Appendix III: Chronologies of Biblical Events

There appears to be a good fit between Old Testament events in the second millennium BC and one of the proposed sets of archaeological dates. There also appears to be a unique chronology to satisfy the chronology of the kings of Israel and Judah, including the synchronous listings in the books of kings. Unfortunately, the chronologies of the second millennium BC and of the kings in the first millennium BC appear mismatched to 1Kings 6:1 by 170 years, and mismatched to Acts 13:19 by 70 years. Tables of both sets of chronology are given below, but the harmony between the two still seems to be elusive.

The chronology below for the 1st Millennium B.C. consists of Yigael Yadin's "Low Chronology" in the East (e.g., Yigael Yadin, "Hazor;" New York: Random House, 1975. p. 144), and the R.A. Parker chronology of Egypt, which are mutually consistent for the time between Abraham's slaying of Ur-Nammu and Joseph's viziership in Egypt. [Perhaps half a dozen alternative chronologies have been proposed for Sumer, and also for Egypt. Thus far, only the combination of "Very Low Chronology" of Sumer and the Manfred Bietak chronology of Egypt, is close to also being consistent with the Abraham-Joseph time line; they would lower the dates by 24 and 25 years respectively (i.e., the dates would be more recent).]

David Rice has reviewed the "Kings" table below for the first Millennium BC, but does not vouch for the Assyrian dates before Tukulti-Ninurta II (where the limmu lists begin), and is "dubious about the list from Necho I back to Osochor." These kings and dates are shown with shading.

For the dates of Sheshonq I and the rest of the Egyptian 22nd dynasty, we are entirely dependent upon the chronology of Solomon and Rehoboam. There is little or nothing by which the 23rd-24th dynasties may be dated, but Taharqa of the 25th dynasty lost two battles (to Sennacherib, and then Esarhaddon, of Assyria); he apparently lost his life in the latter.

Dates for the kings listed under "Victories Claimed by Other Kings" are simply uncritically copied from those listed in the "Kings" table.

Early Bible Chronology and Archaeology

Date	Biblical Event	Archaeological Event	Date
BC		Lugal-zage-si conquers/rules Canaan	BC2248-2224?
		Kings of Akkad (≈ Babel) rule Canaan	2224-2082?
		Six kings of Uruk rule Sumer (= Shinar)	2082-2053
2050?	Abram leaves Ur for Harran (Ge 14?)	Ur-Nammu/Ur reigns over Sumer	2053-2036
2045 Nisan 15	Abram & Lot go south to Canaan	Ur-Nammu conquers the West	2050
2036 (±1)	Abram slays Amraphel, king of Shinar	Ur-Nammu dies in battle ("unjustly slain")	**2036**
2034	Ishmael born		
	Abram goes into Egypt	Mentuhotpe II reigns in Egypt [Dyn 11]	2060-2010
ca. 1971 (±11)	Isaac advised to stay away from Egypt	Dynasty 12 overthrows Dynasty 11	1991
ca. 1851	Joseph sold into Egypt	Sesostris III reigns in Egypt [Dyn 12]	1878-1843
ca. 1843	Joseph put into King's Prison	Nymare Amenemes III reigns [1843 = 0 yr]	1842-1797
1841	Joseph interprets dreams of butler/baker		
1839	Joseph exalted to be vice-ruler	Hammamat stone quarries idled	**1839-1825**
1838-1832	feast years	new farmland opened in Fayum	?
1831-1825	famine years	nomarchs first wealthy! then impoverished	? - ?
1830	Jacob moves to Egypt		
1813	Jacob dies, buried in Canaan	[Amenemes III a hero and still reigning]	
	new king who knew not Joseph	end of 12th Dynasty, Egypt divides	1786
1759	Joseph dies	Lesser Hyksos dynasty reigns [Dyn 13]	1786- ?
		Avaris built as capital [later called Raameses]	ca. 1720
1696	Moses born	Hyksos kings [Dyn 13 or 15?]	
1656	Moses leaves palace, flees Egypt	Khian/Iannas reigns (greatest of Dyn 15)	ca. 1656-1618?
1616	Moses returns to Egypt, plagues begin	Mayebre Sheshi/Jambres Assis reigns?	ca. 1617-1615?
1616-1615	Rivers turned to blood Frogs Lice (or sand flies) Israelites exempted hereafter Flies Murrain (disease) on animals Boils and sores Hail/lightning, thunder, fire on ground Locusts Darkness Firstborn slain [Nisan 14]	Queen Hatshepsut's (1484-1469) later inscription regarding the exodus: "I have restored that which was ruins, I have raise up that which was unfinished Since the Asiatics [Hyksos] were in the midst of Avaris [Rameses] of the Northland, and the barbarians [Israel] were in the midst of them, Overthrowing that which was made..."	
1615 Nisan 15 Nisan 15 Nisan 16 Nisan 17 Nisan 18 Nisan 21	Exodus from Egypt to Sukkoth (holy convocation) to Etham, at edge of desert to Pihahiroth crossing the Red Sea third day's journey into wilderness (holy convocation)	250,000 Hyksos have 600 chariots; they become the most hated kings of Egyptian history [historian Manetho]	[Hyksos dates are somewhat uncertain]
1575 Spring	Joshua conquers/burns Jericho	Jericho destroyed and burned at end of Middle Bronze Age (no lengthy siege)	somewhere in 1580-1530?
1575- ca. 1545	Joshua/Ephraim, then Nahshon/Judah, conquer much of Canaan	Many cities damaged/destroyed at end of Middle Bronze Age, Hazor burned.	ditto
> 1476?	Elimelech (grandson of Nahshon) and his son Mahlen die on the Plain of Moab	[Eglon/Moab rules 1493-1476; Midianites war in Moab 1384]	
1378-1339	Deborah/Barak and Gideon conquer Jabin's army and Midianites; give Israel forty years of relief	el-Amarna letters warn Egypt of the Habiru/Apiru overrunning Canaan; Ilimilku [Elimelech] is a leader.	**ca. 1380** - ca. 1345
1246-1207	Philistine captivity	Merneptah's inscription: "Israel is laid waste, his seed [sovereign] is not"	1218 (±19)
≥1119	King Saul begins reigning over Israel		

Kings as Reconstructed by D. Rice, "Time and Prophecy," May 1995

All Israel (12 tribes)

Saul	1049A*-1010A
Ishbosheth	1010A-1008A
David	1010A-970A
Solomon	970A-930A

Judah (2 tribes)

Rehoboam	930A-913A
Abijah	913A-910A
Asa	910A-869A
Jehoshaphat	(872A*-)869A-848A
Jehoram	848A*-841A
Ahaziah	841A
[Athaliah	841A*-835A]
Joash	835A*-796A
Amaziah	796A-767A
Azariah (Uz.)	(791A-) -739A
Jotham	(750A*-) -731A
Ahaz	(735A-) 731A-715A
Hezekiah	(728A*-) 715A-686A
Manasseh	(696A*-) 686A-642A
Amon	642A-640A
Josiah	640A-609A
Jehoahaz	609A
Jehoiakim	608A-597A
Jehoiachin	597A
Zedekiah	597A*-587A
[Gedaliah	587A]

Israel (10 tribes)

Jeroboam	931N*-910N
Nadab	910N*-909N
Baasha	909N*-886N
Elah	886N*-885N
Zimri	[885N]
[Tibni	885N-881N]
Omri	885N*-874N
Ahab	874N*-853N
Ahaziah	853N*-852N
Jehoram	852N*-841N
Jehu	841N*-814N
Jehoahaz	814N*-798N
Jehoash	798N-782N
Jeroboam	(793N-) -753N
Zechariah	[753N]
Shallum	[752N}
Pekah	752N-732N
Menahem	752N-742N
Pekahiah	742N-740N
Hoshea	732N-723N

Babylon

[Šamash-šum-ukin	668N-648N]
Kandalanu	648N-627N
Nabopolassar	626N-605N
Nebuchadnezzar	605N-562N
Amel-Marduk	562N-560N
Neriglissar	560N-556N
Labashi-Marduk	556N
Nabunaid	556N-539N

Medo - Persia

[Darius	]
Cyrus	539N-530N
Cambyses	530N-522N
Bardiya or Smyrdes	[522N]
Darius I	522N-486N
Xerxes	486N-465N
Artaxerxes I	465N-424N

Assyria

Assur-nasir-apil I	1050N-1031N
Sulmanu-asared II	1031N-1019N
Assur-nerari IV	1019N-1013N
Assur-rabi II	1013N-972N
Assur-resa-isi II	972N-967N
Tukulti-apil-Esarra II	967N-935N
Assur dan II	935N-912N
Adad-nerari II	912N-891N
Tukulti-Ninurta II	891N-884N
Assur-nasir-pal II	884N-859N
Shalmaneser III	859N-824N
Šamsi-Adad V	824N-811N
Adad-Nerari III	811N-783N
Shalmaneser IV	783N-773N
Assur-dan III	773N-755N
[Solar eclipse 10th yr, 763Jn15]	
Adad-Nerari V	755N-745N
Tiglath-pilesar III	745N-727N
Shalmaneser V	727N-722N
Sargon	722N-705N
Sennacherib	705N-681N
Esarhaddon	681N-669N
Ashurbanipal	669N-627N
Ashur-etil-ilani	627N-623N
Sin-sar-iskum	623N-612N
Assur-uballit II	612N-609N

Egypt

[No reliable dates BC 1200-700]

OsochÇr/Tanis	[?985-979?]
Siamun	[?979-960?]
Psusennes II	[?960-945?]
Sheshonq I/Libya	[?945-924?]
OsorkÇn I	(36 years)
OsorkÇn II	
TakelÇt II	
Sheshonq III	
Pami	
Sheshonq IV	
OsorchÇ/Tanis	(8 years)
Shabaka/Ethiopia	?716-695?]
Shabataka	?695-690]
Taharqa	689-664
[Necho I/Sais	670-664]
Psammetichus I	664-610
Necho II	610-595
Psammetichus II	595-589
Apries (Hophra)	589-570
Amasis	570-526
Psammetichus III	526-525

A: year beginning Tishri 1 (near Autumnal Equinox); **J**: Julian year beginning Jan. 1; **N**: year beginning Nisan 1 (near Vernal [= Spring] Equinox).
* Reckoned as 1st year of reign (no accesion year); (....): beginning of co-regency with a reigning king (where applicable).
Kings and dates shown with shading have been added from other sources, and are not the responsibility of D. Rice.

JBPwwChronK.tbl97Ap19

Victories Claimed by Other Kings

Ashurnasirpal II (BC 884-859N)/Assyria put to tribute:

Tyre	Byblos	Maiza	Amurru	
Sidon	Mahallata	Kaiza	Arvad (island)	[ANET 275-276]

Shalmaneser III (859-824N)/Assyria in 1st year (B.C. 858N) claims to have defeated armies from Hattina and allies from Adini, Carchemish, Sam'al, Que, Hilukka, Iasbuq, killing 2,900 soldiers and taking 14,600 prisoners of war, and taking tribute of the seashore kings and of a place called Gusi.

in 6th year (B.C. 853N) claims to have defeated:

Nation	King	Chariots	(Foot-) Soldiers	Mounties
Hamath	Irhuleni	700	10,000	700 cavalrymen
Damascus	Hadad-ezer	1200	20,000	1,200 cavalrymen
Israel	Ahab	2000	10,000	
Que			500	
Musri			1,000	
Irqanta		10	10,000	
Arvad	Matinu-ba'lu		200	
Usanata			200	
Shian	Adunu-ba'lu	30	1[0?],000	
Arabia	Gindibu'			1,000 camel-riders
?		?	?	
Ammon	Ba'sa		[...],000	
		3,940	~ 60,000	+1,000

Claims earlier to have taken tribute from Carchemish, Commagene, Gusi, Melitene, Hattina, Gurgum, but claims no tribute from 12 kings above; claims to have slain 14,000 of their soldiers and to have captured some chariots, but does not state his own losses – nor do we know of another war against Damascus for twelve more years; it seems likely that Shalmaneser had suffered still greater losses. From 1Ki 22:3 it seems likely that Damascus/Syria had lost more than Ahab had, and with Assyria virtually beaten, Ahab felt emboldened to take Ramoth Gilead from Syria (allied with Judah, which had not been involved with Shalmaneser). Ben-hadad's war against Israel had been three years earlier, thus apparently in B.C. 856 (after which he had promised to restore the cities previously taken, 1Ki 20:34).

in the 18th year (B.C. 841) defeated Hazael of Damascus, killing 16,000 soldiers, taking 1,121 chariots and 470 riding horses, but apparently failed in a siege of Damascus; took tribute from Tyre, Sidon, and from Jehu son [successor] of Omri (*Ia-ú-a mâr Khu-um-ri-i*).

The tribute of Jehu (*Ia-ú-a*), son of Omri (*Khu-um-ri*); I received from him silver, gold, a golden *saplu*-bowl, a golden vase with pointed bottom, golden tumblers, golden buckets, tin, a staff for a king (and) wooden *purukhtu*. [ANET 277-281]

Less-Precise Dating Methods for the Remote Past

What is the age of the universe? of the earth? and of man? Which hypotheses and theories can account for all we see around us today? Which ones are consistent with Genesis? Which ones are testable by the scientific method (which is necessary to qualify as science, rather than being just metaphysics or pseudo-science)?

Three illustrative approaches to estimating ages outlined below lend themselves to physical measurements and straightforward mathematical computation.

Cosmology

The equations of the theory of general relativity have been tested in a multitude of ways and have thus far passed every test. It is therefore proposed as the description of cosmology: the dynamics of the universe. The combined equation for Einstein's theory of general relativity may be simply written:

$$\frac{1}{R}\frac{d^2R}{dt^2} = \frac{-4\pi G}{3}\left(\rho+3\frac{p}{c^2}\right)+\frac{\Lambda}{3} = -\frac{GM}{R^3} -4\pi G\frac{p}{c^2} +\frac{\Lambda}{3} \qquad (1a)$$

where R is the radius of the universe (m)
t is time (sec)
G is the universal gravitational constant (6.672×10^{-11} $m^3/kg\text{-}sec^2$)
c is the speed of light (2.99792458×10^8 m/sec)
p is the average pressure of matter/energy throughout the universe (a variable; $Nt/m^2 = kg/m\text{-}sec^2$)
ρ is the large-scale average density of matter/energy in the universe (a variable; kg/m^3)
M is the entire mass of the universe ($\sim5\times10^{52}$ kg)
Λ is Einstein's postulated cosmological constant (but about 27% smaller than Einstein's prediction)

A second equation is $$\left(\frac{1}{R}\frac{dR}{dt}\right)^2 = \frac{8\pi}{3}G\rho - K\frac{c^2}{R^2}+\frac{\Lambda}{3} = \frac{2GM}{R^3} -K\frac{c^2}{R^2} +\frac{\Lambda}{3} \quad \{K\approx0\} \qquad (1b)$$

Equations 1 are simple to write, but more difficult to solve. However, for earliest time in the history of the universe, the pressure term would have been dominant, while for the distant future the density and pressure will become small; so the postulated Λ term would become dominant. For earliest time (assuming an adiabatic expansion – no heat flow to or from the universe – with $p/\rho^{5/3}$ being constant) there is no simple solution of Equations 1. At intermediate times (after the first microsecond, with $T << 3.6\times10^{12}$ ºK) the density term dominates, and a solution is:

$$R \approx \left[\frac{9}{2}GM\right]^{1/3} t^{2/3}\left[1+\frac{\Lambda}{12}t^2+\frac{\Lambda^2}{720}t^4+K\right] \approx 2.5\times10^{11}\, t^{2/3}\ (km) \qquad (2a)$$

With the density term dominant, a present age of the universe of order $t \sim 1^{+}\times10^{10}$ years is thereby implied. (The pressure term further decelerated the expansion, but that negligibly decreases the inferred age of the universe.)

For late times the solution would be (assuming no external intervention; e.g., from God):

$$R = A\, e^{\sqrt{\Lambda/3}\,t} \qquad (2b)$$

where A is a constant ($A \approx 0.753\,[3GM/\Lambda]^{1/3}$, or likely about 0.75×10^{23} km), and $\Lambda \sim 1\times10^{-35}$ $sec^{-2} \approx 1\times10^{-20}$ $year^{-2}$.

Summarizing, Equation 1a predicts a rate of expansion of the universe (in percent per unit time) which initially slows down until it reaches a minimum, and then progressively increases ever after. This behavior is consistent with the recent measurements of cosmological expansion back to nearly the beginning. The imposing result of Equation 2a is that there was an origin of the universe, commonly called The Big Bang.[1]

For at least the first 5×10^9 years, and again from now on, the universe expands faster than the speed of light (possible in General Relativity). Thus, the optimum time to measure the history of the universe is now. Is that a mere fortuity?

"*Thus* **saith the LORD, who stretcheth forth** *the* **heavens, and layeth** *the* **foundation of** *the* **earth, and formeth** *the* **breath of man within him.**" Zech 12:1.

[1] A current best-estimate of the age of the universe is $t = 13.73\,(+0.13/-0.17)\times10^9$ years; by David N. Spergel of Princeton University (and 21 co-authors; submitted in 2006 to *Astrophysical Journal*). And currently $R \approx 1.6\times10^{23}$ km.

Geochronology

There is more than one postulate as to the age of the Earth, which can potentially explain everything we see about us today. Consider three postulates:

Old Earth: If the Big Bang produced all elements, and all isotopes of those elements, then we should observe all the isotopes that have not decayed away in the history of the universe.[2] Radioactive isotopes in solid materials should still be measurable after 5-10 half-lives, but after 20 half-lives they should have decayed to less than 1 part per million (1 ppm) and be virtually undetectable. For an example, consider uranium, for which all isotopes are unstable (radioactive). Nine isotopes of uranium are tabulated below, together with the half-life[3] and the natural abundance of each.

Isotope	Half-life ($\tau_{½}$)	Abundance (%)
$_{92}U^{240}$	14.1 hours	—
$_{92}U^{239}$	23.5 minutes	—
$_{92}U^{238}$	4.4683×10^{9} years	99.2746
$_{92}U^{237}$	6.75 days	—
$_{92}U^{236}$	2.34×10^{7} years	—
$_{92}U^{235}$	7.0×10^{8} years	0.72
$_{92}U^{234}$	2.45×10^{5} years	0.0054
$_{92}U^{233}$	1.59×10^{5} years	—
$_{92}U^{232}$	71.7 years	—
		100.00

The failure to find any $_{92}U^{236}$ in natural uranium suggests that solid uranium ore is at least $(20\times\tau_{½}=)\ 0.468\times10^{9}$ years old. The finding of a small percentage of $_{92}U^{235}$ suggests that solid uranium ore is less than $(10\times\tau_{½}=)\ 7\times10^{9}$ years old.

However, the discovery of $_{92}U^{234}$ does not imply the Earth is less than 5×10^{6} years old, because $_{92}U^{238}$ decays into $_{92}U^{234}$ (via α, β^-, β^- decays). Equilibrium would be established after about 2×10^{6} years, resulting in a $_{92}U^{234}$ concentration of 99.2746% (2.45×10^{5} yr / 4.4683×10^{9} yr) = 0.00544%, which is within the precision of the reported measurement.

If $_{92}U^{238}$ and $_{92}U^{235}$ had initially begun in equal amounts, then an age of the solid uranium ores of

$$T \;=\; \left[\tau_{235}^{-1}-\tau_{238}^{-1}\right]^{-1}\lambda n(99.2746\%/0.72\%)/\lambda n(2) \;=\; 5.9\times10^{9}\ years \qquad (3)$$

would be inferred. If a lesser amount of the less-stable $_{92}U^{235}$ survived the cosmic brew, then the age would be reduced, perhaps by ~10% or so. (Geologists commonly suggest around 4.55×10^{9} years for the age of the solid earth.) Thusly, geochronology offers an upper-limit dating of Genesis 1:2, from which must be subtracted the time for the surface and atmosphere to (radiatively) cool from ~2500ºK to under 1000ºK (below which it would no longer be self-luminous). This delay likely required years, but in the absence of substantial volcanic eruptions might not require millennia. Further delay to Genesis 1:2 is, of course, entirely likely.

Alternative Views

A very young Earth: On the other hand, philosophically one cannot disprove that we were created this morning at daybreak, complete with our memories, and everything around us exactly as we find it. Of course, when we would apply such a philosophy, we should conclude that we cannot learn any lessons from history, because there would not be any history. Thus, we discard such a philosophy.

Young Earth: A young earth, of six thousand years, for example (or any other age), can be postulated in the same manner as a very young Earth, yet without violating any recorded history back to Adam and Eve.

All three views above of the age of the Earth can explain how we find the material world about us just as it is. The scientific approach to resolving two or more contradictory explanations of all the data is called Occam's Razor: Of two

[2] Most metals on earth have stable isotopes constituting 0.1% to 100% of each element. [A rare exception is $_{73}Ta^{180}$, which is only 0.0123% of all tantalum. $_{66}Dy^{158}$ is exactly 0.10% of all dysprosium.]

[3] The half-life, $\tau_{½}$, is defined as the time it takes to decay to half the original amount.

or more explanations which can explain all observations, choose the simplest.[4] At present, the Old Earth approaches appear to require fewer assumptions and are therefore in the lead.

DNA Dating

In the 1970s there appeared to be no way to distinguish Special Creation from Punctuated Equilibrium (Punc Eq[5]). But the sequencing of DNA since the 1980s has changed that. Rebecca Cann and two others at U. California/Berkeley in 1987 demonstrated from mitochondrial DNA (mtDNA) that all women in the world are descended from one common female ancestor.[6] Robert Dorit at Yale with two others in 1995 demonstrated from a Y-chromosome that all men in the world are descended from one common male ancestor. The latter found no differences for 729 base-pairs sequenced for 38 men selected to be representative of the world's male population.

The most-obvious dating would be calculated as follows: Let μ be the expected mutation rate (mutation per year per base-pair, expected to be $<10^{-6}$), N be the number of base-pairs sequenced in each individual, m be the number of base-pairs with a variation (polymorphism), and let W be the number of independent individuals sequenced. Then the estimated age back to the common ancestor will be[7]

$$T = \frac{m}{2\mu N(W-1)} \qquad (4)$$

Those who estimate μ, do so by assuming there was a common ancestor for humans and chimpanzees (Dorit also compares with gorillas and orangutans), and that the supposed split occured 4-6 million years ago. Results for three sequencing studies of the Y chromosome, representative of the world's male population, are

Author[8]	μ (mutation/base-pair year)	N (base pairs)	W (men)	m (mutations)
R. Dorit, et.al.	1.35×10^{-9}	729	38	0
M. Hammer	1.9×10^{-9}	2,600	16	1
L.S. Whitfield, et.al.	$0.9631 - 1.284\times10^{-9}$	18,300	5	3

Combining these data sets in an appropriate modification of Equation 4, using Dorit's hypothesis for μ,

$$T_Y = \frac{0+1+3}{2\times1.35\times10^{-9}\left[729(38-1)+2{,}600(16-1)+18{,}300(5-1)\right]} = 10{,}645\ years \qquad (4a)$$

to which the statistical range must be applied. For the commonly-reported 95% confidence, the most-recent common ancestor (MRCA) would be 4,320 to 27,255 years ago. Using Hammer's μ value of 1.9×10^{-9} mutation/year, the span would be reduced 29% to ≥3,070 to **7,564** to ≤19,366 years ago for 95% confidence (within the limits of the assumptions for the model). In either case, one may rule out times less than the recorded history of four thousand years or so.

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[4] E.g., in the days of Copernicus and Kepler, the Ptolemaic theory of epicycles was still able to predict the positions of the planets. The heliocentric (Sun-centered) approach quickly displaced the Ptolemaic theory, not because anyone had disproved the latter, but because the mathematics was simpler.
[William of Ockham, England (ca. 1285-1349): "Entities must not unnecessarily be multiplied."]

[5] Punc Eq, proposed by Stephen Jay Gould, represents the third version of animal evolution theory, although it denies all three of Charles Darwin's fundamental assumptions: (1) all geological and biological processes continue at a constant rate over all time, (2) each succeeding generation has more genetic variations, and (3) only the fittest survive in a food-scarce environment. For Punc Eq, most or all genetic variations were suddenly produced in one or a few calamities in the remote past (overturning assumptions #1 and #2), while only a very few animal freaks could survive at all in the ensuing food-rich environment (overturning #3).

[6] Rebecca L. Cann, Mark Stoneking and Allan C. Wilson, "Mitochondrial DNA and human evolution;" *Nature* 325, p. 31-36 (1 January 1987).

[7] Note that to identify differences requires more than one individual; hence the factor "(W-1)", not "W." The factor of two (2) in the denominator of Equation 4 arises because both individuals have descended from the common ancestor. If each could be compared to DNA from the common ancestor, the factor of two would be removed from the equation.

[8] Robert L. Dorit, Hiroshi Akashi, and Walter Gilbert, "Absence of Polymorphism at the ZFY Locus on the Human Y Chromosome;" *Science* 268, p. 1183-1185 (26 May 1995). Michael F. Hammer, "A recent common ancestry for human Y chromosomes" [letter]; *Nature* 378, p. 376-378 (23 Nov 1995). L. Simon Whitfield, J.E. Sulston, and P.N. Goodfellow, "Sequence variation of the human Y chromosome" [letter]; *Nature* 378, p. 379-380 (23 Nov 1995).

Such times are orders of magnitude too short for any evolution theories; so to artificially inflate the times a "coalescence" model was developed, which assumes the population was small, roughly constant, and together through all but recent history. This model enables stretching by perhaps one order of magnitude, but not by the two orders, or so, that anthropologists usually desire. Dorit concludes, in footnote 15, that the necessary effective population of 7500 males "is an exceedingly small population size for this entire 300,000 year period; it is far more likely that the coalescence model, which assumes worldwide uniform mixing and a constant effective population size, is not strictly applicable."

However, the statistics of sampling remains to be considered.

There is a certain probability of finding "m" mutations if the actual average is lower or higher. The probability functions are conveniently tabulated in Milton Abramowitz and Irene A. Segun, "Handbook of Mathematical Functions;" AMS-55; N.B.S. (1964). For non-zero values of the integer "m," a confidence, "C" (in percent) will correspond to "Q" values Q = 1 – C/200 (low m; m_-) and C/200 (high m; m_+); that is, if one mutation is found, then half the time (50% confidence) it will have originated from a true average in the range 0.9613 to 2.6926, as may be found in the table below. For "m" values not listed in this table, or for greater precision, use the AMS-55 Table 26.8, with $\nu = 2(m+1)$, and obtain $m_\pm$ from the tabulated values, $m_\pm = \chi^2/2$. (m_- corresponds to the values in the columns of Q > 0.5, and m_+ in the columns Q < 0.5.) For estimating ages, 95% confidence is conventionally reported, though other confidences could be chosen.

Table 1: Confidence that "m" arises from a value between m_- and m_+

Confidence =	99%	95%	50%		50%	95%	99%
Q =	0.995	0.975	0.75	[integer]	0.25	0.025	0.005
	m_-	m_-	m_-	**m**	m_+	m_+	m_+
	0	0	0	<**1** *	0.693*	2.9957*	4.60517*
	0.1035	0.24221	0.9613	**1**	2.6926	5.572	7.4301
	0.33786	0.61867	1.7273	**2**	3.9204	7.2247	9.2738
	0.67221	1.0899	2.5353	**3**	5.1094	8.767	10.98
	1.0779	1.6235	3.3686	**4**	6.274	10.242	12.594
	1.5369	2.2019	4.2192	**5**	7.423	11.668	14.15
	2.0373	2.8144	5.083	**6**	8.5585	13.06	15.66
	3.1324	4.1154	6.838	**8**	10.802	15.763	18.58
	4.3214	5.491	8.620	**10**	13.020	18.390	21.40
	6.2056	6.922	10.422	**12**	15.217	20.962	24.145
	6.893	8.395	12.239	**14**	17.400	23.490	26.84
	10.353	12.217	16.830	**18**	22.808	29.671	33.38
	$m - 2.5758\sqrt{m}$	$m - 1.960\sqrt{m}$	$m - 0.6745\sqrt{m}$	very large m	$m + 0.6745\sqrt{m}$	$m + 1.960\sqrt{m}$	$m + 2.5758\sqrt{m}$

* For m = 0, the minimum value is zero; so the confidence number pertains only to the m_+ values [i.e., Q = 0.5, 0.05, or 0.01; with $m_+ = -\ln(0.5), -\ln(0.05)$, or $-\ln(0.01)$]. E.g., for Equation 4, computations of the mean simply use "m" = <1, and the age is then correspondingly <"T."

Then, for Dorit's data, using his μ value, and "m" values of m_-, m, and m_+ for 95% confidence,

$$T_Y = \frac{0 \; to < 1 \; to < 2.9957}{2\times 1.35\times 10^{-9}\, 729\,(38-1)} = 0 \text{ to } <\mathbf{13{,}731} \text{ years to } <41{,}134 \text{ years} \qquad (4b)$$

More recently, sequencing the Y-chromosome for microsatellites, accruing at about 0.21%/generation, is also leading to ages of order 10^4 years, rather than 10^5 or 10^6 years.

Most of the DNA studies suggest that the most recent common male ancestor is more recent than the most recent common female ancestor. That is consistent with Noah being more recent than Eve. (Note that Noah's three sons are all descended from Noah, but the three daughters-in-law would not be descended from Noah's wife, but from Eve, nine generations earlier.) [Noah's age, about 4500-5000 years ago, would suggest $\mu \approx 3\times 10^{-9}$ mutation/year, not far from the range of values above.]

Cann's mtDNA dating of the common female ancestor is nearly 200,000 years ago, based on an assumed populating of Australia 40,000 years ago, of New Zealand 30,000 years ago, etc. (divergence ≤0.57%). If Australia were actually populated 4,000 years ago, then the age would come down to 20,000 years ago. Statistics could allow another factor of

1.5 or so. But from recently-measured mtDNA mutation rates (~2×10^{-6} mutation/base-pair–year), Gibbons observes of "'mitochondrial Eve', ... using the new clock, she would be a mere 6,000 years old."[9]

Rohde, Olson, and Chang attempt modelling population growths with varying degrees of migration. In the hypothetical example they give, the most recent common ancestor (MRCA) would be about BC2300 – around three centuries after Noah's sons were born – and the other-gender most recent common ancestor around BC5000 – roughly a millennium before Eve. "Our results suggest that the most recent common ancestor for the world's current population lived in the relatively recent past – perhaps within the last few thousand years. And a few thousand years before that... the ancestors of everyone on the earth today were exactly the same."[10]

Thus currently, DNA dating sides more with Genesis than with any known theory of evolution.

[9] Ann Gibbons, "Calibrating the Mitochondrial Clock;" *Science* 279, p. 28-29 (2 January 1998). [Gibbons claims no one thinks Eve could be that recent.]

[10] Douglas L.T. Rohde, Steve Olson, and Joseph Chang, "Modelling recent common ancestry of all living humans;" *Nature* **431**, 2004 September 30. p. 562-565.