The Mathematics of Genesis: Population Growth versus Genetic Diversity

Exploring the Mathematics Behind Adam, Eve, and Noah

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August 16, 2026

Abstract

This paper explores the Mathematical and Genetic questions surrounding the Genesis narratives of Adam and Eve and Noah. Using population growth equations and Genetic bottleneck formulas, we examine whether these Biblical accounts are Mathematically viable from a population Genetics perspective. The analysis reveals that while population growth from small numbers is Mathematically feasible, but Genetic diversity constraints present significant challenges without Divine intervention or alternative interpretations.

Contents

1 Introduction

The biblical accounts of Adam and Eve as the first human parents, and Noah's family as the sole survivors of a global flood, have long been subjects of Theological and Scientific discussion. This paper does not aim to challenge anyone's faith, but it serves to explore the Mathematical and Genetic implications of these narratives using standard population Genetics formulas.

Two distinct types of Mathematics are relevant:

1. **Population Growth Mathematics**: How quickly can a small population multiply to reach current global numbers?
2. **Genetic Diversity Mathematics**: Can a small founding population retain enough Genetic variation to produce a healthy, disease-resistant species?

2 Population Growth: The Multiplication Mathematics

The exponential growth formula is the standard tool for modeling population increase:

$$P(t) = P_0 \times e^{r \times t} \tag{1}$$

Where:

- $P(t)$ = Population size after t years
- P_0 = Initial population size
- r = Annual growth rate (as a decimal)
- t = Time in years
- e = Euler's number (≈ 2.71828)

2.1 Applying the Formula to Noah

Starting with 8 people and assuming the Flood occurred approximately 4,500 years ago:

$$8,000,000,000 = 8 \times e^{r \times 4500} \tag{2}$$

Solving for r:

$$\frac{8,000,000,000}{8} = e^{r \times 4500} \tag{3}$$

$$1,000,000,000 = e^{r \times 4500} \tag{4}$$

$$\ln(1,000,000,000) = r \times 4500 \tag{5}$$

$$20.72 = r \times 4500 \tag{6}$$

$$r \approx 0.0046 \text{ (or } 0.46\% \text{ per year)} \tag{7}$$

A growth rate of just 0.46% per year is very modest. For comparison, the modern global growth rate is about 0.9% per year. Thus, the population growth Mathematics is entirely feasible.

2.2 Applying the Formula to Adam

Using the standard population growth formula, we can calculate the required growth rate for Adam and Eve's descendants to reach 8 billion people in approximately 6,000 years:

$$r = \left(\frac{8 \times 10^9}{2}\right)^{1/6000} - 1 \approx 0.0037 \text{ (0.37\% per year)} \tag{8}$$

Similarly, the genetic diversity retained after n generations follows the formula:

$$D(n) = \left(1 - \frac{1}{2N}\right)^n \tag{9}$$

For Adam and Eve ($N = 2$), this becomes:

$$D(n) = 0.75^n \tag{10}$$

Solving for when 90% of diversity is lost ($D(n) = 0.10$):

$$0.75^n = 0.10 \rightarrow n \approx 8 \text{ generations} \tag{11}$$

Thus, within approximately 8 generations, 90% of the original genetic diversity would be lost. This is far below the 2,000+ founders that geneticists consider necessary for long-term population viability, highlighting the severe genetic bottleneck that a single couple would create.

3 Genetic Diversity: The Bottleneck Mathematics

Population growth tells only half the story. The other half is Genetic diversity, which is governed by the bottleneck formula:

$$H_t = H_0 \times \left(1 - \frac{1}{2N_e}\right)^t \tag{12}$$

Where:

- H_t = Genetic diversity after t generations
- H_0 = Original Genetic diversity (before the bottleneck)
- N_e = Effective population size (number of breeding individuals)
- t = Number of generations

3.1 Applying the Formula to Adam & Eve

For Adam and Eve, $N_e = 2$:

$$H_t = H_0 \times \left(1 - \frac{1}{4}\right)^t = H_0 \times (0.75)^t \tag{13}$$

After 10 generations:

$$H_{10} = H_0 \times (0.75)^{10} \approx H_0 \times 0.056 \tag{14}$$

This means only about 5.6% of the original Genetic diversity remains after just 10 generations (roughly 200–250 years).

3.2 Applying the Formula to Noah

For Noah's family, $N_e = 8$:

$$H_t = H_0 \times \left(1 - \frac{1}{16}\right)^t = H_0 \times (0.9375)^t \tag{15}$$

After 10 generations:

$$H_{10} = H_0 \times (0.9375)^{10} \approx H_0 \times 0.524 \tag{16}$$

After 36 generations:

$$H_{36} = H_0 \times (0.9375)^{36} \approx H_0 \times 0.10 \tag{17}$$

This means:

- After 10 generations (about 200 years), 52.4% of diversity remains.
- After 36 generations (about 700–900 years), 90% of diversity is lost.

3.3 Step-by-Step Comparison

Table 1: Comparison of Adam & Eve vs. Noah's Ark

Factor	**Adam & Eve (2 people)**	**Noah's Family (8 people)**
Starting Population	2	8
Growth Rate Needed (to reach 8B in 6,000 yrs for Adam; 4,500 yrs for Noah)	$\sim 0.37\%$ per year	$\sim 0.46\%$ per year
Fraction of Genetic Diversity RETAINED per Generation	75% (lose 25% each generation)	93.75% (lose only 6.25% each generation)
Diversity Remaining After 10 Generations	$0.75^{10} \approx 5.6\%$ of original	$0.9375^{10} \approx 52.4\%$ of original
Generations to Lose 90% of Diversity	Solve: $0.75^t = 0.10 \to t \approx 8$ generations	Solve: $0.9375^t = 0.10 \to t \approx 36$ generations
Minimum Founders Needed for Long-Term Viability (Geneticists' Estimate)	Impossible (needs $> 2,000$)	Impossible (needs $> 2,000$)
Theological Workarounds	Sibling marriages + Divine miracle	Intermarriage with external populations OR Divine miracle

4 Theological and Scientific Perspectives

Given the Mathematical challenges, several interpretations exist:

4.1 Literal Interpretation + Divine Miracle

Some believers accept the literal reading of Genesis and assert that God miraculously prevented Genetic defects and accelerated mutation rates to generate diversity. This is a supernatural workaround, not a Mathematical one.

4.2 Pre-Adamite Hypothesis

Many scholars suggest that Adam and Eve were the first *covenantal* humans, chosen by God, but that other human populations existed outside the Garden of Eden. In this view, Cain found a wife among these populations.

4.3 Local Flood Interpretation

A growing number of Christians interpret the Flood as a regional catastrophe that destroyed only the Mesopotamian basin. In this model, Noah's family repopulated that specific region but intermarried with surviving populations elsewhere.

5 Conclusion

The Mathematics of population growth shows that a small group *can* multiply into billions within a few thousand years. However, the Mathematics of Genetic diversity shows that such a small group cannot retain enough variation to produce a healthy, viable species without either:

1. Divine intervention (a miracle), or

2. A non-literal reading of Genesis (e.g., Pre-Adamites or a local flood).

Ultimately, this paper does not seek to undermine anyone's faith but it is meant as an invitation to readers into a thoughtful exploration of how Mathematics, Science, and Theology can interact with humility and curiosity.

Acknowledgments

Special thanks to my AI assistant for providing the Mathematical frameworks, equations, and editorial guidance in developing this paper.

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