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Noah's Ark: a saga of science denial

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Abstract
The biblical story of Noah's Ark sits at the intersection of faith and science. Over the years many have debated whether scientific evidence exists that would corroborate biological claims in the Ark narrative. Many religions have flood stories, but the biblical idea of a global flood that covered all land is factually erroneous, there is not enough water, and a global flood would turn all water saline, to the detriment of fresh-water organisms. The boat-building skills necessary for the Ark did not appear for centuries after the supposed flood. The notion that Noah took males and females of animals (plants were not mentioned), so as to not erase all of non-human creation, is biologically impossible given that there are 1.7 million species today, as well as undescribed and extinct species. To rescue the Ark narrative from this fatal flaw, creationists created a pseudo-scientific method called baraminology, which claims that animal "kinds" in the bible were not today's species, but "common denominators" (baramins) from which today's 1.7 million species arose (e.g., evolved, the antithesis of creation). Hence, Noah did not need to bring all species living at the time on the Ark, only a few baramins. The lack of mention of parasites, insects, microorganisms and much of the earth's biodiversity (e.g., kangaroos) reveals the primitive stage of biological knowledge at the time. Recent claims that Noah had dinosaurs on the Ark, and that people co-existed with the 600 species of dinosaurs, including one as tall as a 6-story building, and predators like *Velociraptor*, lack scientific credibility. The idea that today's species arose from a male and female baramin ignores inbreeding effects; matings would between siblings or siblings and parents. That Noah, his wife, three sons and their wives, gave rise to humanity also ignores inbreeding (and the effects of the parasites they carried). Attempts to reconcile biological aspects of the Ark narrative with modern understanding of geological and biological sciences require the denial of science and the substitution of faith. That is, those who believe in the biological accuracy of the Ark narrative have failed the burden of proof. Nonetheless, if someone wishes to derive a spiritual message from the story of Noah's Ark, they can do so without requiring it to be scientifically factual, which is fortunate because it is not.

Keywords Global flood, Baraminology, Inbreeding, Hitchens razor, Parasites, Dinosaurs, Rapid speciation

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"From vaccination refusal to climate change denial, anti-science views are threatening humanity" (Philipp-Muller et al. 2022).

Introduction

For the last century or more, we have relied on scientific inquiry for providing understanding about the natural world and its living things, from microbes to mammoths. Scientific inquiry provides a framework in which observable or measurable evidence is used to test competing hypotheses, leading to the falsification of some or continued acceptance of others. Even what were thought to be well established ideas can be overturned in the face of new or better evidence. In spite of the enormous and undeniable progress made through scientific inquiry, Neil deGrasse Tyson (2017) remarked that never before have so many stood in denial of science. How has the public's confidence in science been eroded?

Philipp-Muller et al. (2022) discuss reasons for the current trend of science denial. They note that when scientific information conflicts with beliefs held in one's social group, a person is apt to be favorable to others with similar beliefs (the "ingroup") and dismiss those with opposing views (the "outgroup") without considering alternative viewpoints. For example, those doubting climate change exhibit hostility towards those that accept that global climate change is supported by scientific evidence. Some who hold strong religious beliefs are anti-science because of the perception that scientists are atheists and favor evolution, making them a part of the religious outgroup. It escapes the notice of anti-vaxxers that they are alive to express anti-science opinions because they did not die or suffer from diphtheria, mumps, pneumonia, polio, tuberculosis, typhoid fever, or smallpox, childhood diseases against which they were probably vaccinated. Thus, we are in a political climate in which it is acceptable to deny scientific evidence simply because someone does not like its implications irrespective of their level of understanding of the topic.

Science denial can be exacerbated when ideas based on faith and those based on observable scientific evidence stand opposed (Coyne 2015). A prime example is the story of Noah's Ark, where some faith-based creationists claim that the Ark narrative is compatible with our understanding of modern biological and geological sciences (Table 1). Examining this story is appropriate given that religious groups in some US states continue to try to have biblical interpretations offered alongside science explanations in public classrooms. Here I review why it impossible to reconcile biblical passages about the Ark with the biological knowledge that has accrued since the books of the Bible were written centuries ago without recourse to science denial. In particular, the burden of proof rests with those claiming biological accuracy of the Ark narrative, and they fall well short.

Table 1 Instances of science denial required to make the Ark narrative biologically realistic

Claims of the Ark Narrative	Scientific Knowledge
1) Noah took a few "baramins" instead of 1.7 million different species alive today	There is no evidence of baramins
2) Baramins diversified into modern species when the Ark returned to dry land	The process is evolution, no mention of this in Bible
3) The Ark included eight people: Noah and his wife, his three sons and their wives	Upon making landfall the level of inbreeding required to repopulate earth would have been catastrophic
4) Dinosaurs were on the Ark	False. There is a 65 million year gap between dinosaurs and humans
5) The entire earth was covered by flood waters	False, there is/was not enough water
6) Noah did not bring 2 of each oceanic species, because they could survive in the salty floodwaters	Saltwater would doom all freshwater organisms; there were no aquariums on the Ark.
7) Noah built an ocean-going vessel to accommodate himself and his family and some number of baramins	Such boat-building skills did not develop for centuries after Noah
8) Parasites were free-living and not debilitating organisms to their hosts, they were not part of the Ark narrative	False. Parasites have been parasites for millions of yrs, and are the most numerous group of organisms; failure of biblical accounts to mention them is a fundamental flaw in the Ark narrative
9) Zooplankton, phytoplankton, insects, or microorganisms are missing from the Ark narrative	These include millions of basic life forms just as ecologically important as animals that breath through their nostrils
10) Major groups of organisms are not mentioned showing a lack of awareness of world biodiversity	Kangaroos, among thousands of other endemics from different continents receive no mention in Ark narrative
11) A male and female of each animal type led to 1.7 million species in ca. 4,000 years	The inbreeding effects would be catastrophic, and this is an impossible rate of new species formation
12) The Ark provided but a single environment	An Ark would need different sections for animals from polar regions, deserts, tropical rain forests, freshwater lakes, etc.
13) The Grand Canyon was formed by receding waters from the biblical flood	The Grand Canyon was formed over millions of years

Floods and religion

Many religions (e.g., Hinduism, Buddhism, Judaism, Islam, Greek mythology) and cultures (China, Japan) have accounts of floods that impacted the local landscape in dramatic ways. The oldest flood narrative is probably The Epic of Gilgamesh, ca. 1750 BC. But no flood story has achieved greater recognition than the biblical story of Noah's Ark, possibly derived from the flood narrative of

Gilgamesh, where the God of the Bible sent a worldwide flood to punish disobedient people, a flood of a magnitude that was catastrophic to anything but organisms that could live in oceans. (Interestingly, it would have taken a truly byzantine step to also kill off all marine life) In the account of Genesis, written around the 5th century BC, it is stated that Noah and his wife, and their three sons and their wives were spared so as preserve a spark of humanity. To survive the flood Noah was instructed to build the Ark, which would allow these eight people to survive at sea whilst the flood waters ravaged any remaining land-dwelling (and freshwater) creatures and the rest of humanity including women, children, fetuses, seniors, handicapped persons, and the infirm. The timing is estimated by young-earth creationists at ca. 2350 BC, hence around 4375 years before present. Apparently, so as not to require a complete reset of creation, Noah was instructed to bring aboard the Ark two of every kind of land-dwelling animal that breathed through nostrils, as well either 7 individuals or 7 pairs of clean animals (those with divided hoofs, that chew the cud, and are cleft-footed, including oxen, sheep, deer, and gazelles). The clean animals were to be kept alive until the Ark was grounded by receding flood waters and then sacrificed to God (i.e., they were not food for captive carnivores). Acceptance of the biological and geological reality of the Ark narrative requires many instances of science denial.

The story of Noah's Ark and the worldwide flood

The flood. — Literal biblical interpretations claim that the flood left no dry land, which if true presents a problem. Mt. Everest is 29,032 ft (8849 m) above sea level, raising the question of how much flood water would need to be added to the earth's oceans to reach such a height? The oceans contain about 97% of all of Earth's water, with the remaining 3% in glaciers, rivers and lakes. If oceans and freshwaters were combined, global sea level would rise about 250 ft, leaving over 29,000 feet of Mt Everest above water, not to mention thousands of other mountains, plateaus, and other high elevation areas. The average height above sea level exceeds 250 ft for all states except New Jersey, Rhode Island, Florida, Louisiana and Delaware, and the District of Columbia. If the water contained in the atmosphere fell to earth as rain it would raise global oceans by about 1.5 inches (Phelan 2022). Claims that ocean valleys were lowered and tall mountains such as Mt. Everest were elevated post-flood, to negate calculations about the lack of water needed to fulfill biblical interpretations (Foley and Lacey 2018), have no basis (e.g., evidence) either in biblical writing or more importantly in geological and oceanographic science. Furthermore, if all fresh (4%) and salt (97%) water were combined, the salinity would be very close to that of today's oceans, dooming all freshwater plants and animals. Thus, there is/was not enough water for the global flood claimed by creationists and claims to the contrary lack scientific evidence.

The Ark.—Creationists have debated the exact dimensions of an Ark that could have been made by Noah and perhaps others, all of whom lacked shipbuilding experience for a vessel of that magnitude. In short even a vessel with the biblical dimensions of the Ark could not have been constructed at that time with the materials at hand and the lack of knowledge in physics, calculus, mechanical engineering (e.g., solving differential equations for bending, torque and shear), and shipbuilding (Moore 1983). The lack of any physical remains from the Ark is consistent with its existence as symbolic, although all that remains of a far smaller ship (Dokos) of the same vintage (2200 BC) is pottery on the ocean floor. Nevertheless, a boat capable of the feats attributable to the Ark (duration at sea, thousands of miles of navigation) is an impossible engineering feat for that time. That the Bible provides some dimensions for an Ark is different from it actually being constructed and seaworthy and capable of supporting thousands of animals for nearly a year. Only finding a well preserved Ark could challenge this criticism.

The Grand Canyon was not carved by receding waters from a global flood. —To provide evidence that there was a global flood, biblical apologists suggest that the Grand Canyon was carved by receding flood waters. There is no geological evidence in support of this claim (Weber 1980). It is known by geologists that the Colorado River has carved the Grand Canyon for the past 5–6 million years, revealing sediment layers older than 1 billion years. Within these layers, fossils can be found revealing what life was like hundreds of millions of years ago, all the way back to the first explosion of life in the Cambrian. Towards the base of the canyon, there are sediment layers that exhibit irregularity from the layers above them. These layers are called unconformities, meaning that a drastic event caused a disruption of the surface to disturb the temporal order of the sediment layers. According to Dr. Karl Karlstorm, geology professor at the University of New Mexico, "The present Grand Canyon is made up of sections each with somewhat different ages and histories. Prior to 6 million years ago, there were paleorivers and paleocanyons whose flow direction and geometry is rapidly getting figured out by the geologic community." The Grand Canyon is a result of geological processes over millions of years, and not a flood 4375 years ago.

Animals taken aboard the Ark: microorganisms to dinosaurs.

An obvious problem with the Ark being the cradle of today's biodiversity is the fact that there are today about 1.7^{+} million living species, other undescribed species, and an even greater numbers of extinct species (at least 95% of all species that have existed). No boat, not even

a symbolic one, could have taken a male and female of each of 1.7 million species (even excluding asexual and hermaphroditic species). However, because Noah was instructed (Belknap and Chaffey 2019) to take animals that breath through nostrils, it would exclude the million or so insects that breath through holes in their exoskeletons called spiracles, or freshwater fish who use gills for respiration (https://Arkencounter.com/animals/how-many/). Some suggest that "most insects could survive outside the Ark". This is false because there is only one group of truly marine insects, the sea skaters (genus *Halobates*, 45 species). If insects were not on the Ark, it leaves the daunting task of how to explain how the 1,000,000^{+} species of insects alive today (https://www.amnh.org/explore/ology/earth/ask-a-scientist-about-our-environment/which-animal-group-has-the-most-organisms) survived in a world with no land and only salt water, and expanded globally to the current species diversity in the ensuing 4375 years. Insects are the most species-rich (non-parasitic) group of animals on earth, play major ecological roles in maintaining soil, recycling, and pollination. Of course, even today few people appreciate the enormous diversity of insects and this was true of Noah's time as well. But that Noah had no instruction for saving insects, which include at least 40% of all species, presents an insurmountable challenge to a literal biological interpretation of the Ark narrative that requires faith rather than scientific evidence.

Microorganisms.--Microorganisms are just as important to the maintenance of earth's biodiversity as animals that breath through their nostrils. Microscopic animals pose a problem for Ark supporters. Zooplankton, the animal basis of the aquatic food web, are microscopic and were not accounted for in Ark or biblical lore, but in any event, those inhabiting freshwater were doomed by the salty waters of a global flood (the same applies to freshwater fish). That is, the flood eradicated the animal base of the food chain in freshwater ecosystems, and there is no explanation how it regenerated, hence, it must be taken on faith alone in the absence of scientific evidence. Also, many species of small-bodied insects as well as most microorganisms are identifiable only by microscopic examination. Unfortunately for potential taxonomists of Noah's time, microscopes were not invented until the late 1500's. The sheer number of microorganisms presents a formidable challenge. Some estimates place the number of microorganisms at a trillion species (Rappuoli et al. 2023). If Noah had 50 years to prepare for the voyage, he would have had to identify 384,615 species of microorganisms per week, without a microscope. And once sorted, they had to be kept alive; unfortunately, petri dishes with agar as a food source were invented much later. If God created all living creatures, one assumes that the sheer number of microorganisms would have deserved mention. To argue that it is irrelevant that God didn't instruct Noah to include microorganisms because people of that day could not see them, is disingenuous.

Plants.--In Genesis 1:11–12, it was noted that the land produced plants bearing seeds according to each kind, and trees bearing fruit with seeds. In addition, ca. 25,000 species of phytoplankton are known, equally important to the base of food webs as zooplankton, and most identifiable only under a microscope. Given biblical mention of plants, it is surprising that Noah received no direct instruction for preserving an integral component of life, namely photosynthesizing plants, although salty floodwaters doomed freshwater plants. Obviously, the Ark could not have supported a massive greenhouse with redwoods to cacti. Some creationists suggest that Noah brought seeds. However, even if Noah had thought to bring seeds, it would have been a botanical impossibility for him to bring sufficient representation to capture the diversity exhibited in today's 380,000 recognized species of plants (not to mention fungi, bryophytes, lichens, etc.), most of which occur nowhere near Noah's home. To exclude a botanical plan is a striking failing of the Ark narrative, in spite of ad hoc arguments to the contrary (Wright undated). In passing, it would seem prudent to have excluded some noxious plants such as the Australian Stinging Bush (*Dendrocnide moroides*) from the Ark.

Parasites.--The world of parasites presents difficulties for Ark supporters. Today, the most common substrate for an animal to live on is another animal. That is, every animal usually has several parasites and some parasites have their own parasites. Some parasites are relatively benign, others more harmful. If God created all living things, one might consider parasites as a pinnacle of creation. In fact, Janovy (2011) suggested that "So God could easily have made tapeworms simply for His own pleasure." Often whether an animal is infected with (created) parasites is impossible to discover without sacrificing the animal, but one might presume that Noah would select animals that were carrying a high diversity of parasites, so that these perfectly created animals would not be lost in the flood, given that they cannot survive outside of a host or in salt water. To deal with the unwelcome possibility that God deliberately created parasites, some suggest parasites might not have been harmful at the time of the voyage. Sherman (2021) suggested "But when God cursed the earth, these creatures probably experienced changes in their body systems and became parasitic." For example, in considering the mosquito vector of the malarial parasite Sherwin (2013) opined "God may have adjusted the original design of these creatures at the time of the Curse, allowing them to feed off other creatures. Or perhaps female mosquitoes lived off high-protein plant extracts before the Fall, using their mouthparts to penetrate into the plant tissues." I am unaware of where

in the Bible it is written that God created a perfect organism but later "switched" it to a radically different life style. The attempt to shoehorn vague biblical references into our modern biological understanding of parasites is an embarrassing example of special pleading and science denial. It is unrealistic to think that biblical writers knew a fraction of what we know today about parasites, and hence, one should not expect anything credible about parasitology from them. But lack of mention of parasites in the Ark narrative is a serious omission. And then there are human parasites.

Humans are host to at least 300 species of parasites and have been since Noah's time. Flurry (2022) mentions in a creationist website (i.e., not a peer-reviewed science journal) that fossilized eggs of human whipworms, tapeworms, roundworms and pinworms were found beneath ancient stone toilets dated as mid-seventh century BC, indicating substantial human gut parasite loads. What about the humans on the Ark? It is unknown which members of Noah's family were hosts to some of the more onerous human parasites, including Guinea worm, *Plasmodium falciparum* (malarial parasite), the helminth *Loa loa* (eye worm), schistosomes (blood flukes), tapeworms, roundworms (elephantiasis), pin worms, or the remaining 300 species of human parasites? To preserve even some human parasites, the parasite load of the 8 crew members on the Ark would have been substantial if not debilitating. As noted above to salvage Noah's legacy from parasites, some (e.g. Sherwin 2013) suggest that parasites were once free-living creatures. In fact, evolutionary biologists think that parasites indeed were once free-living organisms that invaded other organisms, so how does this conflict with the quote from Sherwin (2013)?

The first known parasite appears in the fossil record over 500 million years ago (Zhang et al. 2020). Phylogenies of parasites and their hosts show considerable similarities, indicating that they are co-evolved, plus there are many examples of parasites "jumping" hosts (e.g., some are not host specific). For example, chimpanzees, bonobos and gorillas are hosts to close relatives of the human *Plasmodium vivax*, the parasite that causes malaria outside of Africa. Molecular genetic analysis showed that from an ancient stock of *P. vivax* parasites capable of infecting both humans and apes, a bottlenecked lineage of these parasites emerged out of Africa and underwent rapid population growth in humans as it spread globally in Southeast Asia and South America (Loy et al. 2018; Plenderleith et al. 2022). That is, the nonhuman Great Apes share related parasites, one of which invaded humans. If parasites were originally free-living, they clearly became parasitic prior to the evolution of humans, which creationists say were created after "land animals" that would have to include the higher primates. In addition, parasites have been found in dinosaur scat (Poinar and Boucot 2006). These examples reveal how modern science negates attempts to attribute to biblical writers knowledge they simply did not have. Thus, the parasitic lifestyle is nearly as ancient as life itself, and no scientific evidence suggests parasites transitioned to their current lifestyle post Ark.

Global biodiversity and earth's habitats.-- Knowledge of global biodiversity at the time of Noah was fragmentary, and, for example, the entire marsupial fauna of Australia was unknown to Noah. Kangaroos are not mentioned in the Bible and therefore it is impossible that Noah kept kangaroos, and that the Ark dropped them off in Australia (and other marsupials in South America) before making landfall in Europe at the putative Mt. Ararat site, a navigable distance of approximately 7,000 miles. This holds true for many other kinds of animals, including armadillos, capybara, and kodkod of South America, and hyrax, elephant shrew, and Cape Mountain zebra of south Africa. Lack of mention of the vast diversity of the worlds animals, given that some species (or baramins) are mentioned in the Bible, solidifies the fact that Noah's was unaware of worldwide biodiversity and hence, could not have selected the diversity of animals required to populate the earth with 1.7 million species alive today.

Surveys of the world's biodiversity show that all major terrestrial habitats support living creatures, including polar regions, islands (e.g., New Zealand), cold and hot deserts, tropical rain forests, prairies, marshes, temperate forests, to name a few. Noah would have had to subdivide the Ark into ecoregions that mimic these different environments, a feat that would seem to have merited mention in the Ark narrative.Additionally, after the flood waters receded, how could the earth'sbiomes have remained untouched and suitable for re-occupation?

*Dinosaurs on the Ark.--*Perhaps the most bizarre claim by recent creationists is that Noah took dinosaurs on the Ark (https://answersingenesis.org/dinosaurs/were-dinosaurs-on-noahs-ark/). Unable to deny the existence of dinosaurs, it became necessary to concoct untestable ideas of how Noah brought dinosaurs on the Ark. Anyone with a cursory familiarity with dinosaurs will wonder how any animals on the Ark survived alongside at least two *Tyrannosaurus rex* or two *Velociraptor*. Various explanations have been proposed. Perhaps Noah brought eggs or juveniles of predatory dinosaurs that he kept away from the clean animals (destined for later sacrifice) and other natural prey. Perhaps they hibernated for the entire voyage. More far-fetched suggestions include the notion of Noah raising meal worms for carnivores and insect eaters or making bread out of grasshoppers (Lacey 2021). For obvious reasons, the Bible is mute on care and maintenance of dinosaurs (also large cats, venomous snakes and spiders, Komodo dragon, etc.) on the voyage.

Pre-Flood, if Noah and his family had lived side-by-side with the roughly 700 known species of dinosaurs, some (e.g., *Sauroposeidon proteles*) as tall as a 6-story building, there would be frequent mention of them in the Bible. Claims that biblical mention of "behemoth", "tannin," or "leviathan" were dinosaurs are whimsical at best. It is obvious that people of Noah's day would have been defenseless against predatory dinosaurs. Surely it would have been worthy of biblical mention to explain what weapons people used to fend off a *Velociraptor*, *Allosaurus* or any of the other 100 or so species of predatory dinosaurs. Relatively modern humans killed large animals like mammoths for food but attacking a *T. rex* with a sharpened stick would have been suicidal.

As paleontologists have noted, if Noah and his clan co-existed with dinosaurs, there would be numerous examples of fossil deposits where bones of humans and dinosaurs both co-occur given the huge number of dinosaur fossils from at least 100 locations worldwide (North America 9, Greenland 1, South America 8, Africa 15, Europe 20, Australia 4, New Zealand 1, Asia 38, Madagascar 1, Antarctica 1). Instead, dinosaurs (birds excluded) and humans are separated by at least 60 million years in the fossil record, which explains why there is no mention of dinosaurs in the Bible. Reports that human and dinosaur footprints coexist in Texas have been decisively falsified (Weber 1981). The scientific evidence from geology and paleontology is unambiguous: humans and dinosaurs did not coexist and there were no non-avian dinosaurs on an Ark.

Baraminology: 1.7 million species reduced to 3,500 kinds?

In recognition of advances in scientific inquiry, young earth creationists invented a method termed baraminology (Marsh 1944, Wood 2006; Cserhati and Ahlquist 2019) that superficially appears scientific but can be seen as a pseudoscientific attempt to rescue the Ark narrative. The goal of baraminology is to discover baramins - a generic type of animal that is referred to in the Bible as a "kind" of animal instead of a modern species. In essence, baraminologists study modern species' characteristics to find the "least common denominator" for a group of species and designate this as a baramin. Baramins are separated by insurmountable barriers (Gishlick 2006). Creationists seized upon the opportunity to interpret "kind" as more inclusive than species because it reduced, drastically, the 1.7 million species known today to a minimum of baramins that might fit on the Ark and that eight people could have fed, cleaned up after and cared for. For comparison, the Henry Doorly Zoo in Omaha, Nebraska houses 17,000 animals of 962 species spread over 130 acres, taken care of by about 1,000 full and part-time staff.

Post-flood, baramins are presumed to have given rise to all 1.7 million species existing today, in just over 4000 years, an unheard of rate of new species formation. Today's species are sometimes said to be minor variants of the original baramins, apparently to stave off suggestions of macro evolution, or the origin of new major evolutionary lineages (which would be baramins). However, Ahlquist and Lightener (2021) wrote "there is no question God created his creatures with the ability to reproduce and adapt, filling the world with an astounding array of diversity even within a created kind". Cserati and Ahlquist (2019) wrote "If, based on DNA similarity, Caprimulgiformes and Apodiformes hypothetically come from the same created kind, then why did they diverge so much over the past 6,000 years?" This is indeed the question. Our knowledge of phylogenetics and the fossil record do not support the notion that only minor variations "evolved" from common ancestors, as shown in the study of horses by (Brophy and Gregory 2023). Interestingly, the process of post-flood baramin diversification producing an "astounding array of diversity" is what we recognize as evolution, the antithesis of creationism.

How does one identify a baramin in theory and practice? A critique of the field is given by Gishlick (2006), who wrote that the basic task of baraminology is to find "boundaries in the history of life that cannot be crossed." Because baramins were created kinds, in perfection, they therefore cannot go extinct or give rise to other baramins. However, baraminology is not scientific because this assumption cannot be falsified with evidence– there are no special characters that separate a baramin from a random species. Baraminology amounts to tautology because it recovers its assumptions (baramins) as conclusions (baramins).

In practice, there are parallels between baraminology and the construction of evolutionary trees, or phylogenetics. However, the construction of phylogenetic trees does not have preordained outcomes such as the discovery of special common ancestors separated in evolutionary time by insurmountable barriers. Consider the hypothetical evolutionary tree in Fig. 1. The six modern and two extinct species have common ancestors, and these have common ancestors, eventually tracing back to a single common ancestor. Which common ancestor(s) qualifies as a baramin? The common ancestor of all eight species might be the ancestral baramin. Alternatively because of the extinction of species C and D, there is a morphological gap, often sought after by baraminologists as evidence of insurmountable barriers, between species A and B, and E-H, and one might claim there are two baramins, one leading to A and B, the other to E-H.

There is no scientific (e.g., falsifiable) basis for judging which common ancestor might be *the* ancestral baramin, that is, identifying baramins is arbitrary and

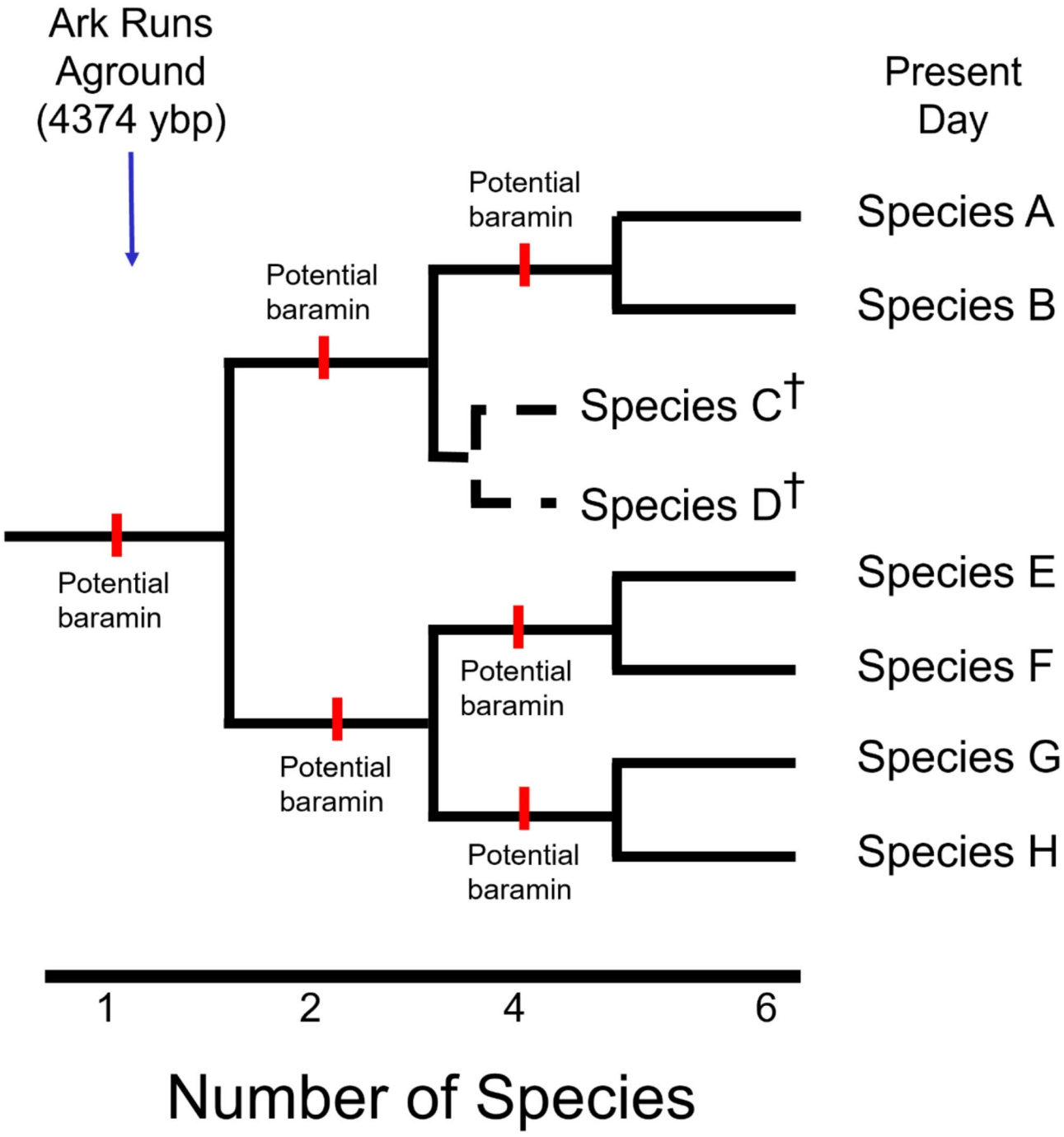

Fig. 1 A general depiction of the evolutionary history of a group species. If the occurrence of today's species from the original baramins was relatively constat there should have been an extremely high number of new species in the era in which taxonomists were first describing species. The dotted lines indicate two extinct lineages. The tree shows that it is arbitrary to designate baramins

nonscientific. Understandably, most analyses of baramins exclude phylogenetic trees (see Brophy and Gregory 2023 for an exception), likely because they show that ancestral baramins go extinct, none is more "common-denominator-like" than any other, and it is obvious that baramins can give rise to other baramins in the same way that common ancestors have their own common ancestors. Phylogenetic trees are too similar to a Darwinian view of descent with modification to fit biblical interpretations of baraminologists. In short, baraminology is a futile attempt to subvert the meaning of phylogenetic trees to serve a biblical (faith) purpose rather than to uncover the pattern of evolutionary history (science) using objective

and falsifiable scientific evidence, without an a priori goal (baramins).

Baraminology and Biological Reality.--A creationist website claimed that their researchers estimated a maximum of 7,000 animals (3,500 baramins) on the Ark (https://arkencounter.com/animals/care/), from which came the entire 1,700,000 million species alive today. Ahlquist and Lightner (2021) wrote "It may be at first perplexing that so many species of landfowl (game birds) differing vastly in size, breeding habits, general ecology, and especially plumage diversity can be derived from a single pair of birds on the Ark." Indeed, no evolutionary biologist thinks this is possible in 4735 years, unless you go back to the dawn of landfowl, around the Late Cretaceous ca. 66 million years ago; then is there sufficient time, and a single common ancestor of the group. It is informative to explore this process with more diverse groups.

Consider the approximately 5,000 species of mammals that exist today. Instead of taking 10,000 individuals, Noah would have taken just a male and female of one or more generic-looking mammal baramins (that carried a few baramin parasites). Upon the Ark making dry land, the mammal baramin (or baramins) and their parasites proliferated into the current diversity: bats, antelopes, camels, giraffes, hippopotamuses, horses, rhinoceroses, tapirs, armadillos, sloths, anteaters, aardvarks, elephants, mammoths, tree shrews, colugos, bison, primates (including Old World monkeys, New World monkeys, great apes including humans), lemurs, rabbits, pikas, rodents, pangolins, dogs, cats, bears, mongooses, and skunks (whales, seals, manatees, sirenians could live in salt water). It is true that all mammals trace to a single common ancestor, but it is a 200 million year old species that resembled a small, nocturnal and subterranean mouse or rat, with long jaws and teeth (Damas et al. 2022). As mammals evolved from this common ancestor, aided by the demise of dinosaurs, it led to the extreme diversity of species from monotremes to blue whales. The above list makes clear that these could not have been derived from a single baramin of even a few baramins. For instance it should be obvious that kangaroos and whales did not come from one baramin, and probably each of the mammalian groups mentioned above would have their own ancestral baramin; hence, Noah's task would have been taxonomically as well as logistically challenging.

Morphological information can be misleading as to actual evolutionary diversity, because of the evolutionary process of convergence: sharks, dolphins and ichthyosaurs look alike, for example, but are not closely related. Genetic information can be used to assess whether there are genetic gaps among modern mammals because the "blueprints of heredity" (DNA) are less prone to convergent evolution. This means that baramins ought to be identifiable as groups of species separated by large, insurmountable, genetic gaps. Buchanan and Zink (2021) compared 20 genes (44,466 base pairs of DNA) for 102 mammal species representing most of mammalian diversity. If the baramin idea is correct, there should be discrete gaps in the distribution of pairwise genetic distances. However, a plot (Fig. 2) of genetic distances reveals no discrete gaps in the genetic divergences that could be baramins. Thus, genetic evidence provides no support for mammalian baramins and given the nature of the distribution any divisions into baramins would be arbitrary. Furthermore, if all 5,000 species of mammals arose in the last 4735 years, they should be extremely closely related genetically, which Fig. 2 shows is not the case. There is no reason to expect mammal baramins to be atypical, leading to the inescapable conclusion that the total number of baramins of all land animals exceeds the capacity of a biblical Ark.

Other challenges abound. If we disregard the plea to ignore insects, dung beetles provide a useful illustration. Dung beetles were associated with the sun god Ra in Egyptian religion and their ecological role well established. There are at least 9500 surviving species today, split among three basic groups (rollers, tunnelers and dwellers) that could conceivably be baramins, occurring on every continent. If Noah had six of these beetles (two of each baramin), to remove droppings from elephants, dinosaurs, rhinos, hippos, swine, etc., the current diversity was reached by the addition of an unprecedented average rate of 2 new species each year. But it is not even that simple. As lineages (baramins) proliferate over the last 4300 years, the rate of new species' occurrence becomes much greater nearer the present time (Fig. 1). That is, when each of the original baramins transformed into two descendants (each a common ancestor), diversity doubled in the first time interval, but with each cycle of speciation, diversity increases more rapidly. Entomologists have been collecting and cataloguing dung beetles, beginning with Linnaeus' *Systema Naturae* in 1735, and they might have witnessed the appearance of newly evolved species under their very eyes, which they did not, nor does the fossil record reveal.

Considering insects as a whole, if the 1,000,000 species (minimum estimate) of insects emerged in the last 4375 years, new species would appear daily. There is no evidence of this in any scientific or lay writings. Even if the evolution of species from baramins stopped for some reason at the dawn of taxonomy 200 years ago, such an increase in the rate of new species arising is not observed in any fossil deposits for any group. Thus, the rapid proliferation of species over the last few thousand years lacks any supporting evidence and renders the model fatally flawed.

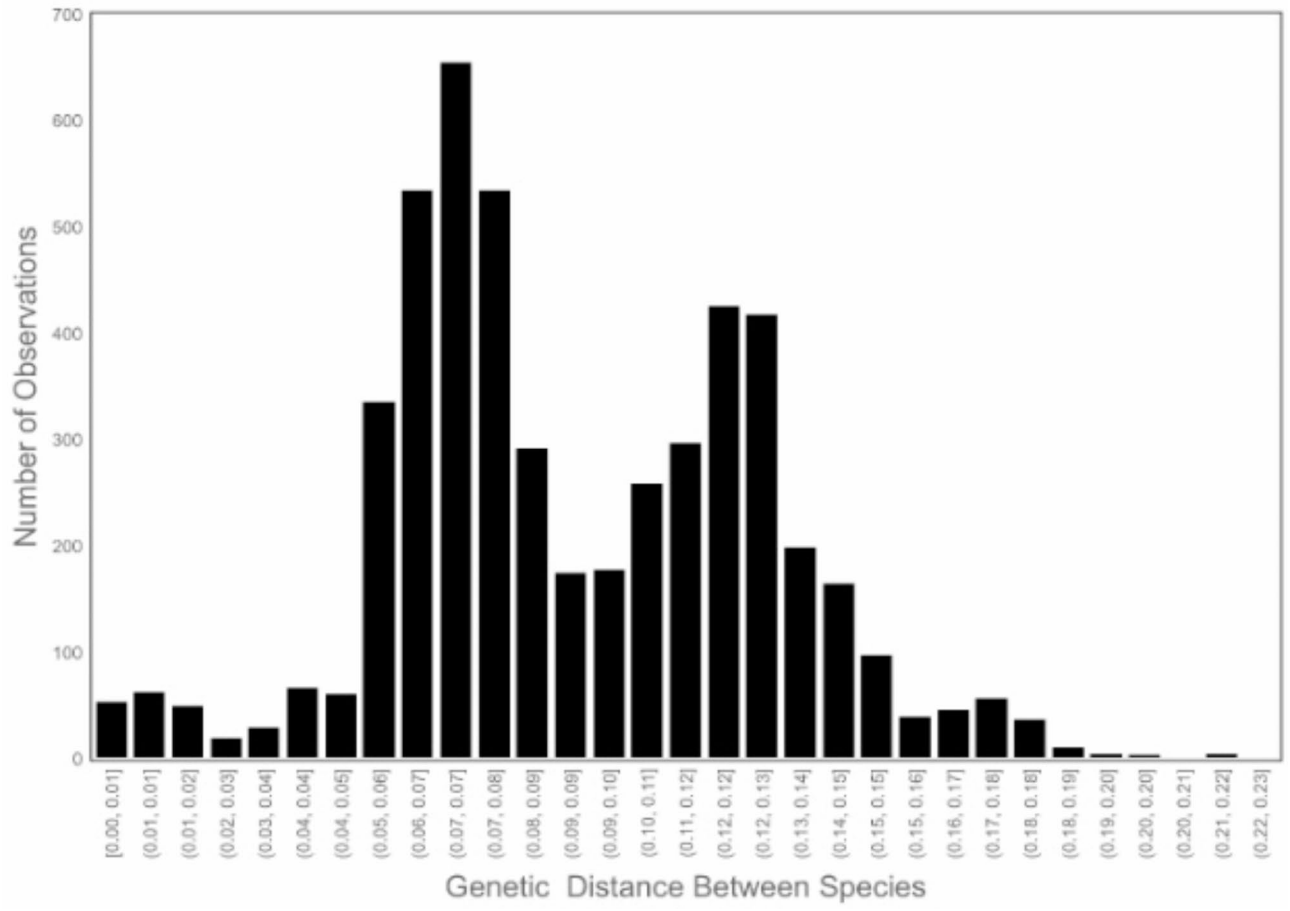

Fig. 2 Histogram showing genetic distances between 102 pairs of mammal species representing most of mammalian diversity for 20 nuclear genes; data from Buchanan and Zink (2021). If there were genetic baramins underlying mammalian evolution, there would be discrete, isolated bars in the histogram corresponding to uncrossable boundaries

The genetic consequences of two by two

Humans have recognized for some time that mating among close kin leads to deleterious and usually fatal effects of inbreeding via the expression of harmful mutations normally masked in the heterozygous state. For example, one of the most distinguished royal houses of Europe was the Habsburgs, having a royal presence from about 1440 until 1806 (with some gaps). To keep wealth "in the family" the Habsburgs practiced consanguineous matings, with frequent marriages between close relatives. Charles II of Spain was the direct descendant of all eight of his great-grandparents who themselves descended from Joanna and Philip I of Castile. Charles II, a result of an uncle-niece marriage, was highly inbred, which was manifested in his being short, lame, epileptic, sterile and sporting a prominent mandibular prognathism, later known as the Habsburg lip/jaw. This level of inbreeding is perhaps surprising given that one of the biblical "Levitical laws" forbids parent-child, sister-brother, grandparent-grandchild, uncle-niece, aunt-nephew, and half sibling marriages. The Habsburgs rolled the genetic dice and the outcome was predictable– extinction of their lineage accompanied by severe and chronic malformations, diseases and illnesses. The same would have been true for Noah and his immediate family, where marriages would have been either incestuous or between first cousins at best.

With such well understood dangers of inbreeding how could the 2×2 pairings of baramins not lead to rampant inbreeding effects, even greater than those observed in the Habsburg lineage? As baramins reproduced, their offspring would be forced into sibling-sibling or sibling-parent matings. To think that the earth's 1.7 million species evolved from a few thousand baramins in a few thousand years defines science denial. The "inbreeding debt" would have been catastrophic. Anyone with a minimal understanding of genetics would recognize that the genetics of this Ark "model" could not withstand that level of inbreeding, and to claim otherwise amounts to ignoring well established genetic theory.

Conclusions

We live in an era where most citizens have historically unparalleled access to scientific information. Yet in spite of this access, several factors degrade accurate dissemination and interpretation of this information. In particular, people lacking sufficient knowledge to understand scientific topics use social media outlets to spread well-intentioned but flawed interpretations from their ingroup that result from misunderstanding scientific information. This is an example of the Dunning-Kruger Effect (Dunning 2011), defined as situations in which a person does not know enough about a topic to realize that they do not understand the topic. This phenomenon is not new. Roman emperor and philosopher Marcus Aurelius (121 AD to 180 AD) stated "The opinion of 10,000 men is of no value if none of them knows anything about the subject." As a result, even in developed and educationally enriched countries, we see a growing public denial of science in which in spite of a person's lack of expertise, they deny a scientific truth if it conflicts with beliefs expressed in their outgroup (Philipp-Muller et al. 2022).

The level of understanding held by those claiming the biological and geological accuracy of the Ark narrative is equivalent to a Dunning-Kruger effect because their limited knowledge base prevents their recognition of fatal flaws in the story. Further exacerbating the problem is that people's misconceptions are reinforced by those that appear better qualified. For example, Ken Ham, founder of Answers in Genesis has no publications in scientific journals, no advanced degrees, only secondhand opinions about geology and biology, yet maintains that the account in Genesis is factual, Noah's flood was real, and that evolution is false. Ham is, unfortunately, not credible source of scientific information. His lack of scientific training is evident when he remarked in answer to the question "What if anything would ever change your mind?" that "No one will ever convince me" that the Bible is fallible, which is a position opposite of scientists. This attitude then, is the root of science denial.

Not all instances of faith and science are incompatible. As noted by the Clergy Letter Project (2025): "We believe that the theory of evolution is a foundational scientific truth, one that has stood up to rigorous scrutiny and upon which much of human knowledge and achievement rests. To reject this truth or to treat it as "one theory among others" is to deliberately embrace scientific ignorance and transmit such ignorance to our children". To mislead the public and taint school curricula by suggesting that the Ark narrative is biologically realistic requires replacing facts with faith, denying scientific evidence. To teach students that Noah took dinosaurs on the Ark is beyond irresponsible, and instead of encouraging creative and critical thinking, it indoctrinates them into science denial. Hitchens (2007) suggested that what can be asserted without evidence can also be dismissed without evidence, the so-called Hitchens Razor. Acceptance of a scientific reality to the Ark narrative is to do so without evidence, and according to Hitchens Razor the Ark narrative can be ignored owing to a lack of evidence. However, scientists have shown repeatedly that claims about the biological reality of the Ark narrative are unsupported by evidence, not just in one aspect, such as the nonexistence of a global flood, but in every aspect (Table 1). In other words, adherents to the biological accuracy of the Ark narrative have failed the burden of proof. Nonetheless, those who wish to derive a spiritual message from the parable of Noah's Ark can do so without requiring it to be scientifically factual, which is fortunate, because it is not.

Supplementary Information

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Supplementary Material 1

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