geography and biology in the Flood, pre-Flood and post-Flood biogeographic distributions are likely to be unrelated. This, combined with long-distance transport of organisms by Flood waters is likely to leave fossils in places unrelated to their post-Flood geographic ranges. Post-Flood diversification, however, ultimately generated the present biogeography. Since post-Flood catastrophism is regional and not global, post-Flood fossils are probably located near to where the organisms actually lived. Post-Flood paleobiogeography should correspond with modern biogeography and converge with it as one steps through younger and younger sediments. If the Primary (Paleozoic) and Secondary (Mesozoic) sediments are Flood sediments, and Tertiary and Quaternary are post-Flood sediments (as suggested by [4]), then one would expect that Primary and Secondary paleobiogeography should not correspond with modern biogeography whereas Tertiary and especially Quaternary paleobiogeography should. This might explain, for example, why all the Australian marsupial fossils are known in Tertiary and Quaternary sediments – and only from Australia. On the other hand, the Secondary paleogeography of silky lacewings (Psychopsidae) seems to correspond to their modern distribution [1].

More divergence should be seen between warm-tolerant taxon pairs than between cold-tolerant taxon pairs.

The cooling of the earth after the Flood occurred coincidentally with both rafting and intrabaraminic diversification. Therefore, the first taxa in the post-Flood world, and thus the first taxa to be rafted, were warm-tolerant taxa. Cold-tolerant taxa would be generated later and would be rafted later. This means that, all other things being equal, transoceanic range disjunctions in cold-tolerant taxa will tend to be between taxa of lower taxonomic rank than the disjunctions in many warm-tolerant taxa. Strong confirmation of this prediction can be derived from the statistics of [31]. Of the more than 3500 transoceanic range disjunctions in seed plants referred to by [31], 79.7% of the disjunctions in arctic, boreal, and antarctic taxa were in species ranges, 20.2% were in genus ranges, and 0.1% were in family ranges, whereas 0.3% of the disjunctions in temperate and tropical taxa were within species ranges, 93.9% were within genus ranges, and 5.8% were within family ranges. The latitude/similarity correlation of [25] in comparisons of plants in Eastern Asia and Eastern North America is also consistent with this claim. Similarly, only three taxa of the nearly 150 transoceanic range disjunctions in freshwater organisms mapped by [5] are disjunctions in species distributions. One of them is the only arctic taxon listed by [5]; the other two are temperate species.

Among amphiatlantic distributions of plants and animals mentioned in [19 Chapter 3], all of the arctic and boreal disjunct distributions are within species and all but a couple temperate distributions are within genera and higher taxonomic units. [21]'s data also confirms this expectation; he found that among taxa with amphi-Indian disjunctions, there was more divergence in lowland taxa than highland taxa.

Some baramins might demonstrate multiple, identical transoceanic dispersal patterns. Although the probability of successful transoceanic dispersal in the present might be vanishingly small, rafting may have been very efficient in post-Flood times. Thus, although *single* oceanic crossings might be considered a strain under present conditions, many baramins may have crossed the same oceanic barrier multiple times in the post-Flood world. This provides a plausible explanation for multiple Iceland-Norway and Greenland-Svalbard crossings evidenced in *Cerastium arcticum* cladistics [16].

CONCLUSION

Because of their poor fit with biogeographic data, many of the conventional models of biogeography rely heavily upon *ad hoc* scenarios such as human or bird transport, range expansion followed by extinction, trans-ice winds, and hypothetical land bridges. Space considerations prevent a complete evaluation of the rafting model introduced here, but preliminary evaluation suggests that a large percentage of global biogeographic patterns are explained by the model without reference to such *ad hoc* explanations. Most of the geographic range disjunctions found by the authors can be explained with reference to rafting on either the Circumantarctic Current, the polar currents, or the North and South Equatorial Currents in the Atlantic, Indian, and Pacific Oceans. The only disjunct distributions which seem to challenge the model are the amphi-tropical and bipolar distributions (which by [31]'s figures account for about 6% of the disjunct distributions in plants). This suggests that something on the order of 90% or more of the major biogeographic patterns might be explainable by this model without reference to *ad hoc* scenarios.

The creation biology community is challenged to test the diversification/rafting model to determine its overall utility in young-age creation model-building. The eighteen tests listed in this paper can form a starting point for such an evaluation. Complete taxonomic lists of islands, shorelines, and continents should be assessed to identify actual areas of endemism and actual levels of taxonomic similarity. From this information, if the rafting mechanism is correct, similarity statistics (e.g., cluster analysis) should arrange geographic locations in precisely the order that currents would carry organisms to those locations. Morphological studies of ecological and rafting tolerances should lead to a number of potential confirmations or falsifications of this

model. Careful comparison of neo- and paleo- biogeography should not only allow polarity tests of dispersal, but also contribute another criterion to the debate over the location of the Flood/post-Flood boundary in the fossil record. Finally, although modern currents can be used as a first-order approximation of post-Flood currents, actual locations and intensities (e.g., Tethys geometry; mountain uplift) should be determined by careful climatic, sea level, and geological modeling.

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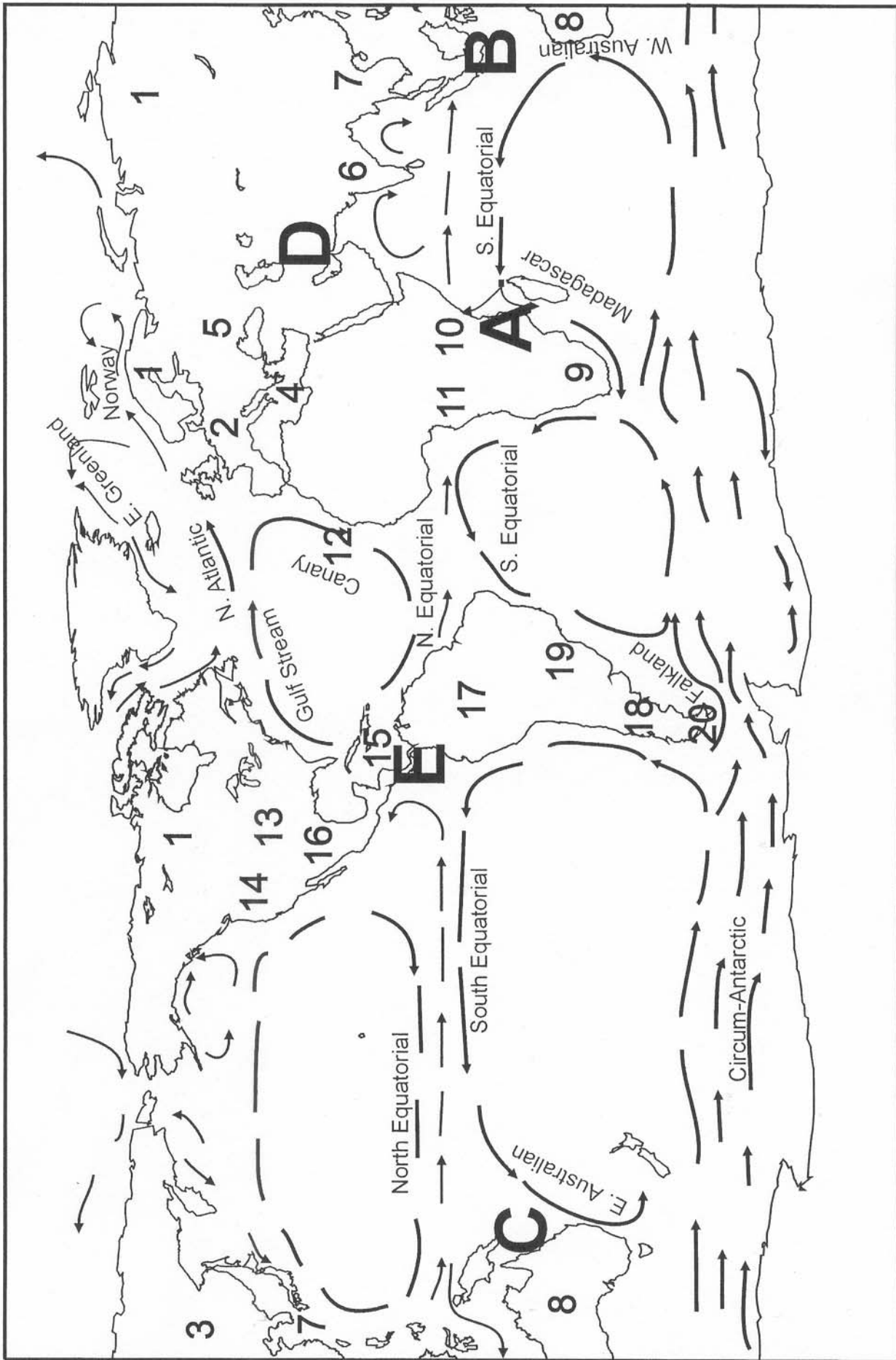


Figure 1: Correspondence of Currents, Gates, and Areas of Endemism. The present configuration of continents and ocean currents is shown. The twenty areas of plant endemism identified by [8] are indicated by numbers 1 through 20. The five biogeographic 'gates' of [9] are indicated by letters A-E.

