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THE BIOTA AND LOGISTICS OF NOAH'S ARK

JOHN WOODMORAPPE
M. S. GEOLOGY, B. S. GEOLOGY, B. S. BIOLOGY
6505 N. NASHVILLE #301
CHICAGO, IL 60631

KEYWORDS

ABSTRACT
This report investigates the identity and housing of approximately 16,000 animals on Noah's Ark. An evaluation of the housing, feeding, and watering requirements of these animals demonstrate the feasibility of the Ark account.

INTRODUCTION
Until the late 18th century, only a few hundred mammalian species were known [77]. Up to that time, the account of the Ark was accepted literally. No problem was seen in the housing and care of this small number of animals.

Now nearly 5000 mammalian species are known [77]. Partly because of the ever-growing number of animals discovered in the last two centuries (and needed to be accommodated on the Ark), the Ark account was gradually abandoned by most believers. For a historical survey of the rejection of the Ark account, see Browne [8, pp. 3-27].

The belief in the impossibility of the Ark spawned various compromises, such as the local flood theory. This reduced the Noachian Deluge to a glorified river flood of the Tigris-Euphrates. In recent years, the Ark account has enjoyed a renaissance of limited general attention as a result of the modern Scientific Creationist revival. This, in turn, has triggered a rather vitriolic backlash against the Ark account by anti-Creationists (notably Moore [52]).

The purpose of this work is systematically to examine the account of the Ark from the viewpoint of the feasibility of the housing of animals on the Ark. Diamond [12] has discussed the work of the 17th Century Jesuit Athanasius Kircher regarding the Ark and its logistics, and challenged modern Creationists to do the same. I have accepted the challenge.

Arguments against the Ark are basically the same, whether they are old or new, or whether they come from unbelievers, modernists, or various evangelicals (i.e. "theistic" evolutionists and semi-Creationists). Some of these arguments are examined and answered in this article. In a future monograph on the Ark, the arguments are rebutted in much more detail and comprehensiveness. The lengthy monograph is tentatively scheduled for publication by the Institute for Creation Research, probably in 1995. Owing to the space limitations of these Proceedings, only a fraction of the information to be published in the monograph can be presented here. Furthermore, only the results of some calculations, without tabulated data or supporting detail, are presented here.

THE QUESTION OF THE SUPERNATURAL
Moore [52] has alleged that the Ark account, in order to work as described in Scripture, would require so many miraculous solutions to (his imagined) insurmountable problems, that it would have been far easier for God to have transported Noah's family to heaven and just recreated a new biota on earth after the Flood. The central fallacy of his argument, solely with respect to theology, is the premise that God always prefers to work one large miracle rather than many smaller ones. Consider, for instance, the fact that God could have instantaneously teleported the Israelites into the Promised Land rather than have worked the many smaller miracles associated with the Exodus and the 40 years in the wilderness. He obviously chose not to do it this way, even though it would have been far simpler (according to Moore's thinking).
Whitcomb [75, p.19] has identified the following six areas of Divine miraculous action with regard to the Flood: 1) the divinely-revealed design of the Ark; 2) the gathering and care of the animals; 3) the uplift of oceanic waters from beneath; 4) the release of waters from above; 5) the formation of our present ocean basins; and 6) the formation of our present continents and mountain ranges. I concur with Whitcomb’s analysis, except that I assume only naturalistic causes in the housing and care of animals on the Ark. The primary reason why I reject miracles not explicitly listed in Scripture (e.g. a supernaturally-induced sleep over the animals on the Ark so that they would require minimal care) is the fact that they are completely unnecessary.

**ANIMALS NOT ON THE ARK**

It was shown long ago [39, 76] that the Ark was not required to carry every species of Kingdom Animalia. Oblivious to this, recent critics of the Ark account (e.g. Moore [52], McGowan [46], and Futuyma [24]) continue to repeat the old canard that it did. For instance, Moore [52, p. 16] fantasizes that the Ark carried deep-sea fish. McGowan [46, p. 57], not to be outdone, puts whales and sharks on the Ark. Futuyma [24, pp. 202-3] adds to the farce by reposting all the millions of plant and animal species on to the Ark.

Fantasies and straw-men of the Ark aside, we can examine what Scripture actually says concerning the types of animal life taken on the Ark. The Hebrew terminology in the Genesis account rules out invertebrates having been taken on the Ark [39]. The same holds true for marine and amphibious vertebrates [29, pp. 86-7]. It is clear that the contents of the Ark were limited to all living and extinct land mammals, birds, and land reptiles [39].

Possibly the more terrestrial amphibians were on the Ark [39]. But since they were few in number [10, 16] and were mostly small in size [10, 35, 62], their presence on the Ark would have had a negligible effect on calculations. For this reason, they are not considered further. At the same time, it must be remembered that I have erred on the side of amphibious animals by virtue of the fact that I have included entire extant and extinct terrestrial families on the Ark, even if some of their members were amphibious. This is necessary because of the fact that many amphibious animals do not show obvious skeletal features reflecting their capability for living in water, making it virtually impossible to know for certain which extinct genera were semi-aquatic and therefore not taken on the Ark.

**TAXONOMIC RANK OF ANIMALS ON THE ARK**

Calculating the numbers of animals on the Ark requires not only an analysis of their taxonomic identity, but also taxonomic rank. Despite years of work by Creationists demonstrating that the Created Kind must be broader than the species, anti-Creationists (e.g. Moore [52]) continue to try to confuse the issue by insisting that the Ark had to house every species of animal.

It is difficult to escape the conclusion that the anti-Biblicists will stoop to any absurdity to multiply the cargo of the Ark into millions of animals in order to discredit the Ark account at any cost. To crown the fraud, the anti-Creationists (e.g. Awbrey [4] and Moore [52]) have the audacity to claim that the Creationists concocted the concept of the Created Kind as an ad hoc device to reduce the numbers of animals on the Ark. Clearly, the shoe is on the other foot.

The Created Kind is not some vague ethereal entity, but is well founded by Creationist scholarship. For instance, there is a wealth of evidence that, at minimum, the Created Kind is broader than the species of conventional taxonomy. Moreover, Jones [37], has showed that the min is a real entity and not simply that 'like begets like'.

Any putative difficulty in the discovery of a one-to-one correspondence between a specific taxonomic rank and the Created Kind in no way negates the concept of the Kind. It merely reflects the artificiality of human taxonomy. Gish [28] recently pointed out that he had been misrepresented by anti-Creationists, and had never suggested that the Created Kind may be as high as the order of conventional taxonomy. In his decades-long studies of turtles, Frair [22, and earlier-cited works] did suggest that the Created Kind among turtles may be as high as the order. However, the Testudines may be an atypically homogenous group, at least at the ordinal level. Furthermore, members of different families within Testudines do not freely interbreed with each other (Frair, personal communication). Following the interbreeding criteria discussed below, it follows that the Kind among turtles must be below the ordinal level.

Jones [38], largely using Scriptural evidence (e.g. the animal lists in Leviticus), demonstrated that the Created Kind is approximately equivalent to the subfamily or family, at least in the case of birds and mammals. Recently, Scherer [68] has arrived at the same conclusion, but on the basis of scientific evidence. This evidence includes numerous documented cases of interbreeding between individuals of different species and genera, as well as interbreeding with a third species or genus in situations where two species or genera do not themselves interbreed. The many instances he cites can be multiplied greatly.

For instance, Hubbs [32] has provided a large inventory of known instances of trans-specific and trans-generic breeding among fish. McAllister and Coad [44] have presented a matrix depicting all known instances of trans-generic breeding in the fish family Cichlidae. (This matrix is quite similar to the one by the Creationist Scherer [67].)
The latter shows trans-generic breeding within the avian family Anatidae). Of course, there are also many more recent examples of hybridization between fish species [45, 49]. There are also many instances of trans-specific and trans-generic breeding among reptiles [5, 23, 33, 50].

Breeding among different species of birds is exceedingly common, and also occurs between genera [73]. For a bibliography of all papers providing similar examples, in just several issues of only one journal of avian biology (Auk), see [51]. There is a recent survey [11] of such occurrences among marsupial mammals alone. Finally, instances of hybrid zones among different species of plants and animals have recently been tabulated [28].

Of course, the above-cited examples hardly exhaust the possibilities for interbreeding between species and genera. Indeed, it is a fact that most species are named according to morphological differences between animals and not according to proven reproductive isolation (Archer [2, p. 130]):

...the fact that only a tiny percentage of recognized species have been tested, naturally or otherwise, for reproductive isolation from other apparently closely related forms...

Many evolutionists (e.g. Awbrey [4]) have claimed that macroevolution is simply microevolution given more time. A corollary of this is that, to be consistent and intellectually honest, since Creationists accept the fact that new species and genera can arise, then they must also accept the evolutionistic claim that new higher taxa can arise. In response to these premises, let us remember that the oft-repeated evolutionistic claim that small changes in populations add up to macroevolutionary innovations over alleged time is not proven. Moreover, the alleged evolutionary origin of families, orders, classes, phyla, and kingdoms is most certainly not simply the origin of new species and genera, just given more time. There is a definite, qualitative difference between the origin of new species and genera, and the supposed evolutionary origin of higher taxa. As Bullock [9, p. 90] writes:

Most of the differences between species evolved in the diversification of species and genera, the lower categories of taxa, and are presumed to be adaptive specializations without any obvious advance in overall grade of complexity. These changes can be called lateral radiations (Bullock, 1991; Harvey and Pagel, 1991).

Another kind of evolutionary change is the relatively rare increase in general complexity, such as characterizes the differences between some phyla, classes, and orders, and possibly a few families.

I have already referred to these changes as vertical grades of complexity (italics in original).

It is interesting to note that the evolutionist Bullock not only echoes what Scientific Creationists have been saying all along, but even uses much the same vocabulary (namely lateral radiations, which is very similar to the Creationist expression: horizontal changes).

Anti-Creationists commonly raise doubts if new species and genera could arise in only the few thousand years since the Flood. In doing so, they display their ignorance of both Creationist and evolutionist research along these lines. Both Creationists [40] and evolutionists [7, pp. 442-3] have compiled numerous examples of various invertebrates and vertebrates giving rise to new species and genera in thousands of years (or much fewer). Some of these examples have subsequently been subject to detailed studies. For instance, Berry [6] has reviewed evidence of rapid speciation in mice in as short a time as a few decades, whereas Kornfield [42] has investigated the origin of reproductively-isolated species of African cichlid fishes in only 5000 years.

One consequence of the glaciation several thousand years ago is that the tropics must have undergone profound climatic changes, because belts of rainfall must have shifted considerably during glacial and interglacial intervals. As a consequence, regardless of whether one adheres to the evolutionistic or the Creationistic time scale, many species in the tropics must have arisen in only the last several thousand years. Nagel [55] has provided evidence that species of central African beetles have arisen in only 5000 years, while Moreau [53] has allowed extensive speciation among tropical birds in a comparative time period.

If, as the preponderance of evidence [38, 68] shows, the Created Kind was equivalent to the family (at least in the case of mammals and birds), then there were only about 2000 animals on the Ark [39]. In such a case it is obvious that there was no problem in housing all the animals on the commodious Ark. However, in order to make this exercise more interesting, I have been more conservative, adopting the genus as the taxonomic rank of the Created Kind. This necessitates, as shown below, approximately 16,000 animals on the Ark.
THE QUESTION OF UNKNOWN EXTINCT ANIMALS

The accommodation of undiscovered (and also undiscoverable) extinct animals on the Ark must be considered. There is no way of determining, or even intelligently guessing, the numbers and sizes of unknown animals. A number of estimates for the numbers of specific unknown types of extinct animals exist (e.g. dinosaurs [14]). However, these are all based on the assumption of the validity of organic evolution and the geologic time scale in their calculations, and thus have no meaning in the Creationist-Diluvianist paradigm.

Considering the results of calculations (not shown), there exists, once all relevant live and known extinct animals are accounted for, a significant amount of unused Ark floor space. This allows a considerable spare floor area on the Ark to account for unknown extinct animals. Of course, we must remember that there is plenty of yet additional room on the Ark by virtue of the fact that I have placed all genera of live and extinct land vertebrates on the Ark, when in reality there were probably only subfamilies or families of the same on the Ark.

Furthermore, the existence of unknown extinct animals is partly offset by the fact that a substantial fraction of all provisionally-accepted extinct genera, all of which are placed on the Ark in this study, are of dubious validity [10]. Indeed, since its inception, vertebrate paleontology has suffered from a proliferation of invalid generic names based on nondiagnostic material, and an exaggeration of the numbers of putatively valid generic names derived from more complete material. In recent decades, a considerable number of extinct genera have been “sunk”, and this process continues today. For example, a recent study [35] has drawn several long-accepted therapsid genera into synonymy.

It is the dubious genera of large-sized animals that have the largest effect on my tabulation and calculations. For instance, for purposes of this study, I have included all 87 commonly-cited sauropod dinosaur genera as valid, and placed them on the Ark (as juveniles). Yet, according to sauropod specialist McIntosh [40, p. 345], only 12 sauropod genera can be regarded as “firmly established” and an additional 12 “fairly well established”.

CLEAN ANIMALS ON THE ARK

Accounting for clean animals on the Ark is problematic for several reasons. In the first place, the concept of a clean animal at the time of Noah may not have been the same as it was millennia later with the Levitical System [43, pp. 190-191]. However, considering the perspicuity of Scripture, I will, in the absence of evidence to the contrary, provisionally assume that the concepts of clean animals were the same during the time of Noah as they were after the inception of the Law of Moses.

It is also difficult to determine whether Noah took seven individuals or seven pairs of clean animals on the Ark. Jones [39] surveyed over 40 Bible commentaries on this matter and found them about evenly divided as to whether Scripture indicates seven pairs and seven individuals.

Nor can we be certain which genera were clean (if we use the genus as the level of the Created kind, as done throughout this work). Scripture considers all reptiles unclean [63, p. 33]. Among mammals, those with cloven hooves that chew continually or chew again (not necessarily ruminate, which is a modern physiological concept) are clean (Deuteronomy 14: 4-6). Scripture specifically lists the clean mammals as consisting of approximately 13 bovid/cervid genera [38]. According to Jewish tradition (for example, Maimonides: [26, p. 49-50]), this Scriptural list is exhaustive; so no other live or extinct mammal is to be accepted as clean, even if it chews again and divides the hoof.

Thus the simanim (sign) of cloven hoofs and chewing again is a necessary but not necessarily sufficient condition for a land mammal to be accepted as clean [20]. For instance, the giraffe divides the hoof and chews again, but there is no clear Jewish tradition of it’s being kosher [63, p. 31]. According to some other Jewish traditions [15], only domesticated animals can be clean. Pertaining to these, only a few tens of genera of mammals and birds are commonly reckoned as domesticated (for a list of these genera, see Fowler [21, p. 1067]). All these considerations rule out numerous wild and also all extinct bovid, giraffid, and cervid genera as being clean. Furthermore, if Scripture is accepted as a self-contained revelation (that is, requiring no extra-Biblical sources of information in order to be understood properly), then it also follows that only animals individually specified in Scripture as clean can be regarded as such.

As for birds, Scripture lists numerous birds which are unclean (see Jones [38] for listing along with taxonomic analysis). However, only several types of birds, belonging to a few tens of genera at most, are mentioned in the Bible as suitable for human use [63]. Again, once Scripture is its own interpreter, then these are the only birds to be accepted as clean. However, if Jewish tradition is considered, then there are only a few additional birds, not mentioned in the Bible, accepted as clean [63].

Various commentators have suggested a connection between Noah’s sacrifice after the Flood (Genesis 8:20) and the identity of the clean animals, but Scripture does not indicate how many animals were sacrificed by Noah [39].
However, keeping in mind the Hebrew terminologies and usages in Scripture, we can note that Noah’s sacrifice was a burnt offering (Hebrew olah, [64, p. 601]). This type of sacrifice, according to other examples in Scripture, is limited to bulls, sheep and goats, and birds [64, p. 601-2]. This adds further support to the limitation of clean animals to certain common animals in Bible lands. Note that this is yet another reason for eliminating from the Ark (as seven individuals or seven pairs) all extinct land vertebrates, as well as all extant land vertebrates not explicitly mentioned in Scripture as clean.

Unfortunately, even this does not allow a precise tally of the number of clean genera on the Ark because there is a notably high degree of interbreeding among genera of clean animals. This can be especially seen among genera in the families Bovidae and Cervidae [74]; genera in Galliformes (various chickens, turkeys, quail, and pheasants [1, 47]; genera in Anseriformes (i.e. many genera in Anatidae [57]; and many genera in Passeriformes (i.e. finches [66]. To further compound the uncertainty, not all genera of Anseriformes and Galliformes are accepted as clean according to certain Jewish tradition [20].

Although it is difficult to enumerate precisely how many clean genera were on the Ark, it should be obvious that there were only a few tens of clean genera at most, and they were mostly small. For this reason, calculations regarding the Ark and its logistics are relatively insensitive to the presence of the clean animals on the Ark, even if they were in seven pairs and not seven individuals. Thus the clean animals are not considered further in this report, although their minimal effect on calculations will be demonstrated in my upcoming Monograph on the Ark.

**NUMBER OF ANIMALS ON THE ARK**

After having determined which animals were on the Ark, I compiled and computed body-mass estimates for all the living and known extinct genera of land vertebrates. There are 85 orders of live and known extinct land vertebrates, but the distribution of their constituent genera is highly asymmetric. Merely the largest three orders (Passeriformes, Squamata, and Rodentia) contain nearly half of the 16,000 animals on the Ark. Because of this asymmetry, I followed a similar methodology employed by May [43] in his analysis of insect body sizes. I studied in great detail the body mass distributions within the several top orders which contain by far the most genera (i.e., to which the overall calculations show the greatest sensitivity), and simply assigned a characteristic value or values for body mass to each small order.

For extinct families and extinct orders, I derived body mass estimates from sources too numerous to mention here. Two of the major sources of general information on sizes (for small orders) were Carroll [10] and Potts and Behrensmeyer [58]. For extinct genera in extant reptilian and extant avian families, I simply extrapolated the total database for body weights of extant genera to the number of extinct ones.

I followed a somewhat different methodology for extinct genera in extant mammalian families. Peczis [57] has found that 67% of mammalian genera tend to occur in the modal body-mass category of the typical mammalian family, and 90% of genera occur in the two largest weight categories of the given family. I thus extrapolated the extinct genera in extant families according to a 2:1 ratio with respect to the aforementioned body-weight categories.

I list sources only for body weights of extant genera. It is worthwhile to note that body mass estimates are available for nearly all land mammal genera [13, 56], and for most extant avian genera [18, 65].

As for extant reptiles, a compendium of body mass estimates for all or most land reptilian genera does not exist. I developed a partial one of my own, compiling estimates for a large fraction of all extant reptilian genera. For tortoises, I converted carapace sizes for various genera [19] into body masses. For squamate genera, I first utilized relatively comprehensive estimates of body masses [3,27,59,60,69,72]. I then expanded this data base by converting snout-vent lengths [17, and other less-comprehensive sources] into body mass. These snout-vent lengths were converted into body masses through the utilization of an appropriate regression [61]. The distribution of body masses obtained for many specific reptilian genera were subsequently extrapolated to the total number of extant squamate genera [16] and extinct ones [10].

To summarize, there were 7, 876 pairs of animals (that is, land-vertebrate genera) placed on the Ark, based on hundreds of sources. Because animals vary greatly in size, even to some extent individuals of the same genus, I have divided all the animals into order-of-magnitude body-mass categories. These span eight orders of magnitude of body mass, ranging in size from hummingbirds (i.e., a few grams per individual) to sauropods (up to perhaps 80 megagrams adult mass). The purpose of dividing all the animals into body-mass categories is to make possible calculations of floor-space requirements for animal housing, as well as the total mass and volume of provender and water for all the animals during a 371-day stay on the Ark.

The number of animals on the Ark, apportioned per body-mass category, in summary is as follows: 869 animals in the 1-10 gram body-mass category, 2343 at 10-100 grams, 1619 at 100 g-1 kg, 1176 at 1-10 kg, 964 at 10-100 kg, 594 at 100-1000 kgs, 258 at 1000-10,000 kgs, and 53 at 10,000-100,000 kgs.
As can be seen from the tabulation, the vast majority of the animals on the Ark were small. The median animal on the Ark was the size of a small rat, about 100 grams [30, p.70]. It is obvious that Whitcomb and Morris [76] have been overly generous to their detractors when they had suggested that the average animal on the Ark was the size of a sheep. In fact, from the tabulation, it can be seen that only about 11% of the animals on the Ark were substantially larger than sheep.

As concerning medium to large animals (that is, all animals greater than 10 kg as adults), I have represented them on the Ark as juveniles. It would not have been worth it to have represented animals smaller than 10 kg as juveniles, because the juveniles would have been near or at adult size by the time of their disembarkation from the Ark.

**ARK FLOOR SPACE ALLOTMENT FOR THE ANIMALS**

How much floor space should be allowed for each size category of animal on the Ark? Moore [42] has cited large floor areas, based on the claims of zoo keepers. However, the zoo is a very inappropriate and misleading analog for the housing requirements of the animals on the Ark. First of all, the zoo is a facility intended for the public display of captive animals, as well as for the relatively comfortable confinement of animals on a permanent basis. Enclosures must generally also be spacious enough for animals to breed in captivity. By contrast, the Ark represents temporary confinement of animals without their necessarily breeding during the stay on the Ark. Furthermore, the zoo represents the elective keeping of wild animals for educational, scientific, and entertainment purposes, whereas the Ark represents an extreme and emergency situation. The Ark was most certainly not a floating zoo, but a floating Flood shelter.

Indeed, during emergencies, we are not primarily concerned with either human or animal comfort, but only with physical survival through the emergency itself (i.e., think of the comfort of people confined in a fallout shelter). Since we only need consider the minimum floor space for animals to survive in reasonable health for one year, we must orient ourselves not according to modern zoos, but according to modern examples of animals kept under conditions of extreme confinement. The closest modern analogues to the Ark are not the zoo but the laboratory animal situation and the intensive livestock unit, commonly known as the factory farm [36]. In the latter, we have up to 100,000 animals, living under very crowded conditions under one roof, and cared for by a handful of people.

We might naturally suppose that there might be some analogy between the Ark and situations where modern animals are transported en masse on ships. However, such animals are at sea usually only a few days or weeks. Clearly, the duration is not comparable enough for a meaningful comparison with the year-long Ark experience.

Moore [52] has criticized Creationists [76] for suggesting that the confinement of animals on the Ark could be compared to the confinement and transport of livestock on railroad cars, because livestock are allowed to leave the cars, during railroad stops, for exercise. He is clearly clutching at straws, because the above-cited examples of intensive animal confinement (namely factory farms and laboratory-animal situations) reflect long-term intensive animal confinement, for months or years, with few or no opportunities for animals to leave their enclosures.

For purposes of estimating the minimum floor space needed for small animals on the Ark, I have used recommended floor-space areas for the housing of laboratory animals [70]. The floor areas for animals of various sizes are: 38.7 square cms for an animal under 10 grams, 110 square cms for 100 grams, 387 square cms for 350 grams, 0.28 square meters for 2-4 kg. For larger animals, I used the values for floor spacing of intensively-housed livestock, because animals must be kept tightly enclosed so that they will be forced to trample their manure through slatted floors (as opposed to lying in it). The floor areas I used (based on [34]) are: 0.56 square cms for a 50 kg animal, 1.11 square meters for a 350 kg one (juvenile of a 1000-10,000 kg adult), and 2.51 square meters for a several hundred kg (or more) animal (juvenile of a 10,000-100,000 kg sauropod dinosaur).

Throughout the calculations, I used these values as midpoints of the body-mass categories. For small to medium-sized animals (i.e., 1 gram to 100 kg), I used the arithmetical midpoint of each category (5 grams, 50 grams, 500 grams, etc.). For larger animals (i.e., 100 kg to 100 tons), I used the geometric midpoint (adults would be: 316 kg, 3160 kg, and 31,600 kg), because larger animals appear to occur at a greater frequency towards the lower category of each respective body-mass category. I used all the midpoints, multiplied by the number of animals in each body-mass category, not only to calculate floor space for housing, but also for purposes of computing the total volumes of potable water and provender for 371 days.
CALCULATIONS OF WATER AND PROVENDER FOR ANIMALS ON THE ARK

Based on the animals and their sizes quoted above, and various equations for water intake of captive animals, I estimate that the total amount of potable water on the Ark was 3.64 million liters. This comprised only 8.43% of total Ark volume, which was 43,169 cubic meters (based on a cubit of 45.72 cm).

As for food, the calculations were not as straightforward, for several reasons. First of all, there is a very large disparity between the food requirements of ectotherms (i.e., reptiles) and endotherms (mammals and birds). We do not know the thermal physiology of therapsids nor dinosaurs, both of which are extinct with no close relatives in the extant fauna. However, I have assumed that their thermal physiology was halfway between that observed in modern mammals/birds and reptiles. This assumption is consistent with the belief that therapsids possessed an intermediate thermal physiology between that usually observed in modern reptiles and modern mammals [31]. Small to medium dinosaurs could have been either ectothermic or endothermic [71]. However, sauropod dinosaurs have been treated here as ectotherms, because a recent biophysical analysis [71] has just about ruled out any possible thermal physiology for them significantly different from that of modern reptiles (scaled, of course, for size).

A further source of complication is the following: Food requirements themselves are subject to a large number of variables, such as dry matter content, digestibility, and bulk density. Based on these and still other factors, along with equations for animal food intake per given ectothermic or endothermic animal mass, I have reached the following conclusion: The total volume of food on the Ark was approximately 3-6 thousand cubic meters. This represented 6-12% of the total Ark volume. The reason for the range of values quoted reflects different combinations of feedstuffs of varying bulk density, digestibility, and moisture content.

CONCLUSION

It is obvious from this work that none of the oft-repeated criticisms of the Ark account can stand up to critical examination. Nor is a constant stream of ad hoc Divine miracles necessary for the Ark account to have happened exactly as the Scriptures teach. Of course, it is not surprising that the Ark account is the butt of ridicule today (note, for instance, the sarcastic cartoon of the hole-filled Ark reproduced in Moore [52] from a newspaper editorial). Fallen man does not want to be reminded of God's judgement in the past any more than he wants to be told of God's judgement in the future.

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